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- 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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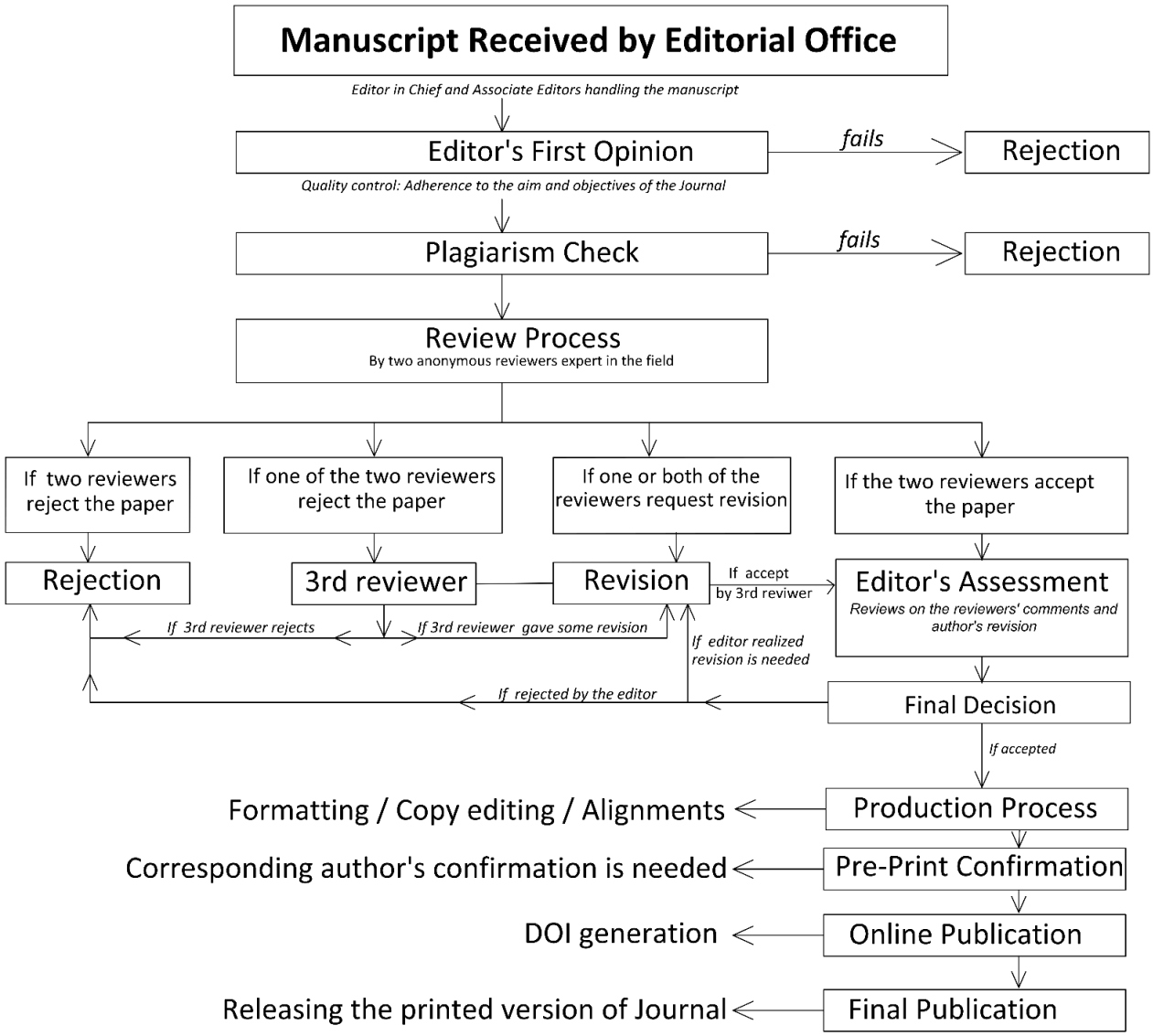
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3. The tone of both the comment and the reply is appropriate for a scientific journal.

A comment will first be sent to the academic editors for an initial check. If it can proceed, it will be sent to the author of the original paper, who will be given the opportunity to write a reply. Normally, the editor will provide a deadline for receipt of the reply in order to assure prompt publication of the discussion. If a reply is submitted in a timely way, the editor will have both the comment and reply reviewed. If the original author chooses not to submit a reply, the editor may elect to proceed without a reply.

In most cases, editors will invite previous reviewers to review both the Comment and Reply (if available). After receiving review reports, editors will send the Reply and review reports to the author of the Comment. The author will be given only one chance to revise the Comment. The revised Comment and review reports will be sent to the authors of the Reply. The authors will also be given only one chance to revise the Reply. Finally, editors will send the revised Comment/Reply to the academic editor for a final decision.

Investigations

Suspected breaches of our publication's ethics policies, either before or after publication, as well as concerns about research ethics, should be reported to our Research Integrity team. Claimants will be kept anonymous if requested, although claimants may also wish to use an anonymous email service such as ProtonMail or TorGuard. The Journal of Contemporary Urban Affairs may ask the authors to provide the underlying data and images, consult editors, and contact institutions or employers to ask for an investigation or to raise concerns.

Sanctions

If the Journal of Contemporary Urban Affairs becomes aware of breaches of our publication's ethics policies, whether or not the breach occurred in the Journal, the following sanctions may be applied across the Journal of Contemporary Urban Affairs:

- Rejection of the manuscript and any other manuscripts submitted by the author(s).
- Not permitting further submissions for 1–3 years.
- A prohibition from acting as an editor or reviewer.

The Journal of Contemporary Urban Affairs may apply additional sanctions for severe ethical violations.

Data fabrication and falsification

Submitted papers found to include false or fabricated data prior to publication will be returned to the author immediately, with a request for an explanation. If no explanation is received or if the explanation

provided is considered unsatisfactory, the journal will notify the author's institution, local ethics committee, or his/her superior. The journal may also refuse to accept further submissions from the author for a defined period. Examples of data falsification or fabrication include image manipulation; cropping of gels/images to change context; omission of selected data; or fabricating data sets. Some journals employ image manipulation software to detect evidence of falsification in submitted manuscripts. The Journal of Contemporary Urban Affairs recognises that falsification is not always deliberate and will encourage its journals and publishing partners to consider each case on its own merits.

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Multiple submissions: It is unethical to submit the same manuscript to more than one journal at the same time. Doing this wastes the time of editors and peer reviewers, and can damage the reputation of the authors and the journals if published in more than one journal, as the later publication will have to be retracted.

Redundant publications (or 'salami' publications): This is the publishing of many very similar manuscripts based on the same experiment. Combining your results into one very robust paper is more likely to be of interest to a selective journal. Editors are likely to reject a weak paper that they suspect is a result of salami slicing. The Journal of Contemporary Urban Affairs evaluates submissions on the understanding that they have not been previously published in, or simultaneously submitted to, another journal. We also encourage editors and journal administrators to keep a clear record of all communications between authors, editors, and peer reviewers regarding the submissions they handle. These records are carefully stored and may be used to facilitate investigations into possible cases of misconduct. Where necessary we will contact and/or co-operate with other publishers and journals to identify cases of redundant publication.

The Journal of Contemporary Urban Affairs considers only original content, i.e. articles that have not been previously published, including in a language other than English. Articles based on content previously made public only on a preprint server, institutional repository, or in a thesis, will be considered.

Manuscripts submitted to the Journal of Contemporary Urban Affairs must not be submitted elsewhere whilst under consideration and must be withdrawn before being submitted elsewhere. Authors whose articles are found to have been simultaneously submitted elsewhere may incur sanctions.

If authors have used their own previously published work, or work that is currently under review, as the basis for a submitted manuscript, they must cite the previous articles and indicate how their submitted manuscript differs from their previous work. Reuse of the author's own words outside the Methods should be attributed or quoted in the text. Reuse of the author's own figures or substantial amounts of wording may require permission from the copyright holder. The authors are responsible for obtaining this.

The Journal of Contemporary Urban Affairs will consider extended versions of articles published at conferences provided this is declared in, a covering letter, the previous version is clearly cited and discussed, there is significant new content, and any necessary permissions are obtained. Redundant publication, the inappropriate division of study outcomes into more than one article (also known as salami slicing), may result in rejection or a request to merge submitted manuscripts, and the correction of published articles. Duplicate publication of the same, or a very similar article, may result in the retraction of the later article, and the authors may incur sanctions.

Citation manipulation: Authors whose submitted manuscripts are found to include citations, whose primary purpose is to increase the number of citations to a given author's work, or to articles published in a particular journal, may incur sanctions. Editors and reviewers must not ask authors to include references merely to increase citations to their own or an associate's work, to the journal, or to another journal with which they are associated.

Research Involving Human Subjects

When reporting on research that involves human subjects, human material, human tissues, or human data, authors must declare that the investigations were carried out following the rules of the Declaration of Helsinki of 1975 (**https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/**), revised

in 2013. According to point 23 of this declaration, approval from the local institutional review board (IRB) or other appropriate ethics committee must be obtained before undertaking the research to confirm the study meets national and international guidelines. As a minimum, a statement including the project identification code, date of approval, and name of the ethics committee or institutional review board must be stated in Section 'Institutional Review Board Statement' of the article.

For non-interventional studies (e.g., surveys, questionnaires, social media research), all participants must be fully informed if anonymity is assured, why the research is being conducted, how their data will be used and if there are any risks associated. As with all research involving humans, ethical approval from an appropriate ethics committee must be obtained prior to conducting the study. If ethical approval is not required, authors must either provide an exemption from the ethics committee or are encouraged to cite the local or national legislation that indicates ethics approval is not required for this type of study. Where a study has been granted the exemption, the name of the ethics committee which provided this should be stated in Section 'Institutional Review Board Statement' with a full explanation regarding why ethical approval was not required.

A written informed consent for publication must be obtained from participating patients. Data relating to individual participants must be described in detail, but private information identifying participants need not be included unless the identifiable materials are of relevance to the research (for example, photographs of participants' faces that show a particular symptom). Patients' initials or other personal identifiers must not appear in any images. For manuscripts that include any case details, personal information, and/or images of patients, authors must obtain signed informed consent for publication from patients (or their relatives/guardians) before submitting them to the *Journal Of contemporary Urban Affairs*. Patient details must be anonymized as far as possible, e.g., do not mention specific age, ethnicity, or occupation where they are not relevant to the conclusions. Editors reserve the right to reject any submission that does not meet these requirements.

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Ethical Guidelines for the Use of Animals in Research

The editors will require that the benefits potentially derived from any research causing harm to animals are significant in relation to any cost endured by animals and that procedures followed are unlikely to cause offence to the majority of readers. Authors should particularly ensure that their research complies with the commonly-accepted '3Rs':

- Replacement of animals by alternatives wherever possible.
- Reduction in the number of animals used.
- Refinement of experimental conditions and procedures to minimize the harm to animals.

Authors must include details on housing, husbandry and pain management in their manuscript. If national legislation requires it, studies involving vertebrates or higher invertebrates must only be carried out after obtaining approval from the appropriate ethics committee. As a minimum, the project identification code, date of approval and name of the ethics committee or institutional review board should be stated in Section 'Institutional Review Board Statement'. Research procedures must be carried out in accordance with national and institutional regulations. Statements on animal welfare should confirm that the study complied with all relevant legislation. Clinical studies involving animals and interventions outside of routine care require ethics committee oversight as per the American Veterinary Medical Association. If the study involved client-owned animals, informed client consent must be obtained and certified in the manuscript report of the research. Owners must be fully informed if there are any risks associated with the procedures and that the research will be published. If available, a high standard of veterinary care must be provided. The authors are responsible for the correctness of the statements provided in the manuscript.

If ethical approval is not required by national laws, authors must provide an exemption from the ethics committee, if one is available. Where a study has been granted an exemption, the name of the ethics committee that provided this should be stated in Section 'Institutional Review Board Statement' with a full explanation on why the ethical approval was not required.
If no animal ethics committee is available to review applications, authors should be aware that the ethics of their research will be evaluated by reviewers and editors. Authors should provide a statement justifying the work from an ethical perspective, using the same utilitarian framework that is used by ethics committees. Authors may be asked to provide this even if they have received ethical approval. Editors reserve the right to ask for the checklist and to reject submissions that do not adhere to these guidelines, to reject submissions based on ethical or animal welfare concerns or if the procedure described does not appear to be justified by the value of the work presented.

Sex and Gender in Research
We encourage our authors to follow the **'Sex and Gender Equity in Research – SAGER – guidelines'** and to include sex and gender considerations where relevant. Authors should use the terms sex (biological attribute) and gender (shaped by social and cultural circumstances) carefully in order to avoid confusing both terms. Article titles and/or abstracts should indicate clearly what sex(es) the study applies to. Authors should also describe in the background, whether sex and/or gender differences may be expected; report how sex and/or gender were accounted for in the design of the study; provide disaggregated data by sex and/or gender, where appropriate; and discuss respective results. If sex and/or gender analysis was not conducted, the rationale should be given in the Discussion.

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Relations with Readers
Readers should be clearly informed about how the research has been funded or other scholarly studies and whether the funders had any role in the research and its publication and, if so, what this was. The editor should make efforts to ensure that the articles published are aligned with the knowledge and skills of the readers.

Relations with Referees
The editor should match the knowledge and expertise of the referees with the manuscripts submitted to the Journal of Contemporary Urban Affairs to be reviewed ensuring that the manuscripts are adequately reviewed by qualified reviewers. The editor should require reviewers to disclose any potential competing

interests before accepting to review a submission. The editor should provide necessary information about the review process to the referees about what is expected of them. The editor must ensure that the review process is double-blind and never reveal the identities of the authors to the referees or vice versa. The editors encourage referees to evaluate manuscripts from an objective and scientific perspective. If necessary, editors may also request that the manuscript be reviewed in terms of English editing. The editor should develop a database of suitable referees and update it on the basis of referee performance and timing. The referee database; it should be attentive to scientists who evaluate the manuscripts objectively, perform the review process on time, evaluate the manuscript with constructive criticism and act in accordance with ethical policies.

Relations with Authors

The editor should provide clear publication guidelines and author guidelines of what is expected of them to the authors and continuously review the guidelines and templates. The editor should review the manuscript submitted in terms of guidelines of the journal, importance of the study, and originality, and if the decision to reject the manuscript is made editor should explain it to the authors in a clear and unbiased way. If the decision is made that the manuscript should be revised by the authors in terms of written language, punctuation, and/or rules in the guidelines (spacing, proper referencing, etc.) the authors should be notified and given time to do the corrections accordingly. The authors should be provided with necessary information about the process of their review (at which stage is the manuscript at etc.) complying with the rules of double-blind review. In the case of an editor change, the new editor should not change a decision taken by the previous editor unless it is an important situation.

Relations with Editorial Board Members

The editor should provide publication policies and guidelines to the editorial board members and explain what is expected of them. The editor should ensure that the editorial board members have the recently updated publication guidelines and policies. The editor should review the editorial board members and include members who can actively contribute to the journal's development. Editorial board members should be informed about their roles and responsibilities such as;

- Supporting the development of the journal
- Accepting to write reviews in their expertise when asked
- Reviewing publication guidelines and improving them consistently
- Taking responsibility in journal's operation

Overall, If the academic editor has ethical concerns about a manuscript sent for review or decision or receives information about a possible ethical breach after publication, they must contact the Editorial Office as soon as possible. Our Editorial Office will then conduct an investigation according to **COPE guidelines**.

To support academic editors, checks are made by Managing Editors and Assistant Editors. However, editors should still report any concerns on any aspect. Checks include

1. Ethics approval and permissions for research involving human subjects, animals or cell lines.
2. Plagiarism, duplicate publication, and that necessary permission from the copyright holder to include already-published figures or images.
3. An international clinical trial registers for pre-registering clinical trials or cites a reference to the registration in the Methods Section.
4. Author background and qualification.

When making a final acceptance decision on a manuscript, academic editors should consider the following:

1. Any facts that might be perceived as a possible conflict of interest of the author(s) must be disclosed in the paper before submission.
2. Authors must accurately present their research findings and include an objective discussion of the significance of their findings.
3. Data and methods used in the research need to be presented in sufficient detail in the paper so that other researchers can replicate the work.

Accountability

Editors attend four annual meetings through video conferences or virtual communications and advise on journal policy and scope, suggest ideas, new initiatives and programs if necessary to include in the journal. They may review submitted manuscripts, identify topics for special issues or attract new authors and submissions if necessary.

Duties of Advisory Board Members

1. The advisory board typically consists of a group of prominent scholars in the field of architecture and urbanism.
2. In the Journal of Contemporary Urban Affairs, the advisory board members are ambassadors for the journal.
3. Board members attend one or two annual meetings through video conferences or virtual communications and advise on journal policy and scope, suggest ideas, new initiatives and programs if necessary to include in the journal. They may review submitted manuscripts, identify topics for special issues or attract new authors and submissions if necessary.

Conflicts of Interest for the Journal's Editorial Team

For this policy, the editorial team of the Journal of Contemporary Urban Affairs includes the Editor in Chief, Associate Editors, Section Editors, Editorial Advisory Board and International Editorial Board members. All such members of the editorial team are referred to hereafter simply as "Editor". Editors who make final decisions about manuscripts should recuse themselves from editorial decisions if they have conflicts of interest or relationships that pose potential conflicts related to articles under consideration. One challenge for editors is to recognize the potential for conflicts of interest and to take appropriate action when biases are likely. A conflict of interest exists when professional judgment concerning a primary interest (such as patients' welfare or the validity of research) may be influenced by a secondary interest (such as financial gain). Perceptions of conflict of interest are as important as actual conflicts of interest.

Types of Conflicts of Interest for editors are:

Personal Conflicts: Editors should avoid making decisions on manuscripts submitted from their own institution, or by research collaborators, or co-authors, or competitors. To avoid the possibility of bias, editors should recuse themselves if they have published with, have collaborated with, or have been in a mentoring relationship with any author or contributor of the manuscript within the past three years.

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Non-financial Conflicts: Other nonfinancial conflicts of interest should also be avoided or disclosed. Editorial decisions should be based on an objective and impartial consideration of the facts, exclusive of personal or professional bias. All decisions by editors should be based solely on the paper's scientific merit, originality, and quality of writing as well as on the relevance to the journal's scope and mission, without regard to race, ethnic origin, sex, religion, or citizenship of the authors.

Submission by an Editor: A paper submitted by an editor or board member will be handled by one of the other associate editors who are not at the same institution as the submitting author. The chosen associate editor will select referees and make all decisions on the paper. The journal's review software, OJS (Open Journal System), does not allow a conflicted editor access to relevant information concerning their manuscript. In addition, a conflicted editor will be barred from participating in any discussion among the editors pertaining to such manuscripts.

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Submission by a family member of the editor(s) or by an author whose relationship with the editor(s) might create the perception of bias: This submission will receive desk rejection.
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- Publishers and editors always be willing to publish corrections, clarifications, retractions and apologies when needed.

Duties of Authors

Ethical Guidelines for Authors
Authors wishing to publish their papers in the Journal of Contemporary Urban Affairs must abide by the following:

- All and only those who qualify for authorship should be included as authors and their contributions given in the manuscript.
- Any facts that might be perceived as a possible conflict of interest of the author(s) must be disclosed in the paper prior to submission.
- Authors should accurately present their research findings and include an objective discussion of the significance of their findings.
- Data and methods used in the research need to be presented in sufficient detail in the paper so that other researchers can replicate the work. Raw data must be made publicly available unless there is a compelling reason otherwise (e.g., patient confidentiality).
- Errors and inaccuracies found after publication must be promptly communicated to the Editorial Office.
- For any content previously published (including quotations, figures or tables), any necessary permission to publish must be obtained from the copyright holder.
- Original research results must be novel and not previously published, including being previously published in another language.
- Simultaneous submission of manuscripts to more than one journal is not permitted.

This list is not exhaustive, and authors should be aware of local regulations and accepted norms within academic publishing.

Authorship and acknowledgements
All listed authors must have made a significant scientific contribution to the research in the manuscript, approved its claims, and agreed to be an author. It is important to list everyone who made a significant scientific contribution. Author contributions may be described at the end of the submission, optionally using roles defined by CRediT. Submitting authors must provide an ORCID and we encourage all authors to provide one. Changes in authorship must be declared to the journal and agreed to by all authors. Anyone who contributed to the research or manuscript preparation, but is not an author, should be acknowledged with their permission. Submissions by anyone other than one of the authors will not be considered.
Authors must declare all potential interests in a 'Conflicts of interest' section, which should explain why the interest may be a conflict. If there are none, the authors should state "The author(s) declare(s) that

there are no conflicts of interest regarding the publication of this paper." Submitting authors are responsible for coauthors declaring their interests.

Authors must declare current or recent funding (including article processing charges) and other payments, goods or services that might influence the work. All funding, whether a conflict or not, must be declared in the 'Funding Statement'.

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Declared conflicts of interest will be considered by the editor and reviewers and included in the published article.

Journal of Contemporary Urban Affairs follows the Committee on Publication Ethics (**COPE**) guidelines which state that in order to qualify for authorship of a manuscript, authors must satisfy the following:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Those who contributed to the work but do not qualify for authorship should be listed in the acknowledgements. Any change to the author list during the editorial process or after publication should be approved by all authors, including any who have been removed. We reserve the right to request evidence of authorship, and changes to authorship after acceptance.

Credit Author Statement

In mid-2012 the Wellcome Trust and Harvard University co-hosted a workshop to bring together members of the academic, publishing, and funder communities interested in exploring alternative contributorship and attribution models. Following the workshop (see workshop report), and working initially with a group of mainly biomedical journal editors (and members of the ICMJE a pilot project was established to develop a controlled vocabulary of contributor roles (taxonomy) that could be used to describe the typical range of 'contributions' to scholarly published output for biomedical and science more broadly. The aim was to develop a taxonomy that was both practical and easy to understand while minimizing the potential for misuse. CRediT offers authors the opportunity to share an accurate and detailed description of their diverse contributions to the published work. CRediT (Contributor Roles Taxonomy) is high-level taxonomy, including 14 roles, that can be used to represent the roles typically played by contributors to scientific scholarly output. The roles describe each contributor's specific contribution to the scholarly output.

Role	**Definition**
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims.
Data curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later re-use.
Formal analysis	Application of statistical, mathematical, computational, or other formal techniques to analyse or synthesize study data.
Funding acquisition	Acquisition of the financial support for the project leading to this publication.
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection.
Methodology	Development or design of methodology; creation of models.
Project administration	Management and coordination responsibility for the research activity planning and execution.

Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools.
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components.
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.
Validation	Verification, whether as a part of the activity or separate, of the overall replication/reproducibility of results/experiments and other research outputs.
Visualization	Preparation, creation and/or presentation of the published work, specifically visualization/data presentation.
Writing – original draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation).
Writing – review & editing	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre-or post-publication stages.

Recommendations for applying the CRediT taxonomy are:

1. **Multiple roles possible** - Individual contributors can be assigned multiple roles, and a given role can be assigned to multiple contributors;
2. **Degree of contribution optional** - Where multiple individuals serve in the same role, the degree of contribution can optionally be specified as '**lead**', '**equal**', or '**supporting**';
3. **Shared responsibility** - Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles.
4. **Not all categories are relevant to each type of research**. Only select those contribution roles that are applicable to your study.
5. The corresponding author is responsible for ensuring that the descriptions are accurate and agreed by all authors.
6. The role(s) of all authors should be listed, as they appeared in the article.

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used:

CRediT author statement:
Conceptualization: J.F., S.M., R.B, M.W. **Data curation:** S.M., J.F., J.S., J.P.B. **Formal analysis:** M.W., J.F., S.M., R.B. **Funding acquisition:** J.F., S.M., R.B. **Investigation:** S.M., J.S., J.P.B., J.F. **Methodology:** J.F., S.M., R.B., M.W. **Project administration:** S.M., J.F. **Writing—original draft:** S.M., J.F. **Writing—review and editing:** J.F., S.M., R.B., J.S., M.W., J.P.B. All authors have read and agreed to the published version of the manuscript.

Note: The corresponding author should act as a point of contact between the editor and the other authors, keep co-authors informed, and involve them in major decisions about the publication. Joint first authors can be indicated by the inclusion of the statement "X and X contributed equally to this paper" in the manuscript. The roles of the equal authors should also be adequately disclosed in the contributorship statement.

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

Read more about CRediT **here**

English Editing and Proofreading

Please write your text in good English (American or British usage is accepted, but not a mixture of these). Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the available English Language Editing centres. During or after the review process of manuscripts if one of the editorial board members of the Journal Of Contemporary Urban Affairs realized that the article needs "English Editing and Proofreading", it is the authors' responsibility to ask a native English speaker or any other organizations to provide proofreader version of the article.

Note: Editing should be done using Microsoft Word. Ask your "proofreader" to turn on "Track change" during the process of proofreading. So, the authors will submit the final edited version of the word file and another word file including the track change.

Note: Before the publication of the article all the articles need to go through the proofreading process.

Note: The following are English language guidelines for submissions to the Journal Of Contemporary Urban Affairs:

- A sentence should not start with But or And (use however or find alternatives).
- Define abbreviations the first time they are mentioned in the abstract, text; also, the first time they are mentioned in a table or figure.
- Please capitalize all words in headings including hyphenated words (e.g., Anti-Antagonist), except conjunctions (*and*, *or*, *but*, *nor*, *yet*, *so*, *for*), articles (*a*, *an*, *the*), and all prepositions (including those of five letters or more) (*in*, *to*, *of*, *at*, *by*, *up*, *for*, *off*, *on*, *against*, *between*, *among*, *under*). The first and last words in the title are always capitalized.
- The 'th' in 19th or 20th should NOT be written in superscript.
- There is no space after > or < unless it is between two figures, i.e., 8 < 9.
- Write 1980s rather than with an apostrophe (1980's) or just 80s.
- Write don't, can't... in full, i.e., do not, cannot.

Reporting standards

Authors of reports of original research should present an accurate account of the work performed as well as an objective discussion of its significance. Underlying data should be represented accurately in the paper. A paper should contain sufficient detail and references to permit others to replicate the work. Fraudulent or knowingly inaccurate statements constitute unethical behaviour and are unacceptable.

Data Access and Retention

Authors are asked to provide the raw data in connection with a paper for editorial review, and should be prepared to provide public access to such data (consistent with the ALPSP-STM Statement on Data and Databases), if practicable, and should, in any event, be prepared to retain such data for a reasonable time after publication.

Multiple, Redundant or Concurrent Publication

An author should not, in general, publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behaviour and is unacceptable.

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The *Journal of Contemporary Urban Affairs* is dedicated to filling the recent gap in the field of urban studies (both in the theory and practice), by examining the emerging social and economic challenges. The journal promotes original academic contributions that are cross-disciplinary to strengthen research under three main areas: *Citizenship Rights and Responsibilities*, *Territorial dynamics*, *and Urban Transformations.*

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-discuss emerging challenges and problems facing global cities within other science fields.

-develop theoretical and methodological foundations in respect of the social and economic problems of contemporary urbanizations.

-bring a scientific view to the emerging social and economic challenges.

-Provide sufficient comparisons of different challenges and solutions facing cities and societies as referred to in the aforementioned main aim of the journal.

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Peri-Urban Pressures: The Interplay of Land Strategies and Urbanization in Algeria's Oran Metropolis

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ABSTRACT

In contemporary times, the worldwide trend of urban expansion has become an inexorable force. This article engages in a comprehensive examination of the intricate dynamics surrounding urban sprawl and land utilization within the peri-urban regions of significant Algerian municipalities, with a specific focus on the city of Oran. Employing a methodology rooted in social geography, this study deploys a trio of investigative approaches: documentary analysis, spatio-temporal scrutiny of peri-urban domains, and in-situ field investigations to shed light on the intricate intricacies of land ownership dynamics in the context of urban sprawl. The swift development of the Oran metropolis, along with its manifold ramifications, underscores a profound disconnection between the aspirations of political stakeholders and the unfolding urban milieu. This article accentuates the pivotal role of land as a coveted resource profoundly influencing the contours of emerging urban regions. In response to these emerging challenges, Algeria must adopt integrated land and urban planning strategies that foster harmonious and sustainable urban development. This necessitates a comprehensive vision for metropolitan regions, a departure from sectoral planning that subordinates agriculture to industrial and urban considerations, and the formulation of efficient and coordinated urban planning instruments. Within this intricate nexus of urban and rural development, the urban sprawl's encroachment upon rural landscapes mandates a strategic approach to attain equilibrium and coherence within the urban fabric.

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Highlights	Contribution to the field statement
-This study will make the understanding of urban transformations in Algeria through the land question -The state must abandon the sectoral vision that always positions agriculture behind the city and the industry - It is important to integrate the land issue into the definition and strategic development of urban projects - There is an urgent need to move away from emergency urban planning to a more considered form of this latter as part of a genuine territorial project	This study is relevant and original in the sense that it allows us to understand, through an approach of social geography, urban transformations in Algeria according to the land question and at the scale of the plot. it is a research method rarely used in the Algerian context because, it reveals concretely, the stakes and the social, economic and spatial consequences of the change of use of periurban land in favour of urbanization.

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1. Introduction

The shifting demographic balance toward urban areas is an established phenomenon, with forecasts predicting that by the midpoint of the 21st century, 70% of humanity will reside in cities (Damon, 2011). This projection, highlighted by the United Nations and echoed in scholarly discourse, underscores the significance of urban dynamics. The physical growth of urban areas is expressed through the extensive footprint of their built environments (Monnet, 1997). Urban expansion often spreads out uniformly, resulting in a pervasive spread known as urban sprawl (Antoni & Youssoufi, 2007, p. 2). The body of research on urban sprawl is extensive and diverse, noted with a hint of irony by some scholars (Hasse & Lathrop, 2003, p. 160). Urban sprawl is often characterized by a particular type of urban growth featuring low-density and dispersed development with significant environmental and societal impacts (Hasse & Lathrop, 2003, p. 160). While some research has highlighted the detrimental consequences of urban sprawl (Kahn, 2000; Freeman, 2001), others have pointed to its potential advantages (Damon, 2011).

The phenomenon of urban sprawl is an integral aspect of urbanization, influenced by factors including population increase, industrial advancement, and the decline of rural areas over the last hundred years. Cities evolve in disparate ways and at varying speeds. For instance, urban centres in the Global South are experiencing rapid expansion and economic investment, while European and North American cities often exhibit sprawling decentralization alongside slowing population growth. Eastern Europe has seen a reverse trend, with cities experiencing a decline (Denis, 2009, p. 33).

In contemporary discourse, the narrative surrounding urban transformation and change is gaining renewed interest, especially concerning urban production and its systems (Arab & Dang Vu, 2019). The definitions of the city are evolving in terms of scale and function, with the emergence of new mega-urban areas that integrate their surroundings and redefine the relationships between city centres and their outskirts (Zeybekoğlu Sadri, 2020).

Amidst these transformations, the issue of housing in sprawling urban landscapes gained prominence. However, other emerging urban concerns are also shaping the development of new urban spaces. These include transitions in energy, environmental stewardship, ecology, digital advancements, demographic shifts like migration and ageing populations, and the interplay between health and urban living (Arab & Dang Vu, 2019). Given these changes, it is crucial to revisit and refine the visions and methodologies for addressing urban development. In this context, the eighth issue of the International Journal of Urban Planning (2019) insightfully addresses the role of actor-system approaches in analyzing urban production shifts.

The contemplation of city production methodologies is crucial, highlighting "the approach to urban production issues," "the urban phenomena posed," and "the production framework itself" (Arab & Dang Vu, 2019). While we align with this perspective, we also adopt a specific viewpoint that emphasizes urban space production modes as essential for analyzing and forecasting urban phenomena. Our research is centred on examining and understanding the actions of the entities responsible for city planning and construction in Algeria, focusing particularly on land in the suburban zones of Algeria's primary cities. It's imperative to pinpoint who these actors are, comprehend their operational framework, and identify the instruments they employ in their undertakings.

Our investigative lens is particularly trained on land as a key catalyst for urban sprawl, which serves as both the foundation and a point of contention among different stakeholders and land users. Land represents a strategic initiative, meticulously conceived by the stakeholders in urban development, and is subject to various limitations such as physical attributes, availability, soil contamination, and access restrictions.

In the context of escalating demand for buildable land, crucial for executing regional planning and development initiatives, especially in suburban localities, land remains a central urban and territorial issue. The quest for its efficient management and governance echoes through political rhetoric, drives land reform agendas, and remains a priority for environmental conservationists and advocates of non-renewable resource preservation. Given that land is a pivotal factor in urban sprawl, the interplay of

land, urban, and planning policies sits at the crux of urban discourse (Nemouchi, 2008, p. 88), and land is seen as a finite commodity.

The availability and mobilization of land for territorial projects—ranging from housing developments to economic zones, communication networks, and agricultural ventures—often present challenges. Thus, addressing land issues at the onset of urban expansion projects and during their development is vital. This approach ensures that the tools and methods used for interventions by stakeholders are meaningful and strategic.

Our analysis is shaped around two principal questions to elucidate the connection between land matters and urban development strategies:

1. How does the accessibility of land influence the trajectory of urban dynamics?
2. What do land appropriation and reallocation strategies reveal about the types of cities being developed?

In our study, land, especially in peri-urban zones, emerges as a rich subject of inquiry. It's in these intermediary spaces, at the crossroads of rural and urban domains, where the push for urbanization brings actor interactions to the forefront, unfolding in localized deeds such as acquisitions, sales, exchanges, and donations. Here, the swift pace of urbanization ignites particular strains around, notably agricultural, land.

In Algeria, the dynamic urban landscape and the utilization of farmland involve a myriad of stakeholders ranging from the government, and decentralized state services (such as the Directorates of Agriculture, Cadastre, Domain, and Urbanism), to local elected bodies, farmers, development advocates (both public and private), recipients of housing programs, and civic groups. Each party formulates strategies around the land to further their specific interests.

This article aims to deconstruct the conversion of agricultural land into urbanized zones in the suburban stretches of Algerian municipalities. Focusing on Oran, which ranks as Algeria's second-largest city following Algiers, we intend to shed light on the methods of agricultural land repurposing for urban use. The significance of this investigation lies in three areas: enhancing comprehension of urban transformation in Algeria as it relates to land issues, delineating the challenges and socio-economic impacts of what can be seen as hasty urbanization, and offering an academic perspective on the pressing concerns of regional planning within the nation.

The decision to examine the situation in Algeria was primarily due to the ready availability of data, as my proximity to the study area facilitates access, and the recognition that "urban land management in Algeria is a complicated arena, influenced by an array of regulations and a diversity of players" (Sahraoui & Bada, 2021). Algerian urban centres are currently experiencing ongoing changes, a direct result of the development strategies post-independence. Industrialization has been a catalyst for regional growth and migrations from rural to coastal cities, resulting in a geographical imbalance which prompted the government to intervene through centralized planning. This approach inadvertently expanded the regional disparities by favouring smaller and mid-sized towns with new infrastructures. In 1974, the government introduced urban planning tools and rolled out land use and housing policies.

Urban policy and its expansion issues have historically been disconnected from broader spatial planning, often being reduced to political agendas within housing and adjustment programs. On the periphery of this government-centric urban framework, the issue of land, particularly agricultural land—predominantly state-owned—has been tangled in various reforms and restructuring efforts aimed at two primary goals: maximizing the agricultural use of land to bolster food security, and shielding this land from being overrun by urban development.

However, the ground realities diverge. Yearly, notable portions of Algeria's prime farmland are converted for urban and economic ventures. The available agricultural land per person decreased from 0.63 hectares in 1967 to just 0.22 hectares in 2008 and further to 0.19 hectares in 2018, a trend that poses a risk to the nation's agricultural capacity and food self-sufficiency. As reported by the Algerian National Office of Statistics (ONS, 2008), the population stood at 42.4 million at the start of 2018, with projections reaching 51.2 million by 2050 (Kateb, 2010). The distribution of this burgeoning

populace is starkly uneven, with the 12 southern wilayas, which make up 89% of the national territory, accommodating only 13% of the population. Contrastingly, the 36 northern wilayas, constituting a mere 11% of the land area, are home to 87% of the population (Omar BESSAOUD, 2019).

Minimizing the conversion of fertile land for urban purposes is a critical objective for Algeria's land use policy, yet every day realities often contradict this aim. It is imperative to note that with a high birth rate, Algeria is considered a youthful nation. The urbanization rate has increased from 31.4% in 1966 (ONS, 1966) to 70.7% in 2015 (United Nations, 2015), with both urban and rural developments heavily relying on land as a fundamental resource.

Following the introduction of our study area and research method, we will initially offer a detailed account of the significant events that have shaped Oran's socio-spatial structure. A historical analysis of the expansion of urban areas in the city's outskirts will provide a retrospective look at Oran's urban growth, allowing us to explore the spatial dynamics of how agricultural lands are conscripted for urban purposes. Subsequently, our investigation will delineate the strategies devised by the government to integrate these agricultural lands into Oran's urban framework, based on empirical data. Our study aims to delve into how land use is factored into the creation of planning documentation and the emergence of new urban functions.

2. Study area and methodology

Oran is a city located in the southwestern part of the Mediterranean basin, more precisely 450 km from the capital Algiers (Figure 1). It is half an hour's flight from the Spanish port of Alicante and one hour from Barcelona and Marseille. Oran remains the metropolis of the whole western region of Algeria, surrounded by medium-sized cities: Tlemcen at 140 km, SidiBel-Abbes at 80 km, Mascara at 100 km, Mostaganem at 90 km and Relizane at 130 km. The influence of the city of Oran extends as far as Béchar and Adrar in the south of Algeria. Since 1972, the spatial expansion of this second-largest city in Algeria has resulted in the artificialisation of an average of 110 ha per year (Trache, 2010).

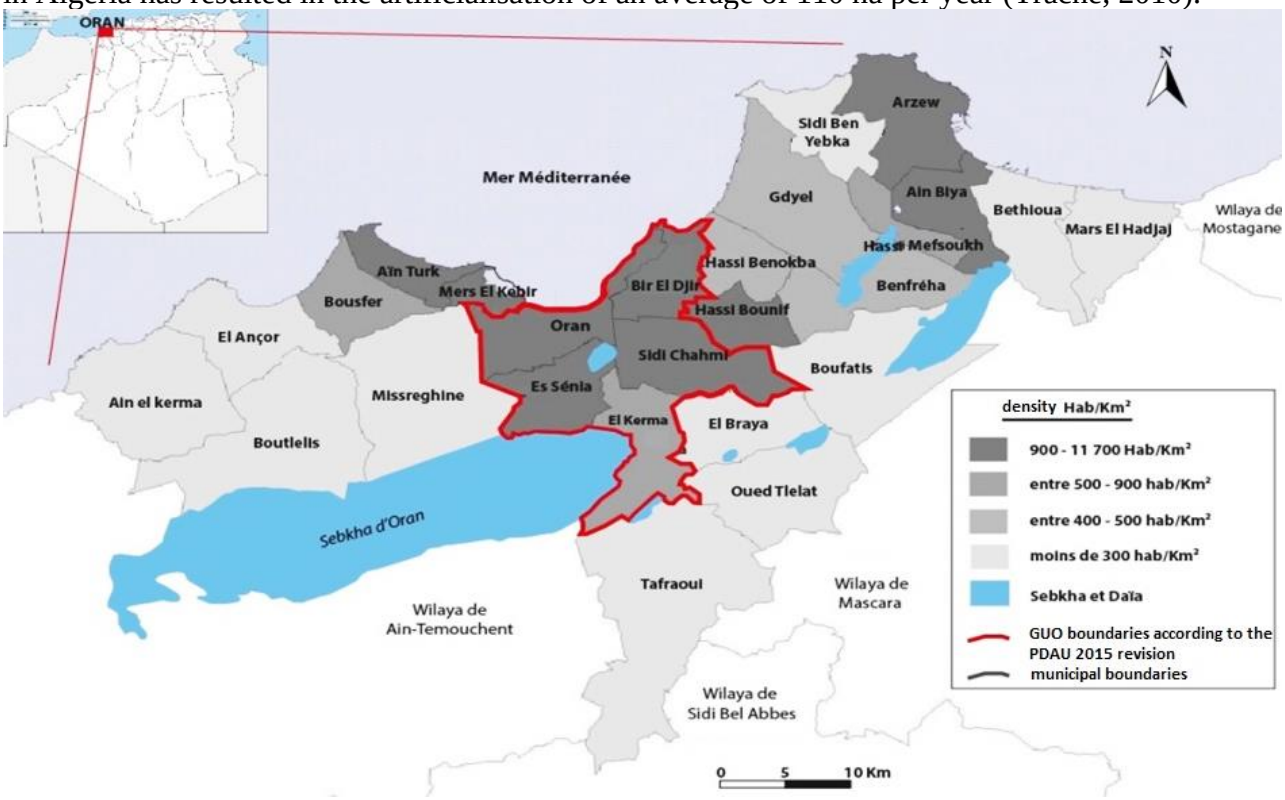


Figure 1. Location and administrative structure of the Urban Grouping of Oran.
Source: (Nemouchi & Zeghiche, 2021)

In this article, the analysis of land stakes for the extension of the Oranese agglomeration is based on a social geography approach. Like the other human and social sciences, this discipline mobilises a

variety of survey and data processing techniques (photography, archives, cartographic documents, academic works, recorded interviews, press articles, statistics, etc.) which provide both qualitative and quantitative information (Blanchard, Estebanez, & Ripoll, 2021).

For our research, we envisaged a combination of three analysis tools:

- The first tool is based on the exploration of works carried out on Oran in different supports (dissertations, doctoral theses, scientific articles, journalistic articles, reports of research offices, final reports of the different development plans, press clippings, etc.). Our documentary research was focused on themes that are inseparable from land tenure such as urban sprawl, peri-urbanisation, agriculture in rural areas, land tenure changes in independent Algeria, the town/country relationship, and peri-urban agriculture, among others. From these readings, it was clear that the land question remains an underlying factor of analysis. However, this has not prevented the scientific community from noting the shortcomings in land management, particularly in the peri-urban areas. All the studies draw up an assessment exacerbated by the failure of urban planning tools and the sectoral conception of planning and development of territories in Algeria.
- The second tool uses a spatio-temporal analysis of the agricultural and urban areas of the Oran metropolis. Mapping has enabled us to identify the evolution of urbanised land and land use in the peri-urban areas of Oran. This situation was drawn up based on graphic documents made, essentially, by design offices (within the framework of the realisation of the PDAU[1]and the POS[2]), university works (doctoral thesis, dissertation, etc.) and satellite images. To map the current urban sprawl in our study area, we used remote sensing data available in the USGS GOV (Earth Explorer) archives. To do this, we used the Land Sat 8 images (LDCM with a spatial resolution of 15 m). The images were selected in such a way that their quality, in terms of the time of year and the presence of clouds, was as good as possible for identifying and distinguishing urban development in the Oran region. We used the functions offered by QGIS 3.22 (SCP: Semi-Automatic Classification Plugin) to recalibrate and improve the resolution of the images. A supervised 'maximum likelihood' classification of the coloured composition (4-3-2) was carried out to identify the land cover classes representing the built environment.
- The third and final tool was the field survey in the Urban Grouping of Oran (GUO), which was made up of 4 communes: Oran, Bir el-Djir, SidiChahmi and Es-Sénia. For our article, we have chosen to conduct our investigations in the municipality of Bir El-Djir. This choice is justified by the land pressure experienced in this municipality due to its proximity to the city of Oran, as well as the speed this territory has been built since the 1990s. We conducted twenty semi-structured interviews with actors whose role was decisive, either in the process of producing urban soils or in the application of policies for the preservation of agricultural land. Our interviews were conducted with the assistance of key informants, working in public institutions concerned with urban planning and land governance. These include the state studies office specialising in urban and territory planning studies as well as, several administrative services of the wilaya of Oran such as the Directorate of Urban Planning and Construction (DUC), the Directorate of Agricultural Services (DSA), the Regional Directorate of the Cadastre and the department of agricultural land of the Directorate of Domains.

The key informants held particular positions in the administrations (head of department, director, design engineer, technician, etc.). Their skills and their ability to intervene directly in the

[1] Master Plan for Development and Urbanism
[2] Land Use Plan

conception and realisation of urban projects gave them the status of experts and key actors in the process of urban sprawl in Oran in general and Bir El-Djir in particular. The choice of these informants helped us to document and better understand the urban problems and land issues in our study area. By using open-ended questions, our interviews addressed several issues related to the city and land governance to understand the mechanism for integrating agricultural land into urban development areas during the urban planning process. In other words, how is the question of peri-urban agricultural land posed by practitioners during the creation of the various urban planning documents (POS and PDAU)? In this perspective, an analysis was undertaken at the plot or block level of the POS. At this level of scale, the land strategies (modes of appropriation, allocation/reallocation and exploitation of the land resource) have been identified and exposed with the help of photography.

3. Oran: urban expansion fuelled by peri-urban agricultural land

In Algeria, both on the coast and inland, urbanisation is gaining ground: the number of cities has increased fourfold in a century (Maachou, 2008). This invading urban phenomenon is gaining agricultural land almost without any resistance, creating, therefore, some pressure on the farms located on the outskirts of large and medium-sized towns.

In 1830, the city of Oran had only 4000 inhabitants. During the colonisation period, the city became the capital of the West thanks to the port activity and the economic development partly based on wine production and also, became a popular destination for the immigration of the population of the French metropolis. At the independence from Europeans, Oran inherited a large housing stock estimated at nearly 40,000 dwellings. “This makes it a privileged city in terms of housing” (Maachou, 2008). However, since its independence, the Oranese metropolis has been, like all large Algerian cities, the scene of numerous urban and agricultural policies which have had an impact on the evolution of its spatial dynamics.

3.1. Three stages of urban sprawl, three logics for urbanising agricultural land

Based on the breakdown of the map: “ The expansion of the Oranese conurbation” from the work of Bendjelid, Hadeid, Mssahel, &Trache (2004), the history of the expansion of the Oranese conurbation can be summarised in three important periods (Figure 2):

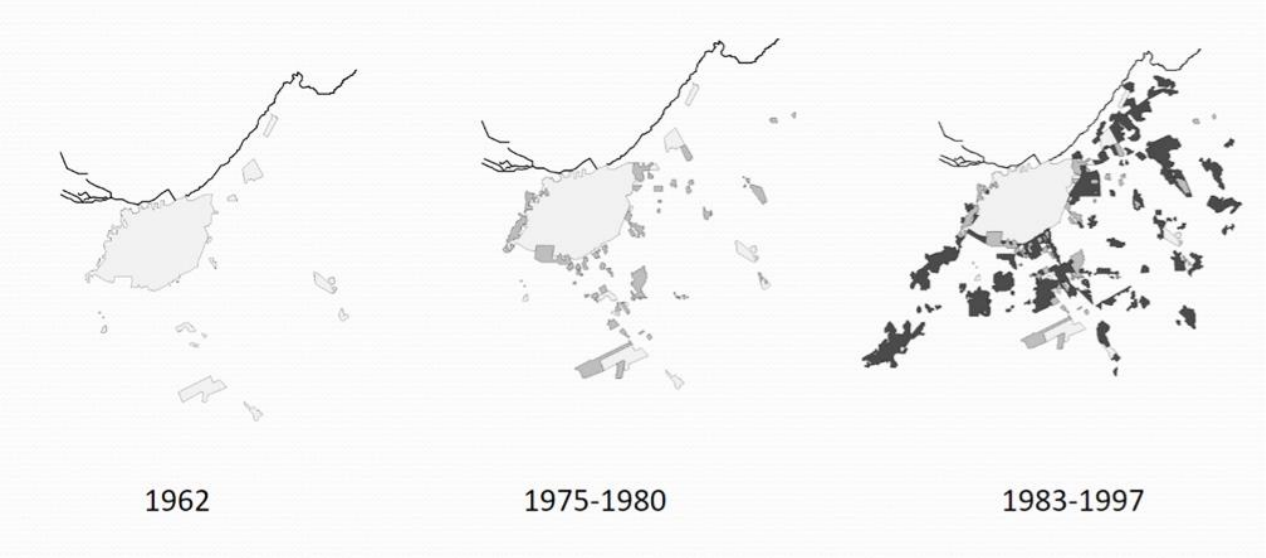


Figure 2. Expansion phases of the Oran conurbation.

- Between 1962 and 1975, the pace of housing construction slowed down thanks to the property vacuum created by the departure of Europeans after 1962. At that time, to quickly launch the country's economic machine, the young independent state opted for a policy of industrialisation of the large and medium-sized Algerian cities (Algiers, Oran, Constantine, Annaba, Skikda). In this context, Oran had to cope with this new territorial reconfiguration and thus became the host territory of several waves of migrants from smaller towns and neighbouring villages.
- Until the end of the 1970s, the urban development of Oran was limited to the third peripheral ring (the old Spanish and French centre and the suburbs of the colonial period) surrounded by orchards and agricultural lands. From 1975 until the end of the 1980s, the State had to cope with a strong demand for housing and therefore decided to launch some urbanisation projects. This planned peri-urbanisation began with the construction of ZHUNs (New Urban Housing Zone) validated by the PUD (Urban Master Plan), which various specialists in urban issues consider to be the origin of the main extensions to the outskirts of the current large Algerian cities. In the Oranese agglomeration, six (06) ZHUNs have been created on a total surface of 1 401 ha.

Table 1. Oran: the different ZHUNs built since 1975.

New Urban Housing Zone	Surface (ha)	Number of habitats
Seddikia	35	1240
Dar El-Baïda	150	1440
USTO	150	1000
Maraval	254	3350
Fellaoucen	700	1000
Khmisti	112	6000

Source: PDAU Oran (1997)

From the 1980s onwards, the State began to implement new individual housing programmes within the framework of housing cooperatives and housing estates. The Urban Master Plan (PUD) drawn up and approved in 1977, mapped out the broad outlines of Oran's urban development, choosing the eastern and north-eastern zones of the city to host the urban expansion. This choice

of land was contested by the agricultural services, which denounced an urban development to the detriment of agricultural land generally considered of good quality. This did not prevent the realisation of major housing and equipment projects, including the University of Science and Technology of Oran (USTO) on 89 ha, designed by the Japanese architect Kenzo Tang and inaugurated in September 1986. The location of the University generated a "considerable impetus to the processes of peri-urbanisation that have reconfigured the Oranese agglomeration in-depth" (Kadri & Madani, 2015). During this period "the urbanised area grew by 1254 ha, two-thirds of which were located in the peripheral areas" (Kadri & Madani, 2015). Following a logic of urgency and catching up, the State began some huge construction programmes that went beyond the PUD and its initial ambition (the spatial planning of urban development in the Oranese agglomeration).

- From the 1990s onwards, there was an acceleration of the urbanisation process in the Oranese agglomeration for two main reasons: the first is the so-called black decade. The security problems that Algeria experienced at that time led to a strong rural exodus which was the origin of an important spatial dynamic. The second reason resides in the creation of new urban planning instruments (PDAU, POS) which set up a new urbanisation process based on a zoning system. In this context, the mother city being saturated, the urbanisation of Oran was transferred to the east of the agglomeration to the peripheral municipalities (Figure 3), materialising in the nibbling of vast surfaces presenting the least constraints according to the availability of land and leading to its overflow (Benkada, 2001).

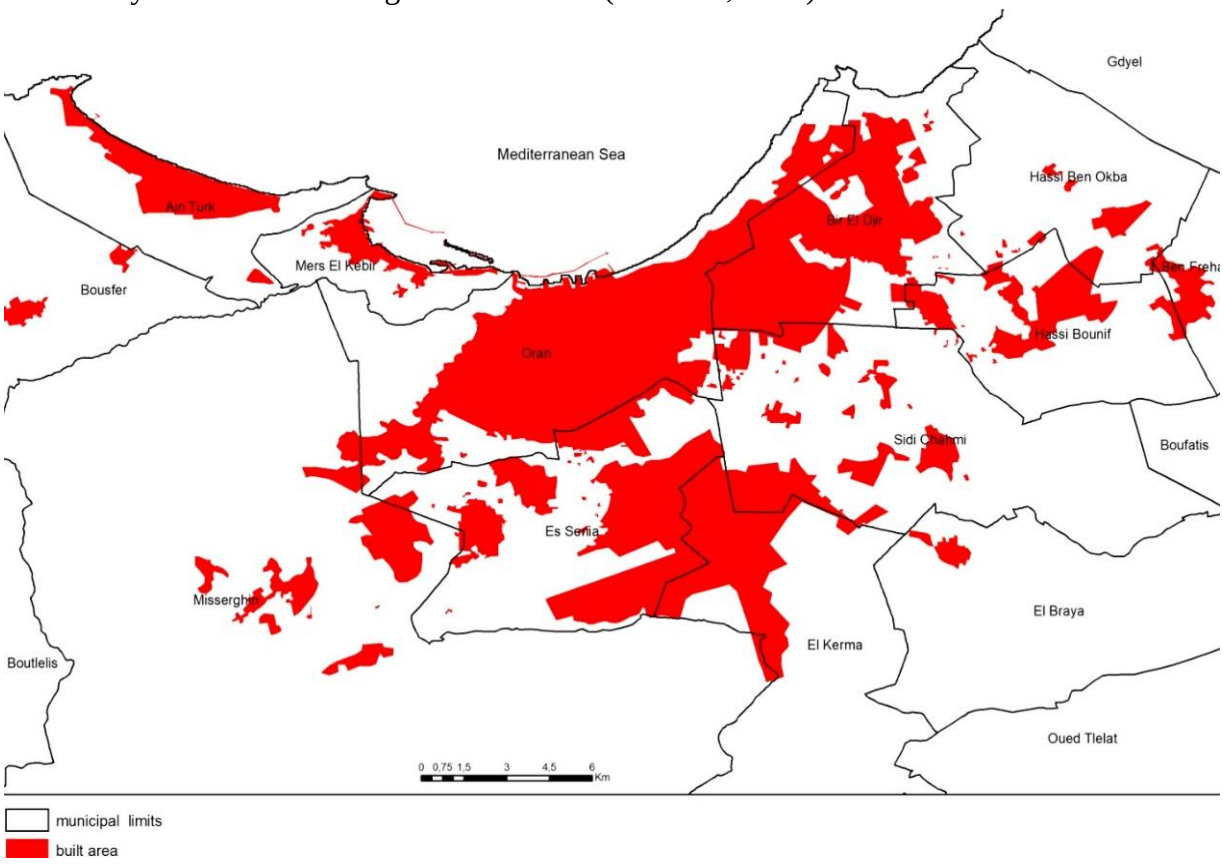


Figure 3. Distribution of the built area in the Oranes agglomeration (2021).

What was then the scope of these new urban planning instruments? And what was their role in the creation and management of new urbanised areas?

3.2.Urban planning instruments and spatial management of the Oranese agglomeration

At that time, in the 1990s, Algeria reviewed the previous dogmas of its land use policy and urban planning. Law n° 90-29 of 1 December 1990 on urban planning provided a new legal framework for spatial planning in terms of functional rules and land use standards. Two urban planning and development instruments were put in place, namely: the Master Plan for Urban Development and Planning (PDAU) at the level of urban areas and the Land Use Plan (POS), as a detailed instrument.

3.2.1. The Master Plan for Urban Development and Planning (PDAU)

The first function of the PDAU, drawn up in the 1990s, delimits the territory of the urban grouping of Oran (GUO) (Figure 1). The GUO comprises four municipalities (Oran, Bir el-Djir, SidiChahmi and EsSenia) and covers an area of 25,057 ha. The urbanised area of the GUO covers more than 8,800 ha or 35% of its total surface area. The remaining 65% of this area is divided between farmlands, forests and uncultivated lands (PDAU, 1997). The PDAU advocates spatial planning based on the zoning method: it divides the urbanisation areas into sectors. The sectors are continuous fractions of the communal territory and are each distinguished by one of the four vocations fixed by Law 90-29 (Article 19): the urbanised sector (SU), the sector to be urbanised (SAU), the future urbanisation sector (SUF) and the non-urbanisable sector (SNU). In the case of Oran, the guidelines of the 1997 PDAU (revised in 2005) project the surface area of the SAU and SUF combined at 1664 ha, located mainly in the eastern zone of the GUO.

3.2.2. Land use plan (POS)

The POS is a regulatory instrument that sets out building rights. According to Article 31 of Law 90-29, the POS sets out in detail the rights of land use and construction, but always within the framework of the provisions set out in the PDAU. This instrument is of two types: the first, 'development or extension', which aims to identify and regulate new urbanisable lands, favours virgin lands on the outskirts; the second, called 'restructuring POS', intervenes within the urban area. In the case of the PDAU of Oran, 66 POSs have emerged and are still in force today (Kadri & Madani, 2015). According to the various research works consulted (articles and doctoral thesis), the extent of the sprawl of the city of Oran has been such that the sectors to be urbanised (SAU) have been rapidly consumed and the sectors of future urbanisation (SUF) have already been urbanised.

In Oran, the spatial expansion of the built-up area has accelerated, as according to satellite image processing, the urbanised surface of the Oranese agglomeration was estimated at 6013 ha in 2008 and 7104 ha in 2017 (Missoumi, Hadeid, & Desponds, 2019). This increase in urbanised space is concentrated in the peripheral areas, previously known as agricultural par excellence. This former agricultural territory, which contains good and very good quality land (the plains of Bir El-Djir, Sidi Chahmi and Es Senia), was used as a basis for the expansion of the Oranese agglomeration. By being located between the city centre and the ring of agglomerations on its periphery, a large part of this agricultural land has become the object of covetousness despite the existence of a body of regulations intended to preserve the rural space and to control the urban evolution of Oran. What is then the process of transformation of agricultural land into urbanisable land within the framework of the urbanisation of Oran? What land strategies were used?

4. Diversion and reallocation of the use of urban sable land in the peripheral zone of Oran

Within the framework of this research, our interviews in Oran (2022-2023) with public actors responsible for urban planning and agricultural land management enabled us to trace and understand the process of allocation/reallocation of peri-urban agricultural land. Two main stages are worth noting:

4.1.The downgrading of state-owned agricultural land by urban planning instruments in favour of urbanisation

In 2011, following the creation of the National Office for Agricultural Land (ONTA) and under the social pressure on housing rights, Algeria promulgated regulations on the declassification of medium and low-yield agricultural land. The declassified plots were recovered and transformed into land for urbanisation.

In the Oranese agglomeration, the declassification of peri-urban agricultural land was carried out with the approval of the wilaya's agricultural services department (DSA). More than 600 hectares of agricultural land have been downgraded in this second Algerian metropolis, mainly in the municipality of Bethioua for the benefit of a large industrial zone where many industrial companies are located. But how can a piece of land of high agricultural value be downgraded to uncultivated land or land with little potential? Our question was left unanswered by a mute administration that avoided answering by stating that all the downgraded agricultural plots were justified without giving any details on the procedure in question.

> **"***The consultation of the DSA regarding the agricultural usefulness or otherwise of certain plots of land remains an administrative formality. When it comes to public and even private state land, the opinion of the DSA is not decisive ..... the land in question is the property of the state and it is free to do what it wants with it...all the strategies employed by the state are within a legal framework and the DSA can do nothing about it* " (agricultural engineer, DSA of Oran)

At the national level, this issue of declassification of agricultural land has generated much debate. In an interview granted to the national newspaper *Le Soird'Algérie*in December 2018, the central director of the Land Organization and Protection of Patrimony at the Ministry of Agriculture and Rural Development (Hamid Hamdani) said that across the country, the equivalent of 40,000 ha of agricultural land had been declassified. Today, the central government is forced to review its agricultural land management policy.

4.2.The reallocation of land use already planned at the level of the blocks of the Land Use Plan (POS)

When the PDAU sets up its zoning, essentially the urbanisation zones and the sectors for future urbanisation (SUF), the perimeter is divided into Land Use Plans (POS), and it is at this level of the allocation of the POS blocks that the various diversions and illicit practices on agricultural land that has become urbanisable take place. Several cases around the city of Oran constitute a concrete example of these land practices that are inconsistent with the development plans for the expansion of the metropolis. Our case studies are concentrated on the territory of the urban area of Bir El-Djir in the east of the Oranese agglomeration.

According to the PDAU of Oran, the municipality of Bir El-Djir was chosen to support, essentially, the eastern extension of the Urban Grouping of Oran (Figure 4). Its communal territory is divided into 18 land use plans (POS). Of the 18 POS, 4 are approved, 12 are being drawn up and 2 have not yet been drawn up. Whether on the ground or from satellite images, the observation is the same: the land of Bir El-Djir is almost totally consumed by urbanisation, despite the non-approval of certain POS or the non-completion of their studies.

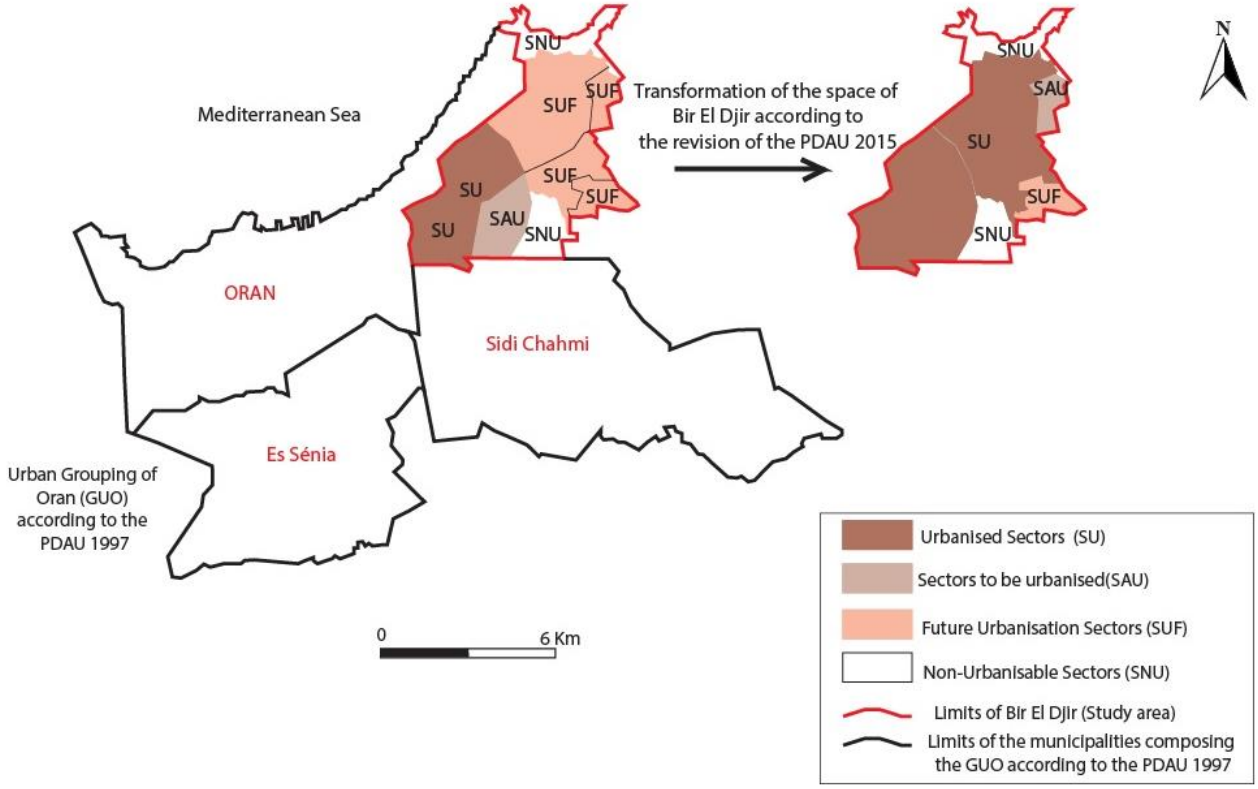


Figure 4. Evolution of urbanisation sectors in the municipality of Bir El-Djir (1997-2015).
Source: reconfigured by the author basis of (Nemouchi & Zeghiche, 2021).

According to our interviews with the technical and urban planning services at the Bir El Djir town hall, the territory of three POS (21, 25, 49) and the SUF (future urbanisation area) were entirely consumed before the POS was even drawn up. The urbanisation of these territories was without official planning or any thoughtful development (Figure 4). This situation confirms the inability of urban planning instruments to deal with land predators in general and peri-urban agricultural land in particular. This administrative dysfunction can be the source of all forms of misappropriation and trafficking in land, as construction programmes are sometimes injected and carried out in a hurry with a simple report from a land selection commission, either at the level of the Daïra (Daïra commission) or at the level of the wilaya (wilaya commission) (Zouani, 2016).

This emergency character in the management and allocation of peri-urban land use means that the State is often obliged to raise technical, financial or even urbanistic challenges. This can be illustrated by the case of the 5000 public rental housing units (LPL) in SUF2, where the OPGI (Public Office of Property Management) was surprised to learn, during the development of the land chosen for the housing estate, that the area is subject to flooding and the project might be abandoned. The solution was very costly for the State because it was necessary to build a 12 m deep gallery with a diameter of 3 m for the drainage network, which was not initially foreseen in the development plan.

The diversion of land in these POSs is also carried out by changing the use of the blocks that make up the POS. It is quite common to plan blocks for individual housing, but in practice, housing estates are built with collective housing, as is the case with the 800 housing estates in the POS.52 (Figure 5).



Figure 5.Collective housing instead of individual housing (plot in POS 52; municipality of Bir El Djir). *Source: Photos taken by the author, April 2023.*

This program is implemented in a space already inhabited and serviced with a predefined capacity. The flow rate of the sewerage system is calculated based on the former individual housing project but, today, the same sewerage system bears the burden of 800 dwellings. Thus when we change the early space occupation from the individual to the collective we can expect future damages. It is obvious that in this process of land misappropriation, the main actor is the real estate developer. The latter manages to acquire land bases belonging to the State at a low price to realize housing sold subsequently at exorbitant prices.

Through these examples of land misappropriation in the suburbs of Oran, we can see that the modes of management and allocation of land resources influence the form and functioning of the city produced. The arrangement of the collective and individual dwelling is anarchic thus creating aesthetically and functionally heterogeneous spaces (concentration of habitat in a reduced space with various heights) (Figure 6).



Figure 6. Heterogeneity of the spaces produced in the periphery of Oran (municipality of Bir El Djir). *Source: Photos taken by the author, April 2023.*

The extension of Oran is disproportionate. The newly built spaces are heterogeneous and result from planning made quickly and without reflections. Urban practitioners (design offices and the urban planning department) are losing control over urban planning, which "*is becoming a simple process of housing production and regularisation of illicit spaces*" (according to an interview with an official at the urban planning and construction department of the wilaya of Oran). In Oran, there is a proliferation of property developments that produce collective housing estates (Figure 7).



Figure 7. Various real estate developments are under construction in the municipality of Bir El Djir.
Source: Photos taken by the author, September 2023.

The urban density has increased in the peripheral zone, having a huge impact on urban management and the quality of life in the new spaces of the Oranese metropolis, such as the densification of the rate of land occupation, the congestion of schools, the delay in the realisation of the sewerage and road network, the lack of public transport in the new urban spaces and the problems of urban security among others.

5. Discussion

While developed countries are now looking for more sustainability in urban management and practices, in Algeria these issues are still a challenge (Berezowska-Azzag, 2012; Signoles, Cattedra, Legros, Iraki, & Barthel, 2014). The State remains focused on land ownership, trying to contain it despite its historical complexity. From independence to the present day, Algeria has published texts and instruments for managing land resources around large and medium-sized towns without, however, resolving its problem of dilapidation and waste.

Between 1992 and 2005, the National Land Use Planning Agency (A.N.A.T) issued a warning, "highlighting the increasing artificialisation of land, the spread of urbanisation and the endangerment of natural and agricultural areas" (Sahraoui & Bada, 2021). Within the framework of the present contribution, we note that the land strategies developed by the actors of the peri-urban territories largely affirm the insufficiency of the laws and the incapacity of the instruments of town planning to control the anarchic urban sprawl and the consumption mass of rare and non-renewable land. The case of the Oran agglomeration shows that this situation is mainly due to:

5.1.The absence of a solid agricultural project

In Oran, the second Algerian metropolis, the peri-urban space, formerly dominated by the vineyards of the colonial farms, offers today a landscape contrasted by the interweaving of several spaces whose functions differ between agriculture, housing and industry. This functional decomposition and recomposition of this peri-urban space is essentially due to mutations in the agricultural sector in post-independent Algeria. Indeed, agricultural land has often been the subject of political reforms and restructuring, reflecting political and economic visions and ideologies (from socialism to the liberation of markets) that are far removed from the aspirations and prerogatives of the rural world. This situation has created a distance between the farmers and the legal status of the farm (the state remains the owner

of the best agricultural land in the country) generating, thus, pseudo farmers "*state officials*"[3] lacking in initiatives and a determined agricultural project. Farmers' feeling of land insecurity and of not belonging to the land, pushes them to try other non-agricultural functions and sometimes to sublet the land that the State has rented to them. Agriculture then suffers from a lack of human investment and the agricultural land adjacent to the large agglomerations becomes a reservoir for urban demands such as the spread of buildings, the establishment of industrial zones and the development of communication networks (roads, railways, etc.). In the case of Oran, the Department of Agricultural Services (DSA) is primarily responsible for this failure to manage and preserve peri-urban agricultural land. The DSA shows an unprecedented fragility when it comes to validating the PDAU's choice of future land for urban development. In our opinion, this weakness of the DSA can only be explained by the absence of a real agricultural project specific to peri-urban areas, such as peri-urban agriculture. In Algeria, this type of agriculture is still in the stage of being researched by academics (Semmoud & Ladhem, 2015; Maachou & Otmane, 2016; Bousmaha & Boulkaibet, 2019). Peri-urban agriculture does not feature at all in the political proposals of elected representatives or in the wilayat's action plans. This type of agriculture is not even identified in the future projects of the various farmers still living in the peri-urban areas of major cities such as Oran. Also, the lack of agricultural production on the fertile land that makes up the peri-urban area (despite the recognition of the agricultural potential of this land) puts the DSA in a weak position compared to other actors such as real estate developers who build instead of the state, or the wilaya, which, under pressure from ministries and civil society, must respond to the housing and infrastructure needs of its territory.

5.2.The massive state ownership of agricultural land and its repercussions on the management of peri-urban areas

It has to be said that the "*state*" legal status of the agricultural land surrounding Algeria's major cities, particularly Oran, has made it easier to use this land for urban development. This state control of agricultural land dates back to the period of independence, when the rebirth of the Algerian national state was expressed through the recovery and management of colonial landholdings, which were characterised by the most fertile land in the country. Colonisation was based on land and decolonisation was also based on land (Nemouchi, 2009). This municipalization of land (1962-1990) resulted in a significant waste of peri-urban land resources, with chaotic forms of urbanization. Added to this is a "monopoly of land management by an administration overwhelmed by the phenomenon of urbanisation" (Saidouni, 2003, p. 141). In a bid to resolve this disastrous land management situation, the state decided to put an end to sole management of land and to open up the market after 1990. This new concept of decentralised, multi-actor land use planning has not solved the problem of land squandering. In the case of the Oran conurbation, this situation has given rise to new actors and new strategies for managing land resources. The most important of these actors are the private land and property development agencies. These agencies are becoming a key factor in the urban sprawl process, as they can acquire land from the state, develop it, build on it and market it. Private land acquisition remains low due to, for example, the absence of an official land market, the incompletion of the urban CADASTRE[4] in some places, the unknown origin of some properties, unresolved land disputes, and illegal occupations, among others. This is a reality that does not allow for the State's definitive and complete withdrawal from the land sector.

5.3.The ineffectiveness of the planning instruments used

This spatial organisation, which takes place around the large Algerian metropolises, remains the domain of territorial planning carried out by urban planning instruments. These instruments officially project a balanced vision of space, using a zoning system established and protected by law. However,

3 Whether at the time of the Socialist Agricultural Domains (DAS) in the early 1980s or after the land restructuring of 1990 (the creation of the EACs and EAIs), farmers were still considered to be simple operators or allottees working on State land.

4 The term "CADASTRE" is borrowed from the French. It is the descriptive and evaluative inventory of plots of land and built buildings.

the conditions and methods for mobilising the land that makes up this zoning, particularly the urban development zones, are not clearly defined, or even non-operational. These include the "*right of pre-emption*", which is difficult to apply in Algerian land legislation and, "*expropriation for public use*", which urban planning instruments do not even manage to take advantage of (Azzouzi & Harkat, 2019). There is a dissociation here between land policy and planning and urban development instruments. This creates a loophole for all forms of urban overruns and blockages. In the case of our study area, the urban planning instruments have not made it possible to ensure the control and management of space, given the initially anarchic (after the expiry of the 1977 PUD) and then poorly planned sprawl of the city (PDAU 1997). The PDAU and POS have become instruments geared towards the immediate regulation of the use of available land without having a global and coherent vision of urban development. They lack coordination and complementarity in their actions (Louafi, 2019).

In short, the rapid sprawl of the Oran metropolis and the multiple effects it produces confirm the extent of the gap between the discourse and ambitions of political actors and the reality of the city that is being built. The growing gap between the planned city and the reality produced on the ground is indicative of the limitations of urban planning instruments within a dynamic demographic, social and economic context (Boumaza, 2006).

It seems that the technostructure in charge of urban management is trying, with difficulty, to take up the challenges of an urban evolution which are not considered by decision-makers. The example of the Oranese agglomeration has once again confirmed the failure of the administration responsible for land governance. This situation of confusion has encouraged the proliferation of all kinds of illicit practices and unimaginable excesses, by both private and public actors, on peri-urban land.

6. Conclusion

Today, Algeria's population is growing rapidly and is concentrated in large and medium-sized towns. In most cases, there is a real and urgent need for housing and infrastructure. Land and real estate are therefore key issues, and various actors in the field are competing with each other.

Following this study, it is clear that land is the determining factor in the production of the city. It is the object of all kinds of covetousness and has a very strong influence on the configuration of new urban areas. In the case of the Oran conurbation, the uncoordinated intervention of state actors in the mobilisation of land resources for the benefit of the urban project has led to anarchic urban sprawl and functional inconsistencies in the spaces produced.

It is therefore vital for Algeria to take on board several practical recommendations that will prevent wastage of land and improve urban functionality and life, starting by adopting a broader and more global vision of metropolitan areas. As a central actor in executive power, the state must abandon the sectoral vision that always positions agriculture behind the city and industry. There is no point in releasing colossal financial envelopes to assist Algerian agriculture if land security is non-existent and the main production factor, land, is frequently cut back to meet the needs of the city and economic prospects outside agriculture. This easy access to peri-urban land resources opens the way to all forms of diversion and speculation around the land. Cities are spreading out in all directions, thus creating an irreversible territorial imbalance. For the State as a planner, it is important to integrate the land issue into the definition and strategic development of urban projects. By correlating land policies with urban policies, the various land-related actions can be controlled. Appropriation strategies will be anticipated and urban sprawl on agricultural land will be optimised. In Algeria, there is an urgent need to move away from emergency urban planning to a more considered form of urban planning as part of a genuine territorial project. This is the only way to control urban growth and produce coherent urban areas.

It is also necessary to put in place effective and operational urban planning instruments because, there is a lack of complementarity between the various planning instruments, which is reflected in a lack of coordination and control. Today, the PDAU and the POS are obsolete in the management of peri-urban space. They are seen as a means of legalising different modes of inappropriate reallocation of peri-urban land. Given that urban and rural development are both subject to the mobilisation of land

resources, the sprawl of the city onto the countryside cannot be resolved overnight. This comes back to the particularity of land, which remains a complex equation with multiple variables.

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The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

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Disaster Vulnerability Assessment of Low-Cost Houses in Java Island

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ABSTRACT

Among all of the Indonesian islands, Java poses the highest risk for all types of disasters, making it a significant threat to low-cost houses due to its high population vulnerability. The objective is to enhance comprehension of it by conducting a building typology analysis concerning various natural hazards/ risks. The methodology consists of 10 sample houses field observation, AutoCAD drawing, literature analysis, and built environment expert interviews. The results developed four categories of houses emphasising brick or timber walls with a combination of clay tile or zinc roofs. Related to disaster vulnerability, an improper building structure is the main problem. Smooth roof material is significant in a volcano eruption, a complete interconnection of structure is a must for the tornado, light materials are preferable in an earthquake zone, natural material is not recommended for high risk of forest fire, and elevating floor is mandatory in flooding. Focus on designing the four categories' houses and quality control of the construction process are two strategies recommended. Also, a minimum of two types of disasters in the area should be considered in the design. Resilient low-cost houses will have an impact on reducing casualties, environmental damage, and economic losses. Covering more samples and areas in Java in future studies will provide a comprehensive understanding of low-cost houses.

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Highlights:

- There are 4 types of low-cost houses on Java Island emphasized in the wall and roof materials;
- Focus on upgrading the design and quality of 4 types of low-cost houses is more efficient as it covers the majority of low-cost houses in Java Island;
- Emphasizes the construction phases are significantly needed, such as the quality of the builder's skills and monitoring intervention, especially for self-built houses;
- A minimum of two types of disasters in the area should be considered in the design due to the multiple types of disasters that could exist in every area;
- Every type of low-cost house has different vulnerability aspects towards different types of disasters.

Contribution to the field statement:

Before providing an instant design solution or any policy towards low-cost houses' vulnerability problems, this study argues that understanding their houses and risk will arguably provide a better picture and insight into a sustainable mitigation solution. Therefore, it will have an impact on reducing casualties, environmental damage, and economic losses.

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1. Introduction

Indonesia is a country that has many high-risk areas with various natural disasters, including floods, landslides, extreme weather, volcanic eruptions, fire, earthquakes and tsunamis. According to The World Risk Index for 2021, Indonesia is ranked 38th of the 181 most disaster-prone countries (Garschagen, Doshi, Reith, & Hagenlocher, 2021). The National Agency for Disaster Management (BNPB-Badan Nasional Penanggulangan Bencana) noted that the intensity of natural disasters in Indonesia has increased significantly in recent years. Based on the BNPB report, in 2020 there were 4,649 incidents of disasters and in 2021 increased up to 16.2%. From the Indonesia disaster-prone index map in 2022 published by the BNPB (Figure 1), it shows that almost all regions in Indonesia are dominated by high disaster-prone levels. Among all five big islands, the BNPB stated that Java is most prone island to disasters. According to the Central Bureau of Statistics (BPS) of Indonesia, the potential for the exposed population is also high because almost 58 percent of Indonesia's population is on Java Island (N.C. Idham, 2019). Based on several reports, housing was the most severely impacted sector after the disasters (Hai & Hoang, 2023; Pribadi, Kusumastuti, Sagala, & Wimbardana, 2014). In 2022 alone there were 95403 houses damaged by disasters and 21% of them were seriously damaged in Indonesia. According to the same report, flood is the most common type of natural disaster followed by extreme weather while the earthquake that claimed the most victims occurred 28 times last year.



Figure 1. Indonesia disaster infographics in 2022 (Source: modification from BNPB).

The majority of these houses are from middle to lower-class groups, it is the largest population in Indonesia. Based on data from the World Bank in 2019, the majority of Indonesia's population is middle to lower divided by middle class (44.5%) and poor (11%). Due to growing demands for more inexpensive basic housing in Indonesia, vulnerable houses continue to develop among low-income and low-to-medium-income communities (Saputra et al., 2017). Lots of previous research emphasized that these groups are the most vulnerable and impacted during a disaster (Yaseen, Saqib, Visetnoi, McCauley, & Iqbal, 2023). Studies show that low-cost houses are more vulnerable to the risk of disaster for several reasons (Charlesworth & Fien, 2022; Ma & Smith, 2020; Pujianto, Prayuda, & Monika, 2019): poorly constructed houses as often built based upon experiences of local masons without technical designs and construction supervision (Tipple, 2005), and mostly located in higher-risk places due to high land prices (Ma & Smith, 2020) or even worst, living in informal settlements.

There are not many studies focused on low-cost house design and the Indonesian government has not published the typical and quantifiable vulnerability of homes (Saputra et al., 2017). Therefore, this study comes out with the research question "What is the typical design for low-cost houses on Java Island and how it is vulnerable to different types of disasters that exist". The objective of this study is to understand

low-cost house designs on Java Island and analyse their vulnerability to various natural risks that exist on the island. The common approach of applying one-size-fits-all solutions for geographically and culturally different regions in some housing projects recently may create more severity of post-disaster situations (Johnston, Taylor, & Ryan, 2022). Before jumping directly into providing an instant design solution or any policy towards low-cost houses' vulnerability problems, this study argues that understanding their houses and risk will arguably provide a better picture and insight into finding a sustainable mitigation solution. Past experiences have highlighted the need for more context-specific approaches, that do not focus only on effective and efficient built products but that directly contribute to a sustainable and long-term vulnerability reduction and poverty reduction (Molesa, Caimi, Islam, Hossain, & Podder, 2014).

1. Material and Methods

This research has two objectives. One is to have a better understanding of the low-cost houses in Java Island. To meet this objective, it used a building typology approach through document analysis and observation on the field. The fieldwork was conducted on Java Island specifically in Semarang province in 2022 with a total of 10 houses as the object samples. It followed with AutoCAD drawing to conduct document analysis together with documentation pictures. Typological studies usually identify and study architectural styles and history based on the structure, material, decorations, form, and contexts of the buildings (Sun, Fan, Duarte, & Ratti, 2022). The typology here is divided by roof, wall, and floor plan where previous study emphasizes the important roles of these aspects in low-cost houses (Agayi & Karakayacı, 2020). The second objective is to analyse the low-cost houses' vulnerability to different types of disasters that occurred on Java Island. This was fulfilled by literature analysis and expert interviews in the field of built environment (architect, architecture and civil engineering lecturer). All of these approaches are categorized as qualitative research methods, which according to (Jamshed, 2014) comprise observation, mapping, documentation, and referring to published documents. A similar study evaluating the strengths and weaknesses of low-cost houses in Iran was conducted through a literature review, observation, and physical analysis (Ghasemi & Özay, 2018).

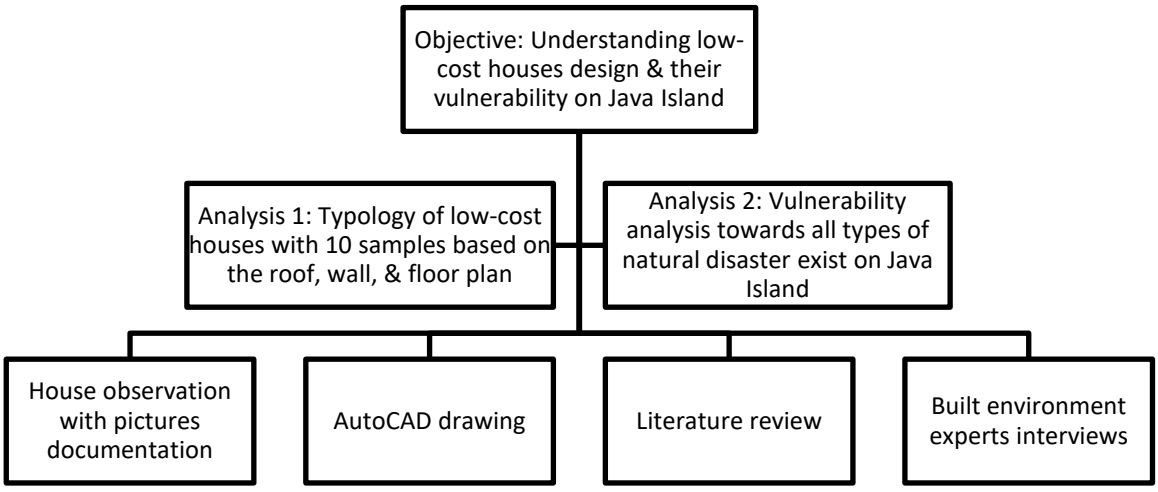


Figure 2. The research methodology.

The challenge found in the field during observation is the difficulty in classifying uninhabitable houses and low-cost houses due to the resemblance among them. Below is the table containing indicators that differentiate between those two. These indicators cannot be seen as individual certainty but rather comprehensive where more than one indicator is needed to determine the grouping. For example, the size of the floor area for low-cost housing has several dissents. The Indonesian Government stated that it should not exceed 70m^2 while according to Prayitno, Kindangen, and Rengkung (2019) is around 22-36m^2. Based on one of the developer websites (RayWhite) that often built low-cost houses in Indonesia, generally, developers distinguish it into 6 types (sizes): 21, 36, 45, 54, 60, and 70. Therefore, it is safe to consider low-cost houses with a floor area of 70m^2 and below. Another important indicator is the existence of a bathroom or toilet. According to data from BPS, just two out of every ten Indonesians live in areas with

adequate sanitation services, including in urban and rural areas. Hence, floor area and the existence of a bathroom/toilet are the two most significant indicators that differentiate a low-cost house with uninhabitable. With these indicators, the houses are selected in the field observation.

Table 1. Differentiate between RTLH and Low-cost House.

Uninhabitable House Definition & Indicators	***Low-Cost House Definition & Indicators:***
Definition: is a residential house that does not meet health, safety, and social requirements. Indicators: ● Walls and/or roofs are in very poor condition that might harm occupants; ● House materials are easily damaged/ rotten; ● No material for the floors directly in touch with the earth or bamboo/timber or cement. Some use ceramics but already damaged; ● No toilet or place for bathing or washing; and/or ● The size of the house is less than 7.2m^2/ person Source: Regulation of the Minister of Social Affairs of the Republic of Indonesia Number 20 of 2017.	Definition: houses built on land with a plot area between 54m^2 and 200m^2 and the building cost per m^2 does not exceed the highest unit price per m^2 for the construction of class C government official housing that applies with a floor area of 36 to 70 m^2 and at least has a bathroom or toilet (Decree of the state minister for Public Housing No.04/KPTS/BKP4N/1995). Indicators: ● The floor area of the building is not more than 70m^2; ● Consists of one floor with a land area of 54-200 m^2 (Joint Decree between the Minister of Home Affairs, the Minister of Public Works, and the state minister for Public Housing, Number 648-381 of 1992, 739/KPTS/1992 and 09/KPTS/1992); ● The space requirement per person is 9m^2 with an average ceiling height calculation of 2.80m; ● The activity room gets plenty of light; ● Ventilation holes of at least 5% of the floor area of the room; ● Room air temperature and humidity are by normal human body temperature; ● Using a direct, indirect and local foundation system made of stone masonry or concrete without reinforcement and the indirect foundation system is ironwood or wood; ● Walls can be made of concrete, boards, half concrete and half boards or other materials such as bamboo which have strong and durable qualities; ● Wall frames for brick houses are made of reinforced concrete structures. For half-walled houses, use half of the reinforced concrete frame and half of the wood frame. For wooden houses that are not staged, the wall framework uses wood. For sloof use reinforced concrete. Meanwhile, wooden houses on stilts use wood entirely, both for the building frame and for the walls and foundation; ● At a minimum use a gable roof with wooden frame trusses with strong and durable class II measuring 5/10 or those that are widely circulated in the market with equivalent sizes; Source: Decree of the Minister of Settlement and Regional Infrastructure No: 403/ KPTS/ M/ 2002

3. Results: House Typology in Java Island

In this study, the focus is the typology of low-cost houses in Java Island. Therefore, any characteristic that is not intended for low-cost houses is excluded.

3.1 Low-Cost Houses in the Modern Era

Officially, the dwellings of the lower middle class in Indonesia can be identified with two types of houses: Uninhabitable Houses (RTLH - Rumah Tidak Layak Fungsi) and Simple Houses (RS - Rumah Sederhana) or Healthy Simple Houses (Rs Sehat). Uninhabitable houses do not meet the minimum requirements for building safety and occupant health (Regulation of the Minister of PUPR of the Republic of Indonesia, 2018). Meanwhile, a simple house is suitable for living and affordable for people with low and moderate incomes (Prastiwi, Saraswati, & Witasari, 2019). Since RTLH does not meet building safety requirements and priority to increase the house quality to at least a simple house condition (Larasati, Yuniningsih, Widowati, & Sagala, 2021), therefore, this type of house's main risk is poverty rather than natural disaster. In this case, RTLH is excluded from this study and focuses on simple houses - where intervention is needed to be resilient.

Another type is vernacular housing. The traditional dwellings have developed to respond to natural environmental conditions, particularly Indonesia's warm and wet tropical climate (N.C. Idham, 2019). In the wealth of archipelago architecture, there have been many studies that prove that vernacular buildings are resistant to several natural disasters such as earthquakes (Putra, 2020) and floods (Nyssa, Susanto, & Panjaitan, 2022). This study also eliminates vernacular housing since it is rarely built lately due to the level of difficulty of construction as well as natural materials that are hard to come by. Additionaly, another type of housing is affordable apartment that in Indonesia it appears to be so far unsuccessful (Rosadi, Meizy, & Suryanto, 2010). This type of residential with the form of high-rise buildings is also excluded in this study because it needs specific analysis and is not a majority case in Indonesia.



Figure 3. Types of houses excluded in this study: vernacular houses in Java (left); flats (middle); and Uninhabitable Houses/RTLH (right).

This simple house group mostly is self-built because cannot afford to use an architect or civil engineer. But there is also a simple house built by private developers or the government which are usually subsidized housing. The figure above shows a simple house (a) built by the community and a simple house (b) built by the developer/government. The majority of this housing, which is made up of landed homes, is located on perimeter land that has been either developed by real estate firms or the communities themselves. Therefore, this study argues it is not suitable to use the term self-housing and prefers the term low-cost or simple house. Since the same main characteristic between those two types of houses (built by the community and developer/government) is the low budget to build. This type of house is usually one-story and made of reinforced concrete which also identifies as the era of modernity in Indonesia after the independence in 1945 (Wihardyanto & Ikaputra, 2019).

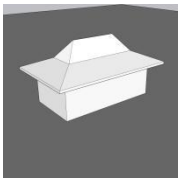


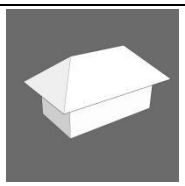
Figure 4. Low-cost houses are self-built by the community (left) and built by a developer (right).

3.2 Typology of Low-Cost House in Java Island Based on the Roof Material

For low-cost houses on Java Island, mostly very simple forms of roofs. Even in vernacular architecture, the difference between villagers and noblemen is the roof. The more complicated the roof shows higher social status and economic class. The next table shows the roof typology for low-cost houses on Java Island.

Table 2. Typology of Low-Cost House Roof Designs in Java.

Roof Design	Illustration	Description	Roof Material	
Panggang-Pe		The shape is the simplest form of a house, consisting of a roof with four or more pillars where the tops are used for drying items such as tea leaves, cassava, corn etc. The shape of the roof of the house consists of one side of the sloping roof with a very simple shape.	 Clay Tile	Most low-cost houses in Java use this material for the roof.
Kampung or *Pelana*		It is an architectural variant that is one level more perfect than *Panggang-Pe*, with a rectangular plan with four pillars, and two sloped roof areas that meet on the upper side and are closed with a conch lid. This form of house was very commonly used by villagers.	 Zinc	Usually used by developers for subsidized housing.
Limasan (traditional version)		The pyramid-shaped house has a rectangular plan, with four roof areas. During its development, the shape of the pyramid was given additions. This variety is widely used both for villagers and noblemen. This is almost close to the "Joglo" roof, which is more complicated and usually owned by the middle-upper class.	 Metal	This is the second material used after clay tile due to its affordable price and ease of use.

Roof Design	Illustration	Description	Roof Material	
Limasan (modern version)		Used by people from middle to lower economic levels. The shape of the building is very simple which is typical of the Javanese house	 Asbestos	According to The World Health Organisation (WHO), about 10 percent of Indonesian homes have roofs made from white asbestos.
Combined 2 or more of *Lima San* shape		Many people use it at a middle economic level. The shape of the building began to lead to a modern form		

3.3 Typology of Low-Cost House in Java Island Based on Wall Material

The Indonesian government distributed prototypes of Healthy House into four types: walled houses; ½ wall houses; wooden houses without stilts; and wooden houses on stilts. This shows that the wall is the main aspect to distinguish the type of houses. Referring to this division, Java Island in the majority is categorized as wall houses. According to Saputra et al. (2017), overall houses in Java Island can be categorized into 5 types: mud bricks - unreinforced bricks with mud mortars; bricks - unreinforced bricks with cement mortars; reinforced bricks; reinforced concrete; and others. The majority (84.8%) of houses use mud bricks, bricks, and reinforced bricks.

Table 3. Typology of Low-Cost House Walls in Java.

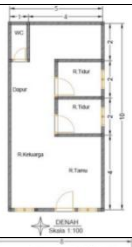
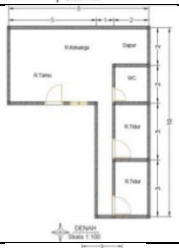
Wall	Illustration	Description
Brick wall		The easy-to-obtain clay raw material and the simple manufacturing process make it relatively inexpensive. The usual size on the market is 25 x 12 x 5 cm or less. Walls of brick masonry are generally made with a thickness of ½ stone and a minimum distance of 3 m is given a practical column as a binder and load distribution. Brick walls are usually worn as a non-structural construction that is not load-bearing.
Brick and cement walls		House uses brick with cement plaster is found in traditional houses of nobles and modern houses. Financial constraints as the main reason, but most brick wall houses will plaster as the finishing at the end.
Adobe wall		Same as brick, this type of house uses adobe brick instead of brick. Also, it was found with or without cement plaster.
Wood plank Wall		Wooden plank walls are used in wood frame construction buildings. Board construction is nailed/screwed to horizontal and vertical wooden frames with a distance of about 1 meter. Yet more attention towards the quality of wood due to the possibility of expansion and shrinkage.

Wall	Illustration	Description
Bamboo Wall		The wall material used is non-permanent. The advantage of using bamboo as a frame material for house walls is that bamboo is known as a renewable building material, hence there is no need for skilled labour and it is enough to use simple tools that are easily found.

3.4 Typology of Floor Plan for Low-Cost House on Java Island

The following table shows the typology of low-cost houses on Java Island based on their floor plans. The coverage floor area for this type of house is in the range of 36-70m^2, so there is not much alternative. The floor plan on this table is originally from Javanese vernacular architecture that still could be found in modern low-cost houses.

Table 4. Typology of Low-Cost House Floor Plans in Java.

Floor Plan	Illustration	Description
I Type		Rectangle plan shape. It has a basic rectangular shape, with variations on terraces and an annexe behind the main building. The main entrance is generally located in the middle of the wall on the side facing the street. Buildings that have a floor plan like this are generally single houses in the local community.
L Type		The shape of the floor plan of the letter L with variations on the position of the terrace and the entrance. A formation like this has a general function as a private residence (single house) in the local community.
T Type		The shape of the floor plan of the letter T with variations in the position of the entrance.
Ordinary People's House Plan		The floor plans of ordinary people's houses also follow the provisions of traditional houses but usally more compact. This is because the land for ordinary people's houses is not as large as that of a nobleman's house.

4. Discussion: House Vulnerability to Disasters on Java Island

The objectives of this study are to understand low-cost house designs on Java Island and analyze their vulnerability to various natural risks that exist on the island. For the first objective, based on the typologies analysis earlier, this study divided low-cost houses on the Java Islands into 4 groups:

1. House with brick/ adobe/ cement wall and clay tile roof;
2. House with brick/ adobe/ cement wall and zinc/ metal tile/ asbestos roof;
3. House with wood/ bamboo wall and clay tile roof;
4. House with wood/ bamboo wall and zinc/ metal tile/ asbestos roof.

The main reason to divide between materials of wall and roof is because on the field mostly low-cost houses in Java Island fall into those four groups. It is understood that the building structure is also closely related to the house's vulnerability (Noor Cholis Idham, 2020). This study found that building structures can be identified based on the walls and roof materials.

All of those four types of houses could be self-built or built by developers or appropriate design/engineered or inappropriate design/non-engineered. Saputra et al. (2017) found that 93.5% of houses in Yogyakarta province (in Java) were non-engineered houses and very vulnerable to earthquakes. However non-engineered houses in his study included brick walls categorized as un-reinforced bricks with mud mortal, un-reinforced bricks with cement mortal, and reinforced brick. Meanwhile, this study argues that those three types of houses could be appropriate if the building structure is properly designed and constructed.

Where definitely, inappropriate design/non-engineered in disaster-prone areas is considered one of the key causes of a vulnerability house and needs to be addressed (Charlesworth & Fien, 2022). Self-made construction and the lack of experience make slum houses vulnerable to environmental hazards and seismic activity (Ebrahimi, Devillers, & Garcia-Diaz, 2022). The number of self-help houses found in post-disaster construction shows that concern for structural safety is still below expectations (Dartanto, 2022; N. C. Idham, 2021). Among them, the self-help housing type is the problem most associated with almost all safety means (Pribadi et al., 2014). Meanwhile, low-cost houses built by developers are more guaranteed because it is required by Indonesian law and because of the involvement of architects and civil engineering experts in the process (theoretically). However, because of the risks of various natural disasters, this type of house remains vulnerable in certain cases.

After acknowledging the types of low-cost houses in Java Island, this study was able to analyse their vulnerability to disaster, especially after categorizing them into four groups. Based on data from the BNPB in the last few years (2020, 2021, 2022), the natural disasters that have plagued Java are tsunamis, earthquakes, floods, tornadoes, droughts, landslides, volcanic eruptions, and forest fires. All type of natural disasters is included in the following analysis except drought which does not have any direct impact on the house damage. The analysis of each disaster threat was built from the interviews with built environment experts (architecture and civil engineering lecturers and practitioners).

Table 5. House Vulnerability Analysis.

Type of Low-Cost Houses		**Vulnerability**	**Disaster Threats**
Brick/adobe/cement wall & Clay tile roof	  	• When the Dutch colonial came, they started using brick walls (N.C. Idham, 2019). They were immediately aware of the danger of earthquakes and took necessary precautions by creating thick brick walls. That is why, many old colonial buildings remain well (Vogelsang, 2020). • The problem with most Indonesian brick wall applications is that this material is only considered a load-bearing wall without	**Earthquake:** Brick/cement wall & clay roof: • This house is vulnerable to moderate-intensity earthquakes; • The masonry wall will result in some failure namely: diagonal and horizontal cracks will reduce the wall stiffness, opening cracks at the corner of the wall, and crushing bricks; • At high-intensity earthquakes, bricks may fall or dislodge; • The clay tile roof is heavy, increasing the lateral force and making the roof highly vulnerable to collapse during the earthquake.

Type of Low-Cost Houses		Vulnerability	Disaster Threats
		considering the shear load (N. C. Idham, 2021). • It is common to find houses using columns without connecting beams. Or, they use it but with poor connection, especially with reinforcing steel bars (Noor Cholis Idham, 2020). This structural failure was responsible for most of the deaths and injuries.	Brick/adobe/ cement wall & zinc/metal roof: • The weight of the zinc/metal roof added to the whole structure made the house less vulnerable to earthquakes; • A lighter material used for roofs will minimize the injured people and casualties that happen during earthquakes. Wood bamboo wall & clay tile roof: • Material from wood and bamboo is light and tends to endure when subjected to earthquakes and have minor damage at moderate earthquakes; • If the bamboo wall falls during the earthquake, it is not likely to cause casualties; • Clay tile roof which was heavy, increased the lateral force and made the roof highly vulnerable to collapse during the earthquake. Wood/bamboo wall & Zinc/metal tile/asbestos roof: • This type of house is lighter structure and has high performance against earthquake load with just minor damage; • A lighter structure will minimize the injured people and casualties happened during earthquake. **Landslide:** Brick/cement wall &clay roof: • Brick/cement wall and clay roof will have light or moderate damage when subjected to landslide because the material is strong enough to resist the soil from the landslide; Brick/adobe/ cement wall & zinc/metal roof: • Usually, brick/cement wall and zinc/metal roof house is strong enough to resist light and moderate landslide. Wood bamboo wall & clay tile roof:
Wood/bamboo wall & clay tile roof	  	• Lightweight wooden construction will create a flexible or minimal movement of the building after an impact because the system will easily return to its original position against heavy materials (N.C. Idham, 2019) especially during an earthquake. • Some traditional wooden houses have also collapsed due to age and poor maintenance (N.C. Idham, 2019). Poor quality materials make it more vulnerable to climate hazards. • The majority of Indonesian traditional architecture is built with natural (timber) materials that create many designs and structural principles that range from simple columns/ beams to massive and complex shapes. And many of them have proven to be able to survive various disasters (Rini & Idham, 2021).	

Type of Low-Cost Houses		Vulnerability	Disaster Threats
		• According to Pujianto et al. (2019), the common cause of Joglo (most common traditional house in Java) damage are: 1. The lack of column foundation impacted a connection failure between columns and foundation; 2. The damage of both column and beam after receiving the lateral force of the earthquake; 3. Failure on the roof structure due to the deformation, unstable, or collapse of the outer structure.	• The landslide can easily damage the house. **Tsunami:** Brick/cement wall & clay roof: • Tsunami will cause severe damage especially to brick wall and clay roof. Brick/adobe/ cement wall & zinc/metal roof: • The masonry walls would fail under the tsunami wave force which in turn would result in the failure of the roof. Wood bamboo wall & clay tile roof: • A house with bamboo walls will be more resistant to tsunamis because water will flow between the walls. Wood/bamboo wall & Zinc/metal tile/asbestos roof: • Bamboo walls will be more resistant to tsunamis because water will flow between the walls. **Flood:** Brick/cement wall & clay roof • Brick/cement wall and clay roof has less chance of collapsing or being structurally damage. Brick/adobe/ cement wall & zinc/metal roof. • Brick/cement wall and zinc metal roof has less chance to collapse or structurally damaged to flood. Wood bamboo wall & clay tile roof: • Wood bamboo wall and clay tile roof are less vulnerable to flood and will not cause major damage to the house structure. Wood/bamboo wall & Zinc/metal tile/asbestos roof • Wood/bamboo wall is less vulnerable to flood but flood will cause damage to asbestos roof. **Tornadoes:** Brick/cement wall & clay roof • Brick/cement walls and clay roofs are less vulnerable to tornadoes because brick and clay are heavy materials.
Brick/adobe/cement wall & Zinc/metal tile/asbestos roof	 	• This is the most common type built by contractors for low-cost housing projects in Indonesia. • The popular way of using zinc or metal tile roof, and roof trusses do not use wood anymore but light steel instead. Yet, the problem is the installation method mostly uses the same way as with wood. Also, the tendency of using heavier roof tiles is high because of economic reasons and comfort expectations however not suitable. • Improper structural systems from truss-like reinforced concrete frame construction are easy to find, such as pointed on top of bearing walls without a proper column system below (Noor Cholis Idham, 2020).	

Type of Low-Cost Houses		Vulnerability	Disaster Threats
Wood/bamboo wall & Zinc/metal tile/asbestos roof	 	• Lightweight structures are the common answer to be less affected by earthquake shakes. Houses built with lightweight materials such as wood may be able to resist strong ground shaking and would also be less deadly if they collapse (Tipple, 2005). • Similar to the previous explanation, the majority of failures with zinc roofs are mostly due to extra light zinc-alum profiles while applying heavy roof tiles (N. C. Idham, 2021). • Another problem with zinc or metal roof tiles is causing heat in the interior space. This can be anticipated with an appropriate calculation by using extra elements installation but will increase the construction budget and also require specific construction techniques (N. C. Idham, 2021) that might not be available for middle to lower class.	Brick/adobe/ cement wall & zinc/metal roof. • Zinc/metal roof will be flown by tornadoes as it is a light material; • The more the angle of the metal roof the more vulnerable to tornadoes; • The connection of the roof frame must also follow the specification of the area of the houses. Wood bamboo wall & clay tile roof: • Wood bamboo walls and clay tile roofs are not prone to tornadoes because clay is heavier and will not easily be flown. Wood/bamboo wall & Zinc/metal tile/asbestos roof • Wood bamboo walls and metal/zinc roofs are more vulnerable to tornadoes as those materials are light. **Volcanic Eruptions:** Brick/cement wall & clay roof • Brick /cement walls and clay roofs tend to be less vulnerable to volcanic eruptions. Those materials can resist heat. Brick/adobe/ cement wall & zinc/metal roof. • One of the important components in volcanoes risk-prone house is designing a roof to withstand a volcanic eruption by creating it smooth, slick surface so that the ash can slide off without collecting on the surface. Wood/ bamboo wall & clay tile roof • The same analysis with brick/cement wall & clay roof, but the concern is with the timber material for wall that is easily burn. Wood/bamboo wall & Zinc/metal tile/asbestos roof • The same analysis with brick/adobe/ cement wall & zinc/metal roof but the bigger risk for the wall material to be burn because made of timber. • Another architectural feature is to have a reinforced structure with

Type of Low-Cost Houses		Vulnerability	Disaster Threats
			titanium. Titanium is durable and robust material often used for lateral support in buildings that may experience a volcanic eruption. **Forest fires:** Brick/cement wall & clay roof • Brick /cement walls and clay roofs are less vulnerable to fire. Brick and cement materials resist more fire. Brick/adobe/ cement wall & zinc/metal roof. • Brick /cement walls with zinc/ metal are also less vulnerable to fire. They are not easily burn. Wood bamboo wall & clay tile roof: • Wood/ bamboo material is easy to burn but clay roof is less vulnerable to fire. Wood/bamboo wall & Zinc/metal tile/asbestos roof • Wood/bamboo wall will be burnt easily, while metal/zinc roof is less vulnerable to fire but it transfers heat easily.

From the vulnerability analysis above, there are several key points: first of all, the main problem for all types of houses is unproper building structure. Brick wall, failure mostly found due to in-complete reinforced steel bars. While for timber wall which should be safer under many type of disaster yet still found many building failure cases. The reasons are poor timber quality and failure connection between columns and foundation or upper beam. For roofs, the trend is using lightweight frames from wood to metal (mainly steel) roof construction. Inappropriate structure is commonly found for this trend especially metal/steel frame that are constructed as same as wood. It is obvious in the field, that zinc/metal roof material starting to dominate low-cost houses. But in Java Island, clay tile roof is still easily found since produced locally by the home-industry at affordable price.

Secondly, the suitability of house materials varies depending on the type of natural disaster. For earthquakes, it is advisable to use lightweight materials for both walls and roofing. Reinforced structures are crucial for brick walls, which have often been identified as causes of casualties. A more suitable choice would be wooden walls with zinc roofing. Regarding tsunamis, generally, no house design is completely safe without robust columns and a two-story structure. In the case of both earthquakes and tsunamis, the main aim is to ensure the house remains intact for a sufficient duration, allowing residents to evacuate to safety. During floods, while all types of houses may be impacted, wooden structures are prone to rot, and concrete may suffer erosion unless properly protected. Asbestos also fares poorly in floods. A two-story design is preferable here as well. Contrary to earthquake scenarios, heavier materials such as brick walls and clay tile roofing offer better resistance against tornadoes, with the critical factor being a robust structural connection from the foundation to the roof. In volcanic eruptions and forest fires, wooden materials pose a high risk due to their flammability. For roof protection from volcanic ash, smooth metal materials like zinc are more effective than clay tiles. However, the challenge is the diversity of types of disasters faced by each location makes the design complicated (Sastra & Idham, 2019). For example, the city of Semarang in Central Java is at high risk

for floods and landslides. But the city of Jember in East Java is at high risk for flooding and tornadoes. The city of Cianjur, West Java, is prone to earthquakes and landslides. Meanwhile, Yogyakarta city has a high potential for natural disasters such as earthquakes, volcanic eruptions, and floods. This is only within the district/city scope, when examined in more detail, the differences and multiple of disaster risk become more diverse at the sub-district level.

To compare, the study of Islam and Hossain (2017) in Bangladesh with their multi-hazards risk, developed 35 (thirty-five) designs of disaster-resilient low-cost houses for eight different geographic regions of Bangladesh. In their study, they identify each region with one or a maximum of two types of disaster. Considering local practice, the availability of building materials, and the culture of the community are significantly important in reducing vulnerable housing. Yet, providing a new design is also challenging for the majority of people.

So, what about houses for Java Island? According to Charlesworth and Fien (2022), there are no universal, one-size-fits-all solutions for resilient design. For Java Island, based on the typology study, it is recommended to focus on upgrading the quality of the four types of houses rather than creating a new design house. Understanding the typology of residents living in disaster-prone areas is important as an input for policy-makers (Amin, Sukamdi, & Rijanta, 2018). Recommendation to upgrade the quality of house by considering at least two types of disaster high risk in the area. Through the vulnerability list from Table 5, design and construction aspects that should be considered for each disaster type are available.

As previous studies show this group of people usually do not have knowledge of construction works and know little to nothing about the maintenance of the house (Hai & Hoang, 2023). This study also emphasizes the construction phases such as the quality of the builder's skills and monitoring intervention, especially for self-built houses. Quality control or inspection should be instituted by local authorities and certification programs for masons/craftsmen are needed to ensure the quality of the construction (Hochrainer-Stigler, Linnerooth-Bayer, & Mochizuki, 2019). This study argued, that focusing on these strategies, it will help the majority of middle to lower-income communities in Java Island to be resilient under the threat of disaster. According to Tipple (2005), important issues in reducing the vulnerability of housing to disasters include improving the ability of dwellings to resist shocks. Because the island of Java is large with cultural diversity, a broader study covering unreached areas with a more representative number of house samples is needed in the future.

5. Conclusion

The aim of this research was to evaluate the design of low-cost housing on Java Island and to assess their susceptibility to the array of natural hazards prevalent in the region. Through a typological analysis, the study identified four principal categories of low-cost housing differentiated by wall and roof materials: (a) structures with brick, adobe, or cement walls topped with clay tiles; (b) those combining brick, adobe, or cement walls with roofs made of zinc, metal tiles, or asbestos; (c) buildings with wooden or bamboo walls and clay tile roofs; and (d) constructions of wood or bamboo with zinc, metal tile, or asbestos roofing.

The vulnerabilities of each house type to different natural disasters common in Java were examined in detail. It was found that brick walls could be earthquake-resistant if fully reinforced with concrete. Wooden and bamboo walls and roofs are preferred for their earthquake resilience, though they also require a robust structural design. For tornadoes, the strength of materials and the integrity of the structural connections are crucial. Conversely, natural materials typically fare worse in forest fires. During volcanic eruptions, the choice of a smoother roof material can significantly mitigate ash damage. In flood scenarios, houses on semi-stilts perform better, although this feature is uncommon in Java's low-cost housing, with exceptions like vernacular or RTLH (Rumah Tidak Layak Huni) houses.

The primary takeaway is that attention to the specific design requirements of these four types of houses, along with a focus on quality construction practices, is essential for creating resilient low-cost housing for Java's middle- and lower-income populations. Disaster preparedness strategies for low-income

housing should incorporate these insights to minimize risks. Future research would benefit from a broader sampling of house types across Java Island to account for its vast geographical spread and cultural diversity.

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The Authors s declare that there is no conflict of interest.

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The data that support the findings of this study are available on request from the corresponding author, Aulina Adamy.

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Urban Heat Island Impact and Precipitation Patterns in Indian Western Coastal Cities

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ABSTRACT

This article investigates the Urban Heat Island (UHI) effect and its interplay with precipitation patterns in the rapidly urbanizing western coastal cities of India. Focusing on the socio-economic dimensions of urbanization, it examines the consequences of increased surface temperatures due to altered urban landscapes and heightened anthropogenic activities. The study evaluates the correlations between UHI intensity, population density, and precipitation during summer and winter across multiple decades—1991, 2001, 2011, and 2021—using the Spearman rank correlation coefficient. Findings indicate a robust positive correlation between surface temperature and population density in summer, with an inverse relationship to precipitation. In contrast, winter data shows an opposite trend, with unclear connections to population density, suggesting that other factors may significantly affect precipitation. The seasonal and temporal analysis of these correlations sheds light on the urban climate's complexity and informs urban planning strategies to mitigate adverse socio-economic impacts related to climate change. This study underscores the need for sustainable urban development practices that consider the intricate dynamics between urban growth and environmental transformations, highlighting the necessity for climate-responsive planning in the socio-economic development of Indian western coastal cities.

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Highlights:

In Indian Western Coastal Cities"
- There is a noteworthy and progressively strengthening positive relationship observed between surface temperature and population density during the summer season. However, during the winter season, there is an insignificant negative correlation observed.
- In the case of surface temperature and precipitation, their relationship is negative during the summer and positive during the winter.
- The link between population density and precipitation is unclear and inconsistently weak, suggesting other factors may influence precipitation more significantly.

Contribution to the field statement:

The research presented in this article is pertinent to socio-economic aspects of urbanization as it provides critical insights into how the UHI effect, driven by population concentration, can exacerbate climate-related challenges such as heatwaves and flash floods. These environmental changes have direct implications on public health, urban infrastructure, and the overall quality of life, influencing socio-economic disparities. The study's conclusions can aid policymakers and urban planners in devising strategies to create more sustainable and resilient urban spaces, ultimately contributing to more equitable socio-economic development in the context of rapid urbanization.

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1. Introduction

Due to increasing development, urbanization is increasing at a rapid scale. As a result, cities are expanding in terms of area and population density. Due to this, built-up area replaces green areas (Malik & Gupta, 2018). As per distribution all over the world, Indian cities exhibited higher densities. India has a smaller share of the world's habitable land mass, about 2.4%, than its population share, which is 18% (Sarbapriya & Ishita, 2011). India's ability to accommodate such a large population on a limited area of land is advantageous because it causes less harm to the natural ecology, but it has many negative effects. One such consequence is urban heat islands. Urban Heat Island exhibits a positive relationship with population density (Oke T. R., 1973; Arifwidodo & Chandrasiri, 2015). Urban heat islands increase as the number of people living per unit area increases. In countries like India, where the densities are already high, it has many negative impacts, such as an increase in discomfort and energy demand, etc. during the summer season (Nuruzzaman, 2015). Several studies have demonstrated a direct relationship between temperature and the daily death rate as the risk of heat-related morbidity and mortality increases (Tan et al., 2010; Gabriel & Endlicher, 2011; Habeeb et al., 2015; Golechha et al., 2021).

The Urban heat island is a phenomenon in which a city experiences higher temperatures than its surrounding rural areas. Luke Howard initially investigated and described this phenomenon in the 1810s. According to Luke Howard, London's downtown area was 2.1 °C (3.7 °F) warmer at night than the surrounding countryside (Mills, 2016). The causes of urban heat islands can be divided into two main categories: natural factors, which encompass urban geography, global climate, and local weather conditions, that are beyond human control. Anthropogenic factors such as city size, human activities, city layout, CO^2 emissions, heat absorption caused by low albedo materials, heat retention in the atmosphere due to air pollutants and urban canopy, reduced convection due to wind obstruction by urban structures, decreased cooling efficiency due to the loss of trees, and heat discharge into the atmosphere from the use of air conditioners, machinery, and vehicles, among other factors, which can be controlled (Nuruzzaman, 2015; Wai et al., 2022). These anthropogenic factors cause changes in net radiation because of a reduction in short-wave solar radiation and incident flux re-emission of long-wave radiation by the urban surface. This is absorbed by the atmosphere and it warms the air (Oke et al., 2017). The main reason for this is that urban areas are increasing, and the pervious surfaces are converted to impervious surfaces. As per various studies, 9 m^2 of green space is required per person (Russo & Cirella, 2018). However, places like Mumbai have less green space per person at 0.12 m^2 (Hwang et al., 2020). Therefore, the rate of evaporative cooling is reduced in the case of urban areas. This raises the temperature in the urban area by heating it (Oke et al., 2017). UHI can be broadly classified as boundary level UHI, which is related to the weather at the mesoscale; canopy layer UHI, which is a near-surface air layer that extends from the ground to the mean building height; and surface UHI, which, is related to land surface temperature (Martin et al., 2015). The land surface temperature that influences surface UHI is the primary focus of this research.

Recently, there has been a noticeable shift in conventional seasonal patterns. An escalation is observed in the occurrence of unforeseen precipitation during periods that were historically non-rainy, and a notable increase in the frequency of heat waves. These climatic shifts have consequently led to increased discomfort within urban locales. Complicating matters further is the accelerating pace of urbanization, which amplifies people's exposure to these unpredicted events (Xiao et al., 2017). Consequently, there exists a compelling need to investigate the intricate interplay between population, surface temperature, and precipitation patterns, particularly during the non-rainy season.

1.1. UHI and Population

The seasonal and temporal distribution of UHI and the effects of various factors on UHI have been highlighted over the past few decades. Since 1937, researchers have noted rising air temperature values in cities, which they have linked to an increase in population and the rapid increase in infrastructure development in the urban environment in response to the increasing demands (Oke T. R., 1973; Oke & Maxwell, 1975; Li et al., 2020). When the graph of the population density and UHI is plotted, a direct association is seen (Mallick, 2021). Within the urban area where the population density and building density are high and green cover is less, records the highest mean air temperature. (Kotharkar & Surawar,

2016). UHI is highly correlated with building height and urban fraction, which affect canopy UHI and surface UHI, respectively. (Li, Y., et al., 2020). When compared over time, areas that have changed from vegetated to non-vegetated areas to accommodate an increase in the population show a significant temperature shift (Zhou & Wang, 2011). To study the dynamics of land use and land cover change over time, researchers use land use indices such as the normalized difference built-up index (NDBI), normalized difference bareness index (NDBaI), and normalized difference vegetation density index (NDVI), which signifies built-up land, bare land, and vegetation, respectively. NDVI is indirectly proportional to UHI, implying that as vegetation cover increases, UHI decreases, NDBI and NDBaI are directly proportional to UHI, indicating that as built-up area and bare land increase, UHI increases (Tran, et al., 2017). When the relationship between UHI and land use indices was studied over a period of time, it was observed that the slope of UHI and NDVI decreased, but that of UHI and NDBI, NDBaI increased (Pal & Ziaul, 2017; Ogunjobi et al., 2018; Dissanayake et al., 2019; Das, et al., 2020;). This shows that over time, due to rapid population growth, green spaces are being converted to built-up regions, which has exacerbated UHI. Population density alters urban form in terms of land cover and morphology. In the case of land cover, as urbanization increases, green cover reduces, and in the case of urban morphology, it reduces the permeable surface fraction that increases UHI (Ramírez-Aguilar & Lucas Souza, 2019) which triggers the UHI. However, this relationship may vary from city to city because of variations in density, urban geography, urban setting, and the heat capacity of the urban fabric (Louiza et al., 2015). Therefore, the investigation of this relationship must be tailored to the specific spatial context.

1.1.1. UHI and Urban Geography

Urban geography impacts UHI. The effect of UHI is different for coastal cities than for inland cities. Urban geography and climate zones play an important role in influencing UHI (Sarkar et al., 1998; Simpson et al., 2008). Depending on the urban geography, UHI shows seasonal variation. The variations are distinct in Inland and coastal cities from those in mountainous areas and polar cities. In coastal cities, the presence of sea/land breeze interaction enhances the cooling effect, which reduces UHI (Yamato et al., 2017; Matsumoto et al., 2017). The absence of sea breeze interaction in Inland cities reduces the cooling effect, thus increasing UHI (Ramamurthy & Zeid, 2017). However, although coastal cities stayed colder than inner city areas during the day, the opposite happened at night as the sea takes a long time to heat up and cool down. Cities in mountainous areas have wind valley systems that consist of up valley winds during the day and shallower winds coming down from mountains during the night, which reduces the impact of UHI (Ketterer & Matzarakis , 2014). In polar cities, snow's insulating capabilities minimize heat storage and the demand for residential heating (Leroyer et al., 2010). In addition, the radiation balance and energy exchanges are further impacted by the snow cover and melting processes, which reduces the latent heat flux (Karsisto et al., 2016). Additionally, polar cities have lower population densities than other cities; hence, the effect of UHI is often less noticeable there. (Leroyer et al., 2010). Urban geography impacts how UHI affects cities, as coastal and inland areas experience seasonal variations in UHI. This research focuses on tier 2 cities within the Western Coastal Region of India, analyzing correlations between the study parameters within a similar category of cities to reduce the impact of outliers.

1.2.UHI and Precipitation

Precipitation can be categorized into two main types: convective precipitation and stratiform precipitation (Houze, 1989). Convection precipitation occurs when the Earth's surface, particularly in an unstable or moist atmosphere, experiences greater heating than its surrounding environment. This heightened heating leads to substantial evapotranspiration, resulting in precipitation. Convection precipitation is characterized by its limited spatial coverage, intense upward motion caused by local heating, and high precipitation intensity. Stratiform precipitation occurs when large-scale winds and atmospheric dynamics force large air masses to move over each other. This type of precipitation is characterized by extensive spatial coverage, weak precipitation intensity, and minimal upward motion (Yang, Liu, & Yang, 2019).
UHI is a local urban phenomenon that alters the thermal balance and, mostly affects convective precipitation. The UHI causes an updraft over the urban area, increasing moist convection, water vapour

content, and cloud fraction, which increases precipitation (Steensen et al., 2022). This phenomenon is also termed 4'O clock rainfall, which is mainly seen in tropical regions of the northern hemisphere. UHI-induced precipitation was first documented by Landsberg (1956) in Tulsa, Oklahoma (Dixon & Mote, 2003). Convective systems significantly affect the atmosphere's thermal equilibrium and thermodynamic differences, which results in varied moisture cycling, latent heat distribution, cold rain, and warm rain processes, and these variations affect the cloud duration and climate of the Earth (Yanai et al., 1972; Biggerstaff & Listemaa, 2000; Lolli et al., 2017). This can negatively impact numerous economies and age groups susceptible to the effects of climate change (Cui et al., 2022; Motanya & Valera, 2016). Maximum summer precipitation is influenced by solar heating and UHI in the afternoon and by UHI in the evening. This accelerates the destabilization of the low-level atmosphere and increases the frequency of convective precipitation. (Ganeshan et al., 2013). Several studies have examined warm-season rainfall modification over metropolitan areas in the past. One of the earliest studies of a substantial upwind rainfall increase in the La Porte area east of Chicago was conducted by Changnon in 1968. Similar rainfall increases noticed over and downwind of several cities have been mostly linked to the UHI (Ackerman et al., 1977; Bornstein & Lin, 2000; Shepherd et al., 2002; Dixon & Mote, 2003; Shepherd & Burian, 2003; Bentley et al., 2010).

In summer, the intensities of the urban heat islands are positively connected with the amount of precipitation. The Bowen ratio impacts in the summer and the Bowen ratio and snow albedo effect in the winter make rural temperatures susceptible to changes in precipitation (Gu & Li, 2018). The effect of UHI on precipitation is also influenced by urban geography. UHI-affected rainfall is observed in inland cities in the late afternoon and early evening, and it intensifies in the downwind direction of the city. As per the findings of this study, a minor temperature elevation of 5.6% within the urban area resulted in an average monthly increase in rainfall rate of approximately 28% within a distance ranging from 30 to 60 km downwind of the metropolitan region. Increases of up to 51% can be seen in some downwind areas. In addition, it was discovered that the maximum rainfall rates in the downwind affected area were 48%–116% higher than the upwind control area's mean value. The maximum value was often discovered at a typical distance of 64 km from the city's centre or 39 km from the boundary of the urban area (Shepherd et al., 2002). Rainfall in coastal cities impacted by UHI is seen during diurnal hours. Due to the interaction between UHI and sea breeze, there may be a localized increase in the frequency and severity of extreme positive rainfall anomalies during the day (Chagnon et al., 1977; Lin & Chen, 2011; Chakravarty & Bhangale,2021; Chakravarty et al., 2021). Even the formation of clouds and thunderstorms might result from the interaction between UHI and sea breeze (Ihadua & Filho, 2021). Precipitation can aggravate the difference in soil moisture between urban and rural locations, resulting in an increase in SUHII during the day and a decrease in SUHII at night (Li, Zha, & Wang, 2020). Assessment of the exposure of precipitation extremes in response to UHI, however, has received less attention to date.

1.3.Population and Precipitation

In terms of precipitation and heat waves, the number of extreme events caused by global warming is increasing, and they are expected to continue to worsen in the future (Myhre et al., 2019). The growing population and urbanized areas are greatly threatened by these events. This growing threat to the population is quantified by extreme precipitation events (EPEs) in terms of extreme precipitation days and amounts (Risser & Wehner, 2017). Exposure to extreme precipitation events is determined by multiplying the population in the area prone to extreme precipitation events (Jones et al., 2015). In terms of population exposure to EPEs, Zhao et al., (2021) discovered that at 1.5 °C, 2 °C, and 3 °C warming levels, population exposure to EPEs is anticipated to increase by 72.4%, 122.7%, and 87.6% respectively. In a study conducted in the Yangtze River Delta region and documented by Shen et al. (2022), from 1961 to 2018, all indices related to extreme precipitation events (EPEs) exhibited an increasing trend. Specifically, during the period from 1984 to 1993 compared to the later period from 1994 to the present, the population's exposure to extreme precipitation events, both in terms of daily, daytime, and nocturnal occurrences as well as the corresponding precipitation amounts, witnessed respective increases of 37% (40%), 34% (39%), and 41% (41%) within the timeframe of 2009 to 2018. Furthermore, utilizing simulations derived from the Coupled Model Intercomparison Project phase 6, incorporating Shared

Socioeconomic Pathways and Representative Concentration Pathways, it was determined that the likelihood of extreme precipitation events exceeding the threshold of the 99th percentile is projected to rise globally across all land areas during the upcoming century. This trend is particularly notable under the SSP5-8.5 no-mitigation scenario. According to this scenario, the occurrence of severe precipitation events worldwide is anticipated to increase by approximately 1.8 times by the end of the current century. Even if early mitigation is carried out using SSP1-2.6, increases are still anticipated, but they are considerably less than SSP5-8.5 (Tang & Hu, 2022). Also, under SSP5-8.5, future global aggregate exposure would rise by at least 50% (Chen & Sun, 2021).

Considering future threats to the increasing population due to unpredicted events, the relationship between UHI, population density, and precipitation needs to be studied**.** This study examines the interrelationship among UHI, population density, and unanticipated precipitation events during the summer and winter in Western Coastal Cities. This research employs hypothesis testing to assess this interrelation. The null hypothesis assumes that there is no correlation between the study parameters, whereas the alternative hypothesis assumes that there is a correlation between the study parameters.

2. Methodology and Tools

The physiographic region of India was studied and the region that receives the highest precipitation (figure 2) i.e. The western coastal area is considered (Suthinkumar et al., 2019). Tier 2 cities (also called "Y" class cities) in the Western Coastal area as per the seventh pay commission are taken for further analysis (figure 3). Data such as population density, surface temperature, and precipitation of these selected tier 2 cities were collected (Figure 1).

To examine the unpredictability of events and shifts in trends over time, the study period is delimited to the summer and winter seasons of 1991, 2001, 2011, and 2021. Population data are gathered from census records for the years 1991, 2001, and 2011, while a population projection method known as the geometric increase method is employed to estimate the population for the year 2021 due to the unavailability of the 2021 census.

According to the Koppen climate classification, the summer season for the Indian west coast encompasses the months of March, April, and May, while the winter season encompasses November, December, and January. Surface temperature and precipitation datasets are sourced from the NASA Data Access Viewer portal. For the specified study years, monthly data on precipitation and surface temperature are procured from the portal. These data are then averaged separately for the summer and winter seasons. The collected and processed data is used for further analysis.

The analysis continues with the execution of a hypothesis test to determine the presence or absence of correlations among the chosen parameters (Figure 1). Spearman's rank correlation coefficient is employed to quantify the correlation between surface temperature, population density, precipitation, and humidity. This correlation is explored in terms of its fluctuation over the specified study period. The findings from this analysis will facilitate the drawing of meaningful inferences regarding the relationships and trends among these variables.

The collected data are processed and analyzed using Microsoft Excel software. To establish the correlation between variables, Spearman's rank correlation coefficient is employed. The rationale behind selecting this coefficient is the fact that the dataset under examination exists in a continuous form, which implies that it is measurable and quantitative. To study the relationship between parameters within the context of continuous data, correlation tests are used. Given that the primary objective of this research is to evaluate the extent of association between two variables, noteworthy correlation tests include the Pearson and Spearman correlation coefficients. Because Spearman's rank correlation coefficient is robust against the influence of outliers, this correlation coefficient is employed.

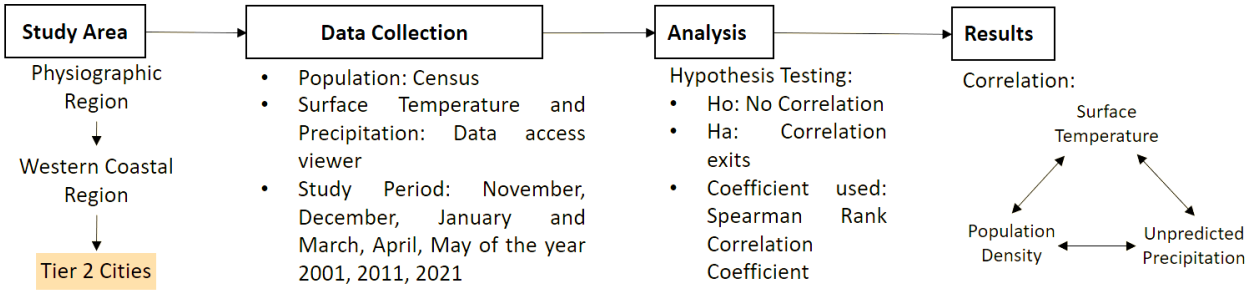


Figure 1. Methodology.

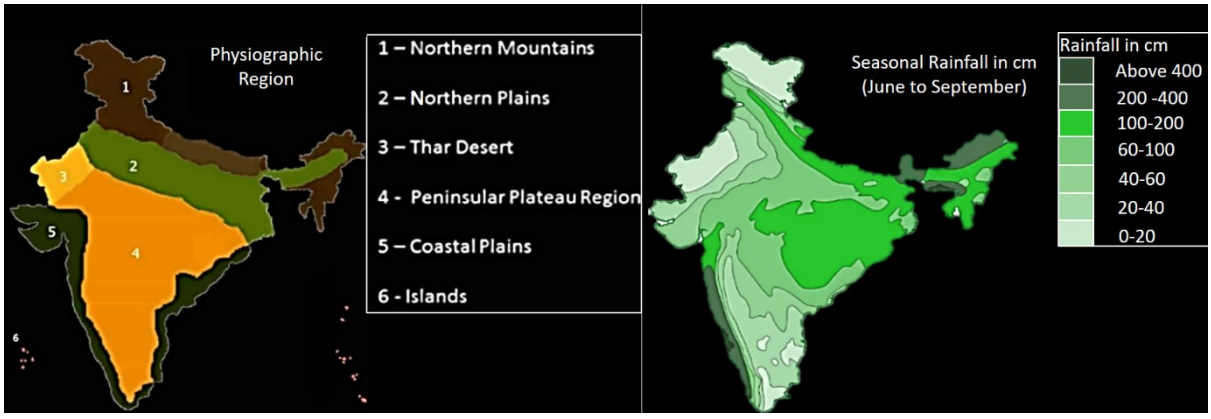


Figure 2. Physiographic region and rainfall distribution (Suthinkumar et al., 2019)

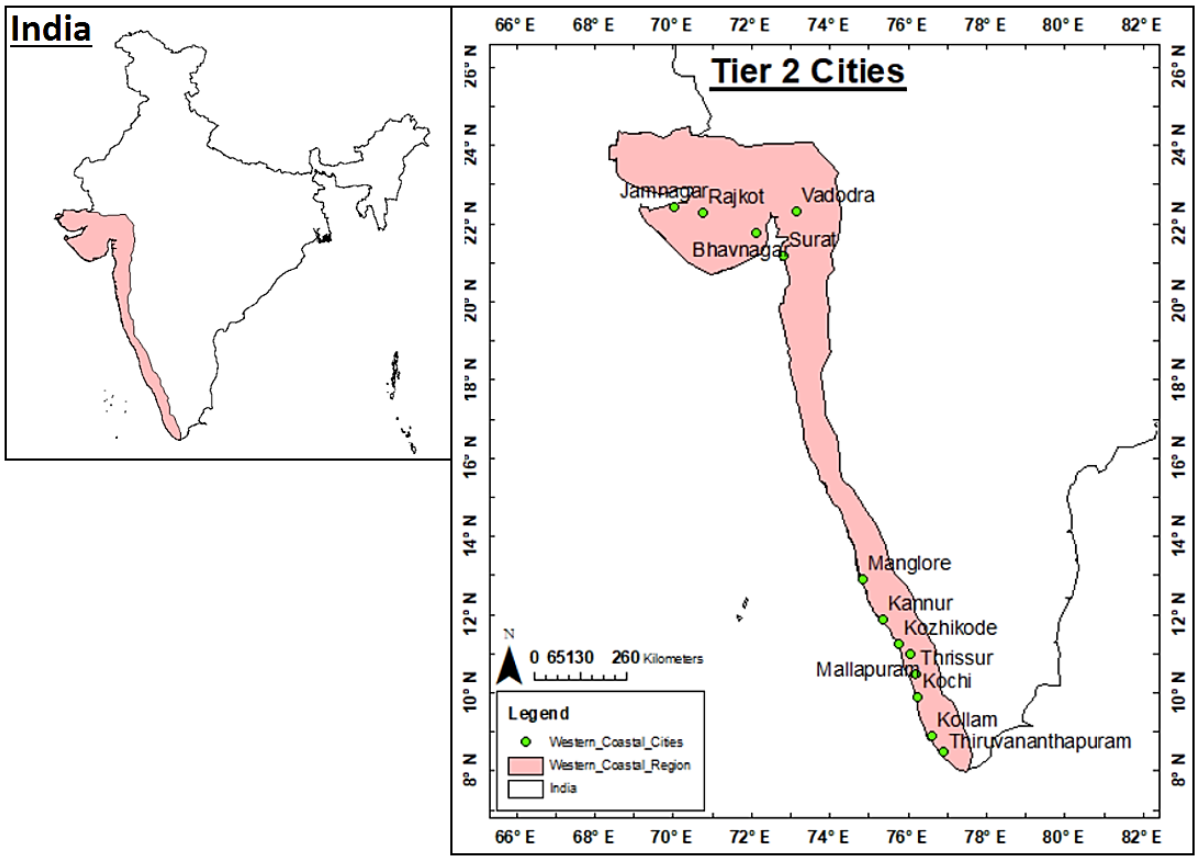


Figure 3. Study area.

Table 1. Cities data.

Sr. no.	Cities	Population	Area (sq. Km)	PD (Pop/sq. Km)	Average Summer Temp (° C)	Rainfall (mm)
1	Surat	4467797	326.5	13721	33.14	1243
2	Kochi	602046	94.8	6345	29.9	3014
3	Bhavnagar	593368	67.5	9681	34.7	656
4	Vadodara	1670806	219	7629	34.07	846
5	Rajkot	1323363	104	12725	32.7	676
6	Mangalore	488968	132.4	3691	29.77	3548
7	Kannur	56823	78	5152	27.25	3320
8	Thrissur	315957	101.5	3112	29.65	3123
9	Kolam	349556	57.3	6090	27.64	2427
10	Kozhikode	608255	118.5	5129	28.84	2011
11	Jamnagar	600943	122	4925	30.5	616
12	Thiruvanantha puram	960437	214.8	4470	29.15	1835
13	Malappuram	101386	58.2	1743	27.6	2852

Tier 2 cities have been selected for in-depth analysis, focusing on key parameters which include population density, temperature, and rainfall. Among, these cities, Surat emerged with the highest population, of approximately 4,467,797 individuals as per the 2011 census (Table 1). This high population is accompanied by a notable population density of 13,721 persons/ Km^2, indicating a concentrated urban environment. This indicates that Surat city is highly densified when compared to other cities. High population density can make the city more vulnerable to extreme and unpredictable events, such as natural disasters or public health crises. When many people live close together, the impact of such events can be more significant. A densely populated city like Surat may put more strain on natural resources, including water, energy, and land. Managing these resources sustainably becomes a critical concern.

For temperature-related data during the Summer season, Bhavnagar stands out among the thirteen cities for its distinct characteristics. Specifically, Bhavnagar registered the highest average summer temperature, reaching approximately 34.7 °C (Table 1). This data point underscores the region's propensity for elevated temperatures during summer. High summer temperatures can affect the well-being of residents, potentially leading to heat-related health issues. Adequate cooling and access to clean water becomes essential during hot summers. Elevated temperatures often lead to increased energy consumption for cooling, which can strain the local energy infrastructure.

Considering the precipitation data among the selected cities, Mangalore holds a noteworthy position. Mangalore receives the highest amount of precipitation among the thirteen cities, measuring approximately 3548 mm. This considerable level of rainfall signifies the region's distinct propensity to experience substantial precipitation events. This substantial amount of rainfall indicates the region's unique susceptibility to significant precipitation events, which can influence water resource management, flood risk, and local agriculture. The region's high precipitation levels can influence water resource management. Proper drainage systems and water storage facilities are essential to manage this abundance of water effectively. High levels of precipitation can increase the risk of floods, especially if the city's infrastructure and drainage systems are not well-prepared to handle excessive rainwater. Excessive rainfall can impact local agriculture, potentially leading to issues such as waterlogged fields, crop damage, and challenges in crop planning and cultivation.

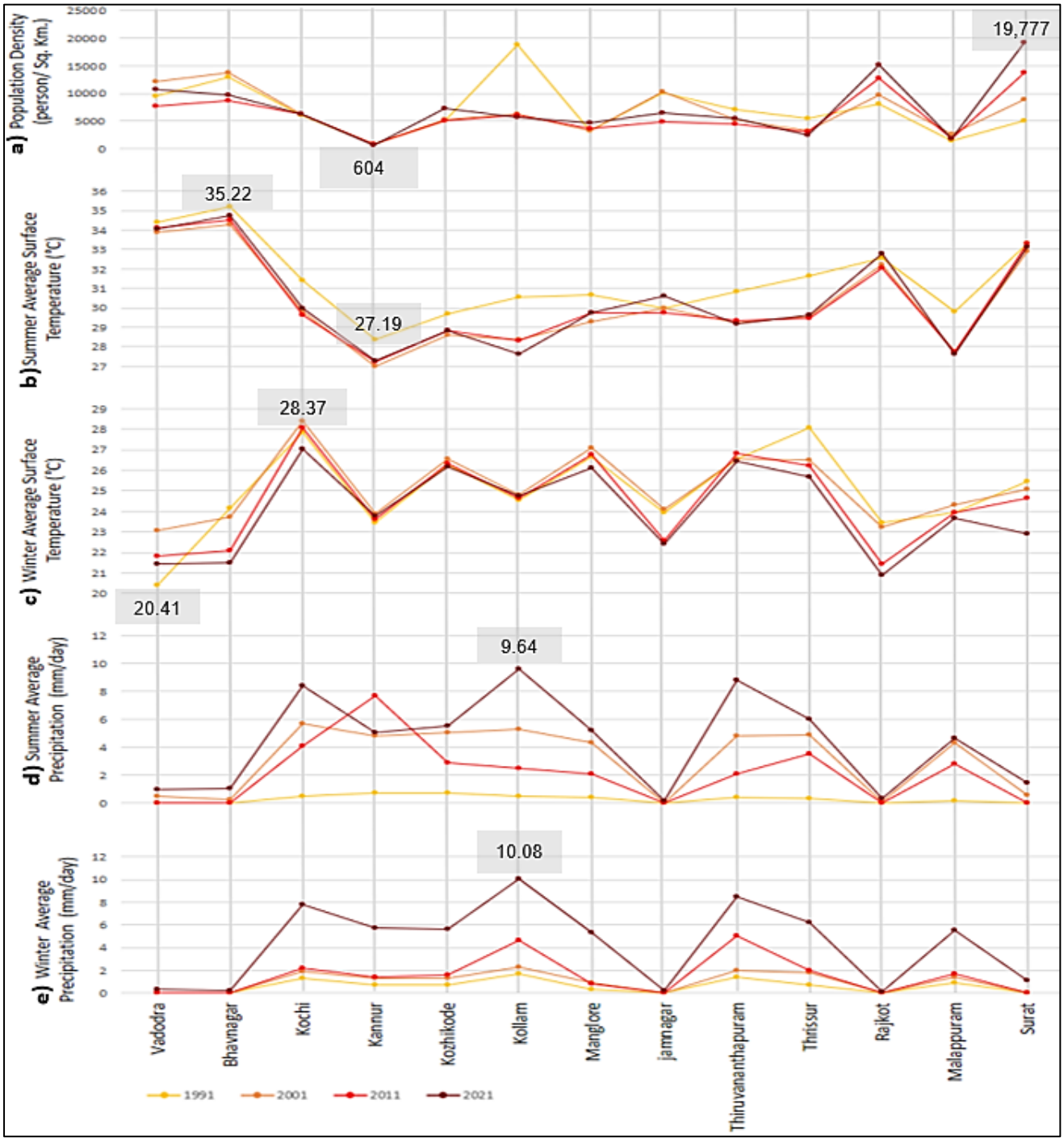


Figure 4. Data of selected cities for the years 1991, 2001, 2011 and 2021 related to **a)** population density (person/ sq. Km); **b)** summer average surface temperature (°C); **c)** winter average surface temperature (°C); **d)** summer average precipitation (mm/day) **e)** winter average precipitation (mm/day).

Surat and Rajkot show an increase in population density over time (Figure 4. a). Whereas, in other cities, due to a lower growth rate of population or expansion of city limits, the densities either reduced or remained constant. In the case of Kollam, as the area increased from 18.48 Km^2 to 57.31 Km^2, a drastic drop in density can be seen from 1991 to 2021 (Kovoor & Panjikaran, 2021). Surat, which is expected to have 62,44,354 populations in 2021, has the highest population density at 19,177 persons/ Km^2. The average temperatures in summer and winter are 33.31°C and 24.66°C, respectively, and the average precipitation in summer and winter is 1.43 mm/day and 1.15 mm/day, respectively (Table 2). Kannur, which is expected to have a population of 47,082 in the year 2021, has a lower population density of 604

person/Km^2 because of its negative growth rate of 1.1 %. The average temperatures in summer and winter are 27.19°C and 23.60°C, respectively, and the average precipitation in summer and winter is 5.05 mm/day and 5.70 mm/day, respectively (Table 2).

Among the recorded average summer surface temperatures, Bhavnagar recorded the highest temperature in 1991, around 35.22°C (Figure 4. b). Its population density in 1991 was 18,080 persons/ Km^2 and Its average annual precipitation in both summer and winter was zero (Table 2). Kannur recorded the lowest average summer surface temperature, 27.00°C in 2001 (Figure 4. b). Among the recorded average winter surface temperatures, Kochi recorded the highest temperature in 2001, around 28.37°C (Figure 4. c). Its population density in 2001 was 6,286 person/ Km^2, and its average precipitation in summer and winter was 5.71 mm/day, and 1.88 mm/day, respectively (Table 2). Vadodara recorded the lowest average temperature of, 20.41°C in 1991 (Figure 4. c). Its population density in 1991 was 9,527 persons/ Km^2 and Its average annual precipitation in both summer and winter was zero (Table 2).

In summer as well as winter, the highest recorded average precipitation is in Kollam in the year 2021 which is 9.64 mm/day (Figure 4.d) and 10.08 mm/day (Figure 4. e) respectively. Its population density in 2021 is 5,628 person/ Km^2, and its average temperature in summer and winter is 27.64°C, and 24.72°C, respectively (Table 2).

Table 2. Comparative analysis of cities with the highest and lowest values of key indicators.

Cities	Year	Population Density (Person/ Km^2)	Average Summer Surface Temperature (°C)	Average Winter Surface Temperature (°C)	Average Summer Precipitation (mm/ day)	Average Winter Precipitation (mm/day)
Surat	2021	19,777	33.31	24.66	1.43	1.15
Rajkot	2021	15,231	32.78	20.87	0.35	0.15
Kannur	2021	604	27.19	23.60	5.05	5.70
Bhavnagar	1991	18,080	35.22	24.12	0.00	0.00
Kochi	2001	6,286	29.79	28.37	5.71	1.88
Vadodara	1991	9,527	34.40	20.41	0.00	0.00
Kollam	2021	5,628	27.64	24.72	9.64	10.08

3. Results

The Spearman rank correlation coefficient is a statistical measure used to investigate the relationship between selected parameters, i.e., surface temperature, population density, and precipitation. It offers insights into how these factors co-variate over a given period. By calculating the correlation coefficient, researchers can determine the strength and direction of the relationship between UHI and the other parameters. A positive correlation indicates that as one parameter increases, the other also increases. Conversely, a negative correlation suggests an inverse relation, where one parameter increases and the other decreases. The analysis conducted over a specific time frame allows researchers to assess variations in the relationship between these parameters. This provides valuable information regarding the impact of one parameter on the other over time. The obtained correlation coefficients provide numerical values that quantify the strength and direction of these relations. Positive values close to 1 indicate a strong positive correlation, whereas negative values close to -1 signify a strong negative correlation. Values close to 0 indicate weak or negligible correlation. These correlation coefficients serve as quantitative measures, enabling researchers to assess the impact of surface temperature, population density, and precipitation on the UHI phenomenon. By analysing these coefficients over time, trends and patterns can be identified, aiding in understanding the complex interactions and dynamics between these factors. This information is highly valuable for urban planners, policymakers, and researchers seeking to mitigate the effects of UHI and create more sustainable and resilient cities.

3.1. Surface Temperature and Population Density

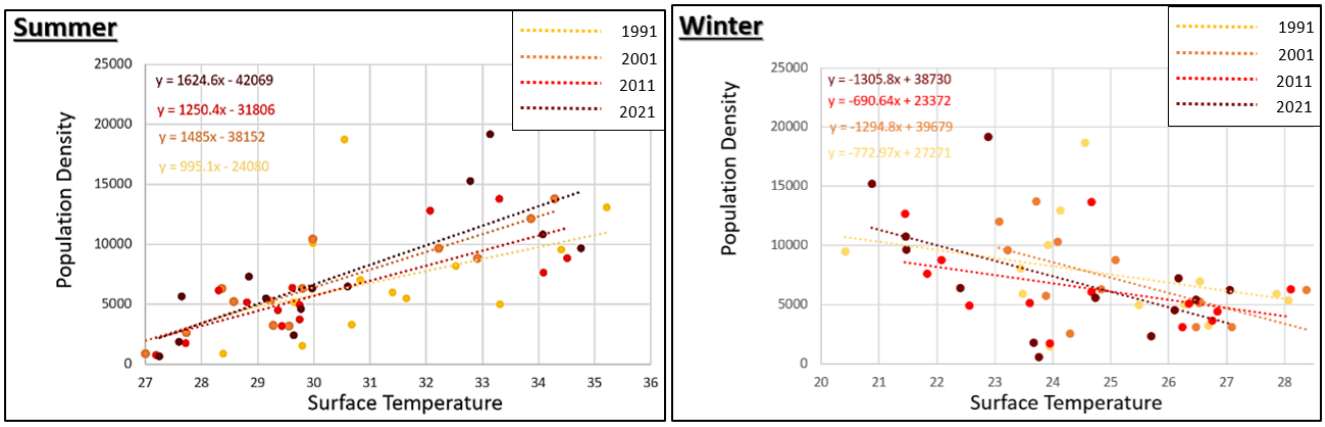


Figure 5. Graph illustrating the relationship between surface temperature (°C) and population density (Person/Km^2).

Table 3. Spearman Rank Correlation Coefficient.

Surface Temperature and Population Density				
Year	**Coefficient (Summer)**	**Remark**	**Coefficient (Winter)**	**Remark**
1991	0.313	Weak Positive Association	-0.374	Weak Negative Association
2001	0.741	Strong Positive Association	-0.621	Strong Negative Association
2011	0.621	Strong Positive Association	-0.451	Moderate Negative Association
2021	0.802	Very Strong Positive Association	-0.505	Moderate Negative Association

The investigation reveals a distinct seasonal pattern in the relationship between surface temperature and population density within the designated study years of 1991, 2001, 2011, and 2021. During the summer, a positive correlation was observed between surface temperature and population density, indicating that as population density increases, surface temperature also increases. Conversely, in the winter, a negative correlation is evident, signifying that as population density increases, surface temperature decreases (Figure 5).

In summer, the strength of the association between surface temperature and population density gradually intensifies over the years. This is exemplified by the correlation coefficient, a measure of the degree of correlation. In 1991, the correlation coefficient was relatively weak at 0.313, but it substantially increased, reaching 0.802 by 2021 (Table 3). This substantial boost in the correlation coefficient signifies a more pronounced and robust correlation between population density and surface temperature during the summer season, implying that as cities become more densely populated, their impact on local temperatures in the summer becomes increasingly significant.

On the other hand, the winter season does not exhibit a similar trend of strengthening correlation between surface temperature and population density. The relationship remains relatively stable across the study years, indicating that population density's influence on winter temperatures remains consistent. This may be due to the stability of heating practices and a lesser impact of urbanization on winter temperatures compared to the summer. These findings provide valuable insights into the complex interplay between urbanization and climate patterns, with potential implications for urban planning, energy consumption, and sustainability efforts.

3.2. Surface Temperature and Precipitation

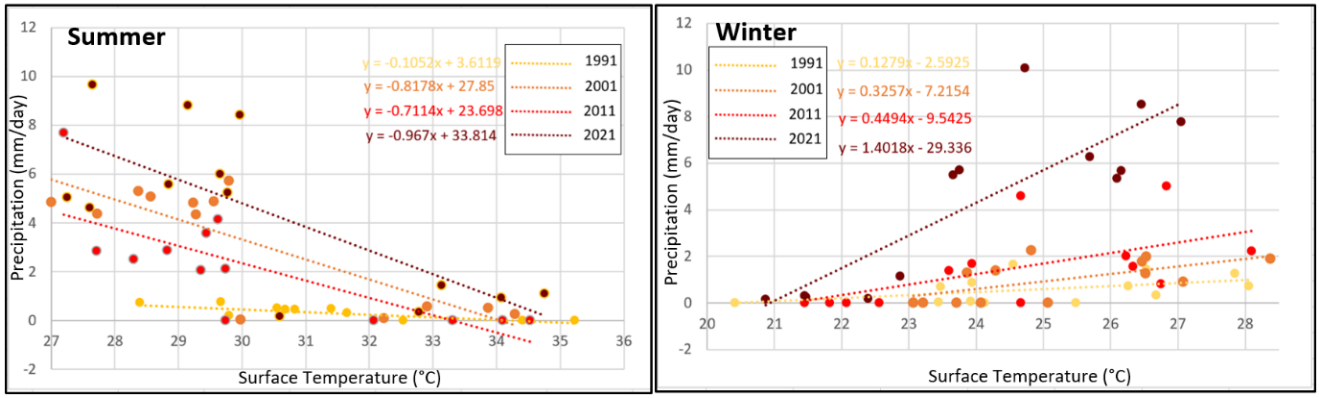


Figure 6. Graph illustrating the relationship between surface temperature (°C) and precipitation (mm/day).

Table 4. Spearman Rank Correlation Coefficient.

Surface Temperature and Precipitation				
Year	**Coefficient (Summer)**	**Remark**	**Coefficient (Winter)**	**Remark**
1991	-0.635	Strong Negative Association	0.511	Moderate Positive Association
2001	-0.621	Strong Negative Association	0.638	Strong Positive Association
2011	-0.740	Strong Negative Association	0.713	Strong Positive Association
2021	-0.588	Moderate Negative Association	0.813	Very Strong Positive Association

A distinct connection between surface temperature and precipitation, exhibiting seasonal variation during the summer and winter is observed. During the summer, a negative correlation exists between surface temperature and precipitation (Figure 6). However, this negative correlation has displayed a tendency to wane over the selected study years. This trend is evident through the decreasing coefficient values indicating decreasing association, which have gradually declined from -0.635 in 1991 to -0.588 in 2021 (Table 4).

Conversely, the relationship between surface temperature and precipitation in the winter season is characterized by a positive correlation, and this association has been growing more robust over time, as observed from the study of the selected study period. This escalating association was observed through the ascending coefficient values. This progression signifies an increasingly pronounced positive link between surface temperature and precipitation during winter.

3.3. Population Density and Precipitation

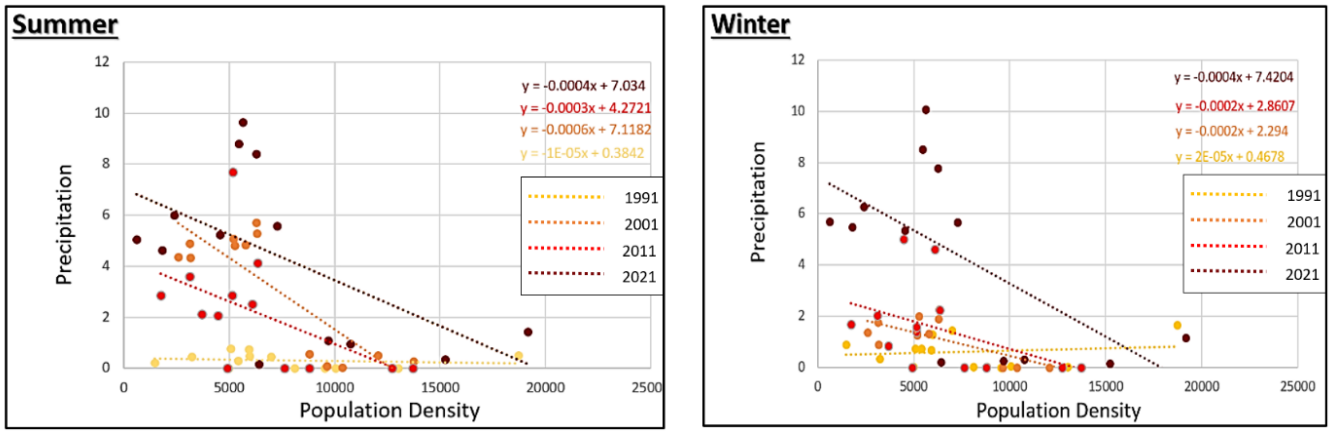


Figure 7. Graph illustrating the relationship between population density (Person/Km^2) and precipitation (mm/day).

Table 5. Spearman Rank Correlation Coefficient.

Population Density and Precipitation				
Year	**Coefficient (Summer)**	**Remark**	**Coefficient (Winter)**	**Remark**
1991	-0.287	Weak Negative Association	-0.115	Very weak negative Association
2001	-0.571	Moderate Negative Association	-0.646	Strong Negative Association
2011	-0.442	Moderate Negative Association	-0.578	Moderate Negative Association
2021	-0.495	Moderate Negative Association	-0.582	Moderate Negative Association

The correlation between population density and precipitation exhibits a negative pattern during both summer and winter (Figure 7). Notably, this negative correlation becomes more pronounced during the summer months, which is evident from the escalating coefficient values observed over the course of the chosen study period (Table 5). However, this trend of strengthening correlation is not evident during the winter.

Considering the null hypothesis (Ho) as no correlation exists between UHI, population density and precipitation. Alternative Hypothesis (Ha) as correlation exists between selected indicators. For the level of significance of 5% and the number of samples 13 (number of cities = 13), r_c is 0.478. This critical value of r_c is compared with the results of the analysis:

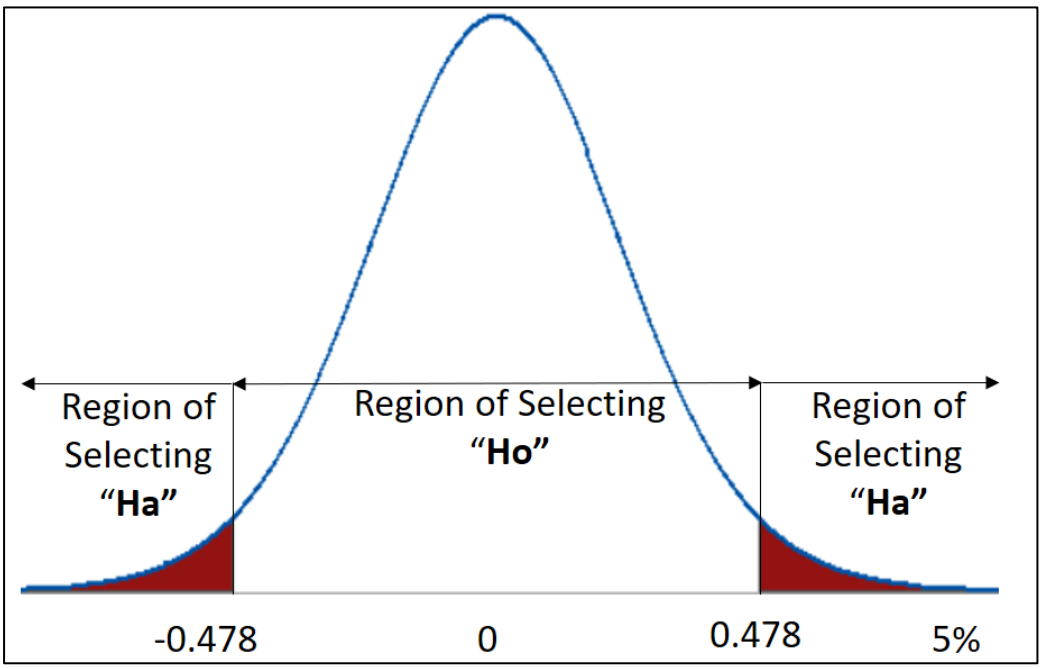


Figure 8. Critical Value of Correlation Coefficient.

Table 6. Table showing theory's acceptability in terms of accepted hypotheses.

a. Surface Temperature and Population Density				
Year	**Summer**	**Hypothesis Accepted**	**Winter**	**Hypothesis Accepted**
1991	0.313	Ho	-0.374	Ho
2001	0.741	Ha	-0.621	Ha
2011	0.621	Ha	-0.451	Ho
2021	0.802	Ha	-0.505	Ha

b. Surface Temperature and Precipitation				
Year	**Summer**	**Hypo Accepted**	**Winter**	**Hypo Accepted**
1991	-0.635	Ha	0.511	Ha
2001	-0.621	Ha	0.638	Ha
2011	-0.740	Ha	0.713	Ha
2021	-0.588	Ha	0.813	Ha
c. Population Density and Precipitation				
Year	**Summer**	**Hypo Accepted**	**Winter**	**Hypo Accepted**
1991	-0.287	Ho	-0.115	Ho
2001	-0.571	Ha	-0.646	Ha
2011	-0.442	Ho	-0.578	Ha
2021	-0.495	Ha	-0.582	Ha

The analysis revealed interesting findings regarding the correlation between the selected indicators. First, the acceptance of Ha indicates that a correlation indeed exists among the chosen parameters. Specifically, a positive correlation has been observed between surface temperature and population density during the summer since 2001 (Table 6. a.). This suggests that as population density increases, surface temperatures also tend to rise, indicating a potential urban heat island effect. However, a negative correlation during the winter is inferred from the negative numerical value of the correlation coefficient. However, empirical support for the strength of this relationship remains inconclusive, as per the results of hypothesis testing. Specifically, the null hypothesis is selected for the examined period from 1991 to 2011, whereas the alternative hypothesis is adopted for the timeframe from 2001 to 2021 (Table 6. a). This discrepancy underscores the intricate and unclear nature of the relationship between surface temperature and population density during the winter.

Furthermore, for the correlation between surface temperature and precipitation, a conclusion was drawn from the calculated correlation coefficients. During the summer season, a negative correlation was observed between these variables, whereas in the winter season, a positive correlation was observed. This observation is reinforced by the acceptance of the alternative hypothesis for both seasonal categories throughout the study duration (Table 6. b). This alignment of hypotheses underscores the substantial and noteworthy relationship between surface temperature and precipitation.

When examining the correlation between population density and precipitation, an indistinct negative correlation was observed during the summer. This is elucidated by the acceptance of the null hypothesis for the study period of 1991 and 2011, and the alternative hypothesis for the years 2001 and 2021 (Table 6. c). In contrast, the winter paints a more definitive picture. This is evidenced by the consistent acceptance of the alternate hypothesis across all periods, for the initial year, 1991.

4. Discussion

The purpose of this study is to examine the relationship between surface temperature, population density, and precipitation to investigate shifts in traditional seasonal patterns. Previous research has indicated a positive relationship between surface temperature and population density (Oke T. R., 1973; Oke & Maxwell, 1975; Mallick, 2021). However, an intriguing trend surfaced in the context of western coastal cities when scrutinizing the association between population density and surface temperature. During the summer, there is a positive correlation between population density and surface temperature, which has grown stronger over time. This suggests that as population density increases, surface temperatures also climb in these coastal cities during summer, aligning with prior research findings. However, during the winter, a contrasting relationship emerges between population density and surface temperature. Here, a negative correlation exists, indicating that as population density increases in winter, surface temperatures tend to decrease. This finding is captivating and could be linked to distinct factors. During winter, factors such as heating systems, reduced solar radiation, and specific urban features may counteract the urban heat island effect, leading to lower surface temperatures in densely populated regions.

As surface temperatures increase, precipitation also tends to increase (Ackerman et al., 1977; Bornstein & Lin, 2000; Shepherd et al., 2002; Dixon & Mote, 2003; Shepherd & Burian, 2003; Bentley et al., 2010).

In the case of these western coastal cities, a positive correlation was observed between surface temperature and precipitation in the winter season, again aligning with prior research findings. However, a negative correlation was observed between surface temperature and precipitation during the summer.
To understand this discrepancy, it is important to consider the unique geographical characteristics of the study area, particularly its proximity to the ocean. Coastal cities are influenced by the presence of the ocean, resulting in distinct weather patterns and thermal effects. One such effect is the unequal heating of land and water. During the day, land heats up faster than the adjacent ocean, creating a temperature gradient. This temperature difference leads to the formation of sea breezes, which blow from the ocean toward the land. Sea breezes are stronger during the summer when the land surface temperature is higher. This stronger sea breeze can dissipate cloud formation, leading to a negative correlation between the average surface temperature and average precipitation in summer. The cooling effect of the sea breeze reduces cloud formation, resulting in lower precipitation despite higher surface temperatures.
Conversely, during the winter, land breezes occur. Land breezes blow from the land toward the ocean at night when the land surfaces cool down more rapidly than the ocean. This can facilitate the formation of clouds and increase the likelihood of precipitation. As a result, a positive correlation is observed between the average surface temperature and average precipitation in winter when the correlation between population density and surface temperature is negative.
These unique coastal weather patterns and the interplay between land and ocean thermal characteristics contribute to the observed correlations in these western coastal cities. This relationship between surface temperature and precipitation may be a result of these specific geographic and climatic factors. These findings highlight the complexity of studying urban climate dynamics and emphasize the importance of considering local conditions and regional variations when analyzing correlations between urban parameters.

5. Conclusion

This study provides a view of the temporal and seasonal correlation between the land surface temperature, population density, and precipitation in the tier 2 Western coastal cities during the study period 1991, 2001, 2011 and 2021. Several conclusions can be drawn from this study.

1. A significant positive relation is observed between surface temperature and population density during summer. This relation is getting stronger over the period, evident from the increasing positive value of the correlation coefficient, from 0.313 in 1991 to 0.802 in 2021 indicating a positive increasing correlation between the parameters. However, an insignificant negative correlation is observed in the winter.
2. The relationship between surface temperature and precipitation is negative for the summer and positive for the winter.
3. The results for the relationship between population density and precipitation suggest that population density and precipitation exhibit unclear seasonal variations in their correlation, indicating the influence of different factors and mechanisms in different seasons. The weak and inconsistent correlation suggests that other factors or regional variations might have a more significant impact on precipitation patterns, which needs to be explored.

Understanding these correlations is crucial for urban planners, policymakers, and researchers to mitigate the urban heat island effect and create more sustainable and resilient urban environments. By considering the relationship between these parameters over time, informed decisions can be made to develop effective strategies to tackle the challenges associated with urbanization, climate change, and population growth.
By dissecting these interactions across seasons and timeframes, a deep understanding of their dynamics emerges. This view aids in making informed decisions regarding urban planning and climate adaptation. Moreover, these insights open avenues for deeper investigations into the mechanisms underlying these complexities. Ultimately, this research enriches our understanding of how these variables intertwine, offering valuable insights for addressing the challenges posed by their interactions.

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Conflicts of Interest
The Authors declare that there is no conflict of interest.

Data availability statement
Data for the analysis is gathered from https://power.larc.nasa.gov/data-access-viewer/.

Ethics statements
Studies involving animal subjects: No animal studies are presented in this manuscript.
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- Data curation, Formal analysis, Investigation, Resources, Software, Writing – original draft & editing: Phd. Rachana Patil.

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Revitalization Approaches to Maximize Heritage Urban DNA Characteristics in Declined Cities: Foah City as a Case Study

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ABSTRACT

Revitalization is an important process in action area planning, especially in the heritage sites located within urban area contexts. Varied techniques and tools of revitalization are applied at various spatial levels, some are suitable for the urban scope, and others suit the architectural building scope. Urban DNA is a term used academically to reflect social, economic, and urban characteristics but has a different interpretation that depends on the spatial scale and context. In action areas, urban DNA refers to the essential visual, social, economic, and physical characteristics that preserve the vital structure of an urban area. Heritage areas are vital in a city structure, in the journey of maximizing the urban DNA chrematistics of heritage sites, sometimes the urban DNA is lost in the process. This paper identifies and encapsulates the importance of Urban DNA in heritage site considerations in the revitalization process within heritage urban context to maximize the socio-economic and visual impacts, especially in declined cities such as Foah City the case study in the Nile Delta region in Egypt. The results pinpoint the most effective urban DNA structure for the declined Foah Heritage Center, despite the city's importance as a ranked third of heritage cities in the country.

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Highlights:

- Revitalization is crucial in urban planning for heritage sites, employing different techniques tailored to urban and architectural scales.
- Urban DNA, comprising visual, social, economic, and physical aspects, is key to maintaining the integrity of heritage areas, though it may be compromised during revitalization.
- This study underscores the significance of Urban DNA in the revitalization of heritage sites to enhance socio-economic and visual outcomes, illustrated by Foah City in Egypt's Nile Delta.

Contribution to the field statement:

This article contributes to academia by emphasizing the importance of revitalizing heritage sites in urban planning and highlighting the concept of "Urban DNA" for preserving heritage areas during revitalization. It offers insights on tailoring techniques to different urban and architectural scales, enhancing socio-economic and visual outcomes. The article also introduces a biological approach for analyzing heritage areas' physical and visual profiles, providing valuable insights for urban planners and scholars in heritage preservation and urban revitalization.

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1. Introduction

Vital human functions play an important role in maintaining the continuity of human performance of basic activities for survival, growth, and physical and mental development, and the basic unit for the preservation of these vital activities is the DNA present in a basic cell which is called the genetic DNA or Human DNA Kaya and Bölen (2017) defined biological DNA as "the genetic material or information and guidance for the development, growth, and reproduction of genes where genetic information is transmitted from parents to children" (Kaya & Bolen, 2017), that distinguishes each human physical and mental characteristics from another. The urban characteristics stand as the urban DNA in this research, which is responsible for maintaining the uniqueness of its own physical and visual qualities that distinguish an urban area from another.

2. literature Review Urban DNA

2.1 rationale and concept of urban DNA

Like the human body's biological structure and evolution, urban evolution can be described as the long-term aggregate effect of urban components such as urban fabric, buildings, activities, and land uses (Silva, 2004). It can be argued that a certain urban area has an element or set of elements responsible for its function such as the performance of a human's genetic DNA, beyond economic, demographic, or other forces that shape the urban area, cities are not just the result of rational planning, in the same way living organisms are not simply what is in their genetic codes, but even unplanned cities evolve by following several simple universal mechanisms regardless of cultural and historical differences. In addition, urban DNA is a view deducted from mechanisms in biological research such as mutation, and hybrid of genes, and these concepts can be applied to urban studies, In that case, the (Element/Elements) responsible for urban character, and activities that distinguish urban areas and confer a unique personality and identity on each area to the extent that the areas are distinct from each other, both functionally and visually (Youssef, 2021). Previous literature has addressed the issue of urban DNA in several research aspects, including addressing the issue of urban DNA as features or qualities that distinguish urban areas from each other, especially when discussing urban patterns and land uses at the level of urban planning of the city (Youssef, 2023), while others addressed the concept of DNA at the larger level in planning through the regional scale of urban regions to study those features and their impact on urban growth and how to characterize patterns of that growth depicted in Figure 1 (Silva & Wu, 2017). The urban planning and design literature dealt with many components of the areas that make them distinct from each other such as street networks, economic activities, elements of movement, and the urban and architectural character of building formations, so those elements can be called in this research, the genetic DNA because of their roles and functions.

Genetic material carries genetic information, guidance, and qualities specific to human genes. Human DNA is one of the most popular biomolecular compounds. Every cell in the body contains DNA, which is located inside the cell's nuclei, and which distinguishes it from other living organisms, by carrying the ingredients, compounds, and elements needed for the components that distinguish each human from the other and cannot be repeated and containing each person's unique genetic code, which carries the instructions for building proteins essential to the human body (Gifford , 2000). Gene, an organism that carries DNA and carries every class of DNA is associated with specific behaviour. It is the smallest basic unit responsible for genetics. metaphorically, in the urban realm, it can be assumed that urban character carries the ingredients, compounds, and elements needed to distinguish each urban area from the other in an urban context (Gifford , 2000). Urban DNA term is used in this research as a representation of the Urban character of heritage areas to understand what makes heritage areas unique in terms of urban character elements that are responsible for creating that unique urban DNA see Figure 1.

The research focuses on addressing urban revitalization strategies in heritage areas, the subject of the urban DNA represented in the features of urban character, the research is focused on identifying the major and minor elements of that urban DNA. The research presents a more focused and

detailed view of the topic of character by identifying the components of the urban DNA of the heritage the essential elements responsible for preserving that character and how it can enhance the strategies and methods of revitalization in the heritage area.

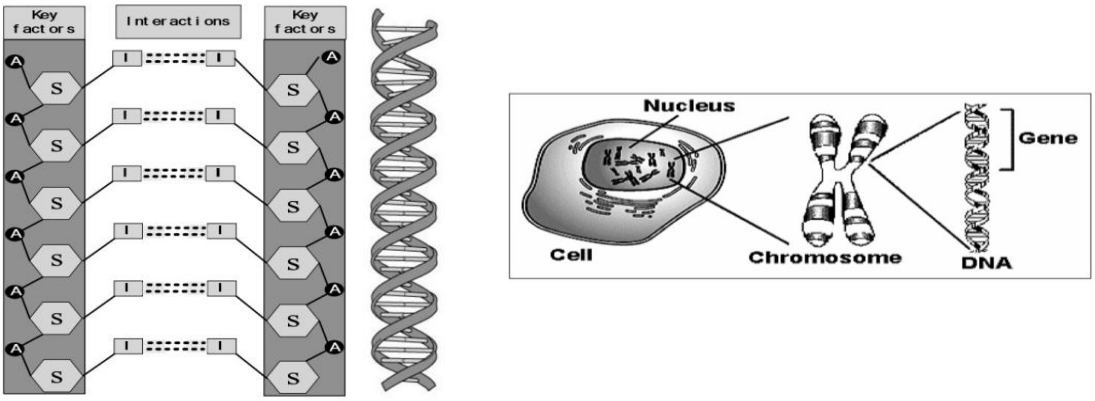


Figure 1. Structure of Human DNA versus Urban DNA (Silva and Wu, 2017).

2.2 Urban Character Context vs. Biological DNA

Previous researchers discuss the similarities between Urban characters including the physical and non-physical and genetic DNA, Urban DNA is a borrowed view of biological research mechanisms such as natural selection, mutation, and hybrid of genes. Researchers have also pointed out that these concepts can be applied to urban studies. Admittedly, it is difficult to identify a general genetic urban DNA for all physical analyses, not only because urbanization is a complex system, but because there are a lot of variables that can affect the forming process and urban fabric forming a different genetic urban DNA group and may be derived from different applications or perspective. Urban DNA was initially discussed in urban growth contexts and quantitative urban modelling, Silva 2004 and 2017, but the idea recently also found resonance in modular spatial design. Batty and Longley (2014) discuss that urban growth processes symbolize rules that dictate how to achieve the organization and replication of primary spatial social entities for certain urban forms and urban functions across metrics (Batty & Longley, 2014). Wu and Silva (2017) discuss that virtual urban DNA should include both spatial and non-spatial genes and that it should reflect both the drivers of urban growth and the institutional responses to it. Regarding the latter, unlike the way biological DNA plays out in natural selection, biological variation, and evolution, urban DNA will have a clear feature of deliberate intervention. In Addition, a different approach focuses not on how to build growth engines and institutional behaviour for urban DNA, but on how spatial planners synthesize a genetic pattern equal to disparities in the spatial distribution of benefits and negative exogenous factors of urban clusters (Silva & Wu, 2017). Despite this, it is possible to define a general structure for the physical genetic DNA, as shown in Figure 1. In general, the physical genetic DNA integrates both spatial and non-spatial genes of the urban character of the city. In that perspective in the spatial scale of urban areas urban DNA of specific functions such as industrial, Historical, and Commercial areas can be deducted in the sense of what urban character elements are responsible for creating that specific Urban DNA for this area. The research is focused on the Heritage area's urban DNA and the various elements that reform that urban DNA.

2.3 Urban Character Philosophy

Researchers discussed the relationship between public and historical character and its impact on urban and human settlements to explore the basic principles of nature's perceptions and historical dimensions. Lynch, 1981 discussed the visual elements of good city form and how designing the city can impact the overall visual image. Cullen discusses how urban form elements and features can weave a certain unique character of cities (Cullen, 1995). Brenner discusses the aspect of scale

that impacts the perception of urban character (Brenner, 2019). Furthermore, is also important to highlight the idea of the effectiveness of urban fabric as a framework for identifying and describing material characteristics that contribute to the formation of the general and historical urban character of cities (Calthorpe, 1993). Karl Kropf (1996), one of the most important researchers discussed this idea of the urban fabric and its relationship to personality and urban character. Kropf says that the character arises as a reaction to a city, a particular area, or a street with an urban and visual distinction in the character of the place. Kropf discussed the idea of character and philosophy that urban character is what determines the shape, features, and features of the place. (Kropf, 1996) argues that the distinctive personality of the age depends on the observation and the element of observation in the visual features and elements of urbanization, so the character can only be identified by knowing the measurement tools of the character and cannot be determined if it does not identify specific and reasonable attributes. Urban DNA concept in the scale of the district can be built on, the philosophy of urban character and its relationship to the formation of urban personality on the 3 basic hypotheses discussed by Kropf as follows:

First hypothesis: Personality is attributed only to the city, The common idea of character is that it is always attributed to cities in general, but Kropf sees that character cannot be reduced to physical objects buildings, or users, but the character is the harmonious of users with physical objects that create a distinctive urban character.

The second hypothesis: Character is a set of differences, features that give the city its character are things that make it different from others. Kropf also regarded the character as a set of differences that characterize civilization as things that make it different from others. In old cities such as Venice and Los Angeles, desert settlements such as Saudi Arabia heritage communities (Alzamil, Al-Qahtani, & Al-Takhifi, 2023), or even in new cities in England such as the city of Milton Keynes, they are distinct and unique cities, each of which has the advantage of giving civilization its identity (Yeang, 2000). So, the character reflects the form of urbanization both in historical areas such as existing cities but can also be applied in new cities (The Urban Task Force, 1999), simple characteristics such as building materials and construction details are not enough to create an entire character but are just part of the character.

The third hypothesis: There are other more important and larger components such as the entire building, plots, blocks, gardens, streets, and areas because there are patterns of materials and the composition of components with each other constitutes a pattern (Abusaada & Elshater, 2023), these components greatly contribute to the composition of the character of the city if we look at the idea of the pattern more broadly or more comprehensively, (Kropf, 1996).

The previous discussion leads to the basic conclusion that dealing with the pattern in the city must understand the interlinkages in Urban Complexity between all those elements, The concept of entanglements is the theoretical basis for perceptions of the shape of the city.

The city is complicated by that concept because it is made up of several systems and composite elements with each other. Analysis of urban context components based on (Kropf, 1996) previous insights of character argument and the similarity in features and characteristics between the biological genetic DNA and the physical genetic DNA is shown in Figure 2 where complexity and hierarchy are the major influences in both biological and urban character.

In addition, similarities extend within the concept of the major unit and the minor unit, in one biological DNA there is a unit called double-strand DNA, which contains a major and minor unit, and through the replication of this unit, a complete biological DNA formation can function perfectly in a human body.

In an urban context, the city spatial formation is almost the same as biological DNA through zones and sub-zones that are replicated with different functions for each zone to create a fully functional urban DNA. It can be assumed philosophically that the assumption of similarities between biological DNA and urban DNA are plausible, and can form a platform to study the elements that

form each urban area's unique character that can be labelled as urban DNA to describe various areas in the city, such as residential, industrial, historical, commercial, etc.

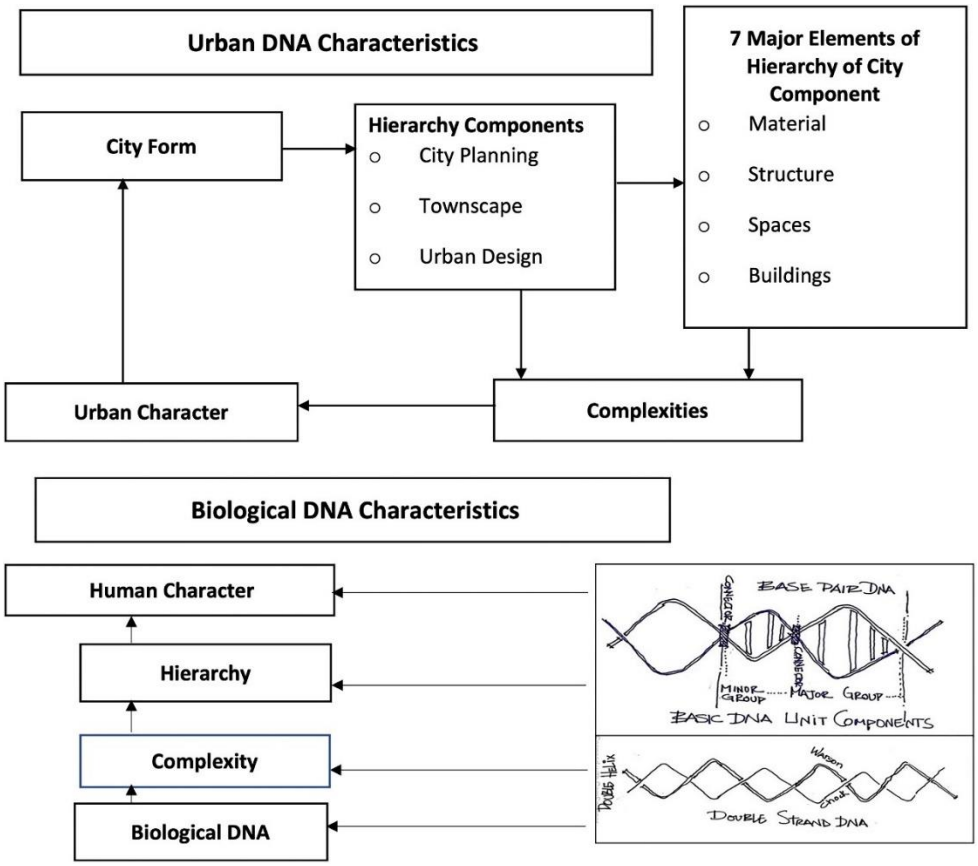


Figure 2. Similarities between Human DNA and Urban Characteristics Complexity DNA.

3 Urban DNA Analysis

3.1 Urban character analysis to form the theoretical base of urban DNA

Many authors discussed the structure and elements of urban character, (Lynch, 1964), (Lynch, 1984), (Cullen, 1995), (Kropf, 1996), and many others, furthermore, the British Urban Design Compendium Report released in 2000 by Yeang, structured the components of urban character concisely, providing an integrated view of what urban character represents within the urban design methodology. In addition, Yeang (2000) provides a systematic method to deal with urban character elements in reshaping and redesigning action areas. That point of view is essential in the revitalization process especially when managing historical and heritage areas, this research adopts the classification of Yeang (Yeang, 2000).

In this research, we reclassified the elements of urban character based on the literature discussion of how Silva, 2004 classified urban data to form urban DNA classification, which is based on dividing elements into three main categories;

1. Spatial Level that indicates the physical characteristics of the urban context,
2. A-spatial level which indicates the non-physical characteristics such as the social, and economic aspects of urbanism, and finally,
3. Interaction factors stand for the elements that are a result of combining physical and non-physical factors such as visual image, skyline, Activities, etc. We can argue that using this classification is an attempt to integrate the concept of complexity and hierarchy of biological DNA into the urbanism point of view to understand what urban DNA should look like. A further step by the research in Figure 3, is an attempt to classify urban character into these main three categories, which contribute towards understanding urbanism from the biological point of view.

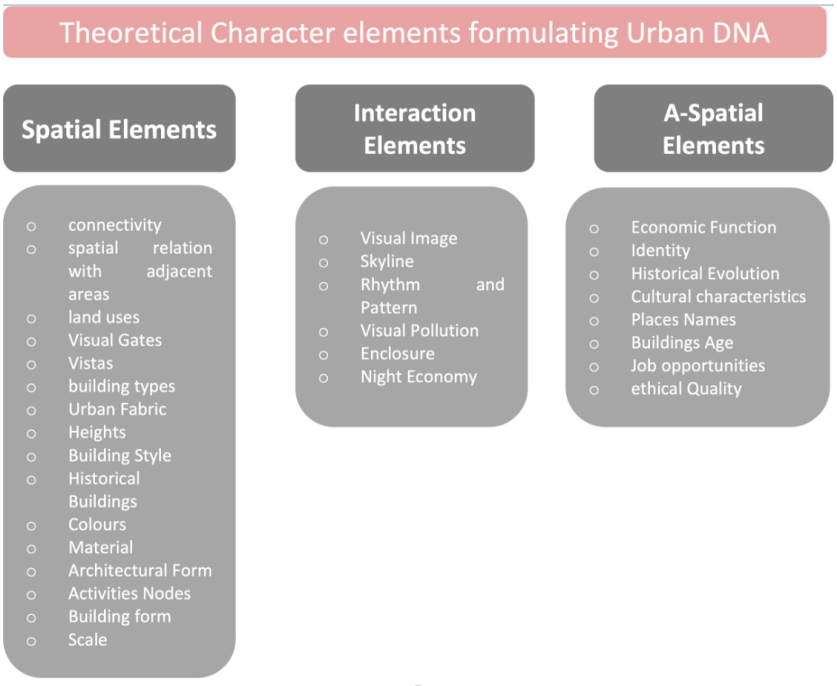


Figure 3. Classification of Urban Character elements into Basic Urban DNA Model of Spatial, A-spatial, and Interaction elements.

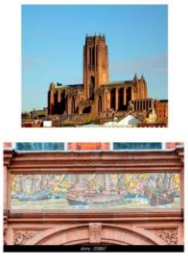
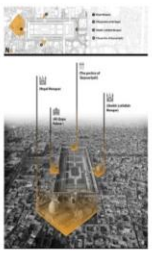
4. Material and Methods

Materials used for this research are two international best practice cases of UNESCO Heritage areas Isfahan, Iran, and Liverpool, UK, (SITES, 2008), in addition to the materials for the city of Foah in Delta, Egypt to apply results of what Heritage area urban DNA might look like. The comparative study addresses the components of the urban DNA test and the character elements of these areas in the form of international examples that applied conservation methods by UNESCO in heritage areas, to extract the components of the urban DNA by analyzing two international best practice heritage areas (Isfahan, Iran- Liverpool, UK) examples and building the specialized questionnaire. Methods used in this research are 1. comparative analytical study of international best practice cases, 2. Expert Questionnaire to pinpoint certain elements that dictate urban DNA in heritage areas, 3., physical and visual analysis of Foah City Heritage Center to recommend how to preserve the unique heritage urban DNA of the old center.

4.1 Best Practice International UNESCO Heritage Revitalization Projects

The study and analysis of the Urban DNA components in these two projects, to understand how revitalization policies influence the heritage urban DNA for the case of Liverpool and Isfahan. The results identified the most influential architectural and urban elements forming the unique urban DNA vocabulary heritage areas. the previous results will be applied in Foah City one of Egypt's heritage areas to reflect the most influential elements that affect Urban DNA in the Heritage area.

Foah City, which, is the third most important heritage area in Egypt after Cairo and Rashid, to draw the general framework of the shape of the urban DNA of the heritage areas that must be systematically taken care of, in the urban revitalization projects of the heritage areas in Egypt. figure 4, depicts the example of the comparative study between Isfahan and Liverpool conducted to interpret the Urban DNA of heritage areas, it discusses how urban character and visual image have important role to play in the urban genetic characteristic of heritage areas.

Comparison Urban DNA Element	Isfahan	Liverpool
Colours Impact on Visual Image and Urban DNA		
Building Materials and Treatments impact on Visual Image Urban DNA		
Visual Edges Impact on Urban DNA		

Comparison Urban DNA Element	Isfahan	Liverpool
Visual Perception Impacts on Urban Image and DNA		
Land Uses and Activities Impacts on Image Urban DNA		
Building Heights Impacts on Skyline of Heritage Urban DNA		

Figure 4. Comparative study (Isfahan, Liverpool) interpretation of Urban Genetic DNA of Heritage Areas.

4.2 Urban DNA of Isfahan and Liverpool

The comparative study of the heritage area of Isfahan City and the waterfront heritage area of Liverpool City, it can be argued that the characteristics of either area cannot be neglected, and despite the many physical, cultural, social, and economic differences between them, one factor remains worth studying, analyzing, and scrutinizing for its preservation, this factor is the urban character of each area. logically, Isfahan's with its long history and distinct various cultures in history, specifically, the Persian civilization created a unique composition of architectural vocabulary that formed its uniqueness. On the other side of the world, Liverpool the heart of the city was distinguished by its important function of the British Empire in the 10th century its heritage value comes from the unique buildings of docks and the surrounding activities of Albert Docks (Zancheti & Hidaka, 2011). Each of them had a set of elements that had a clear impact on the urban and architectural character, which helped to create their genetic DNA describing the city's history, nature, and culture.

4.3 Isfahan Urban DNA Character Elements

Land uses and area function:

The distribution of religious uses and activity has had the greatest weight in setting the features of the heritage area through the proliferation of many mosques in the city of Isfahan, paying attention to the finest details, and rich material through buildings of the heritage area, the commercial activities and land uses accelerate the natural development helped to create urban spaces in the area that meet the individual's initial needs.

Historical development and archaeological buildings:

One of the most important reasons for historical development was religious development. The city of Isfahan witnessed a great religious development beginning with the Persian Empire with other

variations such as the Muguli, Saljouqi, and Safavi. Each of those periods had a pattern of urban formation in which people recorded their history and culture, and that variety created the value of the heritage area in Isfahan (Tahmasebi, 2020).

Style and Identity:

The evolution of the Islamic model element influenced by the mixture of Islamic basic units mixed with far Eastern colours and materials culture formed the basis of Iran's architectural character and identity in the city of Isfahan. It evolved the Islamic style of architectural vocabulary through local colours and materials that earned the area and the whole region a different and non-recurrent character (Rojas, 2023).

Visual image and cultural characteristics:

The cultural characteristics of the population in the city of Isfahan are part of the components of the visual image of the city. Its effective role in acquiring the visual image of Isfahan is undeniable through their thoughts, daily activities, needs, requirements, style, and lifestyle, which are translated into the image of mosques, museums, palaces, markets, workshops, churches, and schools with architectural components that achieve their satisfaction (Jing Xie & Tim, 2017). Political situation: As Isfahan was the capital of Iran at the time of the Safavid caliphate, most of the attention was paid to Isfahan as the great and dominant political region at the time to express the power of the government and the ruler (Cameron & Rössler, 2013).

4.4 Liverpool Urban DNA character elements:

Land Uses and Area Function:

Liverpool Heritage area function of maritime commerce has significantly affected the land uses of the city, especially the waterfront, reflected in the proliferation of marine insurers, jetties, and post offices as the most important and greatest seaport in the United Kingdom (D'Agostino, 2021).

Style and Identity:

Victorian style prevailed in the 18th century, giving Liverpool its architectural identity.

Historical development and archaeological buildings:

At each stage of Liverpool's historical development unique architectural style buildings were built such as Edwardian Baroque, Georgian, and Victorian style. there was a collection of heritage buildings described and demonstrated each provision, thus becoming part of the general part of character of the area (Hmood, 2019).

Visual image and cultural characteristics:

The cultural characteristics of Liverpool City's demographics were a large part of the visual image composition.

Economic situation:

The economic situation has been one of the most influential factors the stable economic situation of the city has played a role in investing and positioning the most important and largest businesses in the heritage area that encouraged commercial and administration activities in the Docks area (SITES, 2008).

4.5 Expert-Based Questionnaire of Isfahan and Liverpool Urban DNA Analysis Rationale

The theoretical discussion of urban DNA previously, and the comparison study of Liverpool and Isfahan, were the basis of building the Expert-Based Questionnaire to seek the answers of the most influential elements that affect the heritage area's urban DNA. In previous figure 4, discussed the philosophical cornerstone of urban DNA in general, but the research argued that within these elements a particular group of spatial and Aspatial elements constitute, formulate, and distinguish urban areas from another, what are these elements in Heritage areas, that the ultimate question of this research.

The researcher through the theoretical framework and comparative study prepared a set of elements that can be tested over the questionnaire to validate whether these elements have been preserved and to what extent through an expert questionnaire. The questionnaire sample is selected carefully between

urban planning and design, and architect practitioners and academics to increase the certainty of the answers, to measure a set of major and minor elements that reflect urban DNA in heritage areas.
The next step is to apply the results of selected elements of urban DNA in the heritage area of Foah City in Egypt to validate and recommend certain urban components that can be pointed out when undertaking a revitalization study of a heritage area and answer the question of what elements need to be considered carefully to restore the area's heritage urban DNA.

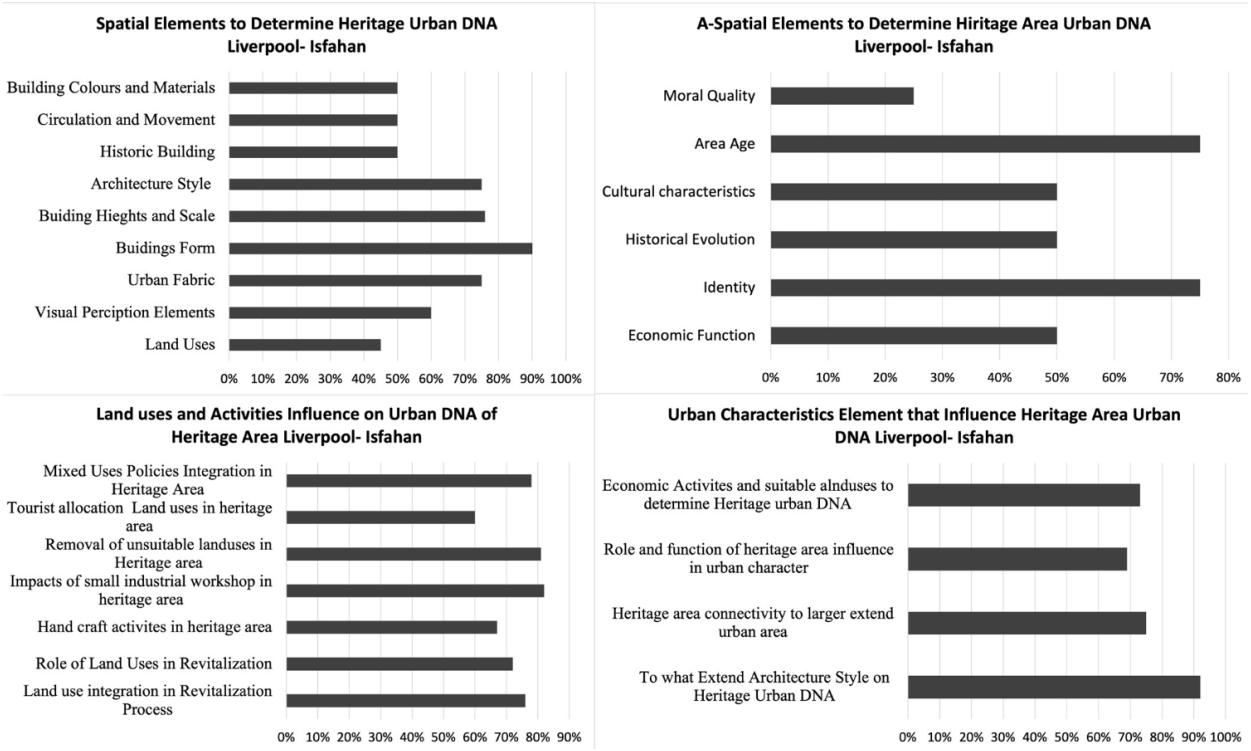


Figure 5: Results of the Expert-Based questionnaire of Elements that influence the Urban DNA of Heritage Areas.

4.6 Isfahan and Liverpool Expert-Based Questionnaire Results

Figure 5, indicates the results of the expert-based questionnaire to articulate the major elements that influence the heritage area's urban DNA, based on the comparative analysis of Liverpool and Isfahan heritage areas, the questionnaire topics are divided into three main sections. Section A tests the spatial elements in in each heritage area, Section B tests the Aspatial elements such as social and cultural issues and Section C tests the interaction elements that combine spatial and aspatial elements such as visual perception and activities and land uses. from the results it can be concluded that;

1. On the spatial elements level, major elements that identify Urban DNA in heritage areas are historical building style, Urban Fabric, and movement circulation, urban form, the number of historical buildings, and visual perception of the heritage urban context.
2. On the A-spatial Level, building identity and age, activities and economic characteristics are major influences in identifying the urban DNA of the heritage context
3. On the interaction level, Visual perception, skyline, urban pattern, and night activities control the identity of the urban DNA of the Heritage Context.

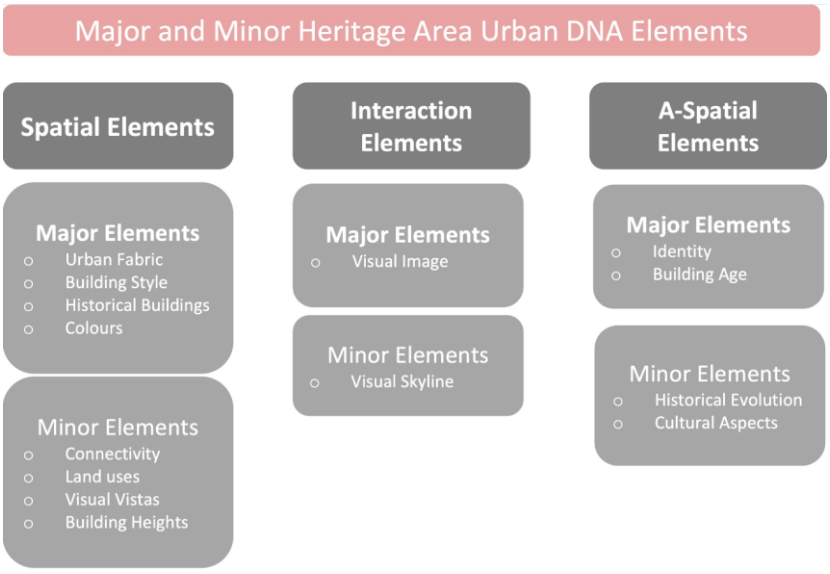


Figure 6. Results of the Expert-Based questionnaire- Final Major and Minor Elements Formulating Urban DNA of Heritage Areas (Researchers, 2023).

Figure 6 depicts the final major and minor elements that influence the Heritage area urban DNA, it can be argued and concluded from the results the following;

A. The dominating elements whether major or minor lies in the spatial aspect, logically because most heritage area character are derived from the value of historical built environment such as urban fabric, historical buildings, and colours, in addition, to connectivity, and land-uses as minor elements are necessary for any urban area urban dynamics, especially in Heritage area where the proper access and suitable land uses can increase heritage area revitalization policies (Couch, 1990).

B. The influences of A-Spatial elements such as social, economic, and cultural elements are focused on a few yet important elements such as building age and identity, historical evolution of the area, and cultural characteristics because the age of the area and identity is a sum of evolving influence of Historical ages the area has experienced in term of social, cultural, and economic changes.

C. The Interaction elements are the combination of physical and non-physical elements depicted in the form of a visual image and skyline, these two elements are the sum of interconnectivity between the area function and built-up area that impacts the form, visual image and the type of activities exist in the area.

Taking into consideration the previous results of what heritage area urban DNA major and minor elements are, the next section of the research is devoted to applying the questionnaire results of urban DNA to Foah City, the results of the questionnaire can ensure the proper revitalization of the Heritage Center in Foah to have the ingredients of Heritage area DNA in future revitalization proposals.

5. Foah City, Egypt a case study application of preserving heritage urban DNA

5.1 Foah City, an important heritage site in Egypt

The city of Foah is the oldest in the region, and its history confirms the relative location as Foah was likely the capital of the Seventh Province in the maritime face of Pharaonic Egypt and was known as "Faithful Conscious" or "Nefer Amente" in the sense of "First Western Region". In the Fatimid era, the city of Foah became a Great Kur Kabbah, while in the Ayubian era, it was influenced by the Islamic war crusade. Foah continued in the Ottoman era as an administrative center in 1826 and established the Rice Country West Section and made Foah its headquarters because it is the largest and oldest of its villages (GOPP, 2020).

5.2 Physical, Social, and Economic aspect of the Foah Old Center

The city's inhabitants depend on agriculture, fishing, and handicrafts, and the city is known for producing different types of fruits, vegetables, and fish. It also features handicrafts and small industries, especially textiles, wood, and copper. The city's economic strength is characterized by diversification in major economic activities and includes agriculture, livestock, fisheries, industry, crafts, and commerce. The city is characterized by neglected numerous and diverse tourist and archaeological resources (GOPP, 2020).

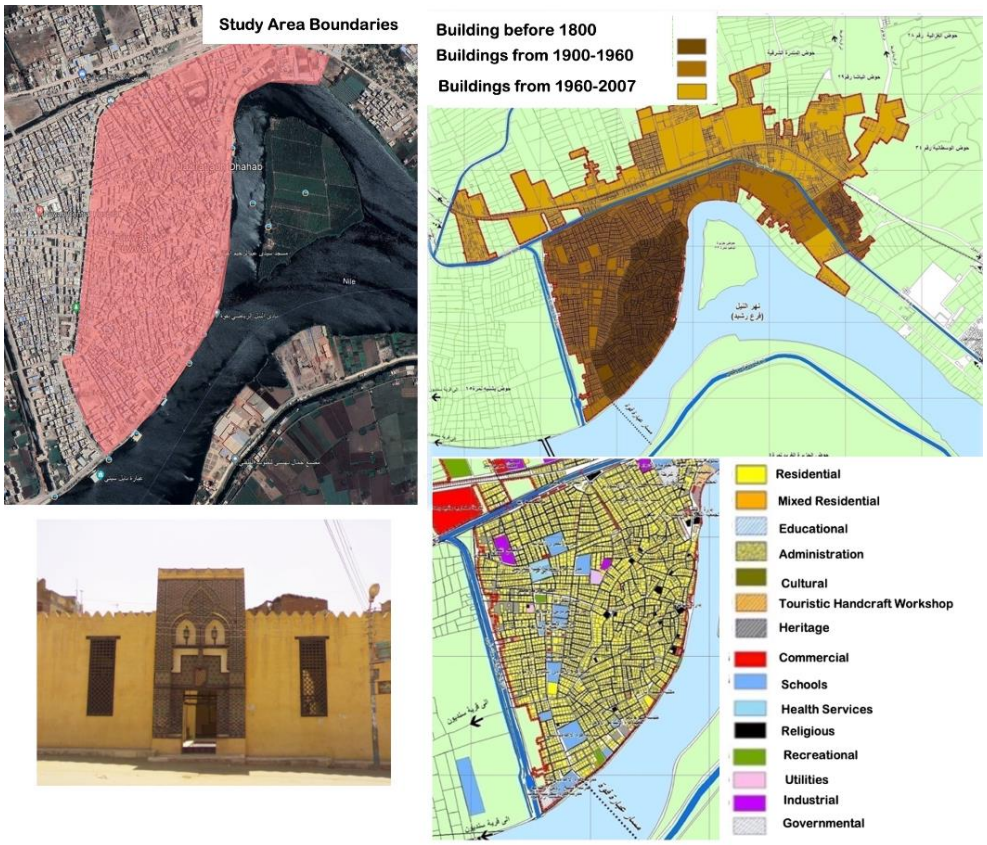


Figure 7. Foah Historical Area Land Uses and Historical Evolution (GOPP, 2020).

5.3 Proposal for urban revitalization of urban DNA of Foah City Heritage Area

Based on the results of the first section of the research concerning identifying the major and minor elements of heritage area urban DNA, a proposal for preserving the heritage center of Foah City is based on (Roberts & Sykes, 1999), (Rodwell, 2008), a discussion of regeneration and revitalization in both urban and historic context, in addition, they took into considerations, the socio-economic and spatial aspects of regeneration. the following elements are proposed to revitalize Foah Heritage Center.

Analyzing Heritage Urban Character:

The first step to conserve the urban DNA of Foah Heritage Old Center is to analyze the component of the urban character of the area based on the diagram in Figure 3, to systematically identify the spatial, A-spatial, and Interaction elements that form the basic ingredients of heritage area including, connectivity with adjacent areas, urban fabric, visual perception, historical buildings context Etc (Vehbi & Hoşkara, 2009).

Identifying Major and Minor urban DNA elements in Foah:

By applying the research results of urban DNA in heritage areas, see Figure 6, and paying more attention to these elements, the research found these elements formulate the essential elements that can conserve the urban DNA of the area, creating an analysis matrix, see Figure 8, it enabled the research to

pinpoint the essential improvements and consideration in the proposal of revitalization process of Foah heritage area.

Recommendations Vital changes on urban DNA elements in Foah:

1. On the Spatial level, elements such as urban fabric, building types, Historical buildings, and colours are major changes to conserve urban DNA in revitalization. Connectivity, Activities, Land Uses, and urban form shaping the minor elements recommended in the old center, to be improved, improve pedestrian movement circulation and controlling vehicle movement in the waterfront and inner city.
2. On the A-spatial level, Heritage identity, Building Age, Historical evolution of the heritage area, and cultural characteristics form the major and minor elements that should be treated very carefully, to maintain a sustainable urban DNA of the area and conserve the urban and architectural identity.
3. On the Interaction level, Visual image is the most important element that defines the Heritage area's uniqueness, combined with the physical and visual skyline as a minor element that controls the heritage's physical and visual perception as a unique area. Through revitalizing these two important elements the Urban DNA of any heritage area remains the keystone of identifying the physical and visual distinction of heritage areas in the city.
4. It can be argued that the nature of urbanism and its complications make the interaction level elements essential in the process as it combines in its nature the overall interaction between social, and economic characteristics with the physical characteristics that define urbanism which can incorporate into the level of interaction between the physical and non-physical elements in urban realm (Roberts & Sykes, 1999).

Foah Heritage Urban DNA Recommendations	Spatial Elements
Major Urban DNA Elements	 **Urban Fabric** Preserving urban fabric including public realm, land uses, encourage, local handcraft as an asset for Foah heritage urban DNA
	 **Building Style** all urban and architectural characteristics should be maintained as an Islamic vocabulary and colours for the Heritage context urban DNA
	 **Historical Buildings** Historical buildings are one of the factors that identify Foah heritage urban DNA
	 **Colours** Colours motives selection must be dominant in Revitalization process to provide uniqueness for Foah heritage urban DNA
Minor Urban DNA Elements	 **Connectivity** Strengthen connectivity with rest of the city will enhance the economic and social prosperity of overall Urban assets
	 **Land Uses and Activities** Suitable local activities and land-uses should be encouraged to maximize the economic and social function of heritage urban DNA
	 **Architectural Form** Islamic architectural regulations for materials, colours requirements in the revitalization process will conserve the visual image of Foah

Figure 8. Foah Urban Characteristics DNA.

6. Results

In the study at hand, an in-depth exploration of the theoretical framework of urban DNA and the analysis of character elements within the city has yielded several critical findings:

Firstly, the shared characteristics of complexity and hierarchy found in both biological and urban DNA have been instrumental in this research. These similarities facilitated a nuanced analysis and identification of the heritage urban DNA, providing a unique perspective on urban planning.

The foundational aspects of physical character stood at the forefront of recognizing urban DNA, acting as a primary reference point throughout the investigation. These physical components have proved to be pivotal in understanding the inherent urban DNA of a heritage city. Employing comparative analysis with two international case studies, the research conducted an empirical validation of theoretical discussions. The Expert-Based Questionnaire method was pivotal in distinguishing between major and minor elements of urban DNA within heritage areas. Spatial-level elements, such as historical building style, urban fabric, movement circulation, urban form, the prevalence of historical structures, and the visual perception of the heritage context, emerged as significant factors in identifying Urban DNA. In contrast, on the A-spatial Level, it was found that aspects such as the identity and age of buildings, local activities, and economic traits exert substantial influence on defining the heritage context's urban DNA.

At the interaction level, the research highlighted that visual perception, the skyline, urban pattern, and night-time activities are determinants in sculpting the urban DNA identity of a heritage context.

Lastly, the application of these findings to the local case study of Foah City has led to actionable recommendations for the city's revitalization process, with an emphasis on preserving its distinctive heritage Urban DNA. The study advises prioritizing the visual enhancement of waterfronts, maintaining a visual connection with historical buildings, and carefully designing the skyline to align with the heritage area's colour scheme. Restricting building heights to preserve the skyline and promoting night-time economic activities, particularly those related to tourism and recreation, are suggested to beneficially impact Foah City's heritage context and urban DNA. These measures are poised to not only uphold but also enhance the unique heritage identity of Foah City.

7. Discussion

7.1 research objectives

The research's main objective is to seek what might be the Urban DNA elements in Heritage area, first the similarities between biological and urban DNA was established in the theoretical part, where both have the complexity and hierarchy characteristics that make sense to use the term urban DNA on the action area level. Urban character rationale as a representative of urban areas DNA was discussed, and classified into spatial, aspatial, and interaction elements following the literature of regional DNA and how urban features can be classified and structured, which enabled the research to classify urban character features into the same classification method. Heritage areas as a unique structure of the city, were the focus of the following section, to answer the question of what major and minor elements of urban DNA can be labelled as heritage urban DNA. A comparison study of international best practice of UNESCO cases were Isfahan and Liverpool to understand the revitalization process have succeeded in depicting the unique characteristics, so we can identify the group of elements that are responsible for a heritage urban DNA by using expert-- Based questionnaire to pinpoint these elements, the last section of the research were applying the results of the heritage area urban DNA on the third heritage city in Egypt, Foah, which can be described as a declined economic city in the northern part of Egypt and lacks attention of revitalization in the old center that became deteriorated in terms of physical (Spatial) and non-physical (Aspatial) characteristics.

7.2 Analytical Urban DNA in Heritage Areas

A set of recommendations based on the analysis results have been structured in the form of a matrix, discussing the urban DNA elements that can assure the uniqueness of the heritage area and return the urban dynamics to the old, neglected center. From the analysis conducted in this research we think

urban DNA is a useful analytical approach and contributes towards defining a new perspective of urban context analysis, also defines the factors of drivers that can create urban DNA of a certain urban area. The research considers a detailed step from discussing Urban DNA on the regional level, where treatments of urban data can be measured objectively with mathematical modelling, into the more subjective level of dealing with action areas where urban DNA is rationally discussed from the point of view of physical and visual elements that makes heritage areas reserve its uniqueness by assuring that revitalization process takes careful consideration when dealing with elements that are responsible for heritage area Urban DNA. The importance of heritage areas comes from being a part of any society's cultural traditions. If properly dealt with, heritage will be a catalyst for social and economic development through tourism, commercial use, and raising land and property values, thereby providing revenues from which maintenance, restoration, and repair costs are paid.

7.3 Urban DNA Future Research on Action Area Spatial Level

Furthermore, Using the method of analysis by biological approach was credited with conceptualizing the physical and visual profile of heritage areas. Investing in the city's historic fabric, buildings and space helps in physical, cultural, and economic renewal, contributes to its developments for the benefit of residents and visitors, and preserves the culture and character of the city. Additional urban controls must be placed within the whole heritage area boundaries and context for urban and architectural development, by the prevailing urban character in heritage areas.

8. Conclusion

The research mainly focused on formulating the link between Biological DNA and how useful for urbanists to use it as a new definition of urban areas' unique characteristics to recognize heritage areas Urban DNA, previous attempts to link biology with urbanism were mainly focused on the national and regional level of urbanism, this research attempt to identify the urban DNA on the action areas level, the research apply the method on heritage area for its importance on the city's social, economic and visual function that creates vibrant and dynamic activities within the city. Research outcomes can be built on for further research on various types of urban action areas to understand what makes an area unique and what elements of revitalization and regeneration process should carefully increase focus on studying, analyzing, and finally taking serious actions to conserve these elements to create a unique urban DNA which will impact and enhance the overall physical and visual characteristics of urbanism. From the study of Foah city and urban government regulations in Egypt, many criticisms arise to conclude its most important notes.

1. Making certain decisions about identifying the urban context DNA and the character of heritage areas must be done by specialists.
2. A dedicated team (planners, architects, artists, two characters) must be available to supervise and implement the revitalization of heritage buildings.
3. The broader scope (buffer zone) must be defined to control and determine changes and planning and design requirements of heritage areas.
4. Preservation and rehabilitation processes are not inconsistent with the revitalization process but must be in an appropriate and compatible framework that respects heritage areas' planning and design requirements.

A comparative Study of Isfahan and Liverpool revealed that the attempt to revitalize Urban DNA in Liverpool by proposing the placement of modern buildings with height and contemporary architectural style beyond the wider area was a failure and found incompatible from the UNESCO side of view and policy. Maybe it was more appropriate with the new buildings proposal, using architectural vocabulary reproduced from the general character of the heritage area creates a continuity of the visual image. On the contrary in the case of Isfahan, the authorities make few positive changes to preserve the urban DNA but with a focus on the historical buildings, not the urban extent of the heritage area. In the case of Foah City to preserve the urban DNA of the heritage old centre, revitalization authorities should activate and redesign vertical pedestrian axes on the waterfront to connect tourism to the heritage area

and increase the efficiency of utilizing the economic and heritage value of the heritage centre. Linking the old centre area (heritage) with the rest of the city, especially the river facade in terms of right-of-way adjustments and increasing economic Tourist-Based activities to emphasize the role of the heritage centre to increase the efficiency of the economic base. In addition, inappropriate activities should be relocated out of the central heritage area, and increase efforts to improve the urban surroundings of archaeological buildings.

Conflicts of Interest

The authors declare no conflicts of interest.

Data availability statement

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

Ethics statements

Studies involving animal subjects: No animal studies are presented in this manuscript.
Studies involving human subjects: No human studies are presented in this manuscript.

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Arch Rowida: Data acquisition, statistics, and Photos; Dr. Mohamed Youssef: Data analysis, Paper writing and editing.

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Original scientific paper

Another Chance: Adaptive reuse of the built heritage strategies for circular creativity

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ABSTRACT

The study delves into the realm of adaptive reuse, exploring its potential in sustainable urban development, particularly focusing on public buildings within the cultural and creative sectors. Through a multiple case study analysis, both qualitative and quantitative methods were employed to scrutinize design strategies and spatial transformations in recent adaptive reuse projects of existing structures. This research investigates the evolution of adaptive reuse, highlighting its historical and theoretical underpinnings, and subsequently examines contemporary approaches towards existing structures in cultural, creative, and public domains. The study findings reveal common characteristics and innovative design strategies employed in recent adaptive reuse projects, emphasizing the transformative potential of neglected or abandoned urban spaces. Utilizing a comprehensive methodology involving case study analyses and diverse data collection techniques, the research underscores the significance of adaptive reuse as an established practice in contemporary architectural and urban design. The article's contribution to the social and economic dimensions of urban development lies in understanding and promoting sustainable, resource-saving strategies. This work paves the way for future research, suggesting potential expansions in creating an 'atlas of adaptive reuse' and exploring comparative analyses between existing reuse and new construction, specifically focusing on public buildings with civic-cultural uses.

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Highlights:	**Contribution to the field statement:**
- The paper raises critical inquiries about the defining traits and primary design strategies of 'adaptive reuse' as an architectural discipline. - It focuses on the adaptive reuse of public heritage buildings in Europe, exploring contemporary practices and approaches. - The study analyzes leading international case studies to identify common features and strategies in the reuse of existing structures for cultural, creative, and public functions. - The aim is to outline commonalities in reuse approaches and portray a snapshot of the recent architectural culture surrounding the adaptive reuse phenomenon.	The design strategies and functional-spatial transformation of the existing. The study, treating a brief historical and theoretical profile of adaptive reuse projects' evolution and interpretations, provides insights for future research on adaptive reuse strategies for the public and creative fields, and on innovative ways to transform the city's public unused or abandoned building stock.

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1. Introduction

Adaptive Reuse can be framed as a growing design approach in contemporary times (Stone, 2023), especially in European urban environments, as witnesses in the growing space and attention dedicated to this kind of design in architectural prizes (Blasi & Giralt, 2019, 2022), in professional practices and applied research (Lanz & Pendlebury, 2022; Mérai et al., 2022); that seems to outline common features and tools. The reuse of already existing buildings is 'as old as a man' and has existed since time immemorial (Wong, 2016), however, in recent decades adaptive reuse started to establish itself as a new approach towards building environment (Flores & Prats, 2016, 2019; Plevoets & Van Cleempoel, 2019). Given the recent pressing demand for sustainability and resource-saving issues, that require transformative and resilient strategies for the city, we can easily argue that the built cultural heritage plays a crucial role in these challenges (Chiacchiera, 2022).

The paper moves from the following premises and background remarks: the presence, especially in the European context, of a huge amount of unused or underused public existing stock, an issue regarding the development and the legacy of the contemporary city; the consequent questions regarding 'what to do with it' and its role as a potential accelerator for urban regeneration; the recent growing of knowledge economy and related forms of entrepreneurship that are radically transforming the urban habitat through the tools of creativity, of intellectual work, of technological innovation, that are strongly connected with the creative reuse of abandoned parts of the city (Baum, 2014; Baum & Christiaansee, 2012); the continuous and pressing demand of sustainable urban development and resource-saving in International and European level. This general framework, together with the observation of many successful international reuse projects and practices that work in the field of urban regeneration, allows us to hypothesize that cultural and creative-led adaptive reuse is an established practice in contemporary urban and architectural design.

From these considerations we can draw some key questions within the research: which are the main characteristics of this 'discipline of the existing' (Flores & Prats, 2016) and which are its main design strategies; is it possible to extract replicable data and characters from renowned contemporary examples? The research hereby presented – conducted within the activities of the Research Group 'Hub for Heritage and Habitat' from DICEA Department of Marche Polytechnic University – deals with the theme of adaptive reuse of public built heritage in the European context, and it aims to investigate, through the analysis of recent outstanding international case studies on the field, which are the main features of the contemporary approaches towards the existing related to cultural, creative and public uses, that can be helpful to extract commons characters, attitudes and reuse strategies, as well as provide to portray a panorama of the architectural culture of reuse of this recent years.

2.1 Materials and method: Outline and structure of the article

After explaining the background materials and the research methodology, the paper provides an insight into the context/exploratory phase of the research (Figure 1), treating the historical evolution of the concept of adaptive reuse, from a spontaneous to an aesthetic act; then, through the description of key and outstanding historical case studies – knowledge phase - it proposes categorisation of design strategies on the existing as actions, helpful to delineate common spatial actions of the case studies; finally it provides a discussion on how the multiple case study analysis were carried out and on how the reprocessing of data from various sources can be an effective tool to depict adaptive reuse projects, to compare one to another and to highlight helpful information about them.

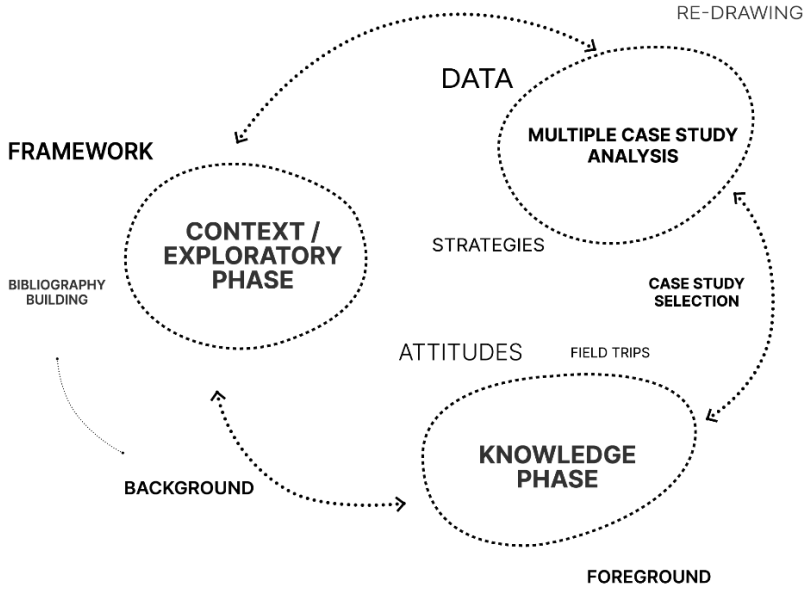


Figure 1. Structure of the Study.

2.2 Methodology and data collection

The research methodology follows the model of the multiple case studies analysis (Aberdeen, 2013; Takahashi & Araujo, 2019; Walker, 1996; Yin, 1994) a typology generally established in the research and divulgative studies on the theme of adaptive reuse (Baum & Christiaansee, 2012; Bollack, 2013; Lang, 2023; Plevoets & Van Cleempoel, 2019; Wong, 2016, 2023). According to Yin, the analysis of multiple case studies guarantees a detailed and broad understanding of the topic, and the data collection and reprocessing of the data provide a scientific basis on which to compare and describe the chosen projects. The criteria on which the case studies were chosen was to choose recent projects - completed no more than ten years ago - of adaptive reuse in the European context, in the field of public uses for cultural and creative purposes, such as civic centres, media libraries, performance spaces, exhibition spaces, shared workspaces, of small-medium scale on the urban context (Lang, 2023; Lo Faro & Miceli, 2021; Plevoets & Van Cleempoel, 2019; Wong, 2016).

The data collection (Figure 2) was conducted by searching for quantitative information on the projects – such as dimensional values and costs of the reuse operations - descriptive sources - from the historical 'life' of the building to information about the processes of transformation, clients, management and financing, functional programmes – but also through in-site visits and photographic selection (Acar, 2018; Fitz & Lenz, 2015; Pelizzari & Scrivano, 2011). Data analysis consisted of the analysis of reuse strategies and actions conducted through 'transformative attitudes schemes' with schematic figures elaborated to synthesize the design actions on the existing – internal and external demolitions, new internal and external volumes, interior refurbishment and action on public spaces – helps to categorise the interventions; from this data analysis, a 'reuse identity figure' in the shape of radar graphs (Kaczynski et al., 2008) is proposed as comparative and analysis tool based on qualitative interpretation of various degrees of 'intensity' of the reuse actions (demolitions, internal reorganisations, new internal volumes, new external volumes, public spaces) that allows quick and easy images that characterise the various interventions. Morphological analyses were conducted through re-drawing of the case studies (Lima & Vieira, 2017; Unwin, 2007) used as knowledge, analysis, and dissemination tools. All these data collection, analysis and reprocessing constitute a corpus that allows the depiction of a 'portrait' of the case study to make it easily understandable and divulgative, as well as comparable quantitative and qualitatively (Guidetti & Robiglio, 2021).

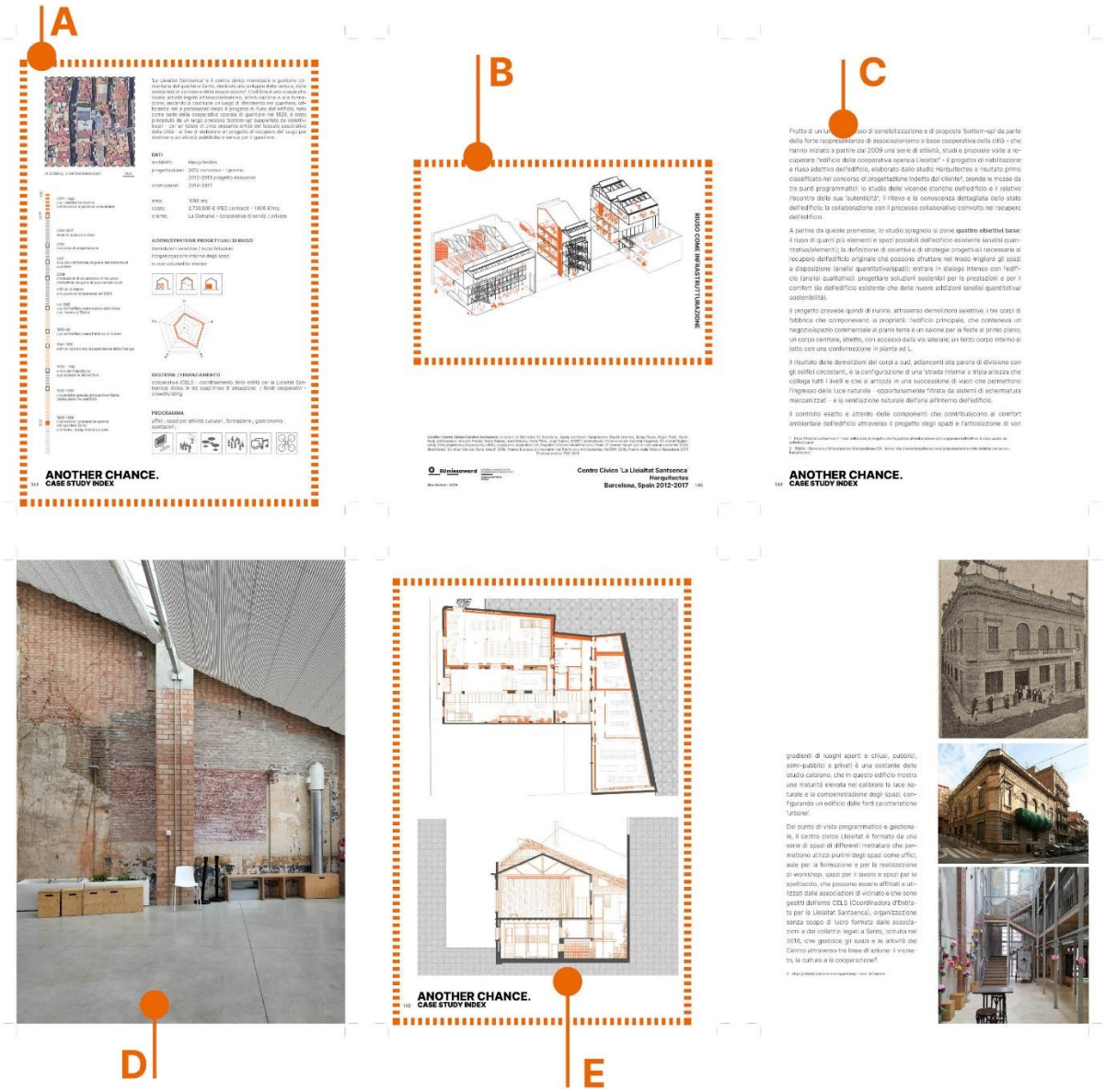


Figure 2. Structure of the Case Study Analysis: A. analytical summary board; B. tri-dimensional re-drawing with highlights on the re-use actions; C. critical text; D. selection of authorial and historical pictures; E. two-dimensional re-drawing (plan-section).

3.1 Discussion. Context-exploratory phase. Historical evolution of adaptive reuse.

The interest in the study of the problem of inserting contemporary actions into the existing cannot be separated from the recognition of the historical events that have characterised its development. The adaptation, transformation, reconversion and variation of existing buildings and structures to accommodate within them functions other than the initial or previous ones, is not a new phenomenon, nor is it a recent one. Looking at our cities and territories we can easily see how the act of building on the existing, of exploiting the ruins of the past for new constructions and the adaptation of old buildings to new uses, is at least as old as human history, and started as a spontaneous act. Building "on" or "over" the built is thus an ancient operation, responding to instances of saving material for construction effort, for individual or collective symbolic exploitation, or economic needs (Posocco, 2016) and the city in its history can be understood as a landscape that the older it gets, the more it continues to rewrite its own memories, as a palimpsest (Corboz, 1983; Machado, 1976).

The continuous and systematic practice of reuse in antiquity represented an important aspect in the development of the city as we know it, contributing to the creation of the sense of 'place', the 'genius loci' from which derives the complexity and spatial richness that only the palimpsest of the city's stratification on itself can offer. From the 19th century onwards, with the introduction of the concepts of conservation,

interventions on the built environments started to become an ‘aesthetic’ and theorised practice, firstly in restoration as opposed to the modern construction of the new. The broadening of the concept of heritage initiated a process of 'mixing' and 'hybridisation' between more conservative ideas on the one hand, and more 'transformative' and 'interventionist' ones on the other, especially in the cultural context of the 1960s and 1970s (Plevoets & Van Cleempoel, 2019).

Artists, architects, critics and intellectuals, in the wake of significant changes in Western society, began in those years to question established theories about the past, the concept of heritage and the relationship with history (Bollack, 2016). The post-war intellectual and artistic evolution, therefore, profoundly influences society's attitude towards the existing heritage. For the architectural project, we go beyond the ruin in an aesthetic sense to find in the assemblage techniques of certain artistic and literary avant-gardes of the 20th century the fertile ground on which techniques of recuperation, assemblage and invention used by modern and contemporary architects are founded (Massarente, 2016).

3.2 ‘Reuse pioneers’ – outstanding examples exemplary of reuse attitudes towards the existing

Starting from the 1960s and 1970s, architects began to apply innovative concepts of reuse of urban public heritage for social, public, and creative purposes and intellectual production: such as Giancarlo De Carlo's decades-long work for the recovery and urban regeneration of Urbino, at the behest of the then rector of the nascent Carlo Bo university; or, in ‘other’ latitudes, Lina Bo Bardi, that in the South American and Brazilian context ‘dominated’ by the great modernist architectural and urban planning operations, began to develop a series of reuse projects that would anticipate contemporary attitudes towards the existing; or like the highly sophisticated and precious museographic interventions of Carlo Scarpa in Castelvecchio in Verona and Palazzo Abatellis in Palermo; or the one in Hamar by Sverre Fehn. At the beginning of the millennium, some reuse projects of former industrial areas and buildings opened the way for the creative reuse of the existing in the contemporary sphere, such as Zollverein industrial park at landscape and territorial scale, now UNESCO World Heritage Site, or Herzog & De Meuron's reuse of the Turbine Hall of the Battersea Power station at the beginning of the new millennium to host Tate Modern Gallery, profoundly marks the international architectural culture, for which the Bilbao effect is not only sought through the heroic construction of the new but through the recovery and creative reuse of the existing. We can see how this attitude in recent times has developed and spread in the continental and international context, for example in the recent and ‘game-changing’ projects by Lacaton & Vassal’s Palais de Tokyo and David Chipperfield’s Neues Museum, that paved the way to establish adaptive reuse projects also at institutional level.

It is from this evolution, in correspondence with exemplary and pioneering projects that the concept of heritage has expanded to include a large number of building typologies, disused industrial heritage and landscapes, comprehending what developed from time, experience and the collective: a condition present in ordinary buildings, of which our cities are full, and that represents a great potential for physical and social reactivation, in which designers can move between various degrees of interventions in a fluid and hybrid complex cultural panorama, that goes from housing to performative and exhibition spaces, to civic centre and collective activities, to new forms of work. The identification, analysis and re-elaboration of those attitudes of pioneering design strategies allow us to identify those reuse ‘attitudes’ as a conceptual framework that guided the following case study analysis and selection.

3.3 Adaptive Reuse attitudes – knowledge phase and Case Study selection

The theme of how to approach, of how to act in the relationship with the built heritage constitutes one of the central nodes of the treatment proposed here for the research: as highlighted above these practices of reuse of an existing endowed with a certain system of 'values', and with characteristics of 'openness' and 'stability' (Baum & Christiaansee, 2012), working and operating on the concept of 'distance' (Caliari, 2010), allows the city to be reorganised from within according to various strategies of action, which can be interpreted more appropriately as 'design attitudes' (Figure 3), useful to understand and to briefly categorise the case studies. Following a 'tradition' of reinterpretations of various design strategies in the literature on the subject (Lanz & Pendlebury, 2022) a series of ‘reuse attitudes’ are proposed: 'reuse as urban strategy', 'reuse as super-positioning', 'reuse as infrastructure', 'reuse as palimpsest', 'reuse as scenography'.

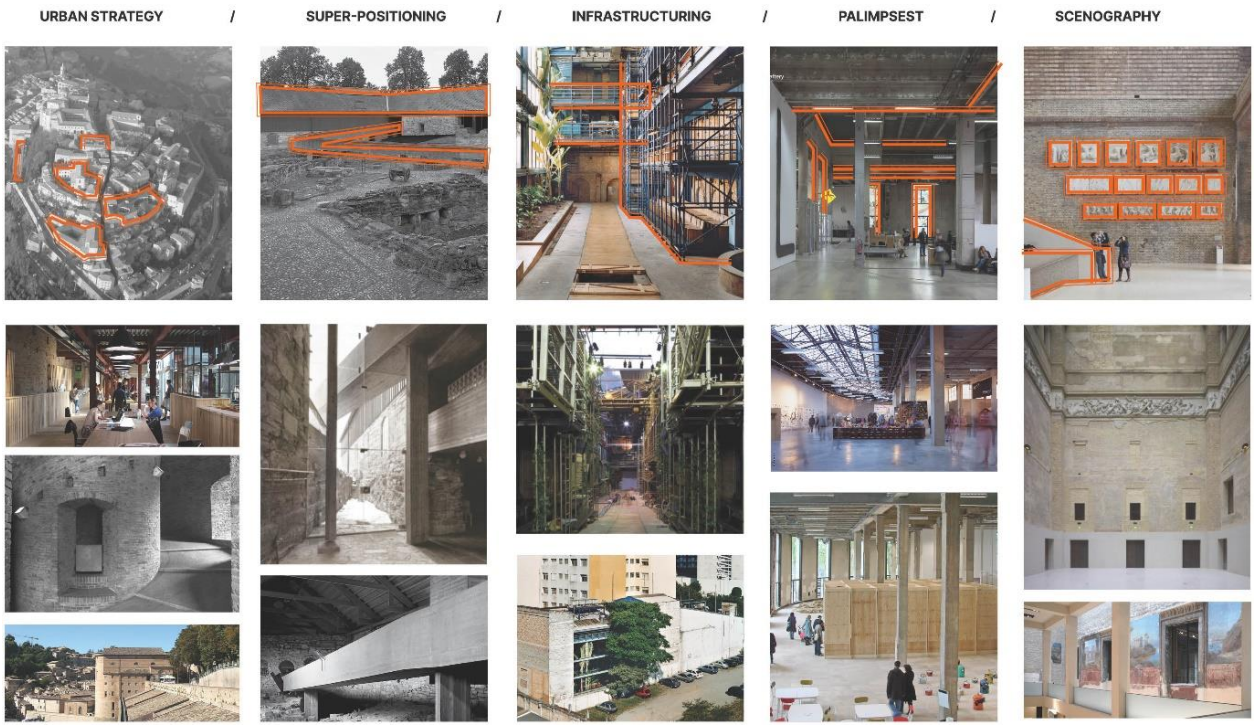


Figure 3. Reuse attitudes. Urban Strategy: G. De Carlo, projects for Urbino; super-positioning: Sverre Fehn, Hamar Museum; Infrastructuring: Lina Bo Bardi, Teatro Oficina; Palimpsest: Lacaton & Vassal, Palais de Tokyo; Scenography: David Chipperfield, Neues Museum.

The categories presented here also correspond to differences in scale and the 'disciplinary approach' of intervention. Reuse projects presented as 'urban strategy' make the general programme and urban regeneration policies their central 'core' ; the projects presented here as a 'palimpsest' work on the theme of working with a profound balance between 'subtracting' and 'adding' with various gradients of intervention in the reuse project, from the almost entirely subtractive action of Lacaton and Vassal at the Palais de Tokyo to more complex and refined processes such as that of the Beckett Hall by the Catalan architects Flores & Prats; other projects focus, instead, on the ‘superimposition’ of a new layer on the existing datum without touching the building on which the project insists: as in the case of Sverre Fehn's project for the Hedmar Museum in Hamar in which the entire exhibition itinerary unravels and develops by detaching itself from the medieval ruins and establishing new contemporary signs that modify and enrich the spatial relationships that are established, or as in the case of de vylder vinck tailleu's 'PC Caritas' project that superimposes a new 'interior landscape' within the carcass of an old medical pavilion on the psychiatric campus of the city of Melle in Belgium; reuse as ‘infrastructuring’ acts with the insertion of new servant or technological spaces on the existing, making it respond to the required functions, like Harquitectes' project for the Lleialtat Santsenca Civic Centre in Barcelona, in which the design of the new hinges around a system of staircases and walkways structurally independent of the existing building constitute a public space inside the building for users; ‘scenography’ deals with re-use associated with museum, exhibition and performance operations, as for example in the emblematic case of David Chipperfield's Neues Museum , in which the project becomes a ground for architectural experimentation in the contemporary approach to reuse and restoration, integrating new and existing in an almost 'sartorial' manner.

The very same choice of the list of case studies is part of the research, with an iterative process of analysis and exploratory phase according to the expansion and contraction of the themes and of the ‘area of interest’ of the investigation. The case study selection, therefore, has developed choosing outstanding and recent projects from the European context, completed not more than 10 years ago, following the mentioned above subdivisions in ‘design attitudes’, in order to have the most comprehensive overview of adaptive reuse in contemporary European architecture (figure 4): for ‘re-use as Urban strategy’ category were chosen the case of Barcelona’s municipal civic centre network, Illa de la Pietat by Toni Girones and the complexes of public cloisters spaces in Reggio Emilia by Zamboni and associates; for ‘re-use as super-imposition’ were analysed Lacol’s La Comunal, a cooperative space in Batllo neighbourhood in Barcelona, and PC Caritas

by de vylder vinck tailleu in Melle, Belgium, together with Assemble's wintergarden in Liverpool; for 're-use as infrastructuring' were chosen the Lleialtat Santsenca civic centre by Harquitectes and Langarita-Navarro's Medialab Prado; as 'reuse as palimpsest' Sala Beckett by flores y Prats and the soon completed Wintergarden in Gent by Atelier Kempe Thill; for 're-use as scenography/montage were analysed BAAS's Oliva Artes in Barcelona and Alda Fendi Esperimenti Rhinoceros in Rome by Atelier Jean Nouvel.

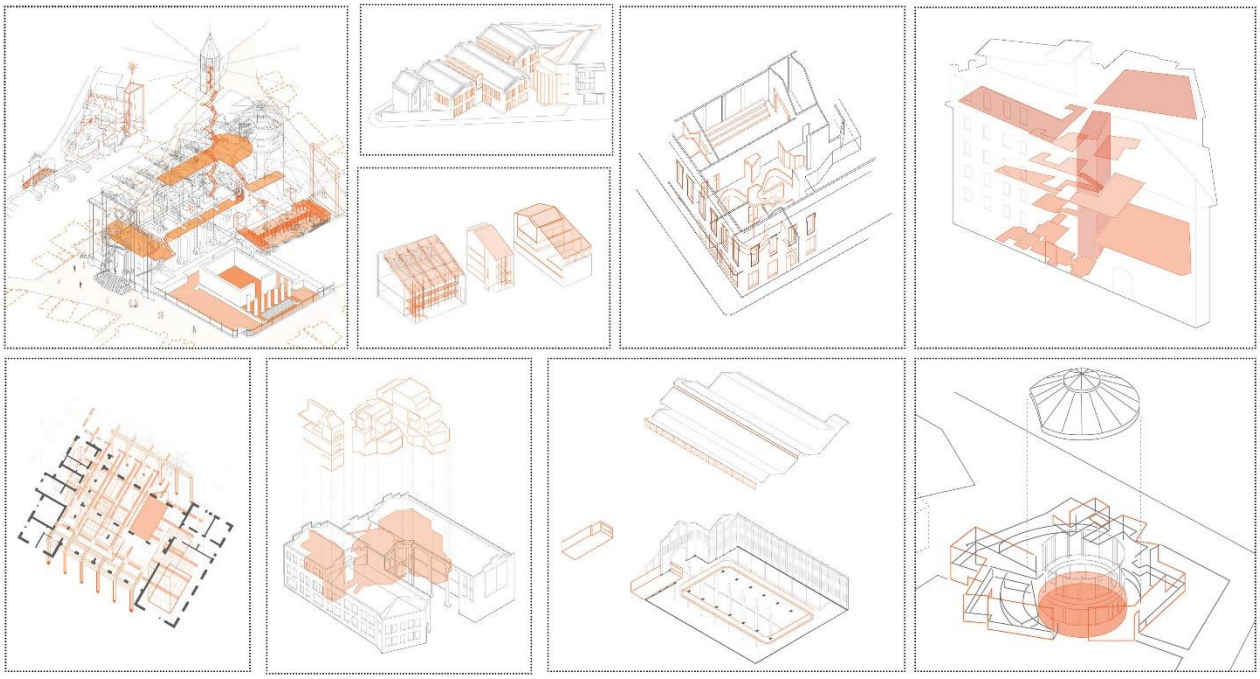


Figure 4. Case Studies selection. from above-left: "Illa de la Pietat" by Toni Girones; "La Comunal" by Lacol; "Sala Beckett" by Flores & Prats; "Rhinoceros" by Jean Nouvel; "PC Caritas" by de vylder vinck tailleu; "Medialab Prado" by Langarita Navarro; "Oliva Artes" by BAAS Arquitectura; "Wintercircus" by Atelier Kempe Thill.

4. Results

The investigation proposed here moves from a multi-instrumental approach whose objective is to understand the dynamics, the intervention methods and the actions put in place in the process of reuse of the analysed buildings, through a case study analysis that utilises different sources and tools, as mentioned before. The results of the data collection and reprocessing is a summary sheet for each case study (Figure 5), that allows comparisons and cross-readings, composed of: projects' significant data such as location, timings and description of the design processes, dimensions, costs and funding methods; graphic synthesis of design strategies (external demolitions, internal demolitions, interior refurbishment, new internal/external volumes, creation of external public spaces) and the building's new functional programme (offices, library/media lab, education, commercial, food/restaurant, entertainment/shows, exhibition, cultural events, cooperative spaces).

Particularly useful to our purpose was the elaboration, for each case study, of an analytical board with graphical schematisation that serves as a 'project identity figure' (CFR 2.2 – methodology and data collection) that provides a visualisation of the main design strategies towards the existing, allowing qualitative comparisons between the various case studies.

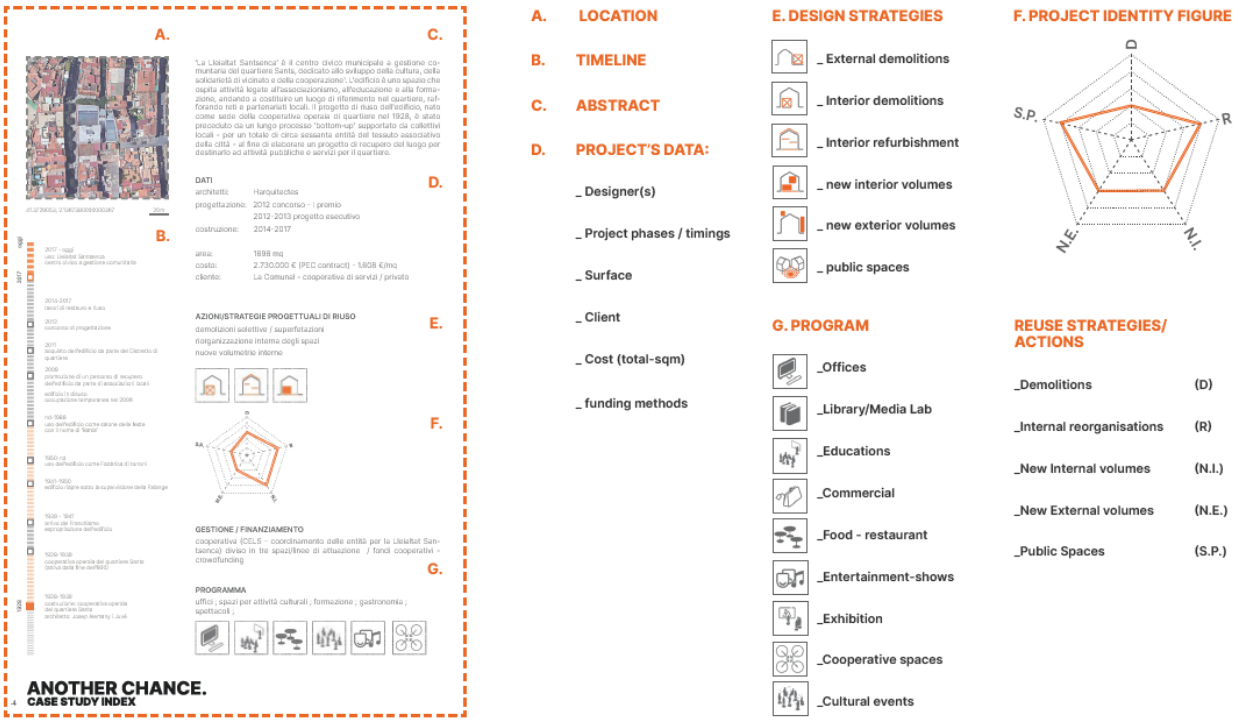


Figure 5. Summary board of the case study analysis.

The development of this process for all the chosen case studies drove us to analytic grid-like comparison tables (Figure 6), that allowed us to establish differences and parallelism between the various characteristics of the projects, such as the design attitudes, in orange, and the uses after the transformations, in grey, together with a qualitative representation of costs and dimensions data of the various projects. These aspects are of important relevance in our study because show how in front of a rich program and the importance of the design project, the costs are relatively low, and augment the replicability of the design strategies, considering that all the selected projects, acting on existing context, as mentioned before, contributes to urban regeneration and on saving resources.



Figure 6. Comparative study analysis.

5. Conclusions

The research 'Another Chance', in the path addressed so far, has shown how the theme of the adaptive reuse of the existing heritage is currently a growing phenomenon in the continental sphere, outlining a general framework of reuse as a contemporary aesthetic practice, that act in complexes of rich 'biographical' histories, made up of uses, abandonments and reuses in the various decades of their life; this gives us an idea of the fact that even the contemporary reuse project is to be understood with a view to 'temporariness', as a moment in the course of very long events, which will hopefully undergo other processes of modification in the near future. The research acts mainly at a qualitative level, through schematisation, re-drawing and graphical interpretations of the projects which aim is to depict a description of the reuse design strategies and attitudes, following a bibliographical tradition on the theme (Baum & Christiaansee, 2012; Bollack, 2013; Lanz & Pendlebury, 2022; Wong, 2016).

The use of quantitative data – building dimensions, costs, etc. – allows effective comparisons between the various projects selected as case studies and other typologies of projects.

The categorisations of the projects presented here as ‘attitudes’ and the proposed summary boards are useful tools to analyse and compare the various projects, and the boards allow replicability to other case studies and expansions and enrichment of the boards itself, being somehow ‘open structured’. The grid for evaluating the design strategies of the various case studies is a 'proactive' tool when applied to applicative cases, providing information, data and correlations that are useful for dealing with design processes of reuse of the existing heritage for creative purposes, both from the point of view of the tools proper to the design of space and on the functional and processual aspects of urban regeneration. The article’s contribution to social and/or economic dimensions of contemporary urbanisation is based on the understanding of reuse processes and strategies in contemporary European architectural urban environments.

Like numerous other research and publications in the field of adaptive reuse, the present one, given the methodological structure of the analysis of case studies, allows an applicability and a widening in the direction of an expansion of the analysed examples, to potentially form an 'atlas of adaptive reuse' that can be a useful tool both for research and for those who work in the construction sector and in that of policies for the city. Even the survey methodology - project sheet with analytical data and personal re-readings - can represent a field of further research development, in the sense of a refinement of the analytical apparatus of the design strategies, especially in the direction of technical investigations on the design strategies faced by the designers on the one hand, or on the economic-processual one on the other, in particular in relation to the aspects of environmental sustainability, going to investigate the relationships between reuse of the existing building and saving the ecological footprint of the construction, compared to similar new construction interventions. An important future research outlook that can enrich the research process object of the paper is the quantitative and qualitative comparison between the existing reuse and new construction, in the same typology of buildings - public buildings with civic-cultural uses.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author, F.C.

Ethics statements

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Studies involving human subjects: No human studies are presented in this manuscript.

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Original scientific paper

Mapping Safety, Security and Walkability of Historical Public Open Spaces in Post-Conflict Libya: Tripoli as North African Case Study

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ABSTRACT

North African cities have been undergoing major transformation over the past two decades following protracted instability, civic uprising, and conflicts, changing their perception from havens to territories of displacements with social, psychological, and physical problems. Historic public spaces in those cities, in particular, form a critical part of urban environments as they have the identity, livelihoods and cross-community engagement in a healthy and fulfilling urban fabric and culture. Whilst there have been several studies on the characteristics of open spaces in urban environments, there is very limited work on the changing perceptions, use and engagement of public spaces in historic cities especially in the post-Arab Spring and its relative instability. This study aims to deploy investigative and creative methods to map, analyse and navigate through the transformation in the perceptions of historic public spaces in Post-Conflict Libya and its divided cities. It will study the users' (locals and visitors) attitudes, movements, and reflections on how those spaces have changed over time. visitors' behaviour in open historical public spaces in Tripoli, Libya. The study explores the relationships between the characteristics of historical public spaces, physical activity, and psychological behaviour. The paper argues that safety and security in public spaces are critical and inherent qualities that inform much of the users' attitudes in historic cities, which has continued to be the case in post-conflict Tripoli.

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Highlights:	**Contribution to the field statement:**
-This study introduces an innovative directional distance function model in a super-efficiency form. -The research employs investigative and creative methods to map, analyze, and explore the evolving perceptions of historic public spaces in post-conflict Libya and its divided cities. - Places a strong emphasis on understanding the attitudes, movements, and reflections of users, including both local residents and visitors. -A key finding emphasizes that safety and security in public spaces inherent qualities that significantly influence the perceptions of users in historic cities even in the post-conflict context of Tripoli.	Numerous studies have investigated the characteristics of open spaces in urban environments, there exists a noticeable research gap regarding the shifting perceptions, utilization, and interactions of people with public spaces in historic cities, especially after the Arab Spring and the associated disturbances. This research aims to bridge this gap by employing investigative and creative methodologies to chart, analyze, and explore the transformation in the perception of historic public spaces in post-conflict Libya, particularly in its divided cities.

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1. Introduction

The historical centres of cities in North Africa have developed over centuries and are shaped by a network of interconnecting local streets and intertwined alleyways that connect people and goods in an orderly and fluid manner (Akbar, 1998). The active and secure socio-spatial systems that enable interactions in these cities have developed a complex organization of relationships that include the integration of public and private spaces in a fluid continuum (Abdelmonem, 2016). However, as these historical centres transformed into modern cities, their spatial organisation evolved and changed, leaving traces of the past intimacy, but equally a sense of loss due to the diminishing sense of community, and active urban life. Public open spaces that used to be active centres of daily life have transformed into congested and hazardous traffic routes. Whilst Cairo and Alexandria in Egypt are struggling with integrating high-way traffic routes into their historic fabric, Tunis and Marakish tend to preserve most of their historic centre's characters and move major traffic routes away from their historic core. Libyan cities, on the other hand, are one example of this transformation in the role of public spaces within their historical centres. This problem has been exacerbated by the ongoing conflict, political instability, and weak governance since the Arab Spring.

The historic spaces in Libyan cities have witnessed a deterioration in the quality of life, safety, and connectivity within their historical structures during long periods of conflict and destruction. This has made many Libyan cities unbalanced and unfriendly to pedestrians, in a unique case within the rich North African cities. Libyan cities are often heavily reliant on vehicle traffic, with a major route contributing to increased and intensified traffic congestion, pollution, and inadequate and unsafe pedestrian crossings, affecting the ability of local residents and users from their inherited sense of belonging, comfort and safety (Lakhder & Dugeny, 2010; Abdulla, 2019). Additionally, the planners and local authorities have shown limited consideration for the needs of persons with disabilities in terms of ease of walking, and limited attention seems to be given to the safety and security of pedestrians when determining urban quality of life. This has led to higher rates of traffic accidents and associated fatalities (Lakhder & Dugeny, 2010; Abdulla, 2019).

Yet, in the absence of a methodological approach and systematic analysis of those perceptions and attitudes within historic cities, planners and urban designers have limited knowledge and information about the factors impacting users' perception and engagement with post-conflict historic cities. This paper aims to fill this gap and offer an innovative framework and systematic analysis of a planning process informed by understanding users' and residents' perceptions and priorities. There has been little research done to comprehend the historical public open spaces, even though numerous studies have highlighted weaknesses and inadequacies in public transportation and urban life in those cities. With an emphasis on the historic area of Tripoli, this study examines the historical open public spaces in the city centres of Libyan cities as a case study of emerging cities going through internal conflict. By examining the elements, features, and patterns that affect the daily lives and activities of users in those spaces, it looks into how the quality of POS influences the growth of livability in the city centre. This paper also seeks to examine the difficulties and success aspects that influence how walkability is perceived in Tripoli's historic open spaces. It will look at the ideas and components of safe public spaces in post-conflict cities. The opinions of Tripoli experts, policymakers, and common people will be noted in this context and analysed.

1.1 Historical Public Open Spaces

There are numerous studies that emphasize that POSs are essential elements that provide functions such as "recreation, community health, connection with nature, and social or environmental preservation" within a city's part (McCormack et al., 2010; Stanley et al., 2012; Pradinie et al., 2016; Carmona, 2019). POS have been fundamental sites for political, economic, and cultural activities since ancient civilizations and up to the present day (Lévy, 2008). POS vary in shape, size, and typology, including squares, plazas, streets, parks, urban squares, waterfront promenades, markets, and sports fields (Askari & Soltani, 2019; El-Basha, 2021). However, no recent study was found to focus on open public spaces located in historical areas. Retaining historical POSs preserves tangible and intangible heritage elements such as surrounding building facades and activities, embodying the life and collective memory of cultures (UNESCO, 2021). In the past, open public spaces served as multifunctional places, providing opportunities for sports,

watching matches, social, political, educational, and commercial interactions. (UNESCO, 2021) defines cultural heritage sites as "areas including archaeological sites that have outstanding universal value from historical, aesthetic, ethnological, or anthropological perspectives." Furthermore, UNESCO states that the protection of historical areas in cities should not be limited to preserving individual historic buildings but should encompass all elements within a comprehensive and multidimensional urban structure (UNESCO, 2021).

According to Camp (2010), "the development of the Athenian Agora began in the 6th century BC during the time of the legislator Solon," the origins of historical POSs can be found in the Greek Agora (public square). Since then, markets, leisure time, and cultural events have all been connected to POSs in Greek cities. Even though the concept of public use of space may be found in ancient Mesopotamia, where Sumerian King Gudea (about 2340 BCE) established the first planned park-like landscapes, POSs have been used for far longer (Gothein, 1928; Ejroushi, 2020). During the Renaissance, POSs played a significant role in the transformation of European cities, as public spaces hosted a variety of social and recreational functions (Wycherley, 1976). Meanwhile, Cordua (2010) drew attention to streets, squares, and plazas in European cities (Lévy, 2008). Since then, the importance of developing open public spaces in European and Arab cities has increased, and there has been a significant awareness of the requirements of public spaces.

Historical POSs in city centres are complex and fascinating places that can have a wide range of meanings and uses. Literally, a historical POS is a spatial public area located in the historical part of a city (Lévy, 2008). Madanipour Gehl (2007) noted that "POS has become an integral part of cities throughout history, to the extent that human settlements cannot be imagined without it." Unfortunately, in developing countries' cities like Tripoli, H-POSs are mostly used as dumping grounds, informal commercial activities, and parking lots (Elkekli, 2014; Abdulla et al., 2016). This research looks into historical POSs and the ways in which the dimensions of historical open public spaces impact activities in Libyan cities, particularly in Tripoli, Libya. It explores the specific concept of H-POSs within the urban context of Tripoli and the historical areas within the city. As explained in the first section, many H-POSs have deteriorated over time due to lack of maintenance, vandalism, low-quality repairs, and changing physical appearances in different periods depending on who has authority over Tripoli. To understand user needs in H-POSs in Tripoli, this research aims to explore the factors that enhance visitor activities in H-POSs. Through a mixed-methods approach, including experimental analysis and a case study of four different historical open public spaces, surveys, direct observation, and focus groups will be conducted.

In recent years, research on POSs has become more prevalent due to fundamental changes in public life resulting from digital technology and the Internet of Things, which have altered the essence of traditional urban spaces (Abdulla, 2019). Therefore, many scholars and authors have attempted to define the characteristics of POSs from different perspectives and identify the factors that contribute to their success. A pioneering study by Lynch (1964) identified five factors that should be present in POSs to ensure their success: vitality, sense, fit, access, and control. (Jacobs & Appleyard, 2015) proposed seven essential goals: identity, livability and control, access to opportunities, authenticity and meaning, community and public life, self-reliance in the urban environment, and an environment for all (i.e., inclusivity and specific access for people with special needs).

Gehl& Gemzøe (2004) and Gehl (2011) have emphasized on several occasions various design aspects that encourage a user-centered approach in designing and using open public spaces. According to Gehl, comfort, enjoyment, and protection are fundamental criteria for any successful POS. He describes that the time people spend in a place in the city depends on their sense of comfort on both psychological and physical levels, and if the level of comfort is low, the time spent in POSs will be short. As for enjoyment, it deals with how to delight users with positive aspects of weather, enjoying views and horizons, the artistic quality of the design of the POSs and its fine details, and the pleasure of experiencing the natural environment (trees, plants, water). As for protection, it encompasses a wide range of preventive measures provided by the place to reduce negative experiences, including safety and security, shelter, and protection from traffic movement.

Similarly, the Project for Public Spaces (PPS), a global organization focused on public space projects, has attempted to establish specifications for successful open public spaces, linked to four main criteria: uses

and activities, comfort and image, access and linkages, and sociability. Three key factors are associated with the effective use of open public spaces, including user needs, quality of physical features, and spatial structure (Abbott, 2015). Considering user needs is fundamental to designing any good open public space, requiring a design that attracts people, facilitates their activities, and encourages them to spend longer periods of time in the space while engaging in these activities (Francis, 2003). At the intersection of academic and policy literature, scholars discuss ways to shape open public spaces and understand how people perceive and use them.

There is a glaring gap in research, and the amount of it is very small when it comes to Tripoli. (Shawesh, 2000) examined the physical characteristics of the city's architecture and urban forms through the natural environment, houses, streets, open spaces, markets, and mosques, for instance, while evaluating changes in Tripoli's built environment's identity. Contrarily, studied public spaces in Tripoli's urban centre in her thesis by examining the factors that influenced its development and alteration during three distinct historical periods: Tripoli's Ottoman occupation, its time as an Italian colony, and the post-colonial period. This paper offers crucial new insights into understanding the current configuration of Tripoli's historic public squares as an illustration of how conflict in emerging cities directly impacts citizens' daily lives.

1.2 Evolution and transition of post-conflict Historic Open Spaces Libya.

In order to understand the history of public open spaces in the city of Tripoli, it is important to comprehend the historical pattern of the development of public squares over time. The city centre of Tripoli has been shaped by different periods throughout its history. Since the arrival of Islam to Tripoli in 643 AD (23 AH in the Islamic calendar), life, language, religion, privacy, and living patterns have changed throughout the entire city of Tripoli (Lakhder & Dugeny, 2010). Public squares or public open spaces became an important element in Tripoli and in all Islamic cities. Therefore, in Tripoli during the Islamic era, POSs included mosques, markets, and public streets, and sharp gender considerations were applied as is the case in most Islamic cities. Mosques, markets, and public streets were established based on the belief in privacy, in addition to compliance with Islamic law (Sharia) regarding "neighbour's rights" (Lakhder & Dugeny, 2010; El-Hasumi, 2018; Akbar, 1998). Figure 1 depicts the city and its port in 1746, with the area within the walls connected to the harbour (Alakhal, 2017).

During the 16th century, North African cities were significantly influenced by the Ottoman Empire, including Tripoli, which became an Ottoman province after many years of Spanish occupation. El-Hasumi, (2018) states that since the Ottomans took control of Tripoli, the city lost the Islamic urban style that previously influenced and led public spaces before the Ottoman occupation (El-Hasumi, 2018). On the other hand, as shown in Figure 2, Tripoli began to rapidly grow in size during the Second Ottoman Period, resulting in the formation of complexes of buildings, streets, and open spaces that combined the central mosque with various religious, educational, funerary, and market institutions (Elkekli, 2014). El-Hasumi (2018) argues that public open spaces expanded outside the city walls during the Ottoman era and were used as markets within the city. The first modern plans for Tripoli were prepared during the Second Ottoman Period, which included the planning and construction of new markets, renowned higher schools, hospitals, post offices, orphanages, and squares (Carmona, 2019). Planning outside the city walls also became a major activity for municipal authorities, leading to the growth of specialized bureaucratic and technical administration (Silva, 2016). El-Hasumi (2018) affirms that Tripoli's market was considered an external world where the city's inhabitants gathered within the walls to express themselves and communicate for various purposes, serving as an active open space that naturally responded to the increasing demand for broader urban areas.

On the other hand, during the Italian occupation of Libya (1911-1943), the character of the city of Tripoli changed significantly thanks to the new Italian authorities (Shawesh, 2000). A large part of Tripoli's historical nucleus was built outside the city walls during this period (El-Hasumi, 2018). The Italian authorities designed a plan for Tripoli according to European urban planning and design principles, transforming the city into a major urban centre with a well-planned modern commercial centre outside the old city walls (Abdulla, 2019).

In 1939, Tripoli's new urban core was created around the Cathedral Square (Algeria Square). The city's POSs were redesigned as shown in Figure 3, Figure 4, and a new urban centre was created, giving the city

a contemporary aspect in the 1930s and early 1940s (Fuller, 2000; El-Allous, 2016). Similar to this, Micara (2021) noted that the creation of a new plaza at the gates to the old city and the castle during the Italian era was a noteworthy effort. This area later on became the city's main public space. In addition to the goal to demonstrate the authority of the Italian dictatorship and improve military services, the coastline road and waterfront were also built alongside the city's historic centre at this time.

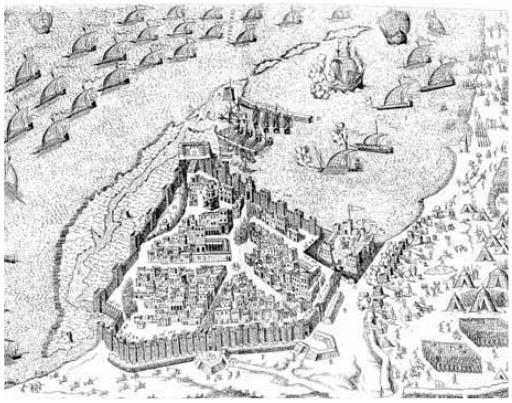


Figure 1. (Left) Plan of Tripoli in 1559 (Alakhal, 2017).



Figure 2. (Right) The Ottoman early urban activities outside the city walls around 1910 (Mezughi).



Figure 3. Development plan for Tripoli 1914.



Figure 4. Seafront and the Corniche with a pedestrian pathway (Grisoni, 2020).

After 30 years of Italian colonization in Libya, the period of Italian occupation ended in 1943 due to World War II. Following Libya's independence in 1951 and the discovery of oil in 1958, the Libyan people gained freedom in using the Italian area in Tripoli, and all streets and squares became accessible to them. However, during this period, the urban fabric of Tripoli changed. The city centre was separated from the waterfront by a highway, and the coastal area of Tripoli was relocated, justifying the change as part of expanding port activities as shown in Figure 5. Additionally, three historical buildings were demolished to create Martyrs' Square, including the Real Miramare Teatro, the National Insurance Institute building, and the Sidi Hammoda Mosque, as depicted in Figure 6 (Ejroushi, 2020).

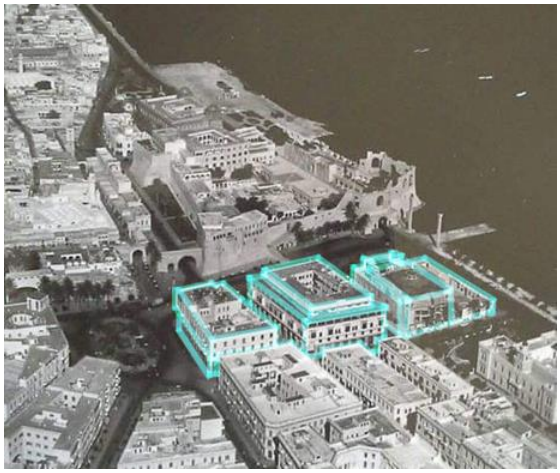


Figure 5. Locations of the main three buildings were removed.



Figure 6. Moving the waterfront into the sea to create the highway. Tripoli, Flickr.com. (accessed on 10 May 2023).

Therefore, the POSs in the historical part of Tripoli have undergone several changes during different periods, giving them historical, social, economic, and political importance. During the Ottoman rule, the open public spaces in Tripoli were used as markets and venues for religious events, representing the strength of the state. After the Italian occupation, the use of POSs continued and expanded. Additionally, new public spaces were created, but the new Italian district in Tripoli was primarily used by Italian settlers. After Libya's independence, the city centre of Tripoli was opened for Libyans to use and visit. However, the current reality of the Libyan city shows a weak relationship between user requirements and POSs within the city, especially regarding the key parts of the city centre (public squares and streets). Public squares (such as Algeria Square and Martyrs' Square) and streets (such as Mazran Street, Omar Al-Mokhtar Street and Rasheed Street) reflect the original concept of urban public space and play a role in enriching the city socially, economically, and politically. The Tripoli region in northwestern Libya is a case of explosive urban growth and urban poverty, which has become an emerging issue in Libyan cities in general. Although Libyan policy designates land for open spaces, they are often unavailable due to weak enforcement and other issues (Abdulla, 2019).

1.3 Users' Needs in Public Open Space

(Gehl, J., 1987) explained the quality of POS based on the types of activities users engage in: social, optional, and necessary activities. Previous research has often been descriptive regarding the success and failure of POSs, focusing on three main aspects: use, activity, and movement. Similarly, there are three main factors associated with the effective use of POS: user needs, quality of physical features, and the spatial structure of the space (Abbasi et al., 2016). Therefore, considering user needs is the key element in any successful design of POSs. Designs that attract people, facilitate their activities, and encourage them to spend more time engaging in these activities are considered the best. It can also be said that quality is related to usability, with certain criteria depending on people's needs and perceptions. If POSs do not meet the users' needs, regardless of other aspects such as aesthetics or the environment, they cannot be considered successful as public open spaces (Askari & Soltani, 2019).

POSs typically possess functional and tangible qualities that positively or negatively impact social interaction, user comfort, and safety, thus attracting people to utilize them. The physical and functional attributes of POSs are linked to activities, accessibility requirements, physical amenities, location, and surrounding land uses (Montero Avila, 2001). As mentioned earlier, social openness, uses and activities, accessibility, connections, comfort, and image are general criteria for the success of POSs spaces. These attributes influence the enjoyment of using POSs and the social life that takes place within them. (Francis, 2003) defined user needs as the facilities and experiences that the public seeks when enjoying public open spaces, and conflicts among users can arise when their demands are not met or when there is conflict between different user groups. Ultimately, public open spaces are evaluated by individuals (i.e., users) based on how well they meet their needs, and this is referred to as a sense of place, which prompts people

to make comparisons and evaluations based on this criterion, but not necessarily based on national attachments to the place (Stokols, 1981). Carr et al., (2007) added six user needs in POS, including comfort, relaxation, passive participation (enjoying the scene without actively participating), active participation (with physical involvement), and discovery. In this research, POSs in historical areas were broadly defined as "spaces existing in the historical zone or open spaces surrounded by historical buildings intended to provide public activities and accessible to the public free of charge".

2. Methodology: Analysing users' perception in historic public space

To understand the nature and dynamics of public activities in historical spaces in traditional cities in North Africa; Tripoli, Libya was taken as a case study in this paper, representing a city experiencing local conflict. The investigation in this paper should focus on the relationships between the characteristics of historical public open spaces in Tripoli and the well-being of users concerning physical activities and social interactions in those spaces. A comprehensive review of the literature was conducted to identify user factors in the use of public space. Figure 7 illustrates the conceptual framework for understanding the integrated impact of safety and security, comfort (aesthetics, planning, management, and pedestrian facilities) on user visits to Tripoli public spaces.

The paper provided a thorough critical assessment of POSs in their theoretical framework in order to accomplish the research goal. To examine different facets of the topic, this research article makes use of several data collection approaches. This makes it possible for researchers to get a more complete and all-encompassing view of reality, illuminating various facets of a particular event and offering a deeper comprehension of the research issue than a single approach would. Case studies, document analysis, surveys, observations, and focus group discussions are some of the mixed methodologies. This study is an empirical investigation on Tripoli's historical public places and the variables affecting their users.

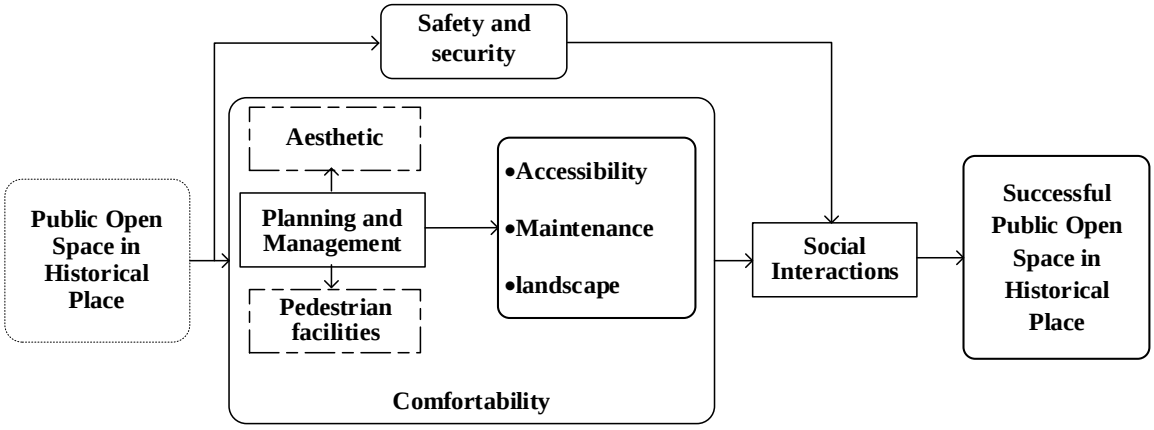


Figure 7. Conceptual framework of factors that affect users' visits to historical public open spaces.

2.1 Empirical research and analysis

In this research, the case study approach was used, where four different POSs in the historical neighbourhoods of Tripoli were selected to ensure the diversity and comprehensiveness of the dataset and analysis. As described by Yin (2013) "Case study can investigate a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident. Furthermore (Song et al., 2016) highlighted that a case study is an appropriate method for exploring phenomena in ambiguous urban spaces. (Yin, 2013) also emphasized that cases can include organizations, processes, programs, neighbourhoods, institutions, events, and other phenomena. The historical area in Tripoli, Libya, was chosen as a case study to understand the concept of historical public spaces and the factors influencing users and their decisions in using the place. Additionally, four locations were selected as case studies, as illustrated in Figure 8, with the following characteristics: Omar Al-Mokhtar Street (Figure 9) is a case study of H-POS with poor infrastructure and few pedestrian use rate, A case study of H-POS with a high pedestrian use rate and strong infrastructure is Martyrs' Square (Figure 10), whereas a case study of a POS with a low pedestrian use rate and good infrastructure is Algeria Square

(Figure 11), and Al-Rasheed Street (Figure 12) is a case study of H-POS with a lot of pedestrian use rate and poor infrastructure.



Figure 8. Four public open spaces were used as case study areas;1: Omar Al-Mokhtar Street, 2: Martyrs' Square, 3: Algeria Square, 4: Al-Rasheed Street.

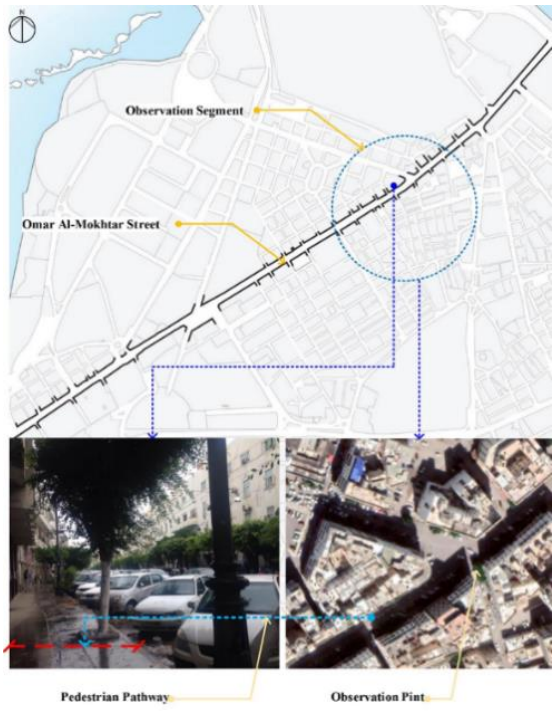


Figure 9. Omar Al-Mokhtar Street.



Figure 10 Martyrs' Square.

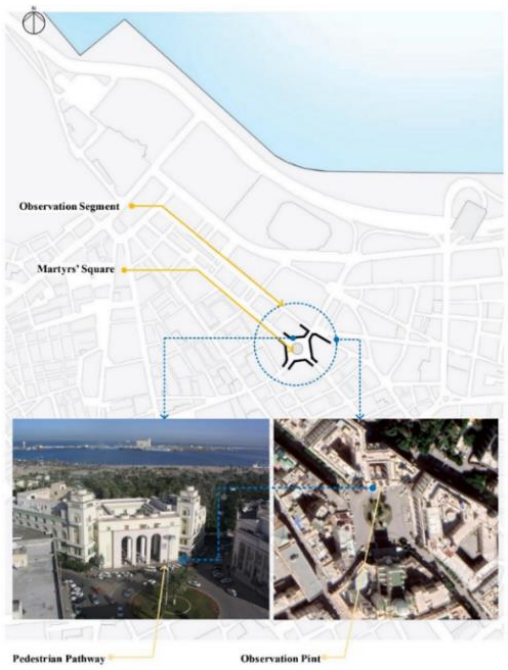


Figure 11. Algeria Square.



Figure 12. Algeria Square.

Observation was used as a qualitative data collection tool during the fieldwork. This tool was chosen because the researcher needed to understand the phenomenon in its context, in the field. The observation included monitoring the physical environment, with a particular focus on pedestrian behaviour. (Marshall & Rossman, 2015) described observation as a "systematic recording of events, behaviours, and artefacts (objects) in the chosen social setting for study." The observation involved spending 30 minutes in the four specified studies at four different times of the day (morning, noon, evening, and night) twice on weekdays and once on weekends, between 08:00 and 23:00. The camera was used to capture photographs, and visual notes, behaviour mapping sheets, and pedestrian count sheets were used as tools in the observation.

2.2 User and Professional Questionnaire Survey

The most important part of the research was the design of relevant and valuable data collection questions to achieve the paper's objective. The study conducted two separate survey questionnaires, one targeting users of the selected POS as case studies, and the other targeting professionals and experts related to the topic. This aimed to gather data on the obstacles and success factors concerning users' prolonged visits to H-POS in Tripoli. The original questionnaires were designed in English and then translated into Arabic. The data collection tool was guided by the "Neighborhood Environment Walkability Scale (NEWS)," "International Physical Activity and Environment Network (IPEN)," "Neighborhood Quality of Life Survey (NQLS)," and "International Physical Activity Questionnaire (IPAQ)" (Craig et al., 2003; Saelens et al., 2003; Cerin et al., 2008).

Participants were selected using a suitable random sample from each of the four case study regions. Based on prior research, the authors created questionnaires for users and pertinent experts that were concise, clear, and self-completable without bias or ambiguity (Barrett & Finch, 2013). A total of 520 questionnaires were distributed to users in the four case study areas (130 in each area), resulting in 427 valid responses, achieving a high valid response rate of 80%. The study followed the suggestion by (Payne & McMorris, 1975) stating that for populations exceeding 100,000, the appropriate sample size for the required accuracy and reliability is 384. A total of 130 questionnaires were distributed to relevant professionals (mostly architects, urban planners, and landscape architects) in Tripoli, resulting in 108 valid responses, with an exceptionally high response rate of 83%. A total of 427 responses were collected from all four case study areas, including 26% (n=111) from Algeria Square (AS), 25% (n=109) from Martyrs Square (MS), 24% (n=105) from Rashid Street (RS), and 23% (n=102) from Omar Al-Mukhtar Street.

2.3 Focus group discussion (FGD)

Guided Focus Group Discussions (FGD) were the third data collection method employed during the fieldwork to supplement the survey results with information based on expert human judgement (Seale, 2017). Because the participants were professionals with years of expertise in the fields of public spaces, public space design and management, and the historical area in Tripoli, the validation procedure using focus groups was thought to be reliable. Government representatives and users were included in the guided discussions to gain a greater understanding of their perceptions of Tripoli's ancient public spaces, the obstacles that prevented people from using them, and the motivating elements for doing so. The guided discussion session had three main objectives: defining and outlining the challenges and success factors in Tripoli's historic public spaces, creating a relaxed but semi-formal atmosphere to encourage participants to discuss all facets of Tripoli's historic public spaces in-depth, and updating the research findings and tactics after validating them with the focus group participants.

The focus group participants were formally invited, and when requested by the participants, phone calls were made to confirm their attendance. 15 participants—eight in one session and seven in the other—participated in the focus group discussions for this study, and each had relevant experience with Tripoli's public and historical places. Participants in Group A included an expert from the government and municipal authorities in Tripoli, urban planners from the private sector (an architect), local urban planning offices (the Tripoli Municipality), and a user of public spaces in Tripoli. A representative from the Libyan Parliament, local communities in central Tripoli, local urban planning offices (Tripoli Municipality), the private sector, an architectural engineer (Libyan National Consultancy Office), and a user of public spaces in Tripoli participated in Group B. There were also two experts from the government and local authorities in Tripoli.

3. Results

3.1 Barriers Limiting Activity in Tripoli's Historic Public Spaces

As previously mentioned, the aim of this study is to identify the main barriers that hinder physical activity and social participation in the historical public spaces in Tripoli. The study presented four different aspects of how physical activity and social participation are practised in these public spaces. This paragraph evaluates the time spent walking in each of the case study areas. The results showed that people do not spend a long time walking in the city center of Tripoli, and approximately 40% of the participants in the user survey prefer to spend 30 minutes or less in the four case study areas. On the other hand, one of the important findings in this study is that nearly 60% of female respondents in the user survey prefer to spend 30 minutes to an hour or more than 60 minutes, contrary to some previous studies that concluded that men spend more time in public spaces. This indicates that there are gender-related differences in the preference for spending time in historical public spaces in Tripoli. It's worth noting that these findings highlight the importance of considering gender-specific factors when planning and designing public spaces to encourage physical activity and social engagement.

The observation method found that more than 70% of the users are males, and the number of females using public spaces in the evening was limited. This partially reflects the conflict in Libya, in addition to social customs that largely restrict women from going out alone in the evening. Similarly, about 50% of all participants visit the four case study areas daily or twice a week. The results showed that "Al-Rashid Street," which is classified in this research as a poorly conditioned area with high physical activities and high social engagement, had the highest number of users during weekdays and weekends. This is attributed (according to observation data) to the diverse daily activities practised in this street, such as shopping and work, which are the most significant factors that encourage people to visit and revisit public spaces in the city centre of Tripoli. This supports the statement made by (Appleyard, 1980) that successful and active public spaces can only be achieved by achieving a proportional balance between different user groups and activities.

According to the study, users' opinions of using POS in historically significant locations are influenced by their age, experiences, and capacity to devote time to visiting those venues at various phases of life. The majority of study participants 50% were in the age ranges of 18–29 and 30-39 years, and they spent more than 60 minutes exercising and interacting with others at the four study locations. However,

according to the prior findings, only around 55% of participants in the age brackets of 40–49, 50–59, and beyond 60 years spent 30 minutes or less. As previously indicated, Tripoli's local administration does not administer the public spaces in the city centre and does not have a formal policy for managing them. Tripoli is typically a car-oriented city. Walking to work and carrying out regular tasks like shopping may be the only physical and social engagement in the city. Numerous barriers, including worries about safety, pedestrian facilities, planning and management, aesthetics, and socio-cultural considerations, may restrict people from engaging in physical activity and social interaction, preventing them from spending much time strolling through Tripoli's public places.

3.2 Safety and Security

Cities need to strengthen safe infrastructure to enhance the quality of living and well-being ; (Burton & Mitchell, 2006). The United Nations - Housing and Urban Development (Un-Habitat, 2013) has pointed out that public safety is a collective effort that requires collaboration from various stakeholders, including the government, municipalities, and the community. The results align with those of (Abdulla et al., 2016) in Tripoli, there is a lack of safety among users of POS, attributed to the ongoing conflict and instability since 2011. In this section of the survey, participants were asked about whether the POSs in the historical part of Tripoli are safe for public activities, and the responses varied depending on the field. Around 46% of architects gave the performance in terms of safety and security a good or exceptional rating, compared to 46% of civil engineers, 50% of landscape architects, and 60% of urban planners who gave it a bad or very poor rating. 60% of public space managers regarded the safety and security performance as inadequate, compared to 50% of city planners who found it to be acceptable. This demonstrates that Tripoli's public spaces are not appropriate for walking, supporting the analysis in the literature review section and highlighting the necessity of determining the dependability of security and safety features to create pedestrian-friendly environments.

The results of this study indicate that the political situation in Libya remains fragile, and the security situation remains dangerous and unpredictable at present, which is supported by the (Abdulla et al., 2017) indicators indicating an increase in crime rates in Libya. Social and security safety were discussed in the collective interactive sessions as major obstacles that hinder walking in Tripoli. This finding was consistent with the responses from ordinary people and professionals. The security and safety barriers have a strong correlation with the time spent walking in public spaces and the likelihood of revisiting them in the future. For example, the absence of police patrols after 8:00 PM in downtown Tripoli provides opportunities for criminals to roam the streets, as indicated in the results of the collective interactive sessions: "The problem is that police patrols operate in Tripoli during the daytime, causing traffic congestion everywhere, while at night, after 8:00 PM, they start to disappear due to criminals, who then begin their operations after this time, preventing people from using public spaces" (Private sector, Collective interactive session - Group A- B6). Therefore, the results of the public and expert surveys suggest that the absence of safe pedestrian facilities, traffic congestion interfering with pedestrian movement in downtown Tripoli, and the lack of police presence in the streets, along with the prevalence of crime and disregard for the law, discourage people from walking frequently in downtown Tripoli.

3.3 Institutional, legislative, management and financial barriers

As the capital, Tripoli faces fundamental challenges, including a lack of urban design maintenance, which has been overlooked by successive Libyan governments, evident in the poor upkeep of public spaces, pedestrian facilities, pedestrian crossings, street furniture, and so on (Lakhder & Dugeny, 2010). Approximately 60% of the total participants, including experts, agreed that there is a deficiency in facilities such as sports equipment, accessibility for people with special needs, physical amenities (such as seating or dining facilities), connectivity between most places in Tripoli, and availability of public transportation. Providing pedestrian facilities is a crucial element for the success of pedestrian-friendly cities. In this survey, participants were asked if the public spaces were suitable for pedestrians through pedestrian facilities, and around 55% responded that pedestrian facilities were few or very few.

The questionnaire responses in the four studied areas confirm the lack of pedestrian facilities, such as seating areas, shelter s, public restrooms, or social gathering spaces. The compiled interactive sessions

indicated that due to the financial constraints faced by the Libyan governments, pedestrian infrastructure is often excluded from the main budgets. As a result, experts emphasized the need for pedestrian-friendly facilities, such as clear pedestrian platforms, crosswalks, marked pedestrian pathways, pedestrian signals, level separations, tunnels, canopies, coordinated green spaces, street furniture, and public transportation access and interfaces that make public spaces more pedestrian-friendly. "I agree with the statement that facilities are one of the most important factors influencing users of public spaces to stay longer and revisit those spaces... such as comfortable facilities, safe amenities, and transportation" (Municipal Urban Planning Office, Compiled Interactive Session - Group A - B3).

In this context ,the institutional ,legislative ,administrative ,and financial realities in Tripoli constitute the most significant obstacles affecting activities in the H-POS in the city .According to Urban Planning Law No .3 and Law No .19 ,urban planning activities are divided into four main levels :national ,regional , local ,and urban (Libyan Government, 2001) Moreover ,it can be observed that there is no agency with a broader authority and responsibility regarding the management of public spaces in Tripoli to establish soft infrastructure such as events ,programs ,and activities ,unlike the hard infrastructure (such as buildings and street design ,etc. On the other hand, (Abdulla et al., 2016) pointed out that centralized planning in Libya might overlook the necessity of local issues ,resulting in informal and delayed development .Since 2011 ,many public sector activities in Libya have been proven to be dependent on unpredictable funding . Participants agreed that Libyan cities are not pedestrian-friendly due to the conflict and instability in the country since 2011 ,mainly because of the lack of clear jurisdiction and overlapping competencies among Libyan institutions .They also highlighted the shortage of financial support ,ineffective management ,and the prevalence of financial corruption in Libyan government institutions as factors hindering the maintenance and efficient management of POSs.

The gap in policies was also noted in the focus group discussion, including the absence of specific planning guidelines for the location of public facilities. Currently, planners decide on the location based on site characteristics instead. The following data clearly illustrates how participants agree on the institutional, administrative, and financial obstacles in POSs in Tripoli: "Currently, in Libya, we have many administrations that are related to public spaces... There is no specific strategy for creating new public spaces and/or managing and maintaining existing ones... Additionally, weak coordination among relevant entities is one of the main issues in Libya at present" (Local communities in central Tripoli, FGD-GB-P3). Another participant said: "For me, the main obstacle in Libya at this time is corruption... Corruption spreads across all government ministries and departments... It hinders maintenance and the creation of more appealing activities in public spaces in Tripoli" (Private sector, FGD-GA-P6).

3.4 Tracing spatial implications of Socio-cultural barriers

According to Frank and Engelke (Frank & Engelke, 2001), personal obstacles are subjective factors that make it difficult to move ,whereas environmental barriers are fixed circumstances that limit activity. The decision to travel may be influenced by individual variables such as lack of time, motivation, social support for exercise, weather, lack of health awareness, and automobile ownership. Social and cultural hurdles are one of the biggest impediments to making Tripoli's old public areas livelier. The findings of this study suggest that one of the most significant obstacles to using H-POSs in Tripoli is the city's social and cultural reality, "Libya is an Islamic nation; its society is religiously conservative; Libyan families need privacy when present in old public places; and based on my experience, families won't visit places that prioritise single men or teenagers, any future strategy or plan must thus take this into account. (Architect, National Libyan Consultancy Company, FGD).

Based on the provided information, the results of this study can be summarized by illustrating the relationship between the variables that affect the four study locations as follows:

Omar Al-Mukhtar Street (OMS): The model in Figure 13 demonstrates the weaknesses in pedestrian facilities, city planning and management, security and safety, and social-cultural interactions. The results confirm that the lack of planning and management of public spaces in the centre of Tripoli has a negative impact on other dimensions of physical activities and social interactions, leading to a decrease in pedestrian numbers on the street. For example, there is a direct relationship between the lack of planning and management and the poor condition of pedestrian facilities. Additionally, the model shows that OMS

possesses aesthetic resources that attract attention, such as historical facades and symbols. According to (Askari, 2014), physical activities and social interactions in public spaces rely on "the invisible aesthetic experience for feeling safe, comfortable, and happy, which makes the public space appealing and inspiring." Therefore, transforming OMS into a pedestrian-friendly street should involve improving its infrastructure, enhancing security and safety, and emphasizing the local administration's importance of increasing comfort on the street, maintaining pedestrian facilities, and diversifying activities.

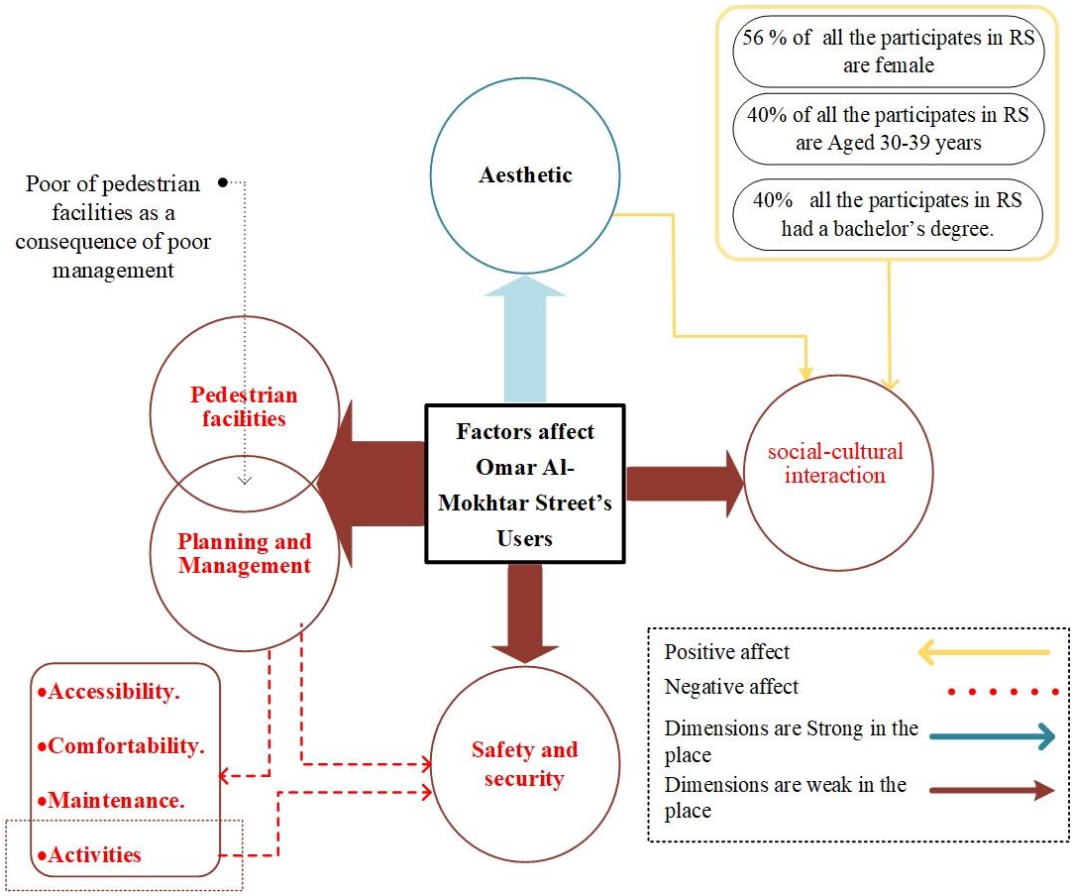


Figure 13. H-POS evaluation model in Omar Al-Mokhtar.

Martyrs Square (MS) is considered one of the most important historical public spaces in Tripoli, located in the heart of the city center. Figure 14 illustrates the deficiencies in pedestrian facilities, city planning and management, security, and safety, which negatively impact pedestrians. Inadequate planning and management in Tripoli have resulted in the lack of pedestrian facilities and their poor maintenance, negatively affecting user comfort. On the other hand, the aesthetics and social-cultural interactions have a positive impact on users, as they express their satisfaction with the limited activities held in Martyrs Square, leading them to spend more time there. This makes it an attractive factor for users who frequent the square and revisit it. One significant result is that the social interactions among users have made Martyrs Square one of the most attractive places for pedestrians. The problem of public transportation in Libya is a general issue, and as shown in Figure 14, the accessibility to and from Martyrs Square negatively affects users. Therefore, improving pedestrian facilities in Martyrs Square comes from the intersection of providing pedestrian facilities with an enhanced performance of local administration in Tripoli, increased security in the city, and an improved public transportation system. The historical significance of Martyrs Square has turned it into a bustling place for users, not only from Tripoli but also from all parts of Libya.

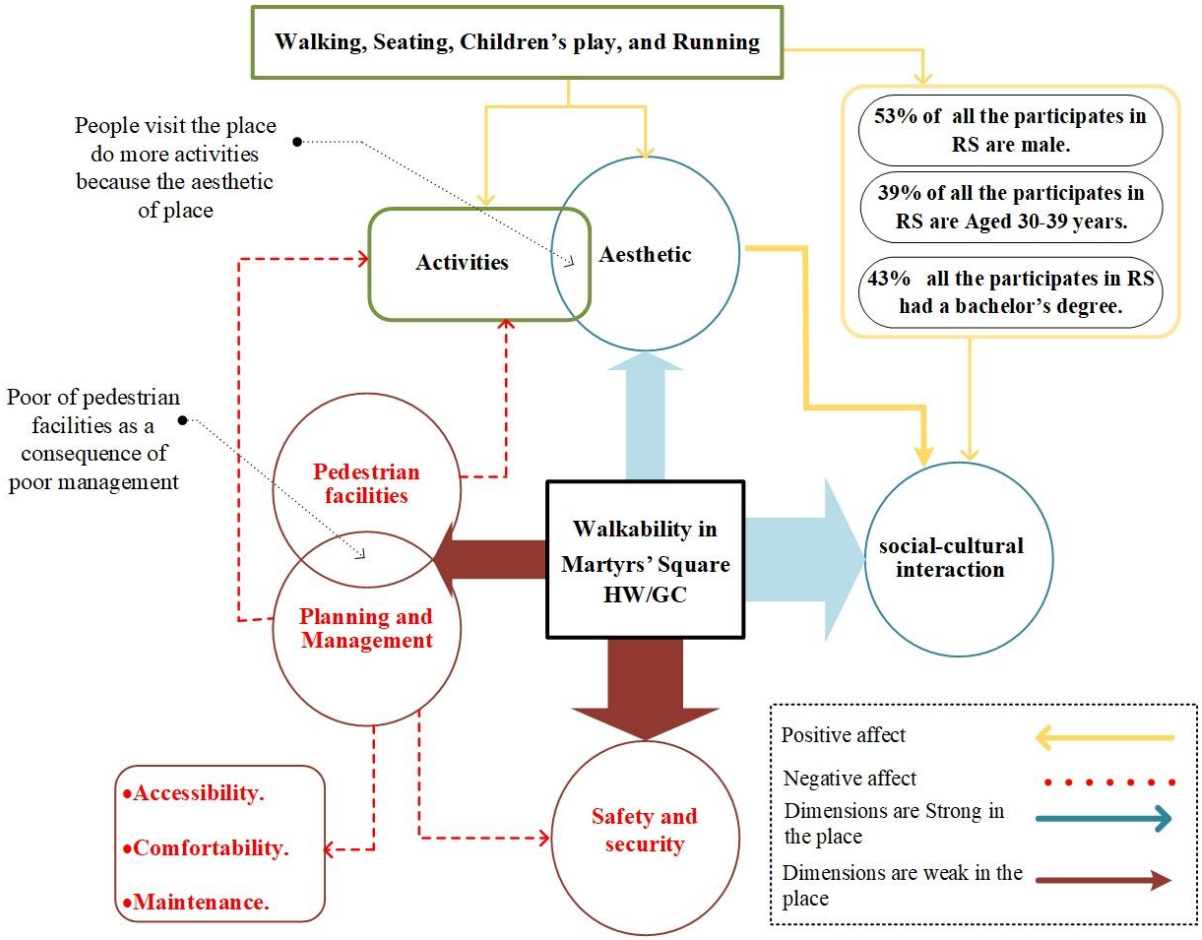


Figure 14. H-POS evaluation model in Martyrs' Square.

Algeria Square (AS) is one of the most important historical squares in Tripoli, as it houses several administrative and religious buildings, such as the municipality and the Jamal Abdul Nasser Mosque. Figure 15 illustrates that the lack of pedestrian facilities and poor management negatively affect pedestrians. Additionally, the absence of amenities, maintenance, and natural landscapes has negative impacts on users who spend extended periods or revisit Algeria Square. The square is considered a safe place, as depicted in Figure 15, and users prefer to frequent it due to the sense of security it provides. As previously mentioned, the Italians constructed Algeria Square to symbolize the beauty of Tripoli, and as such, the aesthetic value of the place has a positive impact on users. Algeria Square is no different from other study locations, and to improve the pedestrian experience in the square, it is necessary to provide public transportation and pedestrian amenities, implement regular maintenance, and offer various social activities.

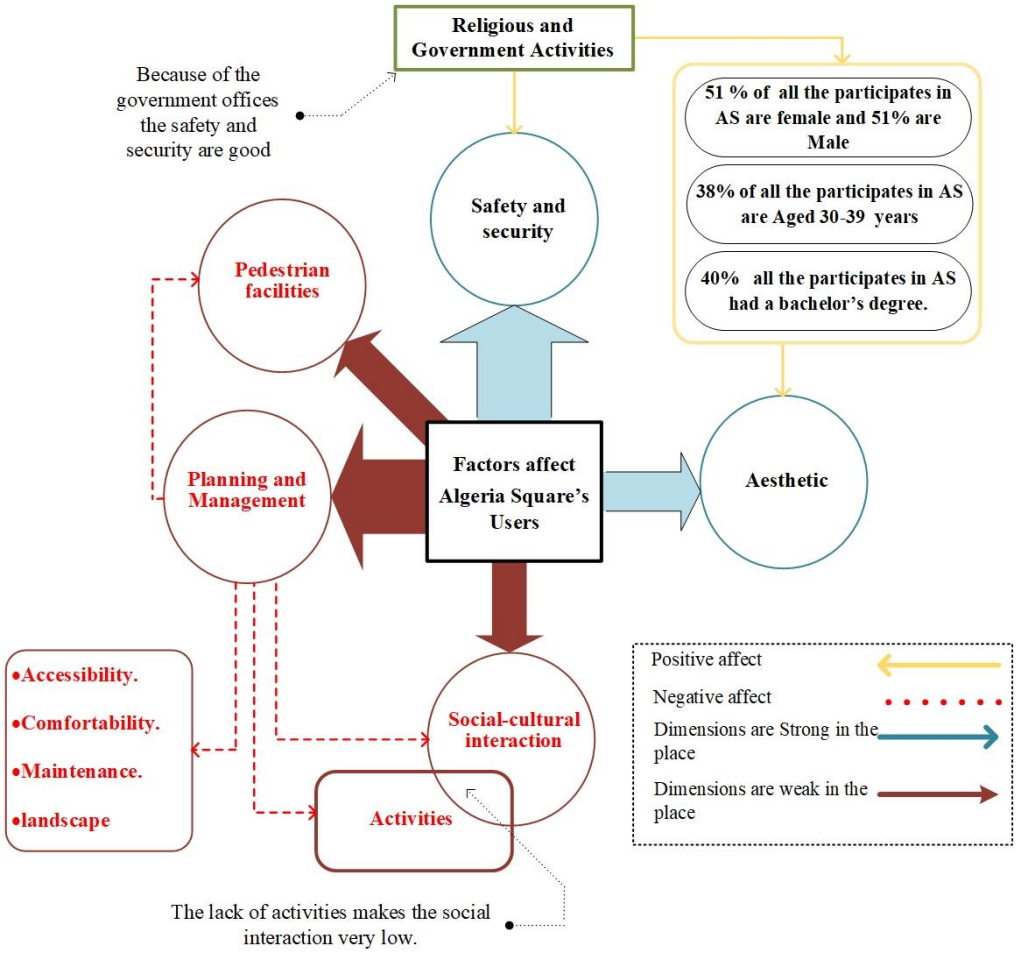


Figure 15. H-POS evaluation model in Algeria Square.

Al-Rashid Street: As depicted in Figure 16, the city's poor planning and management are the cause of the shortcomings in pedestrian facilities, urban planning, and aesthetics, which are evident in the abundance of dirt and a lack of pedestrian facilities. Additionally, using pedestrian crossings as sites to exhibit goods and park cars provides extra barriers for pedestrian passages. According to this study, the supply of pedestrian amenities is hampered by government corruption, poor plan implementation, and an absence of development control. On the other hand, Tripoli's most important business area is Al-Rashid Street. The model demonstrates that despite the unfavourable environmental conditions on Al-Rashid Street, commercial activity benefits pedestrians' sense of security, causing them to visit and stay there. Figure 16 shows that among the four study locations in this paper, Al-Rashid Street has the highest number of users on weekdays and weekends despite having a failing pedestrian infrastructure and pedestrian congestion. This can be linked to the variety of daily activities carried out in this area, including employment and shopping, which are seen to be the most compelling causes luring people to return to the public places in Tripoli's historic centre.

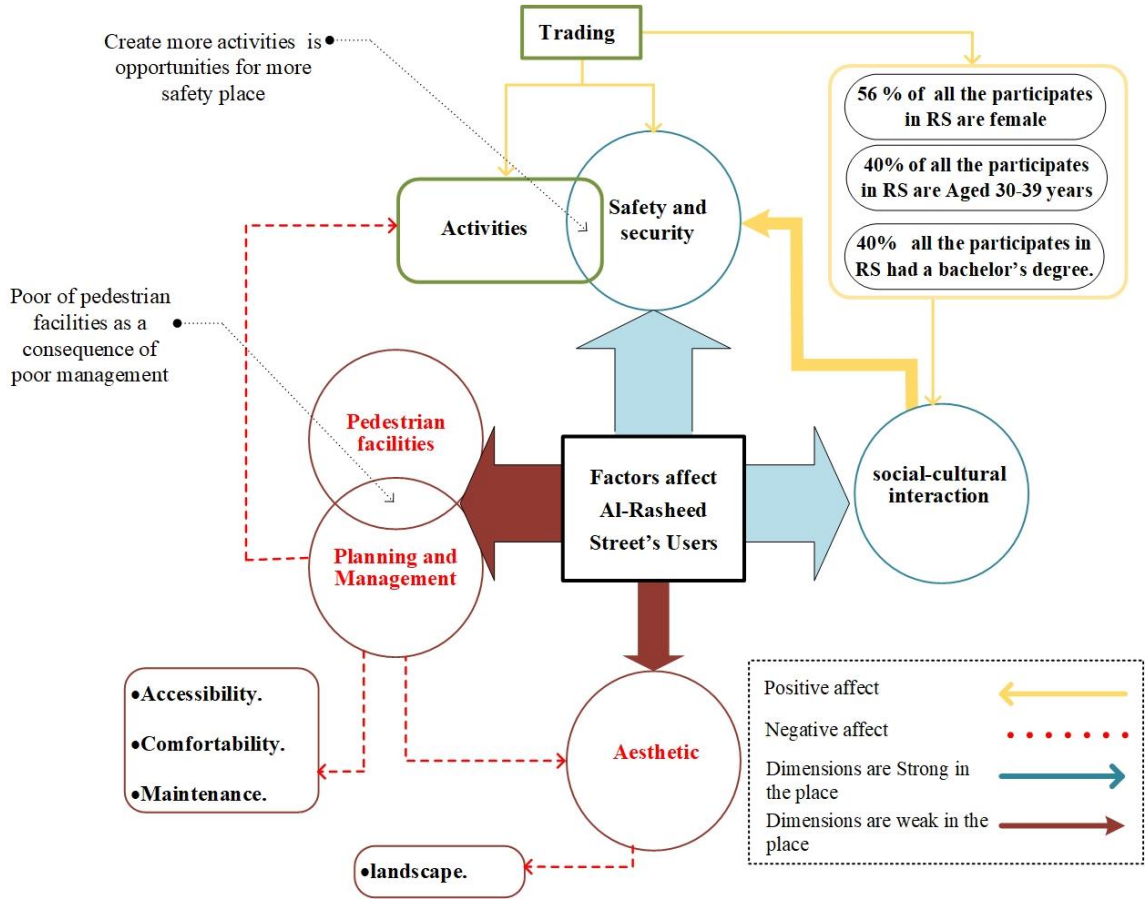


Figure 16. H-POS evaluation model Rasheed Street.

3.5 Building a critical understanding of the barriers impacting the perceptions of public spaces in Tripoli

The findings of this research support Appleyar's (1980) statement, that vibrant and successful public spaces can only be achieved by striking a balance between different user groups and activities. As previously mentioned, local authorities in Tripoli lack an official strategy for public spaces in the city centre, and there is no government management for public spaces. Overall, Tripoli is a city dominated by motorized vehicles, and activities throughout the city are mostly limited to walking to work and carrying out daily tasks like shopping. Obstacles faced by pedestrians in the historical area in Tripoli, such as safety, pedestrian facilities, planning, management, aesthetics, and social culture, discourage people from spending time walking or revisiting H-POSs in Tripoli.

In Tripoli, specific data for assessing the quality of H-POSs regarding safety, security, pedestrian facilities, aesthetics, and social and cultural interaction is not collected. The overall results indicate that age and education are the main social and demographic factors leading people to spend more time in H-POSs in the city centre. On the other hand, from users' perspectives, facilities, safety, and aesthetics are the most significant barriers that limit the possibility of spending extended periods in these spaces. Overall, Tripoli suffers from infrastructure deficiencies, such as a lack of facilities for people with special needs, parking spaces, pedestrian facilities, seating, and shelters. Ewing & Handy (2009) also pointed out that the lack of certain facilities in H-POS hinders physical activity in its simplest form, such as walking, making mobility challenging.

The results of this paper indicate a relationship between the gender of participants in this study and the time spent walking in the study areas. However, gender has no significant relationship with the frequency of revisiting the four study areas, as both genders revisit them to a similar extent. This finding contrasts with Abdulla et al. (2016) study which suggests that gender separation has always been a part of Libyan, Arab-Islamic identity, and traditions, including the use of public spaces. There is a significant relationship between the age of participants the time spent walking in the case study areas and the frequency of revisits. Comparing adults aged 41 to 60 or more, participants aged 18 to 40 spend 60% more time walking. The

participants' education level and the amount of time they spent walking in the model areas are also significantly correlated. Participants with higher education spend more time walking. These results suggest that social and demographic characteristics are closely associated with walking trips.

The capacity and interest of users to travel great distances or spend longer time in Tripoli's H-POS are hampered by a number of barriers. About 60% of the participants estimated these challenges, which include high speeds of traffic near POS, high rates of crime and accidents, a lack of social services, a lack of accessibility for people with disabilities, a lack of urban furniture and amenities (such as seating and dining areas), a lack of connectivity to other parts of Tripoli, and a lack of public transportation options. This section's Principal Component Analysis (PCA) revealed that facilities, safety, and aesthetics are the primary concerns of participants. This shows that consumers' experiences and preferences are highly influenced by the availability and calibre of amenities, as well as by how safe and secure they consider those facilities to be. The analysis of users' needs for visiting POSs found in case study areas that 93% of participants agreed or strongly agreed on the need to increase social activities, 92% agreed or strongly agreed on the need for POSs to encourage people-watching and include fountains, public art, performances, etc., 79% agreed or strongly agreed on the need to make the most of the land that is currently available in H-POSs, and 76% agreed or strongly agreed on the need for POSs to include fountains, public art, According to a PCA analysis of their demands, users in the research settings have needs for physical components, safety and security, and social connection.

4. Conclusions

Cities have increasingly lost their sense of pedestrian culture due to the prevalence of mechanical and vehicle transportation. Urban designers, decision-makers, and professionals, however, continue to emphasise the importance and benefits of walkability as a key factor in the sustainable future of our historic cities, especially considering the challenges of Climate Change. Numerous policies, strategies, guidelines, and specific proposals have been developed and implemented in cities to promote walking as a key means of mobility within the evolving models of walkable cities and 20-minute neighbourhoods. To understand the state of walking in North African cities and their suitability for pedestrian activities, Tripoli was taken as a case study, representing a developing city in North Africa. In this paper, four historical public squares in Tripoli were studied to understand the barriers that hinder Tripoli residents from incorporating walking into their daily routines and reducing reliance on motor vehicles. The main goal of this research is to analyse the barriers and success factors affecting the effective walking experience in the public spaces located in the historical part of Tripoli, Libya. The results of this study support some important recommendations that can be useful in developing Tripoli into a more livable and prosperous city.

The study revealed that the majority of the current public spaces in the historic centre of Tripoli are not suitable to be well-balanced pedestrian-friendly areas. Additionally, Tripoli heavily relies on cars and has an existing infrastructure burdened with traffic congestion and air pollution, lacking adequate and safe pedestrian pathways. As a short-term measure, there is an urgent need to adopt a new policy that prioritizes pedestrians by segregating vehicles from pedestrian pathways. Specifically, dedicating certain streets in the centre of Tripoli exclusively for pedestrians and understanding the needs and reasons behind their preference for walking in public spaces over other options.

Providing clean and well-maintained public spaces makes them more attractive and welcoming to all users, encouraging them to visit and stay for longer periods. Amenities such as seating, public toilets, shelters, and sidewalks can facilitate pedestrian movement during adverse weather conditions. The study also revealed that public transportation is often unavailable and inefficient in Tripoli, leading people to heavily rely on private cars. Therefore, improving the quality and efficiency of public transportation can alleviate traffic congestion and related issues, reducing pressure on the road infrastructure and urban areas in general.

On another note, designing pedestrian-friendly transition areas with a new pavement plan to unify the pavement pattern with the soft landscape is recommended. Renovation and maintenance of buildings in Tripoli's city centre, including providing access for people with disabilities to all H-POSs and other urban elements, are also crucial. In this context, pedestrian-friendliness, safety, and security play important roles

in shaping urban life in H-POS and their surroundings. While the safety infrastructure is an element in security, it does not entirely reflect the potential threats pedestrians face in post-conflict urban areas. The study highlights the absence of police presence and the prevalence of weapons as major threats pedestrians face in public open spaces in post-conflict Tripoli.

Furthermore, the study shows that the livable H-POS are not solely tied to the physical environment but also the safety and security factors. To increase pedestrian safety, adjusting vehicle speed when crossing unprotected roads with median signs, creating pedestrian crossings, installing traffic signals, and regulating all intersections around public spaces and pedestrian crossings are recommended. Additionally, to reduce crime within H-POSs in a city that has faced armed conflict, several measures can be implemented, such as organizing group activities to encourage people to walk together, installing surveillance cameras, and increasing foot patrols by the police.

The city of Tripoli and its H-POSs in the city centre should be able to accommodate various activities, including sitting, dining, shopping, engaging in different activities, and sports. The municipality of Tripoli should diversify activities in historical public open spaces, such as sports, social, religious, and festivals. Similarly, management of POSs should grant equal access rights to all individuals, without discrimination or barriers based on age, gender, or educational level. A master plan and guidelines for historical public spaces should be established, defining relevant types of public open spaces and their associated conditions, along with an integrated and adaptive management plan for individual developments, increasing awareness of the importance of H-POSs among stakeholders. Collaboration between local organizations is essential for the implementation and management of historical public open spaces, including the Libyan Urban Planning Association, urban planning management in municipalities, the National Organization for Information and Documentation, survey management, and remote sensing centres.

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Conflicts of Interest

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

Data availability statement

- Appendix A: Observation Method; https://doi.org/10.7910/DVN/LUQGNA
- Appendix B: Users Questionnaire; https://doi.org/10.7910/DVN/LUQGNA
- Appendix C: Professionals Questionnaire; https://doi.org/10.7910/DVN/PIYV29

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Original scientific paper

Adaptive Strategies Used in Urban Houses to Overheating: A Systematic Review

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ABSTRACT

Recently, urban regions are experiencing prolonged heat exposure due to climate change and increased population expansion. Physiological, psychological and behavioural measures improve residents' thermal comfort to solve the overheating issues generated by the scenario. However, adaptive strategies have not been clearly categorized based on the building construction process. This paper systematically reviews 101 documents published from 2013 to 2023, across 22 countries, with a focus on Nigeria. Using descriptive statistics and content analysis, we identify and categorize 52 adaptive strategies into four groups: urban design, effective building design, insulation, and occupants' behaviour. These strategies are further classified according to their application in the building process stages: pre-design, design, construction, and post-construction. The study provides a full response to overheating in the building sector with efforts to reduce energy consumption rate and greenhouse gas emissions. The findings of the study contribute, significantly to improvement in occupants' health care and well-being, as well as high productivity levels and socioeconomic benefits. Future research is therefore recommended in the efficiency of its implementation to develop innovative and cost-effective solutions in the construction industry towards sustainable urban development.

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Highlights:	Contribution to the field statement:
- This paper provides evidence for the geographical distribution of studies on adaptive strategies to urban overheating. - Detailed information on the causes, effects, and solutions to overheating issues in buildings was achieved through a mixed method of data collection. - A combination of both the active and passive strategies provides a lasting solution to overheating issues. - Categorisation of adaptive strategies into pre-design, design, construction, and post-construction stages improves the building construction industry thereby enhancing the building sector.	The knowledge gained from the study's systematic review is useful to policymakers, architects and urban planners in making decisions and regulations about urban development in accordance with the building regulations. The manuscript's knowledge gap is a valuable contribution to sustainable development by enhancing the building sector for socio-economic benefits. It will act as a web for all stakeholders in the building industry by addressing overheating issues in energy, environment, engineering, science and other areas which are most concerned with the socio-economic impacts of urbanisation.

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1. Introduction

Recent increases in consistently high temperatures and extreme heat have been negatively impacting both physical and mental health. This issue is particularly prevalent in heavily populated urban areas, where over half of the population resides (Olugbenga & Adekemi, 2013), and this urban population is projected to grow by an additional 13% by 2060 (Lembi et al., 2021). The rise in temperatures is associated with a mix of natural phenomena and human-induced urbanization factors (Keys et al., 2016). Buildings, which are meant to offer comfort and shelter, as people spend most of their time indoors, are failing to meet these expectations due to climate change impacts (Akande, 2021; Owolabi, 2017). The situation in urban houses is further aggravated by rapid population growth, leading to overcrowding, aging infrastructures, subpar housing conditions, and environmental deterioration (Akinyemi et al., 2020; Muhammad, Bello, & Ishaq, 2021). These issues have contributed to the expansion of urban built-up areas, especially in developing countries, leading to environmental challenges like greenhouse gas emissions, poor indoor air quality, and global warming (Adedire & Adegbile, 2018; Nazarian, et al., 2022; Lomas & Kane, 2013). The concept of adaptive capacity, defined as the ability of a system to adjust to climate change and mitigate its effects (Cinner et al., 2018; Adefisan & Ahmad, 2018), is vital in this context. Recent literature reviews emphasize that adaptive strategies are essential for managing overheating problems in buildings to ensure occupant comfort (Mesfin et al., 2020).

In a bid to manage the effects of overheating, it was observed that occupants of urban houses are exploring different adaptation measures to achieve effective building performance (Stagrum et al., 2020). Responding to these problems contributes to energy saving in buildings with the use of efficient appliances and materials (Gunawardena & Steemers, 2019). It further ensures residents' good and healthy condition thereby improving their productive lifestyle (Thathsarani & Gunaratne, 2018). This invariably boosts economic development and enhances the socio-economic status of the country (Sholanke, 2022; Folkerts, et al., 2020). The management principle is likened to the traditional architectural building style in terms of the building design, the materials used for construction, and the building operations, which display a passive solution to overheating (Adunola, 2014). This becomes a necessity, as an improper management of the excessive heat leads to an increase in energy consumption in trying to achieve a cooling effect; a higher cost of living that differentiates status among human living standards; sicknesses and heat-related issues that consequently leads to death (Adegun & Ayoola, 2019). Deduction from the ongoing gives the reason why previous works of literature are enriched with studies on various adaptation mechanisms (Adaji et al., 2019; Akinola *et al.*, 2020; Morey et al., 2020).

Previous studies have highlighted the factors that constitute overheating and classified the different adaptive strategies for overheating (Gamero-Salinas, *et al.*, 2021; Fosas *et al.*, 2018; Gunawardena, 2015; Vellei *et al.*, 2016), however, little efforts have been recorded to systematically identify and categorize them. Even though, the adaptive strategies were been identified in the existing works (Drury *et al.*, 2021), little attention is paid to the implementation of their application in the planning and designing of buildings in Nigerian urban areas (Hellwig *et al.*, 2019; Alozie *et al.*, 2019; Manzano-Agugliaro *et al.*, 2015). This has been a barrier to effectively managing the effects of overheating in urban houses (Hao *et al.*, 2022).

Given the above, this paper aims to investigate available literature on ways to improve the thermal comfort of occupants in urban housing provision by focusing on the effective utilisation of different adaptive strategies adopted for overheating in urban houses with the following objectives:

i. To identify countries that have studies published on adaptive strategies for overheating in urban houses.
ii. To determine from the literature, the methodologies adopted to carry out studies to identify the adaptive strategies.
iii. To investigate how the control of overheating has been accomplished in urban homes using the identified adaptive strategies.

This article contributes to knowledge by assisting in making policy decisions on the careful placement of urban fabrics in line with building regulation practices. It will improve the construction industry with the adoption of the right strategy for overheating at each stage of the building process for an effective result and also boost research knowledge about the geographical distribution of previous studies. The categorization of adaptive strategies based on the stages of the building construction process, as

highlighted in this study, creates a better understanding of how the strategies can be integrated into the building sector. This will, therefore, reduce overheating and improve occupants' thermal comfort and well-being to achieve a more cost-effective and sustainable development.

2. Materials and Methods

A systematic review of published literature was adopted because it accommodates the appraisal, summary, and findings of a large number of research publications on a particular subject (Nunn & Chang, 2020). Secondly, previous authors, as evident from the literature, adopted a similar approach in their respective studies (Kinnumen *et al.,* 2022; Chapman *et al.,* 2017). A five-step approach used in carrying out the review encompasses (i) formulation of research questions, (ii) search strategy, (iii) inclusion and exclusion criteria, (iv) selection criteria, and (v) data extraction and analysis as adopted in previous literature (Alrasheed & Mourshed, 2023).

2.1 Formulation of Research Questions

This first step is the basis of the research work to guide the review using information gathered from the collected data. The increasing potential of the impact of climate change and the rate of urban growth in cities has led to an increase in air temperature from 0.7^0C – 7.6^0C (Nazarian, et al., 2022). This has made the building sector account for over 25% of greenhouse gas emissions resulting in a high demand for spatial cooling (Tootkaboni et al., 2021). The negative effect is most noticeable in buildings with low thermal mass, no shading devices, or new homes with high energy efficiency, where the elderly, sick, and children are most vulnerable (Mourkos, 2020). While the extreme heat in most developing countries, with the building sector recording 53.3% of the highest consumption of energy, most research studies focused on physiological, psychological, and behavioural categories of adaptive measures to provide solutions to overheating problems. However, efforts to determine the causes of overheating and various ways to properly manage the problem in the building sector generated the following research questions; (i) which countries have studies published on the use of adaptive strategies to manage overheating in urban houses: (ii) according to the literature, what study methodologies have been used to examine the contributing factors and adaptive strategies to overheating in urban houses and (iii) how has the control of overheating in urban houses been accomplished using adaptive strategies?

2.2 Search Strategy

A comprehensive literature search was conducted using electronic databases including Google Scholar, Semantic Scholar, Science Direct, and Taylor & Francis to identify the articles to be included in the review. The search is based on the specified search engines owing to the fact that Google Scholar contains grey literature with records of online materials for both peer-reviewed and non-peer-reviewed journals (Shariff, et al., 2013), which, when combined with other databases, gives a detailed and wider coverage of the better results required for a systematic review (Teo & Ling, 2020). Searches were carried out using "overheating in buildings, thermal comfort in residential buildings, overheating, and urbanisation". A literature search was also carried out using keywords such as '*thermal comfort, adaptive strategies, urban development, heat island effect* and *urban overheating'* to be able to find papers that capture the scope of the studies. The documents found were in the form of research articles, conference papers, theses, articles in press, journal pre-proof, editorial journals, and book chapters. The literature search for the study was limited to the causes of overheating and the adaptive strategies used in urban residential buildings to manage the effects.

2.3 Inclusion and Exclusion

Since rapid urbanisation is occurring in major cities with people spending more than 80% of their time indoors (Liu et al., 2021a), the building sector has been recorded to account for more than 30% of global final energy consumption which leads to a greater percentage of carbon emissions (Thapa, 2022). It is therefore, paramount to have detailed information about the overheating experiences and the adaptive strategies captured from a comprehensive list of studies across an appreciable number of years for a

greater understanding of the phenomenon. This will also help determine areas where each adaptive strategy is most suitable for application in the building sector.

The inclusion criteria for the review comprised (i) studies focused on dwellings, (ii) studies that investigated factors causing overheating in buildings and ways to solve the problem, (iii) studies published in the English language, and (iv) studies published between the year 2000 and 2023. This resulted in the identification of 435 downloaded works of literature considered to have the potential to be included in this review. Reading through the titles of the downloaded papers, 227 documents that did not capture the scope of the study were excluded at the first stage. A further screening of the remaining documents based on the research objectives excluded 80 other papers in the second stage. Furthermore, scanning through the 128 documents left, 27 papers that do not contain relevant information needed on adaptive measures to overheating in dwellings were also excluded. After considering various factors that are relevant to the research questions, 101 papers determined to be related to the study were subjected to review. Fig 1 below shows how we arrived at a total of 101 articles for the review. The exclusion criteria include studies outside the inclusion criteria and not peer-reviewed studies.

2.4 Selection Criteria

After a thorough review of the screened search, the 101 documents drawn from Semantic Scholar (9), Google Scholar (45), Taylor & Francis (7), and Science Direct (40) were finally included in the review. The full text of the documents was read and analysed, in-depth to identify the adaptive strategies used in urban houses based on their methodology, context, and findings that are subjected to the currency of articles published within the last 10 years (2013 - 2023). These are based on documents with rich contents of empirical evidence and review by looking at their titles, abstracts, keywords, and conclusions. Additionally, the search extended to the reference list of identified articles for relevant studies.

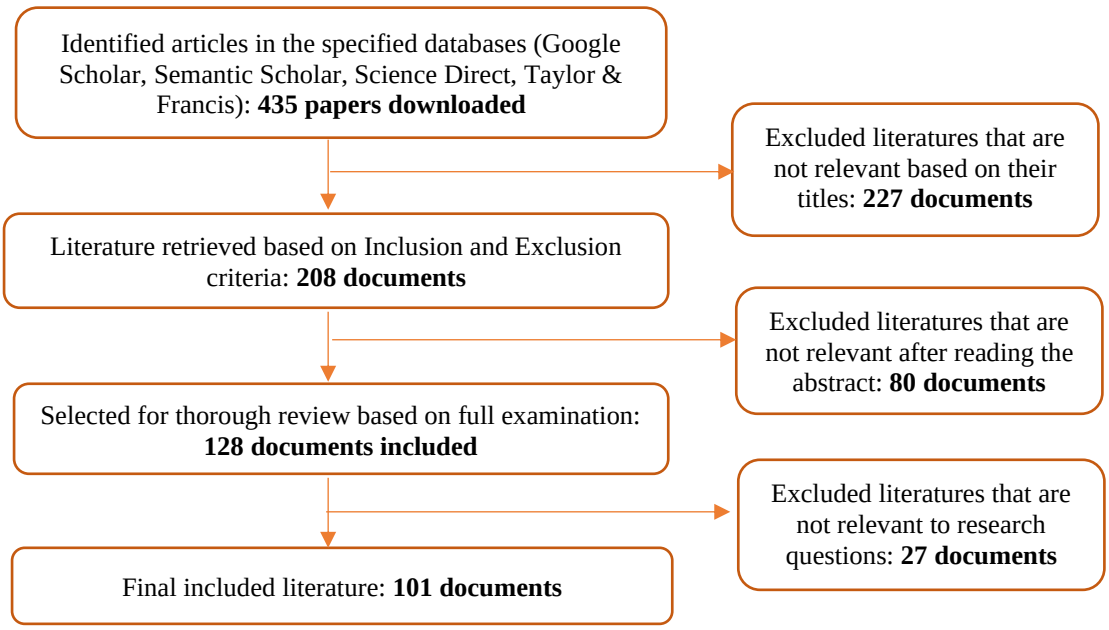


Figure 1: Inclusion and Exclusion Criteria.

2.5 Data Extraction

Considering the systematic review of the identified documents, the extracted data encompasses the context in which the study has been carried out, the methodology used in researching adaptive strategies for overheating in urban houses, and the categories of adaptive strategies used in urban houses. The findings are being presented in both qualitative data using thematic content analysis and quantitative data using frequencies, percentages, and rankings, with the results using tables, charts, and texts for better understanding.

3. Results

3.1 Publications on Adaptive Strategies to Overheating

Evaluation of the reviewed papers shows that twenty-two countries have published studies on various adaptive strategies for overheating. Figure 2 shows the distribution of the countries identified from the review against the number of studies done on adaptive strategies for overheating. Eighty-five percent (85%) of the studies were carried out between 2018 and 2023. This confirms the opinion of Laoudi et al. (2020) that overheating is a major concern for human health. It was found that the majority of studies in the downloaded papers were carried out in Nigeria and the United Kingdom. Nigeria ranked first on the list, with 22 published empirical studies carried out on a wide range of topics including indoor thermal comfort conditions, design strategies, building renovation, window configuration, the effect of vegetation, energy efficiency, and weather conditions. The data above confirms that emerging nations, particularly those in Africa, are struggling with overheating due to increased urban growth in Gamero-Salinas (2021). The United Kingdom comes next with eleven (12) published papers, while Europe comes third with five published papers.

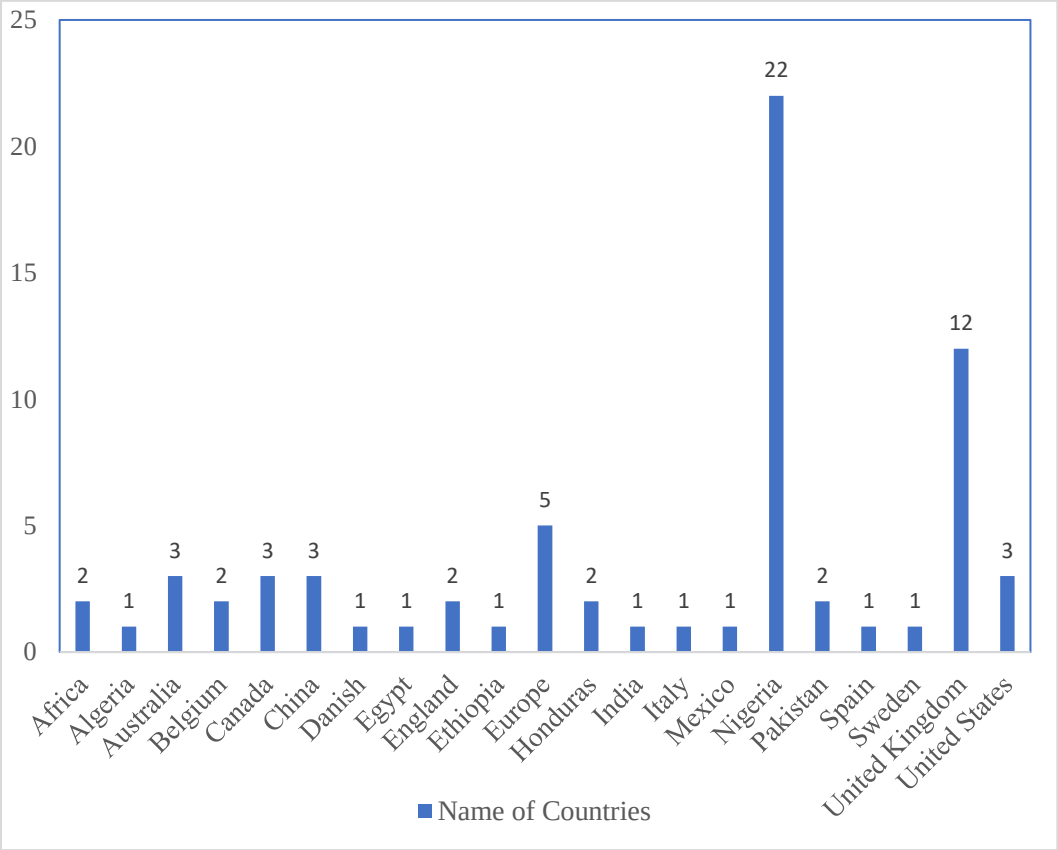


Figure 2. Distribution of Publication by Country.

3.2 Identification of Adaptive Strategies to Overheating in Urban Houses

The papers included in the article comprised various sorts of works of literature for which things downloaded were published. These have been divided into five categories for better analysis due to the larger coverage nature of data gathering to produce a comprehensive result. Energy-related articles are found in the first section, with Energy & Buildings at the top of the list, followed by Energy and Energy & Built Environment. The remaining sections are Science, Environment, and Engineering, while all other publications are categorised as others. Table 1 depicts the types of papers that have published studies on adaptive strategies for overheating.

The distribution of the 101 pieces of literature that were eventually included in the study comprises 52 (51.49%) publications that are editorials, review articles, and research articles that feature most in the

downloaded papers. Scientific articles come next with 17 (16.83%), followed by research papers with 9 documents (8.91%). Others are conference papers with 7 documents (6.93%), paper reviews 6 (6.94%), article-in-press, 4 (4.96%), book 1 (0.99%), book chapters 3 (2.97%), and academic journals 2 (1.98%). The distribution is shown in Figure 3 below. These elements were then thematically analysed to determine the coping mechanisms employed in urban houses.

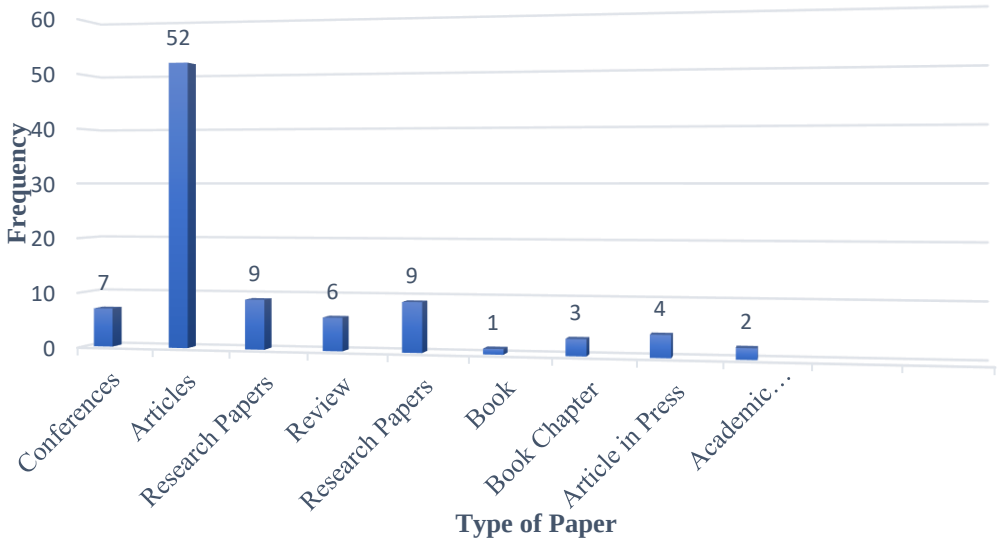


Figure 3. Distribution of Publications Included in the Study.

In the course of their research, several authors employed a variety of methodologies to analyse the remedies for overheating (Mourkos et al., 2020; Rodrigues & Fernandes, 2019; Daniel, 2015; Ashtiani et al., 2014). Investigations of the environment, structures, energy consumption, weather, and occupants are the different techniques discussed in the literature. All of these have played a role in urban overheating. Fig. 4 displays the methodologies that various researchers utilised to determine the adaptive strategies used to maintain overheating in buildings. Twenty-eight of the empirical studies which represent 50.91% employed the quantitative method, while twenty-one (38.18%) used the mixed method, and six (10.91%) carried out their studies using the qualitative method.

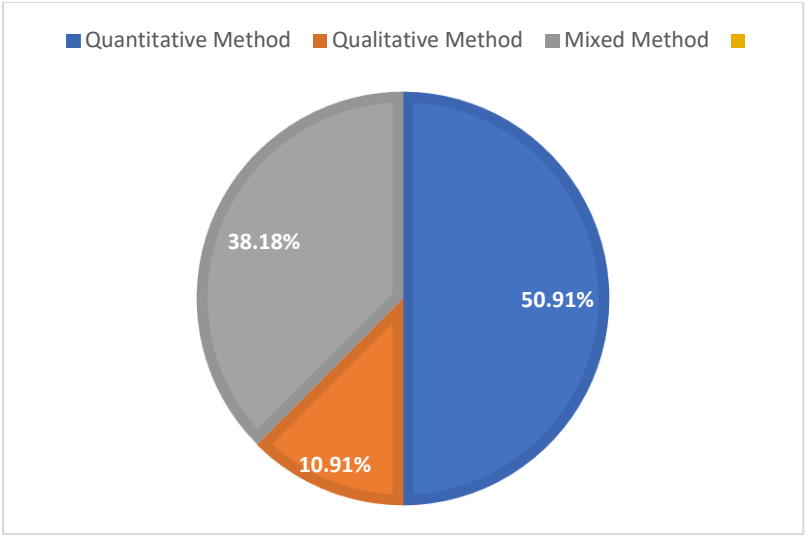


Figure 4. Distribution of Investigation on Adaptive Strategies to Overheating in Buildings.

The majority of the quantitative investigations carried out used survey techniques, where both the internal and external temperatures of the case buildings were tracked by field measurement with the use of monitored sensors and thermometers (Charles, 2022; Morey *et al.,* 2020). For better understanding, the actual building fenestration measurements were also taken along with pictures (Nwalusi et al., 2022; Okpalike et al., 2021). Data from the simulated scenarios on the building's and thermal performance were collected using questionnaires (Ouanes et al., 2022; Tettey et al., 2019; Mohammed & Alibaba, 2018; Bhikhoo et al., 2017; Argueso et al., 2014; Porrit et al., 2013). Focus group interviews were used to collect information for the qualitative technique on weather conditions and the thermal parameters of the buildings. In addition, participant observations with the aid of interviews were used to learn how occupants respond to and maintain overheating in relation to the review of literature on the phenomenon (Thapa, 2021; Gilabert et al., 2021; Laouadi *et al.,* 2020; Liu *et al.,* 2020; Baniassadi *et al.,* 2019; Verchev et al., 2019). However, several studies used both the qualitative and quantitative methods of research to provide a more reliable result (Bugenings & Kamari, 2022; Gupta *et al.,* 2021; Ochedi & Taki, 2021; Schunemann *et al.,* 2020; Ibrahim *et al.,* 2021; Williams *et al.,* 2019; Vellei *et al.,* 2016; Clear *et al.,* 2014; Mastrucci *et al.,* 2014).

Table 1: Groups of Downloaded Journals from the Databases.

Energy	**No**	**Environment**	**No**	**Engineering**	**No**	**Science**	**No**	**Others**	**No**
Energy & Built Environment	4	Indoor & Built Environment	5	Building & Engineering	1	iScience	1	American Journal of Engineering & Applied Science	1
Energy & Buildings	9	Building & Environment	8	Civil Engineering	1	Applied Sciences	1	International Journal of Interdisciplinary Research	1
Energy Reports	1	Climate	4	Journal of Engineering Research & Application	1	Thermal Science	1	Journal of Environmental Research and Public Health	2
Energies	3	Earth and Environmental Science	1	International Journal of Engineering & Advanced Technology	1	Technium Social Science Journal	1	South African Journal of Geomatics	1
Energy & Sustainable Development	1	Environmental Health and Ecology	1	Journal of Building Services Engineers research technology	1	Architectural Science Review	1	Advance in Hydrology & Meteorology	1
Energy Efficiency	1	Landscape & Urban Planning	1	International Journal of Applied Engineering Research	1	Path of Science	1	Sustainability	8
Applied Energy	3	Environmental Resource Letter	1			Acta Scientific Engineering Science	1	Building & Cities	4
Renewable & Sustainable Energy Review	1					Science of the Total Environment	1	Materials Today	1
						Wiki Journal of Medicine	1	Building Research & Information	4
						Journal of Medical Internet Research	1	Health Forum	1
								Public Health	1
								Conferences	7
								Book	1
								Book Chapter	3
								Community Development	1
								Sustainable Cities and Society	2
								International Journal of Building Pathology and Adaptation	1
								Nature Climate Change	1
Total	23		21		6		10		41

3.3 Adaptive Strategies for Overheating in Urban Houses

Previously published research demonstrates that efforts to prevent overheating and preserve thermal comfort in buildings have included adaptive techniques (Charles, 2022; Nazarian et al., 2022; Okafor et al., 2022; Gamero-Salinas et al., 2021; Chen, 2019; Wang, Ji, & Ren, 2017). Evidence from the literature review shows that adaptation strategies are ways to respond to uncomfortable situations of extreme heat in order to achieve thermal satisfaction (Nazarian *et al.,* 2022; Folkerts *et al.,* 2020; Fosas *et al.*, 2018). Because overheating is influenced by factors including outdoor environmental conditions, the design of the building, the internal production of heat, and the occupants' behaviour (Taylor et al., 2023; Gamero-Salinas *et al.,* 2020), the adaptive strategies are sectioned into four groups. These groups are (i) urban design strategies where the use of cool pathways lessens the intensity and impact of urban heat islands; (ii) effective building design that springs from the conventional architectural building style as a heat control strategy; (iii) exposed thermal mass where daytime lighting is absorbed and then released during the night; and (iv) occupant's behaviour. Table 2 depicts the list of identified adaptive strategies from the literature by grouping them in relation to the factors that influence overheating.

These four groups of adaptive strategies are further categorised based on their area of implementation in the building construction process in support of findings from the studies of Gamero-Salinas *et al.* (2021) that overheating reduces when proper building design is in place. The building construction process, denoted by different stages, includes (i) the pre-design stage, (ii) the design stage, (iii) the construction stage, and (iv) the post-construction stage. Table 3 shows the categories of adaptive strategies adopted at different stages of the construction process, as grouped in each section.

4. Discussion

An appreciable amount of literature was downloaded from the databases focusing on adaptation measures, which confirms the fact that overheating has been a pressing and current issue in the sustainable environment (Bundle *et al.,* 2018; Quinn et al. 2014). The evaluation states that a variety of methodologies comprising questionnaires, observations, instruments, and focus groups were used to gather data on subjects including the environment, buildings, and the people who are most concerned about overheating problems. This allows the authors to capture detailed information on how the problem of overheating has been managed within the environment. Nigeria ranked highest among the twenty-two nations with 14 documented research studies on adaptive measures to combat overheating in urban housing, bolstering the conclusion that emerging nations are already feeling the effects of urbanisation and climate change (Gamero-Salinas, 2021).

Moreover, despite being a developed country, the UK came in second with 11 documented studies on adaptive strategies for overheating. This problem has been discovered to be a reoccurring issue due to migration resulting from the economic benefit enjoyed by residents (Brotas & Nicol, 2017). The negative effect led to poor indoor air quality, in buildings coupled with heat-related diseases and sickness in residents (Chen & He, 2022). Finding solutions to the issue contributes to energy efficiency in buildings, enhances occupants' health and wellbeing, and thereby improves productivity and economic benefits. This has been discovered to boost development and socio-economic status. Consequently, urban migration is encouraged by a greater rate of socio-economic benefits, resulting to low labour rate, less productivity, and underdevelopment.

Active technologies provide an immediate response to lessen the risk of overheating, but a lasting solution can serve future generations through passive means (Taylor et al., 2023; Widera, 2021; Haruna, Muhammad, & Oraegbune, 2018; Clear et al., 2014). The active approaches contained in the literature feature mostly in the post-construction stage, where occupants of the building provided immediate responses to the uncomfortable situation. (Singh *et al.,* 2014; Clear *et al.*, 2014). Consequently, inappropriate implementation of these strategies can potentially increase the risk of overheating, resulting in high energy consumption and

increased health risk. This is due to the fact that the insulation and retrofitting domains have produced contradictory results with the choice and application of material for building construction (Onyenokporo & Ochedi, 2018; Psomas *et al.,* 2016).

However, the passive approaches highlighted in the literature are lasting solutions to overheating problems to achieve sustainable development (Mahar *et al.,* 2019; Moore *et al.,* 2017; Mulville & Stravoravdis, 2016; Santamouris & Kolokotsa, 2014). This measure is significant for the traditional architectural building styles, which prominently depict passive design strategies adopted to overcome overheating problems in most Nigerian buildings (Inusa & Alibaba, 2017). It is obvious that traditional architectural building styles are still relevant in the construction industry (Nwalusi et al., 2020). Therefore, it has become relevant to adapt our culture of building construction methods to account for a variety of elements across time.

Nevertheless, heat management measures are categorised to include (i) physiological adaptation where the body system is affected by environmental factors when exposed to heat, (ii) psychological adaptation which depends on individual feelings in relation to some factors like body weight, age and financial status, and (iii) behavioural techniques subjected to both conscious and unconscious acts as ways to enhance human thermal comfort (Ma, et al., 2021; Alwetaishi, 2016; Yang et al., 2014). This has further been discovered to cover both active and passive design methods (Garcia *et al.,* 2019). The analysis of the groups of adaptive strategies highlighted in this review is composed of passive approaches as a reflection of (i) heat and solar protection that prevent interior heat buildup, (ii) heat modulation, which has the extra benefit of minimising significant temperature when both internal and external temperatures rise, and (iii) heat dissipation, which releases surplus heat from within the building at a reduced temperature (Gamero-Salinas et al., 2021; Vellei et al., 2017; Wang et al., 2017).

The appropriate arrangement of urban fabrics produced by the application of government regulations for the thoughtful placement of parks and gardens throughout urban regeneration activities is a hallmark of a good urban design approach. Developmental activities will also centre on urban greening, which includes using trees as canopies to shade open areas and vegetated land cover to stop rainwater runoff from depleting the soil. All of these will facilitate government decision-making on social development and geographic distribution.

More intelligent building design is informed by an adherence to legal requirements. Effective space placement within the building also heavily weighs the building's orientation to maximise the advantages the surrounding area has to offer. This establishes the kind of building design and construction style, which is shown in the kind and arrangement of window openings, the materials utilised for the building envelope, the ventilation system, and the utilisation of balconies to improve the building's perspective. Stated differently, these techniques look at the height and treatment of the roof, the energy consumption rate of the appliances, and the qualities of the materials used for the building parts in order to prevent heat gain from the building. A quick action taken by conscious or unconscious human behaviour contributes to a cost-effective measure that is demonstrated in moving from one location to another, having a cold drink or shower, adjusting activity level, wearing less clothing, sleeping outside, and turning on the air conditioner and fan.

An examination of the identified strategies described in the published works concludes that adaptive strategies reduce energy consumption levels in buildings, enhance occupants' health care and wellbeing, improve productivity levels, and contribute to the economic benefits and social development of urban areas. Therefore, deduction from the explanations provided in the literature shows that the building life cycle requires a combination of active and passive measures (Vázquez-Torres & Gómez-Amador, 2022; Ibrahim *et al.,* 2021; van Hooff, Blocken, Hensen & Timmermans, 2014). An all-encompassing strategy is therefore highlighted in this study to manage overheating problems in the building sector based on the building construction process (pre-design, design, construction, and post-construction stages) to manage the overheating challenges.

Table 2: List of Adaptive Strategies by Group.

Groups	Adaptive Strategies	Sources
Urban Design Strategies	Urban greening	Mastrucci et al. (2014), Matandirotya e*t al.* (2020), Alrasheed & Mourshed (2023), Ashtiani *et al.* (2014), Ehsan *et al.* (2021), Akinola *et al.* (2020), Widera (2021), Chen (2019).
	Vegetation	Nwalusi *et al.* (2020), Adegun & Ayoola (2019), Alozie *et al.* (2019), van Hooff *et al.* (2014), Alrasheed & Mourshed (2023), Brotas & Nicol (2016).
	Careful placement of parks/garden	Muhammed & Alibaba (2018), Ehsan *et al.* (2021), Chen & He (2022), Chapman *et al.* (2017).
	Tree canopies	Chapman *et al.* (2017), Ehsan *et al.* (2021).
	Urban renewal	Chen & He (2022).
	Blue/green infrastructure	Santamouris & Kolokotsa (2015).
	Government policy decision	Attia & Gobin (2020), Bundle *et al.* (2018).
	Proper layout of urban fabrics	Chen & He (2022).
	Enforcement of building guidelines	Akinola *et al.* (2020),
Effective Building Design	Building orientation	Nwalusi *et al.* (2020), Muhammed *et al.* (2018), Mohammed & Alibaba (2018), Brotas & Nicol (2016), Haruna *et al.* (2018), Tettey *et al.* (2019), Bhikhoo *et al.* (2017), Adegun & Ayoola (2019).
	Window orientation /configuration	Ibrahim *et al.* (2021), Tettey *et al.* (2019), Alozie *et al.* (2019), Bhikhoo *et al.* (2017).
	Type of building	Mohammed & Alibaba (2018), Williams *et al.* (2019), Ochedi & Taki (2022), Bundle *et al.* (2018), Alozie *et al.* (2019).
	Higher roof fraction	Nwalusi *et al.* (2020).
	Use of stack ventilation	Adaji *et al.* (2019), Fosas *et al.* (2018), Gupta *et al.* (2021), Bhikhoo *et al.* (2017).
	Low window-to-floor ratio	Okpalike *et al.* (2022), Haruna *et al.* (2018).
	Weather consideration	Liu *et al.* (2021a).
	Building form	Nwalusi *et al.* (2020), Gamero-Salinas *et al.* (2021), Liu *et al.* (2020b).
	Use of balconies	Gamero-Salinas *et al.* (2021), Nwalusi *et al.* (2020).
	Natural shading	Bugenings & Kamari (2022), Gamero-Salinas *et al.* (2021).
	Adequate ventilation	Gamero-Salinas *et al.* (2021), Ochedi & Taki (2022), Alwetaisi (2016), Thapa (2022), Alozie *et al.* (2019).
	Shaded space	Brotas & Nicol (2016), Fosas *et al.* (2018), Liu *et al.* (2021a).
	Cool paint	Alrasheed & Mourshed (2023).
	The right choice of building materials	Nwalusi *et al.* (2020), Adaji *et al.* (2019), Attia & Gobin (2020), Alozie *et al.* (2019), Ehsan *et al.* (2022).
	Effective positioning of spaces	Mohammed *et al.* (2018)
Insulation	Cool roof	van Hooff *et al.* (2014), Santamouris & Kolokotsa (2015), Attia & Gobin (2020).
	Roof/window overhang	Williams *et al.* (2019).

	External shutters	Liu *et al.* (2020b).
	Permeable surfaces	Ochedi & Taki (2022), Tettey *et al.* (2019), Bundle *et al.* (2018), Akinola *et al.* (2020).
	Energy-efficient measures	Okafor *et al.* (2022).
	Use of curtains/blinds	Okafor *et al.* (2022), Matandirotya *et al.* (2020), Williams *et al.* (2019), Schunemann *et al.* (2020), Chen & He (2022),
	Utilization of natural building materials	Chen (2019), Attia & Gobin (2020), van Hooff *et al.* (2014), Vellei *et al.* (2016), Thapa (2022).
	Retrofitting	Mastrucci *et al.* (2014), Ibrahim *et al.* (2021).
	Green roof / green wall	Morey *et al.* (2020).
	Low thermal mass of building envelope	Nwalusi *et al.* (2020), Gamero-Salinas *et al.* (2021), Liu *et al.* (2020b), Hao *et al.* (2022), Liu *et al.* (2021a), Thapa (2022), Ehsan *et al.* (2021), Widera (2021), Bhikhoo *et al.* (2017).
	Cool pavement	Garcia *et al.* (2019).
	Phase change materials	Schunemann *et al.* (2020), Alrasheed & Mourshed (2023), Chen (2019), Haruna *et al.* (2018), Santamouris & Kolokotsa (2015), Nwalusi *et al.* (2020), Liu *et al.* (2020b).
Occupants' Behaviour	Movement action	Zepeda-Rivas & Rodriguez-Alvarez (2020), Laouadi *et al.* (2020), Vellei *et al.* (2016), Singh *et al.* (2014), Ehsan *et al.* (2021).
	Better housekeeping	Vellei *et al.* (2017).
	Opening/closing window/door	Gamero-Salinas *et al.* (2021), Gunawardema & Steemers (2019), Clear *et al.* (2014), Alwetaishi (2016), Laouadi *et al.* (2020), Gupta *et al.* (2021), van Hooff *et al.* (2014), Vellei *et al.* (2017), Wang *et al.* (2017), Singh *et al.* (2014).
	Sleeping outside	Ehsan *et al.* (2021).
	Taking cold drinks/plenty of water	Zepeda-Rivas & Rodriguez-Alvarez (2020), Gamero-Salinas *et al.* (2021), Morey *et al.* (2020), Alwetaishi (2016), Gupta *et al.* (2021), Vellei *et al.* (2017).
	Adjustment of human activity	Gunawardema & Steemers (2019), Chen & He (2022), Clear *et al.* (2014), Attia & Gobin (2020).
	Taking a shower/using a wet towel	Ehsan *et al.* (2021).
	Reducing clothing level	Zepeda-Rivas & Rodriguez-Alvarez (2020), Chen & He (2022), Morey *et al.* (2020), Clear *et al.* (2014),
	Night-time ventilation	Alwetaishi (2016), Laouadi *et al.* (2020), Attia & Gobin (2020), Gupta *et al.* (2021), Wang *et al.* (2017), Singh *et al.*(2014).
	Personal environmental control	Ma *et al.* (2021), Alwetaishi (2016).
	Reduced energy consumption	van Hooff *et al.* (2014), Fosas *et al.* (2018), Gupta *et al.* (2021), Vellei *et al.* (2017), Ibrahim *et al.* (2021), Alozie *et al.* (2019), Widera (2021).
	Refurbishment	Vellei *et al.* (2016), Singh *et al.* (2014).
	Drawing curtain/blind	Vellei *et al.* (2017), Adaji (2017).
	Use of ceiling fan	Adaji (2017), Ochedi & Taki (2022).
	Use of an air-conditioning system	Williams *et al.* (2019), Morey *et al.* (2020), Alwetaishi (2016), Gupta *et al.* (2021), Chapman (2017), Santamouris & Kolokotsa (2015), Thapa (2022).

Table 3: Categories of Adaptive Strategies based on the Building Construction Process.

Group	Pre-Design Stage	Design Stage	Construction Stage	Post Construction Stage
Urban Design Strategies	Government policy decision Proper layout of the urban fabric	Enforcement of building guidelines Careful placement of parks and garden Urban greening	Blue/green infrastructure Tree canopies	Urban renewal Vegetation
Effective Building Design	Weather consideration Compliance with building regulations Type of building design	Building orientation Building form Window orientation Effective positioning of spaces Low window-to-floor ratio Incorporation of balconies Natural shading Green wall Use of stack ventilation	The right choice of building materials Window configuration Proper landscaping Cool paint Green roof Higher roof fraction Introduction of external shutters	Vegetation Shaded space Adjustment of indoor shading/ventilation
Insulation	Tree planting Blue/green infrastructure	The low thermal mass of the building envelope Green wall Window overhang Roof overhang Higher roof fraction Landscaping Cool roof Roof overhang	Utilisation of natural building materials Low thermal properties of building materials Phase change materials Double glazed window Permeable surfaces Retrofitting Use of external shutters Cool pavement Reflective materials	Energy-efficient measures Use of ceiling fan Installation of air-conditioning system Use of curtains/blinds
Occupants' Behaviour	Compliance with building regulations Weather consideration	Reduced energy consumption Night-time ventilation	Energy-efficient appliances Retrofitting Refurbishment	Movement action Adjustment of human activity Taking shower Taking cold drinks Spending time outside Opening/closing windows/doors Putting on the fan/air conditioning system Personal environmental control Changing clothing level Drinking plenty of water Sleeping outside Taking a shower/using a wet towel Drawing curtain/blinds Better housekeeping

5. Conclusion

This article has identified the countries that have conducted research on adaptation strategies, the methodology used to identify the adaptive methods used in urban homes to manage overheating issues, and the approach for controlling overheating in urban homes through a systematic review. The following conclusions are drawn from the data: First, research on responses to overheating was conducted using both qualitative and quantitative research methodologies, and a mixed method was used to provide full results on the adaptive tactics employed. Second, papers on different overheating management strategies were found in twenty-two (22) different countries, with the majority of them being from Nigeria. Third, the four groups of the identified adaptive strategies from the literature (urban design strategies, effective building design, insulation & occupants' behaviour) were further categorised based on the building construction process to consist of the pre-design, design, construction and post-construction stages.

The findings of this review show that the application of these categories of adaptive strategies in the building construction process will improve the indoor and outdoor air quality of buildings to achieve comfort. Additionally, despite the trend in technical advancement and modernization, the old architectural construction styles remain essential in the building sector to achieve a comfortable and successful lifestyle. Therefore, by addressing the impacts of indoor air quality and urban overheating based on the highlighted categories, this study has the potential to reduce greenhouse gas emissions, energy consumption, and urban heat island effects. Its adoption would also enhance both the health and well-being of the populace; their productive lives as well as the nation's economic growth towards sustainable urban development and public health.

The knowledge acquired from the systematic review of the study is valuable to policymakers and urban planners in making policy decisions and regulations relating to the layout of urban fabrics in accordance with building regulation practices. Furthermore, it will assist Architects in the production of functional and effective building designs to suit occupants' comfort. It will also benefit the researchers by assisting them to determine the geographical distribution of research efforts. In all, the review serves as a web among urban planning, architecture, environmental science and economics considering various topics that have addressed overheating issues in energy, environment, engineering, science and others which are most concerned with the socio-economic impacts of urbanisation.

Given the aforementioned, it is suggested that more research be done on the efficiency of implementing these categories of adaptive strategies to overheating in the building sector for new innovations and cost-effective construction practices towards achieving sustainable development and healthy living.

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Place Attachment of Shoppers: A Study of Palms Mall, Ibadan, Nigeria

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ABSTRACT

The shopping mall has emerged as an important component of many cities. While the rapid development of malls and the increasing patronage show their viability and acceptance by the populace, respectively, there is a dearth of studies that examine the impact of its physical and behavioural attributes on attachment. This study examines the effect of physical characteristics, activities, and socioeconomic characteristics on place attachment to the first standalone mall in Ibadan, Nigeria. From a sampling frame of 7, 115 shoppers, quantitative data was obtained from 350 respondents using systematic sampling on April 29, 2017, through a structured questionnaire. The data was analysed using mean, factor analysis, cross-tabulation, correlation, and categorical regression. The findings show that the most prevalent activities are meeting others (α = 0.77); leisure (α = 0.75); and, parties and hanging out (α = 0.70). The important physical attributes are circulation, wayfinding, and aesthetics (α = 0.87); access to mechanical conveyors, mall decoration, and quality materials (α = 0.80); and, ambience (α =0.79). However, the regression results show that the most important factors of attachment are access to mechanical conveyors, mall decoration, and quality materials (β = 0.334); leisure (β = 0.279); purchasing activities (β = 0.236); and, meeting others (β = 0.165). Hence, these factors should be considered in creating new malls in the city. In the context of urbanism, this is key to the social and economic revitalization of cities.

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Highlights:	Contribution to the field statement:
- Circulation, wayfinding, and aesthetics represent the most valued physical quality of the mall - The most prevalent activity at the mall is meeting others - Access to mechanical conveyors, mall decoration, and quality materials enhance bonding with the mall - Leisure is an important activity for attachment to the mall - Sustaining the factors of attachment to malls can enhance the social and economic development of cities	This study adds to the existing knowledge of place attachment by highlighting the important physical, behavioural, and socioeconomic factors that make people bond with the mall. It also shows that a valued aspect of the mall may not necessarily result in attachment.

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1. Introduction

Malls are emerging in different locations across the globe, and the city of Ibadan is no exception. They constitute a building typology that is new to the people's retailing culture and urban lifestyle. The gradual increase in the number of malls suggests that it is an impactful development in the city. It is very likely that certain physical, psychological and social attributes of the mall make it impactful. It is, therefore, essential to explore the factors that make people bond with the mall.

Place attachment (or the bonds with places) is a relevant concept for examining factors which make people feel attached to malls. It is an essential evaluative place construct that shows the role of place in people's lives. It is a measure of the bond that exists between people and place (Lee & Jeong, 2021). According to Scannell and Gifford (2010), it is a multidimensional construct that develops through affect, cognition, and behaviour. On the one hand, Widya et al. (2019) and Zhu et al. (2012) consider that this bond could be cognitive or affective. On the other hand, Reese et al. (2019) describe it as a cognitive-emotional construct. Their approaches show that place attachment may be a unidimensional or multidimensional construct in a residential setting. However, there is little information about the nature of attachment in a retailing typology such as the mall.

Examining place attachment in the mall has some invaluable benefits. A study of place attachment to the mall is critical because it can elucidate the impact of the mall on urban living. Understanding place attachment to malls can assist policymakers in the decision-making process to enhance the economic and social development of cities, consequently providing input into policies for the development of new malls in the city and the designs of new cities.

Furthermore, examining place attachment facilitates programming and post-occupancy evaluation of the mall (Horayangkura, 2012). The results of a place attachment study provide invaluable feedback for existing malls and implications for future mall designs. A study of place attachment can uncover essential factors for design consideration, consequently assisting the design and urban planning process. Such data can help designers and planners to effectively communicate to clients the spatial and functional aspects of malls, which make people attached to the mall. Such information will result in more needs-responsive designs in the future.

Another benefit of evaluating bonds with the mall is that the results will reveal the comfort and affordances that people derive at the mall. Such comfort and affordances may be related to cleanliness, lifts and escalators, a relaxed atmosphere, large cinema screens, and aesthetically pleasing facades and interiors. Such information can guide retailers on the type of services to offer at the mall, including an effective organization and appearance of the physical environment of their stores. Therefore, the purpose of this study is to examine the factors that make people bond with the mall.

1.1 Literature review

Existing literature suggests that people develop emotional bonds to third places[1] such as coffee shops and wine bars. Muchmore, the literature shows that there are different kinds of factors that make people attached. One such group of factors is physical factors. For example, Debenedetti et al. (2014) utilized a qualitative approach to examine the bonds people have with commercial places. The study found that attachment to such commercial places increased because people were familiar with such places, considered them unique, and had a feeling of safety in them. Consequently, users found it a homey place, participated in wine preparation activities and were also financially generous to the attendants.

Furthermore, Waxman (2006) utilized an interview approach and found that cleanliness, good scent, sufficient lighting, comfortable seats, and the ability to view exterior activities were the most valued design characteristics in certain coffee shops. Also, Van den Berg et al. (2021) found that some physical attributes in a shopping area positively affected the sense of place in the Netherlands. However, they were not explicit about these attributes in their study. In addition, Kusumowidagdo et al. (2015) conducted interviews at the mall and found that circulation, layout, spatial organization, zoning of stores, ambience, and interior design increased place attachment to the mall. Though insightful findings, it is not clear

[1] Third places are public places that facilitate social interaction beyond the dwelling and workplace (Finlay et al., 2019; Williams & Hipp, 2019)

which of the physical attributes are the most important in determining attachment to the mall. This knowledge gap may have resulted, in part, from the utilization of a qualitative approach for the study. Though a qualitative approach ensures an in-depth understanding of place attachment, a quantitative method helps to quantify important factors of attachment and make predictions and inferences about such variables (Babbie, 2020). Utilizing a quantitative approach, Idoko et al. (2019) found that mall layout and aesthetics enhanced shoppers' attitude to malls in Nigeria. However, there is limited knowledge about the importance of this factor compared to other physical factors, for place attachment to malls.

The literature also provides evidence concerning the role of certain physical factors on attachment to other place types. For example, studies show that internal improvement using floor tiles (Furtado & Renski, 2021) and internal layout, universal entrance design, and sunlight (Shiran, 2019) affect bonding to homes. However, an understanding of the extent to which these physical factors can affect bonding to malls remains a gap in the literature.

Another critical factor that the literature has shown makes people attached to places is activities. Activities are practices that occur due to the affordances that a particular setting offers (Cresswell, 2011). In their scoping review, Pettersen et al. (2023) found that leisure, hanging out, and socializing, which some shopping malls afforded, motivated the use of shopping centres. Also, Kusumowidagdo et al. (2015) found that adolescents used malls for hanging out, visiting the gymnasium, doing internet-based activities, and seeking ideas for design projects. These studies focused on the *motivation to use space* and the *use of space*. Nevertheless, there is a dearth of knowledge of the impact of activities on place attachment.

The closest study of the effect of activities on attachment to retail settings was conducted by Kim and Park (2018), who studied the effect of shopping frequency on bonding. They reported that shopping frequency, a measure of activity, affected place attachment with a mall and with street shops. However, an understanding of the activities which are important for place attachment to the mall remains unclear even though the mall affords a lot of shopping activities.

Interestingly, the literature shows the effect of activities on place attachment regarding other types of places. For example, Amole (2014) reported that decoration behaviour improved students' attachment to halls of residence in southwestern universities in Nigeria. However, activities such as decoration may not be possible in the mall because the mall is not a personal place. Consequently, a gap still exists with respect to the types of activities which encourage place attachment in the mall.

Another factor in literature that affects the bonds people have with places is the characteristics of the people. The mall is an enculturated typology in the city. Moreso, it is of a Western civilization. It is likely that people's self-identity and attributes will affect how they evaluate the physical characteristics of the mall and what they do there. The literature on attachment to homes suggests that age, marital status, education, income, and duration of stay determine place attachment. In Nigeria, Ayoola et al. (2019, p. 33) and Adewale et al. (2020, p. 8) found that the length of stay improved attachment, but Dlamini et al. (2021, p. 6) reported a negative effect in South Africa. Also, Lu et al. (2018, p. 147) found an inverse effect of income on attachment. However, the moderating effect of socioeconomic characteristics on the impact of physical characteristics and activities on attachment to the mall specifically has not been well studied.

Finally, although studies of mall attachment have been conducted in developed countries such as the Netherlands, America, and France, no known study of place attachment exists concerning malls in Nigeria, especially in West Africa's largest city, Ibadan. A study such as this is necessary because malls, like most other building typologies, are culture-specific. It is likely that the factors that enhance attachment to this mall may or may not be the same as those of other countries. As such, this study will aid the understanding of how culture-specific place attachment is as a concept.

Given these gaps, the objectives of this study are thus: to examine the dimensions of the physical attributes of the mall, to describe the activities at the mall, to examine the strength of place attachment to the mall, and to examine the simultaneous effects of the dimensions of the physical attributes, activities, and socioeconomic characteristics on place attachment to the mall. Figure 1 illustrates the conceptual framework for the study. First, it shows that physical attributes and activities can enhance place

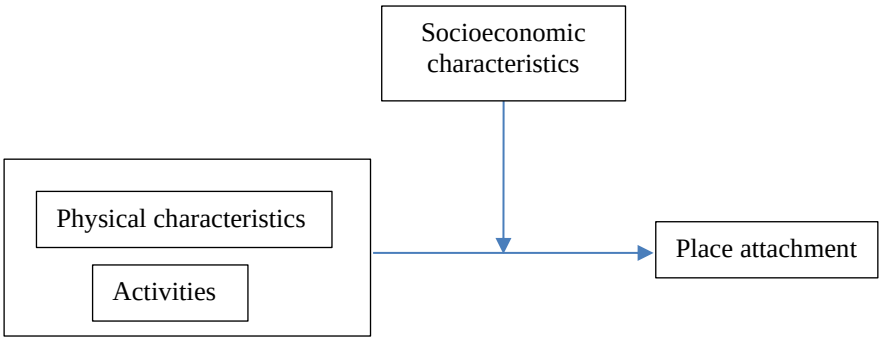


Figure 1. Conceptual framework of the study.

attachment to the mall. Second, the effect of physical attributes and activities on place attachment may be subject to the socioeconomic characteristics of users.

This study comprises five sections. The first section shows the state of the literature regarding attachment to the mall, other retail typologies, and other place types. The second section discusses the research methods utilized in pursuing the research objectives, and the third section presents the study's findings. The fourth section discusses the results, while the final section covers the conclusion.

2. Materials and Methods

2.1 Research design

The study is part of a more extensive study of culture and sense of place of shoppers in a mall in a city. A case study of a single mall was done because this study considers that malls are highly contextual and culture-specific. The study's result will apply to this mall and allow the understanding of the issues of design, layout, and behaviour concerning place attachment.

2.2 Sample size

Within this single mall, a sample of respondents was obtained. To do this, a preliminary survey was conducted to get the number of shoppers who visited the mall. Consequently, foot and car counts were performed. Since the mall's opening period was from 9 a.m. to 9 p.m. daily, counting took place two hours each in the morning (10 – 12 a.m.), afternoon (1 – 3 p.m.), and evening periods (5 –7 p.m.). To facilitate the counting process, the corresponding author and five well-trained research assistants took turns for seven days. In the end, an average of 7,115 daily shoppers were counted. From this sampling frame, a sample size of 356 was estimated based on Cochran's formula set at a 95% confidence level (Cochran, 1977). However, the study utilized a sample size of 400 to account for unforeseen rejection and to reduce the achieved margin of error.

2.3 Measures

Quantitative data were obtained using structured questionnaires. The questionnaire was designed to elicit responses regarding physical characteristics, activities, place attachment, and socioeconomic characteristics. Socioeconomic characteristics such as age and sex, were designed as nominal or interval variables. Physical characteristics were operationalized as the physical quality of the mall. Fourteen (14) statements were used to measure the physical quality of the mall, and these statements were related to circulation, aesthetics, spaciousness, accessibility of mechanical conveyors, acoustics, smell, and temperature. General design criteria such as lighting, circulation, and aesthetics were adapted from Zandvliet (2014). Items that are more specific to the mall, such as the accessibility of lifts, stairs, and escalators, were added by the authors.

Activities were operationalized as the strength of activities and were measured with twenty statements regarding shoppers' activities at the mall. The variables were related to eating, social interaction, purchase, window shopping, watching movies, and playing games. Items related to social interaction, unplanned purchases, and physical exercise were adapted from Michon and Chebat (2004), while items

such as sitting at the food court and eating at the mall were designed by the authors of this study, based on the onsite observation of the activities afforded by the mall, during the presurvey of the mall.
Place attachment was conceptualized as a unidimensional construct. It was measured with four attachment statements. They were all adapted from Lalli (1992). See Appendix 1 for the scale items.
In the questionnaire, all the variables that measured physical quality, strength of activities, and attachment were designed as ordinal variables on a 5-point Likert scale of agreement; "1" represented strongly disagree, while "5" signified strongly agree.

2.4 Data collection

Data collection occurred on the last Saturday in April 2017. This day was selected because it had been identified from the preliminary survey as the day with the highest number of visits to the mall. Four trained research assistants participated in the distribution and collection of questionnaires. The field workers were positioned at the three access locations at the mall. A systematic random technique was used to select one of every twenty shoppers who entered the mall across those accesses to participate in the survey. Potential respondents were encouraged to complete the questionnaire at their convenience during their visit and return it to field workers on exiting the mall. The introductory section of the questionnaire elucidated the purpose of the research and clarified that it only took about 10 minutes to complete. As their identity regarding the name or house address was not required, shoppers' information was kept anonymous. The data collection exercise lasted the whole day.

2.5 Data analysis

Data cleaning was done after the data collection process to exclude improperly filled and missing data. In the end, 350 questionnaires were valid for analyzing the data. The Statistical Package for Social Sciences (SPSS) version 20 was utilized for statistical analysis. The variables and responses were coded and inputted directly to the software.
Means, modes, frequencies, and percentages were utilized to describe respondents' socioeconomic characteristics, physical characteristics, activities, and strength of attachment. Higher scores on physical quality, activities, and attachment were interpreted as higher physical quality, higher strength of activity, and higher strength of attachment, respectively.
To describe the strength of place attachment, an overall place attachment score was computed for each respondent by summing each respondent's scores on all the four variables that measured place attachment. After this, respondents were grouped in two groups: those with low attachment scores (representing the low attachment group) and those with high attachment scores (representing the strong attachment group).
Principal component analysis and a varimax rotation were utilized to obtain the critical dimensions of physical quality and activities concerning place attachment in this mall. The varimax rotation ensured that independent factors were obtained. The set criterion was to retain factors with an eigenvalue of at least 1. Cronbach's alpha coefficient (α) was used to ensure that the overall scales and subscales consistently measured the same thing. This was achieved by suppressing correlation values that were less than 0.4. A Kaiser-Meyer-Olkin (KMO) value showed the significance of each factor.
Categorical regressions were used to test the predictive effects of the physical attributes, activities, and socioeconomic variables on place attachment. In the first model, the independent variables for the categorical regression model were the dimensions of the physical quality and strength of activities, while the dependent variable was place attachment. The second model tested the moderation effects of socioeconomic characteristics on the effects of physical attributes and activities on place attachment. A goodness of fit value, R^2, was utilized to ascertain the significance of the models. Before the regression analysis, each variable was associated with place attachment. This association was done to elucidate an understanding of an independent relationship with place attachment. Also, cross-tabulation helped to ascertain the effect of each socioeconomic variable on place attachment, and chi-square tests showed the significance of each result. Spearman's correlation was used to test the relationship between the physical attributes, activity dimensions, and place attachment.

3. Results

3.1 Socioeconomic characteristics

The findings show that more males (57.7%) visited the mall. In addition, most respondents were between 20 and 35 years (68.6%), singles (70.3%), Yorubas (84.6%), well-educated (84.9%), employed (84.3%), earned between N18 000 and N40 000 monthly ($20 - $50) 28.9%, and have used the mall for more than two years (35.7%). See Table 1 for detailed statistics.

Table 1. Socioeconomic characteristics of shoppers (N = 350).

Variable	Value	Frequency	Percent
Sex	Male	202	57.7
	Female	148	42.3
Age*	<19	49	14.0
	>19 – 35	240	68.6
	> 35 – 55	53	15.1
	>55	8	2.3
Marital status*	Single	246	70.3
	married	104	29.7
Ethnic group*	Yoruba	296	84.6
	Non-yorubas	54	15.4
Education*	Low	53	15.1
	High	297	84.9
Employment status*	Unemployed	55	15.7
	Employed	295	84.3
Monthly income	< N 18 000	87	24.9
	18 000 – N 40 000	101	28.9
	40 000 – N 80 000	59	16.9
	80 000 – 150 000	41	11.7
	> 150 000	62	17.7
Length of time of use of mall*	First time	25	7.1
	< 1 year	102	29.1
	1 – 2 years	98	28.0
	> 2years	125	35.7

*Variable was recoded to improve interpretation.

3.2 Dimensions of physical quality and activities

3.2.1 Dimensions of physical quality

Three factors were obtained. Each factor had significant items (KMO = 0.84). A Cronbach's alpha (α = 0.9) showed that items in the overall scale consistently measured the same thing. Also, the internal consistency results within the subscales showed that the scales adequately measured the mall's physical quality. Table 2 shows an overview of the items, factors, and Cronbach's alpha coefficient values. Five items had strong loadings on the first and second factors, while the third factor had four variables loaded on it. The first, second, and third factors accounted for 23.4%, 19.7%, and 19.4% of the total variance in the physical quality of the mall. All the factors explained 62.5% of the total variance in the physical quality.

Table 2. Dimensions of the physical quality of the mall.

Factor (% variance)	Variable	Mean	SD	Loading	Cronbach's alpha (α)
F1: Circulation, wayfinding, and aesthetics (23.4%)	I can easily move around in this mall	4.2	0.84	0.779	0.87
	The corridors are wide enough to accommodate my movement	4.2	0.85	0.756	
	I can easily find my way around this mall	4.1	0.81	0.754	
	The mall environment here is spacious for the activities I engage in	4.1	0.82	0.716	
	I find this mall to be beautiful and attractive	4.2	0.85	0.691	
F2: access to mechanical conveyors, mall decoration and quality materials (19.7%)	I easily access the escalator while moving around this mall	3.6	1.03	0.817	0.80
	I easily access the lift while moving around this mall	3.5	1.05	0.749	
	The physical arrangement of the settings in this mall provides a sense of culture through its decorations	3.7	0.97	0.646	
	I can easily access the staircase while moving around this mall	3.9	0.86	0.643	
	This mall is well constructed with quality materials	4.0	0.89	0.525	
F3: The ambience (19.4%)	The lighting in this mall is adequate for what I do here	4.2	0.81	0.755	0.79
	This mall smells good	4.1	0.79	0.751	
	The noise level in this mall is comfortable to perform my activities	3.7	1.05	0.715	
	The temperature in this mall is comfortable to perform my activities	4.2	0.82	0.670	

Total variance explained = 62.5%.

"Circulation, wayfinding and aesthetics" – CIRCU, "access to mechanical conveyors, mall decoration and quality materials" – ACCESS, and "the ambience" – AMB, were used to describe the first, second, and third factors, respectively. CIRCU explained the most variance, while ACCESS and AMB explained similar variances in the physical quality of the mall.

3.2.2 Dimensions of activities

The extracted factors obtained explained a total variance of 58.4% in the strength of activities. After rotation, the first factor accounted for 14.8%, while the second, third, fourth, and fifth factors accounted for 14.6%, 13%, 8.1%, and 7.9%, respectively. A KMO of 0.84 value showed that each factor contained significant items ($p < 0.05$). A Cronbach's alpha reliability value of 0.9 showed that the scale was adequate in measuring the internal consistency of the variables for activities. Only 18 items of the 20 were retained in the scale. The items *'I park my car at the mall' and 'I pass time at the mall*' were removed because the first was the only item on a factor, while the other did not load on any factor. Five items each loaded on the first and second factors, three on the third, and two on the fourth and fifth factors. The first to fifth factors were described as "meeting others" – MEET, "leisure*"* – LEI, "parties and hanging out" – PAR, "purchasing activities*"* – PURCH, and "socializing and entertainment" - SOCI, respectively. MEET explained the most variance, while SOCI explained the least variance in the strength of activities at the mall. See Table 3 for the factors, their loadings, and the mean values of the variables in each factor.

Table 3. Dimensions of the activities of shoppers at the mall.

Factor (% variance)	Variable	Mean	SD	Loading	Cronbach's alpha
F1: Meeting others (14.8%)	I sit at the food court	3.0	1.18	0.789	0.77
	I eat at the mall	3.3	1.19	0.761	
	I come here for a business meeting	2.6	1.14	0.617	
	I walk in the mall for the purpose of exercise	2.7	1.17	0.565	
	I interact with other shoppers in the mall	3.2	1.12	0.581	
F2: Leisure (14.6%)	I read at the mall	2.5	1.14	0.736	0.75
	I go to bar	2.7	1.23	0.724	
	I play games at the mall	2.8	1.22	0.686	
	I take pictures at the photographers' stand	2.8	1.18	0.569	
	I participate in contests	2.6	1.14	0.514	
F3: Parties and hanging out (13%)	I follow the trend in fashion	3.2	1.10	0.797	0.70
	I go to celebrate occasions	3.1	1.13	0.699	
	I engage in unplanned purchasing	3.3	1.15	0.686	
	I go for window shopping	3.3	1.19	0.479	
F4: Purchase activities (8.1%)	I purchase household items	3.6	1.09	0.815	0.52
	I buy food items at the mall	3.7	1.05	0.709	
F5: Socializing and entertainment (7.9%)	I watch movies at the mall	3.5	1.17	0.835	0.51
	I meet with family and friends	3.6	1.01	0.549	

Total variance explained = 58.4%.

3.3 Strength of place attachment

Table 4 shows the mean and modal values of variables that measured place attachment. The feeling of relaxation at the mall was the most rated attachment variable, while a feeling of separation from the mall was the least rated variable.

Table 4. Mean scores of place attachment variables.

	Variable	Mean	Mode
Attachment	ATTACH 1	3.8	4
	ATTACH 2	3.4	3
	ATTACH 3	3.3	3
	ATTACH 4	3.0	3[a]

The lowest and highest scores obtained for attachment were 4 and 20, respectively. Scores from 4 to 12 were described as low attachment, while those from 13 to 20 were described as strong attachment. The statistics show that most shoppers (61.4%) had a strong attachment to the mall. Figure 2 illustrates the statistics of the strength of attachment.

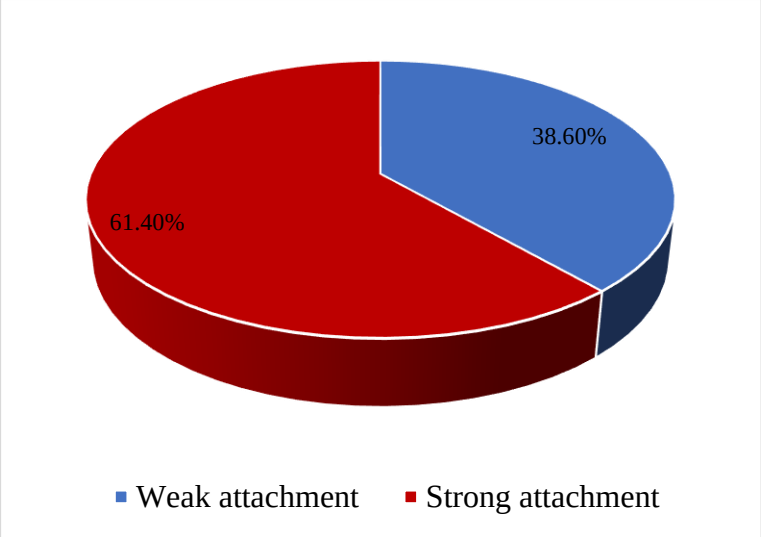


Figure 2. Strength of attachment.

3.4 Place attachment, physical characteristics, activities, and socioeconomic characteristics

3.4.1 Association of place attachment with criterion variables

Of all the socioeconomic variables, only ethnic group ($\chi^2 = 7.774$; $df = 1$; $p < 0.01$) was related to place attachment. Gender ($\chi^2 = 0.825$; $df = 1$; *ns*), age ($\chi^2 = 2.302$; $df = 3$; *ns*), marital status ($\chi^2 = 0.872$; $df = 1$; *ns*), level of education ($\chi^2 = 2.870$; $df = 1$; *ns*), employment status ($\chi^2 = 0.134$; $df = 1$; *ns*), monthly income ($\chi^2 = 3.340$; $df = 4$; *ns*), and length of time of use of mall ($\chi^2 = 7.050$; $df = 3$; *ns*), were not related to place attachment. However, Spearman correlations results showed that place attachment was positively associated with CIRCU ($r = 0.2$), ACCESS ($r = 0.5$), AMB ($r = 0.3$), MEET ($r = 0.4$), LEI ($r = 0.4$), PAR ($r = 0.3$), PURCH ($r = 0.2$), and SOCI ($r = 0.2$), at $p < 0.001$. ACCESS had the most substantial relationship with place attachment, while CIRCU, PURCH, and SOCI had the least effect on place attachment.

3.4.2 Regression results

The model that explained the predictive effects of the physical factors and activities was a good fit (F = 5.06, $p < 0.01$). It was significant with the predictor variables. The coefficient of determination (R^2), the model's measure of goodness of fit, showed that the independent variables explained 35.8% of the total variance in place attachment. In addition, all the predictor variables were strongly correlated with the predicted variable (multiple R = 0.623). Table 5 shows the variables and their standardized Beta values. The table shows that CIRCU, PAR, and SOCI did not significantly predict attachment. On the other hand, ACCESS (β =0.334) had the most substantial predictive effect on place attachment, followed by LEI (β = 0.279), PURCH (β = 0.236), and MEET (β = 0.165). These factors had linear predictive relationships with place attachment. As such, a unit increase in ACCESS, LEI, PURCH, and MEET would increase place attachment by .334, .279, .236, and .165, respectively.

In the second regression model, the control variables were included. The result was a good fit (F = 5.813, $p < 0.01$). All the predictor variables were strongly correlated with place attachment (R = 0.702). The coefficient of determination (R^2) value showed that the independent variables explained 40.8% of the variance in place attachment. The beta values of all the predictor variables obtained in the first model were slightly reduced except for AMB. In this regression, the variable with the most predictive effect on place attachment was ACCESS (β = 0.272), followed by monthly income (β = -0.232), PURCH (β = 0.219), LEI (β = 0.205), AMB (β = 0.19), level of education (β = -0.172), and MEET (β = 0.158). Only monthly income and level of education had inverse relationships with place attachment. As such, a unit increase in monthly income and education would result in a decrease of .23 and .17 in place attachment, respectively.

Table 5. Categorical models of place attachment.

Variable	Model 1		Model 2	
	Beta	**F**	**Beta**	**F**
Circulation, wayfinding and aesthetics	-.210	1.630	-.187	1.336
access to mechanical conveyors, mall decoration and quality materials	.334***	6.011	.272***	6.655
The ambience	.159	1.934	.190**	3.509
Meeting others	.165**	3.391	.158***	4.647
Leisure	.279***	9.117	.205***	6.137
Parties and hanging out	-.156	0.552	.032	.030
Purchasing activities	.236***	6.138	.219**	5.165
Socializing and entertainment	.110	0.466	.032	.043
Sex			.057	2.019
Age			.059	.401
Marital Status			.012	.080
Ethnic Group			.046	1.590
Education level			-.172*	4.673
Employment Status			.091	3.411
Monthly income			-.232***	7.774
Length of use of the mall			-.044	.354
	$R = 0.668$, $R^2 = 0.358$, df = 48; F = 5.06, $p < 0.001$		$R = 0.702$, $R^2 = 0.408$, df = 50; F = 5.813, $p < 0.001$	

*p < 0.05 **p < 0.01 ***p < 0.001

4. Discussion

4.1 Physical quality and activities at the mall

In this study, "circulation, wayfinding, and aesthetics" was the most important physical attribute of the mall. For some reason, this result supports Afacan's (2012) finding that circulation was the most important physical quality of a mall in Turkey. This is because circulation was used in that study to describe the use of mechanical conveyors and the legibility of the mall. The reason why the accessibility of mechanical conveyors may not be the most important in this study may be due to their location. The layout of the mall in this study shows that the escalator, lift, and staircase are positioned towards the rear exit of the mall. They provide access to the food court, cinema, and bar, which are located in the mall's basement. As such, shoppers who may not engage in the activities in the basement may not have the opportunity to see or experience these mechanical conveyors.

Besides the physical qualities of the mall, this study found that the mall provided the opportunity for engaging in many activities including leisure. This result supports Erkip's (2003) finding that leisure was an essential activity at the mall, and Vural Arslan et al.'s (2010) result that leisure and socializing activities were the reasons people used the mall. Based on this trend, the mall may be described as a multi-purpose typology and an important place for leisure activities.

4.2 Place attachment to the mall

4.2.1 Strength of place attachment

This study found that most shoppers had a strong place attachment to the mall. This result was expected because people tend to bond towards places which they adjudge to be comfortable, useful, and symbolic (Scannell & Gifford, 2017). Moreover, the literature shows that place attachment increases with a better assessment of place (Casakin et al., 2021; Dlamini et al., 2021, p. 6). Since respondents had good assessments of certain physical attributes of the mall and could also engage in many activities in one place, it was not surprising that they had a strong attachment to the mall.

4.2.2 Factors of place attachment to the mall

The factors of attachment to malls differ by context. Idoko et al.'s (2019) result indicated that aesthetics enhanced shoppers' attitudes to malls in Nigeria, and Kusumowidagdo et al.'s (2015) found that circulation, spatial layout, and ambience influence bonding with malls; however, this study found that access to elevator, escalator, and stairs, as well as the use of quality materials, are the most critical factors of attachment. This may have occurred because elevators and escalators are not common in many public buildings in the city of Ibadan. Since shoppers had free access to them at the mall, the presence of these conveyors may have contributed strongly to their memories of the mall and invariably to their attachment to the mall.

Furthermore, this study shows that the most important activity that makes people bond with the mall is "leisure activities". Trenberth and Dewe (2002) demonstrated that leisure is an important activity which enhances well-being and alleviates stress. Given this finding, leisure is an essential aspect of human lives. Since people were attached to the mall because of this activity, the mall may be described as an important place for rejuvenation. Although Kim and Park (2018) found that shopping frequency makes people attached to the mall, this study shows that leisure activities such as playing games and reading are more critical for attachment to the mall than shopping activities. Since Rosenbaum et al. (2016) recorded an increased attachment towards malls with green and natural features, complementing the provision of settings for leisure with natural elements can optimize this activity, consequently enhancing bonding with the mall.

The next important activity after "leisure activities," which makes people attached to the mall, is "purchasing activities." Such activities are related to the purchase of food and household items. According to Maslow, food is a fundamental need of humans (Zalenski & Raspa, 2006), so it was expected that people would bond with the mall since it was a place where they could actualize these basic needs.

This study also found that "meeting others" enhanced attachment to the mall. This result buttresses Idoko et al.'s (2019) finding that social connections affect the attitude of shoppers.

Furthermore, this study found that specific human characteristics impacted the effects of physical and behavioural factors on place attachment. In this study, "the ambience" became important when socioeconomic attributes influenced the model. Of all the socioeconomic variables, only monthly income and level of education predicted attachment, and both relationships with attachment were negative. A possible explanation for the negative effect of both variables on place attachment could be that those who earned more could afford such settings, while those who earned less may need help to afford the luxury and comfort of the mall. As such, those with lower incomes might have appreciated the mall's relaxed environment better than those who earned more. The result concerning the relationship between education and attachment is consistent with studies of other place types. Authors speculate that lower levels of education increased attachment in residential environments (Belanche et al., 2021; Rollero & De Piccoli, 2010).

Another change which occurred in the second model as a result of the effect of socioeconomic attributes is that all the critical factors of place attachment in the first model recorded slight reductions in their predictive strengths. This was an expected result because the emergence of the effect of new variables can suppress existing factors. Also, monthly income became the strongest predictor of place attachment

after "access to mechanical conveyors, mall decoration, and quality materials." This was an expected result because most services and products at the mall are at a price. As such, the ability to acquire these affordances would affect the bonding with the mall.

4.3 Recommendations for designers, mall managers, and policymakers

The findings of this study are useful for design professionals, managers, and policymakers. Designers should consider that the presence of stairs, lifts, and escalators is important for attachment. Therefore, future design considerations should ensure that they are easily sighted, functional, and accessible. In addition, leisure settings should be prioritized. Settings for playing games, reading, taking photographs, and work spaces should be considered in future designs. Even for the existing mall under study, certain rearrangements can be made to provide for these settings. Hence, mall managers, in collaboration with designers, should consider how the mall may be reorganised to cater to leisure activities.

Apart from leisure activities, socializing activities are critical for attachment to the mall. However, the provisions of such settings in the mall are connected to floor areas for different food vendors and the bar. Because there are certain restrictions to utilizing the sitting areas for those who do not patronize the food vendors or the bar, socializing activities may be inhibited, resulting in low attachment. This study suggests that settings for social interaction (e.g., eating, sitting, and holding business meetings), which are not attached to any food vendors but managed as dedicated settings for meeting others, should be provided for the existing mall and subsequent mall developments.

Finally, policymakers should consider that the mall is not just a useful place but also a place that appeals to users. Therefore, the development of more malls can provide opportunities for more people to enjoy its benefits, and sustaining the factors of attachment can increase the patronage and sustainability of the mall. In the context of urbanism, this is key to the social and economic revitalization of cities.

5. Conclusions

5.1 Summary

This study examined the most critical factors of attachment to the mall. First, it examined the dimensions in which the physical attributes and activities were evaluated. Second, it examined the effect of these factors and the role of socioeconomic characteristics on place attachment to the mall. Circulation, wayfinding, and aesthetics; access to mechanical conveyors, mall decoration, and quality materials; and the ambience, described the physical attributes of the mall. Meeting others; leisure; parties and hanging out; purchasing activities; and socializing and entertainment were the types of activities that respondents engaged with at the mall. The most critical factor of attachment was access to mechanical conveyors, mall decoration, and quality materials. This factor was followed by leisure activities; purchasing activities; and, meeting others. The ambience, income, and education became important factors upon the influence of socioeconomic attributes.

The findings of the study have the following implications. First, a good evaluation of the mall may not necessarily result in an attachment to the mall. As such, studies need to be cautious in making conclusions about the effect of valued attributes of the mall on attachment without verifying such connections to the mall. Second, other activities apart from shopping have been consistently overlooked in the studies of place attachment. Meanwhile, such activities may have a greater impact on attachment than shopping. Third, attachment to the mall is based on how useful and appealing a place is, and this is more important than the length of time people spend in it. Some places, such as the mall, evoke strong connections even at a first visit, while other places may require spending a lot more time for attachment to occur.

5.2 Limitations of the study

In this study, the factors of attachment accounted for less than 40% of the total variance in place attachment. This minimal effect may be, in part, a result of using a scale measure comprising a mix of items utilized in other studies and those the authors of this study added based on an observation of the mall. Future research may account for more design and behavioural factors by utilizing a mixed method that is based purely on the mall(s) under study. First, a qualitative approach should be utilized to document

the activities of people at the studied mall and also the valued physical aspects of the mall. These attributes may be subsequently used to design a questionnaire to assess the critical factors of place attachment.

Another limitation of this study is the clarity and distinctiveness of the factors of attachment, especially regarding the physical attributes—specific factors related to more than one theme. Therefore, rather than factorising through analytical methods, the author(s) can group similar items into factors. Then, a confirmatory test can be used to investigate the relatedness of the items in each factor. A third limitation relates to the construct of place attachment. The items in the scale were general place attachment items, so we could not check for social and physical attachment. A more robust finding can be obtained if the place attachment scale contains general, physical, and social items.

5.3 Strengths and Recommendations

This study is the first to examine the critical physical and behavioural factors of place attachment in an emerging retailing typology. Besides shopping, it considered the role of other activities in attachment. Consequently, it presented the factors of attachment in a hierarchy that serves as a scale of preference for maximizing future design and planning efforts. As such, its results are useful for designers, planners, and policymakers: designers should pay more attention to the provision of leisure spaces; planners should identify potential locations for the development of new malls; and policymakers should invest in the provision of new malls.

This study also has implications for future research endeavours. Future studies that seek the most important factors of attachment should be done in other malls to develop a theoretical understanding of the contextual nature of malls. Also, since the physical attributes set the stage for activities, some activities may likely impact attachment through design qualities. Therefore, future research may consider using path models to ascertain this.

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Appendix 1. Scale items of place attachment.

	Variable
Attachment	I feel relaxed when I'm in this mall (ATTACH 1)
	I feel happiest when I'm in this mall (ATTACH 2)
	This shopping mall is my favourite place to be (ATTACH 3)
	I really miss this shopping mall when I'm away for too long (ATTACH 4)

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A Preliminary Study of the Relationship Between Built Environment of Open Space and Cognitive Health of Older People

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ABSTRACT

Many older people are facing various risks of cognitive impairment, while outdoor activities in open spaces may be helpful for their cognitive health. However, the effect of open spaces on cognitive health is unclear. This study aims to investigate the relationships between the cognitive health of older people and the built environment of open spaces. A questionnaire survey of 60 older people aged 60 and above was conducted. Results identified three major components of the built environment of open spaces, namely, planning, supporting facilities, and building services. According to the correlation and regression analysis, it is revealed that 8 BEOS items, including green ratio, a width of the pathway, maintenance of the whole garden, the color of green space, diversity of plants, location, and font of signage, artificial light of sitting area were positively related to memory, while only the size was negatively associated with memory. Only the green ratio could positively predict the concentration. The judgment was positively influenced by the green ratio, width of pathways, maintenance of the whole garden, color of green space and diversity of plants. A BEOS – cognitive health model for older people was built in this study. The results highlighted the importance of plants for cognitive health. Several recommendations, such as not-so-large sizes and diverse plants with vivid colors and signages with big fonts, etc., were proposed to improve the built environment of the open spaces and support the declining cognitive health of older people.

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Highlights:	Contribution to the field statement:
- This paper provides evidence for the effect of built environments of open spaces on cognitive health. - The built environments of open spaces - cognitive health model has been built. - The benefits of plants for cognitive health have been emphasized in this study. - Practical recommendations on built environments of open spaces have been proposed to improve the cognitive health of older people.	This study fills a gap in understanding the specific features of urban open spaces that can enhance cognitive functions such as memory, concentration, and judgment in the elderly, providing valuable insights for urban planners and policymakers to foster age-friendly urban environments.

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1. Introduction

Ageing is a serious problem faced by many countries and regions all over the world. By the end of 2021, the population over 60 years old in Hong Kong accounted for 28.6% of the total population (Census and Statistics Department, 2022). People will suffer from the decline of cognitive health when they are getting old. Poor cognitive health increases the risk of older people getting lost, suffering from negative emotions and higher mortality, and creating difficulty in dealing with complex housework and personal issues, which definitely increase the burden of caregivers and make older people more likely to be institutionalized (Lloyd et al., 2001). However, it is expected to improve cognitive health via outdoor activities (Linde and Alfermann, 2014).

Due to the high density in Hong Kong, indoor space is really limited for residents. Residents, especially older people, have to go to open spaces for rest or activities (Richardson et al., 2013), e.g., major parks, pocket parks, gardens, and sitting-out areas (Leisure and Cultural Services Department, 2021). Due to the limited mobility of older people, they normally prefer open spaces that are relatively near their homes (Lau et al., 2021). Unfortunately, the existing open spaces are not particularly designed for older people. Thus, older people encounter a lot of problems while visiting the open spaces. For example, they may get lost with unclear signage due to the complicated roads and the same scenery in a large open space. Although much of the research investigates the effects of green space for physical activity and stress on older people (Park et al., 2016), it remains unknown how the built environment of open spaces (BEOS) affects the cognitive health of older people. Because poor cognitive health can bring great risks and adverse effects to the daily life of older people, it is urgent to improve the cognitive health of older people by improving the BEOS. Therefore, this study aims to investigate the influence of BEOS on the cognitive health of older people by building a BEOS–cognitive health model for older people.

2. Literature Review

2.1. Cognitive health of older people

Cognitive health is the ability to think, concentrate, and memorize (Stern and Carstensen, 2000). With ageing, the brain function progressively degenerates. The rates of heart disease, diabetes, stroke, and other diseases usually increase among older people, while their sleep periods and participation in social and physical activities decrease accordingly. These factors are all considered to have negative effects on the cognitive health of older people, including memory loss, less concentration, poor judgment, etc. (Lloyd et al., 2001).

As one of the most obvious indicators of cognitive health, memory can be classified into long-term memory and short-term memory. The former is the ability to remember things that happened a long time ago, while the latter refers to the ability to remember information in a recent period (Verhaeghen, 2014). The process of memory includes encoding, storage, and retrieval. Older people with poor memory may find difficulties in all these three processes and get lost (Shiffrin and Atkinson, 1969). Older people also tend to forget their experiences and acquaintances, damaging their social relationships. Activity spaces and fitness facilities encourage older people to be physically and psychologically active, which is good for improving their memory (Feter et al., 2019). Some special facilities, such as eye-catching sculptures, may help older people better remember their location (Eichenbaum et al., 1999).

Concentration deficits can occur with only mild declines in cognitive health (Silveri et al., 2007). The declined concentration makes it difficult for older people to learn and complete tasks. In recent years, older people have relied more and more on smartphones (Zhou et al., 2014). However, checking smartphones can be a serious distraction and impair concentration (Chu et al., 2021). On the other hand, exercising, doing leisure activities, and being away of information overload normally improve concentration (Linde and Alfermann, 2014). Plants have a great potential to untense the directed attention system and recover attention (Raanaas et al., 2011). Visiting open spaces is, thus, expected to enhance attention.

Poor judgment is another early signal of impaired cognitive health. Older people with poor cognitive health have difficulty identifying danger, making financial decisions, and evaluating distance while driving (Lloyd et al., 2001). In reality, loss of judgment can be a serious handicap when older people need to decide on surgery or a new treatment for a serious illness. Poor of open spaces cause negative emotions and unsafety feelings, hindering the decision-making of older people (Menne and Whitlatch, 2007).

2.2. Built environment of open spaces

The built environment refers to the artificial surroundings for human activities (Leung et al., 2020). It is a broad concept including three components: planning, supporting facilities, and building services (Leung et al., 2021). Planning refers to the layout and landscape design of the open spaces, which consists of the size, green space, fountain, recreational courts, sitting area, etc., in the whole garden. A simple and clear layout with a loop circuit may be easier for older people to orient (Kessels et al., 2007). A high green ratio may help older people to restore their attention, benefit their concentration, and attract them to do more physical activities (Richardson et al., 2013), while the appropriate sitting area also plays a key role for older people with limited physical ability to rest in the daily life (Lau et al., 2021). Supporting facilities mean small facilities that can help older people perform well (Leung et al., 2020), such as seats, signage, recreational facilities, and colour. Seats with proper shape and height may reduce the risk of falling when standing up and protect older people's spines (Yim et al., 2020). Because of the poor eyesight, older people may not see the letters on the signage clearly. However, appropriate recreational facilities may encourage them to do exercises frequently, which is good for cognitive health (Linde and Alfermann, 2014). The diverse color of plants may benefit older people's special memory by strengthening the encoding-specificity effect, especially in natural scenes (Park et al., 2016).

Building services aim to keep a comfortable environment for visitors (Leung et al., 2021). In the open spaces, it mainly includes the artificial lighting environment in the evening. Many older people have night blindness and often cannot see obstacles clearly at night. Adequate artificial lighting of pathways may help older people distinguish obstacles and changes in height and help them identify the dark shadows or steps on the road, which may support their judgment in open spaces (Lu et al., 2019).

2.3. Theoretical Grounding

Older people are facing numerous stressors during their daily lives, such as declined physiological and psychological health, loss of independence, financial insecurity, hopelessness, pain and illness, deteriorating personal relationships, etc. These stressors further destroy psychological and mental health, especially cognitive health (Mikneviciute et al., 2022). *Stress Reduction Theory* suggests that contact with nature, such as watching green plants outside the window or movies of natural scenery, can reduce stress (Ulrich, 1984; Ulrich et al., 1991). As a convenient way for older people living in high-density cities to engage with nature, visiting open spaces is expected to reduce stress, which may have an impact on cognitive health in older people (see Figure 1).

On the other hand, daily activities involve great direct attention, causing mental fatigue. *Attention Restoration Theory* claims that natural stimulus evokes indirect attention that does not need a lot of cognitive effort and allows directed attention to rest (Kaplan, 1995). Thus, exploring natural environments, especially true natural environments, can restore cognitive resources. This further restores mental fatigue and gives people a clearer mind and focus (Ohly et al., 2016). According to this theory, older people's cognitive health is expected to be improved by visiting green spaces like open spaces (see Figure 1).

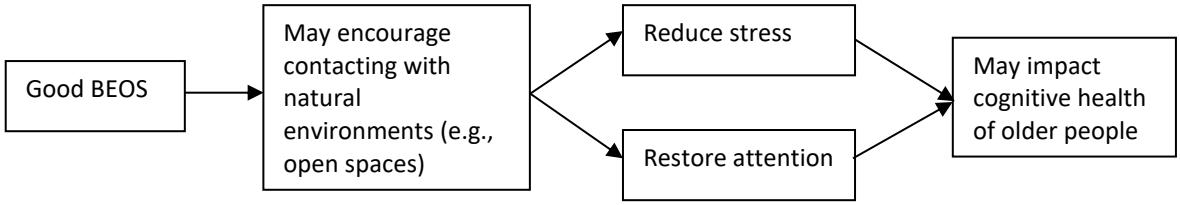


Figure 1. Theoretical framework.

3. Materials and Methods

3.1. Research Model

Based on the literature review, a conceptual BEOS–Cognitive Health model is proposed in Figure 2. It is hypothesized that the three BEOS components (planning, supporting facilities, and building services) have a significant impact on the cognitive health of older people, including memory, concentration, and judgment.

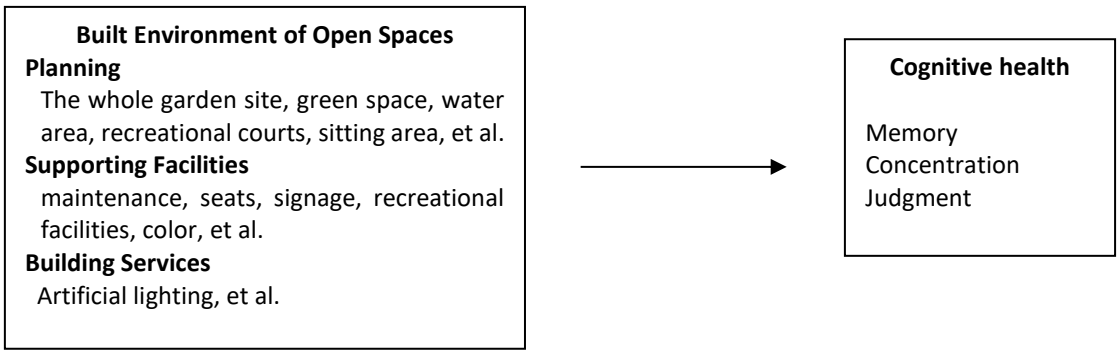


Figure 2. Conceptual BEOS – Cognitive Health Model for Older People.

3.2. Methods

To study the influence of BEOS on the cognitive health of older people, a questionnaire survey was conducted face to face among older people aged 60 and above who visit open spaces frequently. The questionnaire includes three parts: (1) the background information about older people and the open space; (2) the satisfaction degree of 17 BEOS items; and (3) the satisfaction degree of their cognitive health (see Figure 3). In the second and third sections of the questionnaire, one item included one question, namely the satisfaction evaluation of that item, ranging from 1 (very dissatisfied) to 5 (very satisfied) with a 5-point Likert scale. The items about the BEOS were selected according to previous measurement tools and research on open spaces, like Environmental Assessment of Public Recreation Spaces (EAPRS), Natural Environment Scoring Tool (NEST) and Quality of Public Open Space Tool (POST) (Broomhall et al., 2017; Gidlow et al., 2018; Saelens et al., 2016). The cognitive items were selected from the WHOQOL-BREF (Whoqol Group, 1998). To ensure the content validity of the questionnaire, the whole questionnaire was read through and verified by the expert in an age-friendly environment.

The questionnaire was distributed in three big open spaces with abundant facilities. The three open spaces are respectively located on Hong Kong Island, Kowloon Peninsula, and the New Territories. To ensure the participants understood the content, the questionnaire was translated into traditional Chinese. The survey was conducted face to face in February and March, during which period the weather was pleasant in Hong Kong. Thus, older people would go out frequently instead of staying indoors due to uncomfortable temperatures or bad weather. All the questions were asked in Cantonese or Mandarin (i.e., the participants' native languages). After the data collection, Pearson correlation analysis and multiple regression analysis were used for the data analysis.

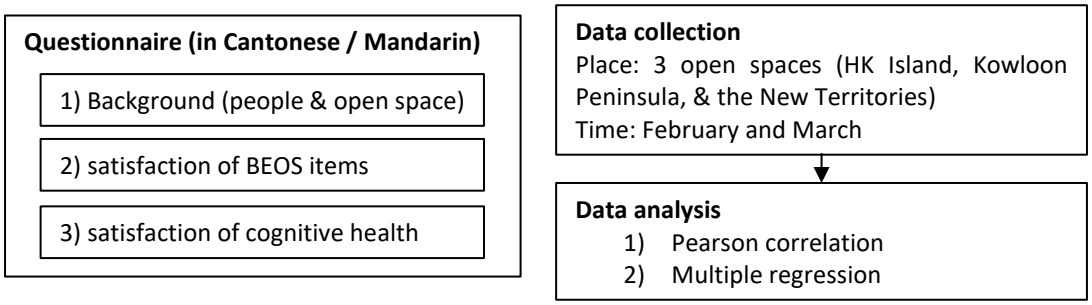


Figure 3. Research methods of the questionnaire survey.

4. Results

Sixty older people from three open spaces participated in this study, while 27 (45%) of them were male and 33 (55%) of them were female. Eighteen respondents (30%) were aged 60-69, 38 responders (63.3%) were aged 70-79, and 4 responders (6.7%) were aged 80 or above. Most of the participants (56 people, 93.3%) walked to open spaces, and others (4 people, 6.7%) went to open spaces by bus. All of them arrived in open spaces within half an hour, including 7 people (11.7%) who arrived within 5 minutes, 30 people (50%) in 5-10 minutes, and 23 (38.3%) of them in 10-30 minutes.

The results of the correlation showed that the three cognitive health items are mostly related to each other. Green ratio (P3: 0.427**), artificial light of sitting area (P17: 0.262*), location (P14: .308*) and font (P15: 0.286*) of signage, diverse plants (P11: 0.264*), and maintenance of the whole garden (P9: 0. 286*) were positively related to memory (C1). Only the green ratio (P3: 0.306*) was positively related to concentration (C2). Green ratio (P3: 0.297*), the width of the pathway (P8: 0.308*), the color of green space (P10: 0.265*), the diversity of plants (P11: 0.320*), and maintenance of the whole garden (P9: 0.420**) were significantly related to judgment (C3) (see Table 1).

Table 1. Correlation between BEOS and Cognitive Health of Older People.

	C1	**C2**	**C3**
Cognitive health			
C1 – Memory	1		
C2 – Concentration	.470**	1	
C3 – Judgment	.462**	.610**	1
Planning			
P1 – Open space size	-0.015	0.067	0.113
P2 – Green space size	0.155	0.168	0.206
P3 – Green ratio	**.427****	**.306***	**.297***
P4 – Sitting area size	-0.146	-0.031	-0.047
P5 – Water area	0.047	0.108	0.115
P6 – Recreational court size	-0.023	0.052	0.066
P7 – Connectivity of pathway	0.240	0.010	0.140
P8 – Width of pathway	0.210	0.085	**.308***
Supporting facilities			
P9 – Maintenance of whole garden	**.286***	0.077	**.420****
P10 – Color of green space	0.094	0.163	**.265***
P11 – Diversity of plants	**.264***	0.123	**.320***
P12 – Number of seats	0.127	0.036	0.000
P13 – Number of recreational facilities	-0.072	-0.054	0.034
P14 – Location of signage	**.308***	0.193	0.246
P15 – Font of signage	**.286***	0.209	0.187
Building services			
P16 – Artificial lighting of pathway	0.193	-0.029	0.000
P17 – Artificial lighting of sitting area	**.262***	0.111	0.187

Four multiple regression models were developed at the basis of the regression analysis (see Table 2). All BEOS items were put in the model as independent variables, while three cognitive health items were entered as the dependent variables. The results showed that in Model 1, memory (C1) was positively predicted by the green ratio (P3), and maintenance of the whole garden (P9), and negatively

predicted by open space size (P1) with 26.4% variance. With 7.8% of the variance, concentration (C2) was positively correlated with the green ratio (P3) in Model 2, while in Model 3, judgment has a positive relationship with the maintenance of the whole garden (P9) and green ratio (p3).

Table 2. Regression between BEOS and Cognitive Health of Older People.

Models	**B**	**S.E.**	**Sig.**	**VIF**	**R**	**R^2**	**Adj. R^2**	**ANOVA**	
								F	**Sig.**
1 C1 – Memory ⟵ Built Environment of Open space									
(Constant)	1.012	0.559	0.076		.549	0.301	0.264	8.045	.001
P3 – Green ratio	0.456	0.113	0.000	1.100					
P9 – Maintenance of whole garden	0.301	0.109	0.007	1.143					
P1 – Open space size	-0.303	0.137	0.031	1.242					
2 C2 – Concentration ⟵ Built Environment of Open space									
(Constant)	1.667	0.455	0.001		.306	0.094	0.078	6.013	.017
P3 – Green ratio	0.324	0.132	0.017	1.000					
3 C3 – Judgment ⟵ Built Environment of Open space									
(Constant)	0.873	0.517	0.097		.490	0.240	0.213	8.988	.000
P9 – Maintenance of whole garden	0.365	0.108	0.001	1.012					
P3 – Green ratio	0.251	0.115	0.033	1.012					

Note: S.E. = standard error; Sig. = significance; VIF = variance inflation factor; Adj. R^2 = Adjusted R^2

A final BEOS–Cognitive health model for older people in the community was made based on the correlation and regression result (see Figure 4). All the items confirmed by correlation or regression analysis are included in the model. It is shown that both correlation and regression verified that the green ratio has positive impacts on all three cognitive health items, while the maintenance of the whole garden can positively predict memory and judgment. Apart from that, only the correlation analysis shows the positive relationships between the diversity of plants, location, and font of signage, artificial light of sitting area, and memory, as well as the positive influences of the width of the pathway, colour of green space and diversity of plants on judgment. The only negative relationship is found by regression analysis between open space size and memory.

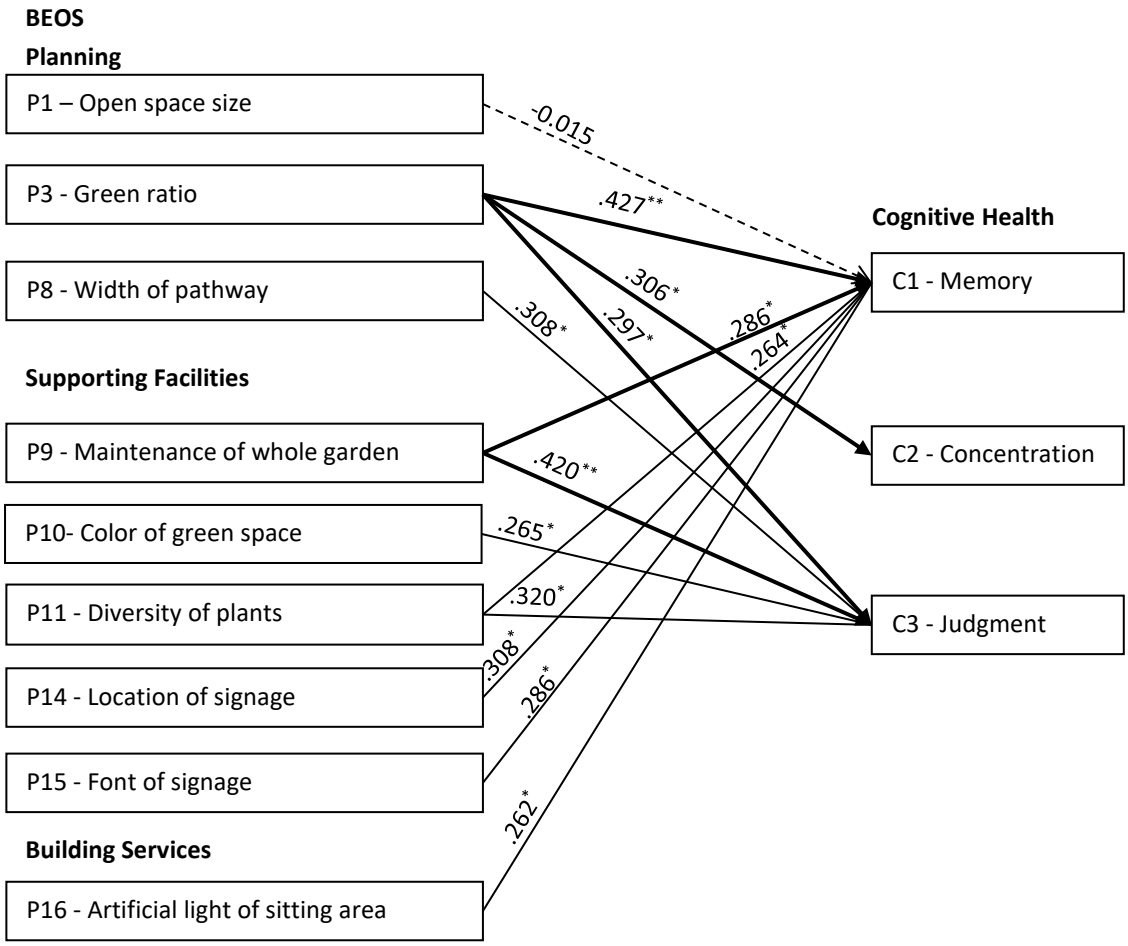


Figure 4. BEOS–Cognitive Health Model for Older People in Communities.

Note: ⟶ significant positive relationship confirmed by both correlation and regression analyses;
⇢ significant negative relationship confirmed by regression analyses;
____ significant positive relationship confirmed by correlation analyses.

5. Discussion

To investigate the relationship between BEOS and cognitive health, this study conducted a questionnaire survey of the elderly in 3 open spaces. Based on the descriptive statistics result, the frequency of visiting open spaces and background information of older people revealed that most of the older people who usually visit open spaces have relatively good health and eyesight. This indicates the current built environment in open spaces is extremely not suitable for those with poor health and eye conditions, which prevents them from coming to open spaces. To reveal the relationship between the BEOS and cognitive health and build a BEOS–cognitive health model for older people in communities, correlation and regression analyses were conducted. The model showed the important positive relationship of *green space* (*green ratio, colour of green space,* and *diversity of plants*) to the cognitive health of older people, especially the green ratio, which is related to all three items of cognitive health. Green space has long been recognized as an essential element of psychological and physical health (Richardson et al., 2013). This study pointed out that the cognitive health of older people also gained benefits from green spaces. The bustling city life consumes their directed attention capacity and brings difficulty for people to make judgments. Contacting with nature, like plants, can bring people four kinds of restorative experiences, namely being away, fascination, extent, and compatibility. These four kinds of restorative experiences can capture involuntary attention and restore attention fatigue in daily life (Kaplan, 1995). A higher green ratio gives older people more opportunities to contact nature and be away from the concerns of daily life, thereby restoring their attention and helping them to concentrate, remember, and judge (Strunk et al., 2019).

Interestingly, the diversity of plants was positively related to judgment and memory, and the colour of the green space positively predicted judgment. Different types of plants perform different specific experiences, e.g., brushed and trees form a "wall" around the open space to lead older people to get away from the hustle and bustle of the surrounding city area (Nordh et al., 2009). Moreover, plants with beautiful green colour stabilize the autonomic nervous system and activate alpha brainwaves so that older people enjoy the open space with physiological and psychological relaxation (Park et al., 2016). However, this cannot explain why these two items fail to predict concentration at a significant level. Other possible explanations include the presence of some outstanding plants with special characteristics as landmarks that help older people remember (Keil et al., 2020). On the other hand, the diverse vivid colours of plants can stimulate the brain, which may help with decision-making and problem-solving. For example, some studies have found that red can improve performance on detail-oriented tasks, while blue can enhance creativity (Mehta and Zhu, 2009). However, the exact reasons for these relationships still need to be studied in the future.

It showed that the location and font of signage were positively related to memory. It is not hard to understand that an open space with big, vivid, conspicuous signage with clear information can help older people remember their location. Because of impaired eyesight, if the font size is small, older people need to get very close to reading the words (Hou et al., 2018). At this time, if the signage is placed in a very high or low position, the old people must work very hard to look up or bend down to see the words clearly. This would cause great trouble for older people to read information. Hence, older people may rarely use the signage to remember the place. Some recognizable signage with special characters can also make the open space more memorable to older people (Leung et al., 2020).

The size and the maintenance of the whole garden played an important role in memory and judgment. It is interesting that the satisfaction with open space size is negatively related to memory. Older people have a lower preference for large open spaces than the general adult population (Lau et al., 2021). The memory space theory supports that a complex space benefits memory through cognitive mapping (Eichenbaum et al., 1999). However, due to the declined special memory, older people can hardly use this kind of contextual memory (Kessels et al., 2007). On contrast, a big and complex space can cause barriers for them to recognize their location and memorize the event. On the other hand, a cluttered environment can distract people, making it difficult to make decisions and remember the environment (Peelen and Kastner, 2014). A well-maintained open space removes the chaotic elements (e.g., garbage and graffiti) that confuse older people and then helps them to judge and remember the situation.

The width of the pathway positively predicted the judgment. Older people often have difficulty moving around (Yim et al., 2020). If the width of the pathway is too narrow, they need to pay more attention to staying safe while walking than to make other judgments. Pathways with the proper width will occupy less attention of older people, leaving them more cognitive space to make decisions. It was shown in the result that there was a positive relationship between artificial light in sitting areas and memory. Sedentary is the most popular activity in open spaces during the night-time. More and more older people like to check their mobile phones when sitting in the open space (Zhou et al., 2014). Bright light in the evening has a positive impact on working memory while using smart devices (Kretschmer et al., 2012). Thus, it is important to provide enough artificial lighting in the sitting area.

6. Recommendation

Green space plays an important role in older people's cognitive health. A large proportion of green space should be provided in the open space. In addition to the number of plants, the species and colour of plants should also be considered. A diversity of plants with vivid and a variety of colours should be planted in the open spaces to enhance the memory, concentration, and judgment of older people. Signs must have clear, big fonts, preferably icons with text. Clear and precise directions should be given to highlight important places such as toilets and entrances. The signage with a big font size should be placed slightly lower than the height of human eyes, about 1.2-1.5m (Launer et al., 1996), and in an easily accessible place. In this way, ordinary, hunchbacked, and wheelchair-bound older

people can all easily read. An open space for old people does not need a large area, but the gardens should be well maintained, keep cleaning, remove obstacles, and repair broken facilities.

As for the limitations, only 60 older people participated in this study. However, the gender distribution of the elderly is consistent with the existing gender distribution of older people in Hong Kong. Besides, the subjects came from three main regions of Hong Kong, namely Hong Kong Island, Kowloon, and the New Territories. Thus, it can be said that the samples were representative. However, this study only asked the older people in three big open spaces, while mini-open spaces, pocket open spaces, and sitting zones were excluded from this study. Open spaces with different sizes may have diverse built environments and different types and numbers of facilities. The range of populations they serve varies at the same time. Visitors may behave differently as a result (Lau et al., 2021). Thus, further study is suggested to explore the relationships between built environments in small open spaces and the cognitive health of older people.

7. Conclusions

Cognitive health plays an important role in older people's daily life. The BEOS can impact the cognitive health of older people. To improve the cognitive health of older people by enhancing the BEOS, this study investigated the relationship between BEOS and the cognitive health of older people by building a BEOS–cognitive health model. The results revealed that memory was positively associated with green ratio, the width of pathways, maintenance of the whole garden, the color of green space, diversity of plants, location, and font of signage, and artificial light of sitting area, while only the open space size negatively influenced memory. One BEOS item, namely the green ratio, could positively predict the concentration. The judgment was positively influenced by the green ratio, width of the pathway, maintenance of the whole garden, the color of the green space, and the diversity of plants. The benefits of plants for cognitive health have been emphasized in this study. To improve their memory, concentration and judgment, practical recommendations have been proposed. Larger green spaces with diverse and colorful plants, signage with proper location and fonts, and good maintenance of the open space were suggested in this study. However, this study only collected data in big open spaces and lacked data in small open spaces. Thus, the built environment of small open spaces should be further studied in the future.

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Conflicts of Interest

The author(s) declare(s) no conflicts of interest.

Data availability statement

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is not available.

Ethics statements

Studies involving animal subjects: No animal studies are presented in this manuscript.

Studies involving human subjects: No human studies are presented in this manuscript.

Institutional Review Board Statement

Not applicable.

CRediT author statement:

Ruozhu YIN: Formal analysis; validation; visualization; writing - original draft; writing - review.Mei-yung LEUNG: Funding acquisition; conceptualization; project administration; resources; supervision; methodology; data curation; investigation; writing - review & editing. Yueran LI: Writing - review. All authors have read and agreed to the published version of the manuscript.

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Perceived Urban Design Across Urban Typologies in Hanoi

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ABSTRACT

In light of the rapid global urbanization, urban design has been shown to contribute largely to promoting the health and well-being of urban citizens. However, studies of urban design are underrepresented in low- and middle-income countries in Asia, where urban forms are traditionally compact and complex with multiple layers. Hanoi, a typical city in low- and middle-income countries, exhibits five unique urban typologies generated through official planning, unregulated development, and historical fluctuations. This study examines the perceived urban design from a sample of 218 participants across five urban typologies in Hanoi using an established scale. The findings suggest that perceived urban design is significantly influenced by urban typologies. Old urban typologies tend to report higher scores of land use mix and access to services but lower scores of walking facilities and street connectivity than modern urban typologies. The study contributes to our understanding of urban design in Hanoi, providing policymakers and urban designers with essential insights for sustainable urban development.

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Highlights:	Contribution to the field statement:
- Perceived urban design varies across urban typologies in Hanoi. - The urban typologies in Hanoi, together with their characteristics, have significant impacts on perceived urban design in both a positive and negative direction. - Despite having better infrastructure and facilities, New Urban Areas have a lower perceived urban design score than older urban typologies like Ancient Quarter or French Quarter	- Enhances understanding of perceived urban design and its relation to urban typologies in Hanoi. - Adapts the NEWS tool, originally designed for U.S. cities, to the unique urban context of Hanoi, thereby filling a knowledge gap in perceived urban design in mid- and low-income Asian countries that are underrepresented in existing literature. - Provides valuable insights for policymakers, planners, and urban designers, aiding the development of sustainable urban design policies, strategies, and initiatives.

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1. Introduction

Studies on urban design have typically used two types of measures: objective measures and perceived measures. Despite their usefulness and popularity, objective measures such as those using D variables (e.g., density, diversity, design) are argued to be insufficient in depicting urban design in relation to its suitability for physical activities(Sallis et al., 2011). The gross characteristics of urban physical attributes collected from objective measures might not influence the overall encounter people have whilst on streets (Ewing et al., 2015). Another problem is that obtaining objective spatial data can be challenging and costly (Brownson et al., 2009) because they may be insufficient, inconsistent, not available, or administratively burdensome to use, especially in low- and middle-income countries (Porter et al., 2004; Salvo et al., 2014). Exploring residents' perceptions of the built environment through perceived measures is important as it complements data from objective measures and contributes to a better understanding of walking behaviour (Hoehner et al., 2005; McCormack et al., 2007; Parra et al., 2010). Importantly, there are numerous established tools that measure a resident's perception of the walking environment such as the Perceived Walking Environment Tool (Humpel et al., 2004), the Neighbourhood Walking Survey (Li et al., 2005), the Perceptions of Environmental Support Questionnaire (Kirtland et al., 2003). Among the tools, the Neighbourhood Environment Walkability Scale (NEWS) (Saelens et al., 2003) and its abbreviated version (NEWS-A) have been used most extensively (Cerin et al., 2008; Cerin et al., 2007; Oyeyemi et al., 2016). However, these tools have been developed in US and research using them comes from high-income countries such as the USA, Australia, and European countries, where cities are less dense in both population and destination compared to many low-income cities across the Asian continent (Cerin et al., 2007). Research in this field is still underrepresented in Asia where cities exhibit local walking-related characteristics (e.g., air pollution, crowdedness, diverse terrain, diverse destinations) that differ enormously to less dense locations (Cerin et al., 2007). Some studies have attempted to apply the tools like NEWS in the Asian context, but only from developed countries like Japan (Inoue et al., 2009), China (Cerin et al., 2007), and South Korea (Kim et al., 2016) where the urban design and urban and transport infrastructure are already well-developed. In most developing countries in Asia – like Vietnam, cities are only beginning to see rapid urban development (Chen et al., 2020). Such cities have high population density featuring a dynamic blend of functions that often arises from historical shifts and unregulated growth rather than deliberate governmental planning and where development is generally associated with underdeveloped urban infrastructure (Storch et al., 2008). Conducting research to comprehensively grasp the influence of these attributes on the perception of urban design is imperative for developing appropriate urban design policies and strategies. This study chooses Hanoi, a city in a developing Asian country as its research focus because it serves as a clear embodiment of the typical urban characteristics found in Asia and possesses a unique lifestyle and culture, which can be attributed to its intricate and extensive history of development. Furthermore, the present time in Hanoi is exceptionally opportune for conducting research aimed at improving urban design because the city finds itself at the turning point in urban development and has an opportunity to determine a sustainable pathway distinct from other developed or developing Asian cities which have embraced unsustainable patterns, such as urban sprawl, over-reliance on automobiles, and significant pollution.

To investigate the perceived urban design in Hanoi, this present study systematically customized the NEWS-A tool to the Hanoi context and employed it to assess various aspects of perceived urban design. Subsequently, the study compared ratings of perceived urban design among five typical urban typologies across Hanoi to highlight the influence of urban typologies on perceived urban design. The present research followed the theoretical framework as in Figure 1.

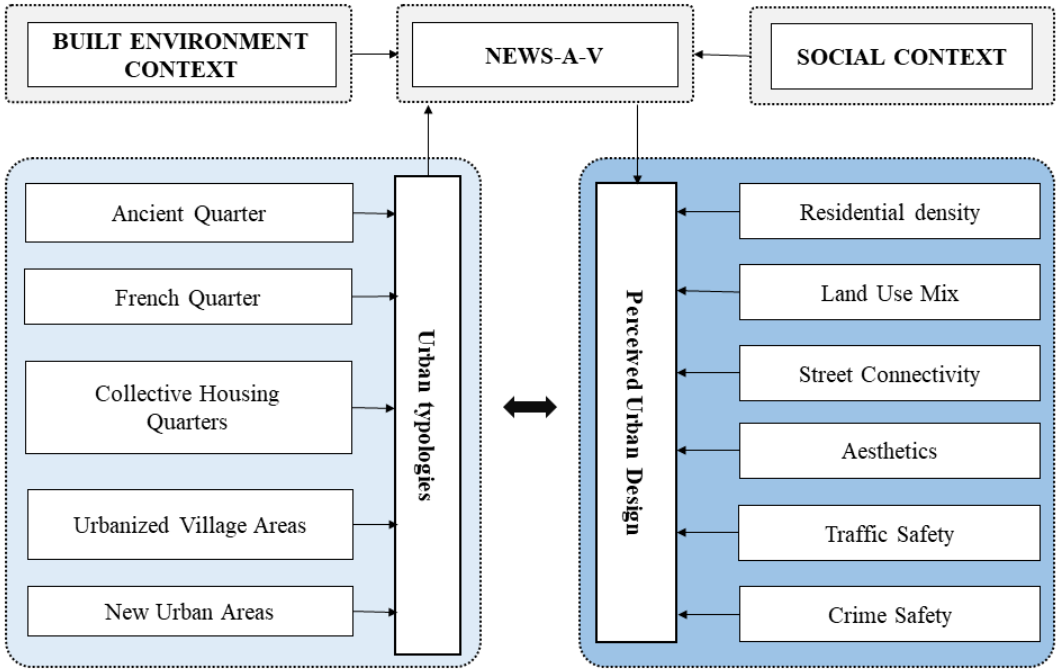


Figure 1. Research framework.

2. Material and Methods

2.1. Materials: the five urban typologies

Over the years, Hanoi has undergone several transformations in its urban design, with each era leaving its mark on the urban design. Originally made up of 36 merchant guild streets, the Ancient Quarter was a maze of narrow streets and alleys that date back to the 11th century and has since developed into the heart of Hanoi. The area is known for its traditional architecture, which includes narrow tube houses, temples, and pagodas. The Western foreign influence gained momentum through the French colonization that extended from the late 19th century to the mid-20th century, eventually resulting in the establishment of the French Quarter. (Geertman, 2007). During the French colonial period, Hanoi underwent a major transformation in its urban design. The French introduced wide boulevards, public parks, and other elements of European urban design to the city. Following its liberation from French colonization in 1957, Vietnam adopted a socialist model heavily influenced by the Soviet Union. (Geertman, 2007).

In the early 1960s, Hanoi witnessed the construction of Soviet-style apartment complexes throughout the city. These districts, sometimes referred to as Collective Housing Quarters or "KTT" in Vietnamese, were designed to accommodate sizable populations, ranging from 7,000 to 12,000 residents. They typically featured a central four- to five-story building surrounded by public amenities like parks, community courtyards, schools, kindergartens, and markets. Between 1965 and 1975, a significant portion of Hanoi was devastated by the war but was subsequently rebuilt. While the process of transitioning villages, particularly those near the city center, into urban areas had been ongoing for decades, Hanoi's rapid urbanization truly began following the economic reforms of 1986, known as Doi Moi. Despite the absence of official planning and infrastructure development, numerous villages underwent swift urbanization to meet the housing demands of the growing economy, giving rise to an urban typology known as Urbanized Village Areas. These areas were characterized by a prevalence of self-constructed houses and an intricate network of narrow, lengthy, and winding lanes that were informally arranged and interconnected to mimic the layouts of former villages. Starting in the 1990s, many traditional neighbourhoods were demolished to make way for modern buildings and infrastructure, leading to the creation of various New Urban Areas. These zones featured contemporary housing styles, including high-rise apartments and spacious single-family homes, along with improved public services and amenities

(JICA, 2007). The characteristics and the location of these five urban typologies are illustrated in Figure 2.

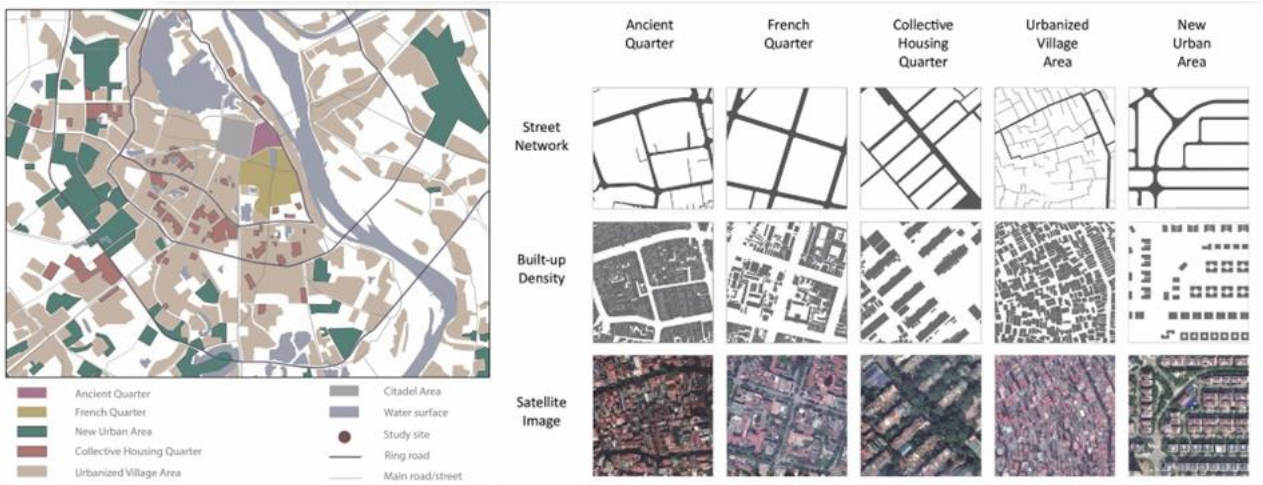


Figure 2. Characteristics and distribution of five urban typologies in Hanoi.

2.2. Methods

2.2.1. Site Selection and Sampling

The sampling uses both stratified sampling and multi-stage cluster sampling to ensure randomness and enhance the representativeness of the sample. Excluding all rural communes, all urban wards in Hanoi were stratified into 5 groups based on their urban typologies: (i) Ancient Quarters; (ii) French Quarters; (iii) Collective Living Quarters; (iv) Urbanized Villages; (f) New Urban Areas. Figure 1 illustrates the characteristics of those urban typologies. In the second stage, two wards were randomly selected in each group to have 10 wards (See Figure 1). After creating the list of streets in these 10 wards, four streets were randomly selected in each ward to make a total of 40 streets. Finally, houses that share the same selected street were numbered and 6 numbers were randomly selected. The research team then approached the selected houses and one member of the household living in the house was invited to participate in the research. If all the household members of selected houses refused to participate, other houses on the street would be randomly selected and approached until there were 5 to 6 consented participants on each street. Eligibility criteria for choosing participants included: (i) being current residents of Hanoi; (ii) being residents of the Hanoi area for at least 6 months; (iii) being able and willing to answer questions in Vietnamese, which is the official language in the study region; (v) not having any disability that prevented independent walking; (vi) no visible signs of cognitive impairment; (vii) must be 18 years of age or older. A total of 218 participants were recruited, and the response rate was 100% due to the sampling strategy discussed above.

2.2.2. Research instrument adaptation

The perception of urban design for physical activity such as walking was assessed using the NEWS-A instrument. NEWS (also called the San Diego instrument) is a 98-question instrument developed by Saelens et al. (2003) to assess the perception of neighbourhood design features believed to be related to physical activity. The NEWS questionnaire has an abbreviated version (NEWS-A) with 54 items which achieves the same as the extended NEWS. They have been adapted and translated into various languages and found to be reliable and valid in many countries (Arvidsson et al., 2012; Cerin et al., 2008; Cerin et al., 2010; Hallal et al., 2010; Sheu-jen et al., 2010; Stopher et al., 2007). The NEWS-A questionnaire assessed several environmental characteristics grouped into 8 main subscales and 4 single items as follows:

1. Residential density
2. Land use mix (Land use diversity)
3. Access to services

4. Street connectivity
5. Walking facilities
6. Aesthetics
7. Pedestrian traffic safety
8. Crime Safety

Four single items:

- Lack of parking
- Absence of cul-de-sacs
- Hilliness
- Physical barriers

All items, except for the residential density and land use mix subscales, are assessed using a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). Residential density items are assessed on a 5-point Likert scale and weighted relative to the proportion of various types of residences, from single-family detached homes to high-rise apartments with a numerical response ranging from 1 (none) to 5 (all). Land use mix is rated by the walking distance in minutes (from 1-5 minutes to more than 30 minutes) to various types of businesses or facilities such as stores, restaurants, and post offices. In most items, a higher score suggests a better environment for walking. However, for some items, like those in traffic safety and crime safety, the subscales have inversed scores, which means a higher score means a reduced likelihood of walking in the environment. The overall score of each subscale is the means of scores of items belonging to this subscale.

As mentioned above, since the tool was developed in the US, an adaption process is required to apply it to the context of Hanoi. The adapted version was named NEWS-A Vietnamese (NEWS-A-V). A multi-disciplinary panel of experts from the fields of urban design (n = 2), urban planning (n = 1), and transportation (n=1) reviewed the original English version to discuss how to adapt them to reflect the built environment of Hanoi. Criteria used for selecting the multi-disciplinary expert panel include: (i) senior researchers/lecturers on the field; (ii) currently doing research and have publications about Hanoi in the last 10 years; (iii) fluently in English. After review, a number of original items were modified or removed while new items that were relevant to the study setting and target population were added.

Table 1. Adaptation of NEWS – A – V.

Modified items	Reason
Changed ‘townhouses or row houses of 1-3 stories’ to ‘townhouses or row houses’	The number of stories of townhouses and row houses varies greatly in Hanoi
Changed destination ‘supermarket’ to ‘supermarket/big market’ and ‘vegetable market’ to ‘vegetable market/small market’	To specify the destination because markets/small markets are common destinations in Hanoi
Changed destination ‘video store’ was changed to ‘Internet/gaming cafe’.	Video stores have no longer existed while internet/gaming cafes are popular entertainment destinations in Hanoi
Changed destination ‘recreation centre’ to ‘Sports centre/Football fields/swimming pools.	To specify the destination because playing football and swimming are popular recreational activities in Hanoi
Change item ‘Sidewalks are separated from the road/traffic in my neighbourhood by parked cars’ to ‘There is a painted line that separates the sidewalks from parking spaces’	The painted line to mark the parking area is common on sidewalks in Hanoi
Change ‘30 Mph’ to ‘50 Kph’ and ‘100 yards’ to ‘100 metres’	The Metric system is used in Vietnam
Changed items ‘The streets in my neighbourhood do not have many cul-de-sacs (dead-end streets)’ to ‘My	Cul-de-sacs is uncommon in Hanoi

neighbourhood does not have many dead-end streets' and moved to the 'Street Connectivity' subscale	
Moved two single items 'Parking is difficult in local shopping areas' and 'There are major barriers to walking in my local area that make it hard to get from place to place' to the 'Access to Services' subscale	As suggested by the expert panel and to match the original NEWS
Removed items	**Reason**
Removed item 'There is a grass/dirt strip that separates the streets from the sidewalks in my neighbourhood	Grass/dirt strip is uncommon in Hanoi
Removed single items 'The streets in my neighbourhood are hilly, making my neighbourhood difficult to walk in.'	Hanoi has a relatively flat terrain
Added items	**Reason**
Added destination 'Religious places'	Religious places such as pagodas or churches are common destinations in Hanoi
Added item 'The sidewalks in my neighbourhood are well maintained' to 'Walking Facilities' subscale	The poorly maintained sidewalk is a common issue in Hanoi
Added item 'Sidewalks in my neighbourhood are often encroached or obstructed by parked vehicles, sidewalk businesses, vendors, or physical obstructions' to 'Walking facilities' subscale	Sidewalk encroachment is common in Hanoi

2.2.3. Analysis

Perceived urban design scores were compared between the five typical urban design typologies of Hanoi namely the Ancient Quarter, French Quarter, Collective Housing Quarter, Urbanised Village Area, and New Urban Area. The mean combined scores of eight subscales for five urban typologies were also Z-scored and then visualised in a box plot chart for comparison. Multiple linear regressions were applied to determine the relationship between the participants' perceived urban design and the five urban typologies. The five urban typologies were dummy-coded and entered the regression analyses with the New Urban Area as the reference category. All analyses were conducted by using SPSS version 28.0 for Windows with the R-essential add-in.

3. Results.

Table 2 reported the perceived urban design by demographics and urban typologies, while Figure 3 compares the Z-score of perceived urban design between the five urban typologies. Overall, Hanoi has high scores (over 2) for all perceived urban design sub-scales, especially for land use mix and density. People in the youngest age group (18-24) had the highest mean score of Residential Density while the oldest group (60+) perceived the highest mean score of Street Connectivity. Males and females shared similar perceptions of urban design except for Traffic Safety where males rated the traffic of Hanoi higher than females. Among five urban typologies Ancient Quarter and French Quarter have a higher perceived land use mix, while New Urban Areas have better walking facilities. Crime safety and traffic safety are almost the same across urban typologies. All the typologies have a higher score for street connectivity than Urbanised Village Areas.

Table 2 Perceived urban design by age, gender and urban typology.

	Residential Density		Land Use Mix		Access to services		Street Connectivity		Walking Facilities		Aesthetics		Traffic Safety		Crime Safety	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age																
18-24	**314.83**	90.69	3.89	0.52	2.72	0.36	*2.86*	0.55	2.80	0.40	2.50	0.34	2.57	0.28	*3.07*	0.22
25-44	309.40	78.70	**3.97**	0.52	*2.71*	0.38	2.98	0.61	2.79	0.45	**2.55**	0.32	2.67	0.27	*3.07*	0.27
45-59	*296.35*	88.80	*3.75*	0.67	**2.76**	0.42	3.13	0.58	**2.93**	0.52	2.44	0.46	**2.68**	0.38	**3.18**	0.32
60+	303.72	77.78	3.90	0.67	2.73	0.32	**3.17**	0.75	*2.71*	0.69	*2.35*	0.50	*2.52*	0.59	**3.18**	0.44
Gender																
Male	*307.25*	82.80	**3.92**	0.51	**2.75**	0.34	*2.96*	0.62	**2.81**	0.45	**2.53**	0.36	**2.66**	0.29	*3.04*	0.23
Female	**309.60**	83.35	*3.90*	0.60	*2.69*	0.40	**3.02**	0.60	*2.80*	0.50	*2.48*	0.37	*2.60*	0.36	**3.14**	0.33
Urban typology																
Ancient Quarter	*254.60*	67.03	4.06	0.34	**2.93**	0.24	**3.40**	0.52	2.77	0.32	2.71	0.26	**2.80**	0.24	3.13	0.25
Collective Housing Quarter	280.00	57.78	3.72	0.35	2.81	0.20	3.05	0.55	3.11	0.34	**2.79**	0.20	2.70	0.35	**3.20**	0.27
French Quarter	275.21	84.99	**4.44**	0.49	2.83	0.24	3.12	0.66	*2.43*	0.51	2.38	0.35	2.64	0.17	3.05	0.24
Urbanised Village Area	307.21	78.73	3.90	0.62	2.82	0.28	*2.46*	0.32	2.51	0.30	*2.22*	0.38	*2.51*	0.43	*3.02*	0.33
New Urban Area	**325.02**	71.46	*3.45*	0.40	*2.22*	0.37	2.91	0.54	**3.21**	0.28	2.44	0.30	*2.51*	0.31	3.07	0.30

Note: boldface font indicates the maximum values, and italic font indicates minimum values.



Figure 3. Z-score of perceived urban design for five urban typologies (developed by Authors).

Table 3 shows the associations between perceived urban design and urban typologies. In terms of perceived Residential Density, the Ancient Quarter and French Quarter had significantly lower scores while Collective Housing Quarter had a significantly higher score compared with the Urban New Areas (the reference urban typology). Urban New Areas had a significantly lower perceived Lan Use Mix than all other urban typologies.

Table 3. Associations between perceived urban design and urban typologies.

Urban typologies	Residential Density	Land Use mix	Access to Services	Street Connectivity	Walking facilities	Aesthetics	Traffic Safety	Crime Safety	Total Score
Ancient Quarter	**-70.419**	**.616**	**.707**	**.488**	**-.444**	**.266**	**.289**	.058	**-68.439**
	<.001	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	.337	**<.001**
French Quarter	**-45.023**	**.271**	**.586**	.148	-.097	**.349**	**.188**	.134	**-43.445**
	.004	**.006**	**<.001**	.197	.210	**<.001**	**.006**	.028	**.006**
Collective Housing Quarter	**50.186**	**.993**	**.605**	.209	**-.778**	-.060	**.134**	-.023	**51.265**
	.002	**<.001**	**<.001**	.068	**<.001**	.357	**.047**	.700	**.001**
Urbanised Village Area	-17.814	**.458**	**.600**	**-.451**	**-.698**	**-.213**	.002	-.052	-18.168
	.257	**<.001**	**<.001**	**<.001**	**<.001**	**.001**	.978	.387	.249

Note: New Urban Areas is the reference urban typology, boldface font indicates that the coefficient is statistically significant.

4. Discussion

4.1. Residential density

Although, Hanoi has a high level of residential density, townhouses or row houses are the dominant residential typology while apartments with over 13 stories are the least popular typology. The townhouses (rowhouses), often called 'tube house' in Vietnam, has been the most dominant dwelling typology in Hanoi for centuries (Kien, 2008). The limited presence of high-rise apartments can be traced back to the planning regulations in Hanoi, which impose height restrictions on buildings across most areas of the city, with the exception of new urban zones where high-rise apartment complexes remain permissible. Within the inner city, residential buildings commonly attain heights ranging from 10 to 13 meters, while in the Ancient Quarter, their elevation is restricted to a mere 6 to 8 meters (Anh et al., 2018). Five-stories Soviet-style apartment block is the main dwelling typology in the Collective Housing Quarters but is infrequent in other urban typologies.

4.2. Land use mix

Among destinations, the participants agreed that coffee places are the most popular destination which tended to always be present within a 5-minute walk from their homes. This result is reasonable when Vietnam is famous for its rich coffee history and culture. In 2019 the country exported $2.39B in coffee, making it the 2nd largest exporter of coffee in the world. The domestic market is also very active, especially in large cities like Hanoi. Coffee shops, coffee stands, and beer shops can be found everywhere in Hanoi. They are places for not only enjoying coffee but also working, chatting and meeting others for personal or business purposes. The convenience of coffee shops makes them an unsubstituted part of Vietnamese daily life (Ta, 2016). Other destinations within walkable distance include convenience/small grocery stores, clothing stores or restaurants. Most participants' workplaces and schools seemed to be far from their homes (more than a 15-minute walk). Hoylyoak and Bray (2015) and Nguyen (2021) found that an average routine work trip in Hanoi has an average distance of about 7.2 km, which is equivalent to about a 1-hour walk.

4.3. Access to services

Most participants reported that transit stops (bus stops or metro stations) are easy to access in Hanoi. However, public transport only accounts for 4% of total trips in the present research and below 10% in other studies from Hanoi (JICA, 2007; Pham, 2017). The problem of public transport may not lie only in

the availability of the network. A study of 800 students in Hanoi revealed that motorcycle ownership, part-time employment, and fear of sexual harassment (among women only) are some of the reasons that led students to quit riding buses (Nguyen & Pojani, 2022). Participants agreed that stores are within walking distance from home in most neighbourhoods, reflecting the vibrant commercial activities along streets in Hanoi. Participants also reported that it's not difficult to park their vehicles in Hanoi, which seems to be an unexpected result in a high-density city like Hanoi. However, it should be noted that illegal parking is very popular in Hanoi (see Figure 5), especially in the CBD area (Thanh Truong & Ngoc, 2020; Vu, 2017). A study by Vu (2017) pointed out many reasons for this behaviour including the shortage of parking spaces, low level of enforcement, and high parking charges of legal parking.



Figure 5. Parking violations on sidewalks.

4.4. Street connectivity

The majority of participants agreed that there are many alternative routes to go from one place to another place in their neighbourhood. hey also believed that the distance between intersections is usually under 100 metres. The main street network of Hanoi is considered to be insufficient for the transport demand (Pham, 2017), but it is supported by the secondary networks of small streets and alleys. Although these dense and complex "narrow-alley" networks are often inaccessible by cars and buses, they provide many alternative routes, significantly reducing the travel times for small vehicles and pedestrians (Nguyen et al., 2020). However, the alley network often does not have many intersections and it does have many dead-ends.

4.5. Walking facilities

Participants reported that sidewalks are present and well-lit at night in most streets in their neighbourhood. However, they shared the concern that sidewalks are not well maintained and are often obstructed (see Figure 6). Sidewalks are usually poorly maintained with uneven surfaces and cracks and gaps (JICA, 2007). In Hanoi, sidewalks are considered a semi-public semi-private space (To, 2011) and are commonly taken over by local people for all kinds of private use, from social meetings to working, playing, or cooking (Labbé, 2021). Besides, there are also numerous facility-related obstructions on the sidewalk such as electric posts, cables, and electrical cabinets and temporary obstructions such as dumped garbage or construction materials. While local authorities periodically conduct "sidewalk clean-up campaigns,", these campaigns are often imposed without much flexibility and consideration for the real needs of local people. Hence, the desired level of efficiency is not achieved, and the sidewalks consistently remain disorderly. (Han et al., 2019). Participants also reported the common presence of the sidewalk painted line that divides the sidewalk width into two parts: one side permits businesses and their parking, while the opposite side is designated for pedestrians. This line visually reminds people of space for pedestrians, but it is usually violated (Han et al., 2019).



Figure 6. The sidewalk is occupied by parked vehicles and personal activities.

4.5. Aesthetics

The most remarkable point stated by the participants about the aesthetics in Hanoi is the presence of trees along the streets in most areas, especially in the French Quarter, the Ancient Quarter and the New Urban Areas (see Figure 4). However, due to the construction of urban transport infrastructure, thousands of trees were cut down and removed from many streets such as Kim Ma, Nguyen Trai and Pham Van Dong, raising concern about pollution and urban heat consequences (Liou et al., 2021). Participants also highlighted that Hanoi has interesting buildings to look at along its streets. The high density of activities and highly mixed architecture make streets and sidewalks in Hanoi diverse, vibrant, and attractive (Ho et al., 2021). The participants rated Hanoi's urban design as very low because of the lack of natural sight along the streets. Due to rapid urbanisation, it becomes more and more difficult to see natural sights such as rivers, lakes, or large green spaces in most neighbourhoods.

4.6. Traffic and crime safety.

The worst traffic hazard in the minds of participants was the heavy traffic along their nearby streets. The high volume of traffic often results in serious congestion as well as an increasing level of air and noise pollution, negatively influencing the walking experience. It also increases the risk of collision for pedestrians. However, the heavy traffic also contributed to the slow speed of traffic in the neighbourhood. Participants agreed that exceeding the speed limit was not a problem in their neighbourhoods.

The majority of participants had no concern in relation to crime in Hanoi. They agreed that walking is safe throughout Hanoi during the day and at night, which is also supported by the fact that streets are often well-lit at night as confirmed in the result for Walking Facilities. Participants also perceived that the crime rate is low, and it does not discourage them from walking. The heavy traffic and the large number of pedestrians on sidewalks in Hanoi also help to improve crime safety as per the classic concept "eyes on the street" by Jane Jacobs (1961)

4.7. Perceived urban design and urban typologies.

As seen in Table 1, people in all urban typologies perceived a significantly higher land use mix in their neighbourhood than those in New Urban Areas. With the dominance of identical villa and apartment buildings, New Urban Areas have low-mix land use and long distances to different land-use destinations. Although having lower built-up density and more open spaces, New Urban Areas have more high-rise buildings which were given a higher weight index than houses in the computational process, leading to a high score of perceived residential density. Similarly, Collective Housing Quarter, thanks to the dominance of five-stories Soviet-style apartments and the encroached houses also got a very high score of perceived residential density from people living there. Despite the high built-up density, residential density is hindered by limited building height in other urban typologies. However, the ongoing urban renewal process, characterized by the transformation of existing areas into new residential developments

with higher floor area ratios to maximize profits, is gradually increasing residential density in many parts of Hanoi (Tung, 2018).

Participants from French Quarter rated their neighbourhoods have the best land use mix. The French Quarter has many public buildings such as government offices, hospitals, theatres, cinemas, representative offices, libraries, and post offices. Simultaneously, it hosts many commercial establishments, such as hotels, restaurants, coffee shops, stores, and malls, owing to its location in the city center. High land use mix is also prevalent in other urban typologies, except for New Urban Areas where residential land use dominates. The same pattern repeated with 'Access to services' where New Urban Areas have a significantly lower score than other urban typologies. Participants in New Urban Areas reported they did not have adequate services within a proximity distance. In New Urban Areas, traditional shops are frequently supplanted by shopping malls, which can offer pollution-free indoor shopping settings for neighbourhoods. However, in doing so, they diminish both the accessibility to essential services and the social vibrancy of the streets in those areas (Bäckman & Rundqvist, 2005).

On the other hand, New Urban Areas exhibited significantly higher perceived 'Walking Facilities' and 'Street connectivity' compared to all other urban typologies, thanks to their well-designed infrastructure featuring a grid-like network of main roads and spacious, attractive sidewalks. However, the robust transport infrastructure seemed to encourage drivers to exceed speed limits in most streets, resulting in lower 'Traffic Safety' ratings from residents in New Urban Areas compared to those in the Ancient Quarter, French Quarter, and Collective Housing Quarters. This finding aligns with a previous study by Thi et al. (2011) which found that new urban areas contribute, on average, to higher traffic accidents and fatalities compared to old areas.

5. Conclusion

The research's findings showed that people in Hanoi perceive urban design features differently. Residential density and land use mix are generally perceived as positive in most parts of Hanoi, while walking facilities, traffic safety, and aesthetics are not as favorable. The urban typologies in Hanoi, together with their characteristics, have significant impacts on perceived urban design in both a positive and negative direction. Despite having better infrastructure and facilities, New Urban Areas have a lower perceived urban design score than older urban typologies like Ancient Quarter or French Quarter. This discovery implies that Hanoi should reevaluate its approach to city development. Instead of simply embracing modern Western-style planning and urban design, it is crucial to thoroughly examine the local urban forms and typologies already present and use this knowledge to achieve the most effective urban design. Moreover, there is valuable insight to be gained from documented experiences of urbanization in Western countries.

The research also demonstrated the effective adaptation of the NEWS tool, originally designed for U.S. cities, to the significantly different urban context and design of Hanoi. This study contributes to bridging the knowledge gap regarding perceived urban design, particularly in the region of mid- and low-income Asian countries, which have been inadequately represented in existing literature. We expect that the NEW-S-V scale can be used in future studies as an appropriate method to collect perceived urban design data in other cities in Vietnam, providing useful findings for policies and strategies as well as implementing interventions in urban development and planning. Nonetheless, it is imperative to make modifications to account for the impacts of the local context. For instance, in the context of densely populated urban areas like Asian cities, adjustments should be made to measures of residential density that depend on building typologies. Furthermore, it is necessary to incorporate additional criteria for evaluating the informal components frequently found in developing nations, such as street markets or sidewalk businesses, which can significantly influence accessibility to services and pedestrian facilities.

We recognize several limitations in this study. The primary limitation is the relatively small sample size (n = 218), which could have been expanded to yield more substantial data for analysis. Additional limitations stem from the distinctiveness of Hanoi as Vietnam's capital and a major tourism hub. This distinctiveness can introduce greater variability in the data. For instance, the concentration of tourism-related facilities in the Ancient Quarter might substantially influence the perception of urban design in

this urban typology. The exceptional nature of Hanoi also makes it challenging to extrapolate the results to other cities in Vietnam. To sum up, this research enhances our comprehension of how urban design is perceived in various urban typologies in Hanoi. It offers valuable insights to inform the decisions of policymakers, planners, and urban designers, enabling them to formulate sustainable urban design policies, strategies, and initiatives that enhance the city's quality of life and ultimately foster the well-being of its inhabitants.

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Do Young Professionals in Malaysian Urban Areas Prioritise Sustainability When Making Housing Decisions?

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ABSTRACT

The present study delves into the decision-making processes pertaining to housing among young professionals residing in urban areas, focusing particularly on their preferences for sustainable housing options. Understanding the factors influencing the housing preferences of this demographic is critical for promoting sustainable urban development, given the ongoing challenges of urbanisation and environmental issues faced by cities. This study aims to explore the decision-making process pertaining to housing among young professionals in Malaysian urban areas and its correlation with sustainability. This study employs a mixed-methods approach, encompassing surveys and in-depth interviews, to analyse the significant factors and decision-making criteria of young professionals residing in urban settings concerning housing. This study primarily focuses on the economic aspect of housing decisions, specifically home affordability, without dismissing the social and environmental factors that may also influence these decisions. The present study contributes to the ongoing discourse on urban sustainability by elucidating the dynamic and evolving preferences of young professionals residing in urban areas. The findings provide valuable insights for politicians, urban planners, and developers who aim to construct housing options that are both sustainable and appealing to this influential demographic group. Ultimately, this contributes to the overall sustainability and resilience of urban communities.

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Highlights:	Contribution to the field statement:
-Most Malaysian young professionals prioritise home affordability over other factors when making housing decisions. -The study also highlights the impact of spending habits on home decisions. -The study emphasises the critical role of neighbourhood safety as a social factor influencing housing decisions.	The findings give useful information for politicians, urban planners, and developers striving to build more sustainable and appealing housing options for this influential demographic group, ultimately contributing to the overall sustainability and socio-economic resilience of urban communities.

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1. Introduction

In the dynamic landscape of urbanisation, housing decisions are of paramount importance in the crucial choices that individuals and societies make. As the world continues its rapid urban transformation, housing becomes a central nexus where socioeconomic, environmental, and personal factors converge. Young professionals, often on the cusp of their careers and personal lives, find themselves at the epicentre of these urban changes. This demographic's housing preferences, decision-making processes, and the role of sustainability therein have become subjects of paramount importance. Malaysia, like many other emerging economies, is undergoing significant urbanisation. In response to the pressing issues of climate change, resource scarcity, and an ever-increasing population, its cities are rising, diversifying, and striving for sustainability.

The primary objective of this study is to elucidate the complexities of decision-making pertaining to housing among young professionals in Malaysian cities and to determine how their choices intersect with sustainability. This study is both relevant and essential, as it aims to bridge the gap between the housing industry, urban planning, and the demands of an expanding population. The implications of this study extend well beyond the academic realm, resonating with policymakers, urban planners, real estate developers, and, notably, young professionals who make critical decisions regarding their future. The progression of cities corresponds to the housing options that are accessible to individuals. The housing decisions made in the present will have enduring impacts on the sustainability of cities and regions, encompassing the environment, society, and economy. Young professionals, being a dynamic and influential cohort, constitute a unique and insufficiently researched demographic with specific viewpoints and objectives regarding housing. Understanding their sustainability choices, beliefs, and decision-making processes might thus direct and impact the future of urban housing development.

The present study explores the decision-making process pertaining to housing among young professionals in Malaysian urban areas, addressing questions such as: To what extent does the cost of living affect housing decisions? What is the impact of the social factor on housing decisions? What is the environmental factor involved in making housing decisions? This study is based on the wider framework of urban sustainability, and its discoveries have significant implications for academia, urban policymakers, and housing developers. The findings of this study can provide valuable insights for the development of environmentally friendly and attractive housing options that cater to the specific demands of this key demographic. This study contributes to the overarching objective of improving the sustainability and resilience of urban areas in response to rapid urbanisation and increasing environmental issues.

2. Literature Review

a. Sustainability

A plethora of studies on sustainability have been conducted over the years since the blueprint of Agenda 21 in 1992. In fact, the 2030 Agenda for Sustainable Development Goals (SDGs), which started in January 2015, has advanced the idea of sustainability since the 1972 United Nations Conferences on the Human Environment in Stockholm (Vasallo & Bueno, 2021) and has since been furthered by the 2030 Agenda for Sustainable Development Goals (SDGs), which commenced in January 2015. The concept of sustainability is commonly defined by three fundamental pillars: environmental, social, and economic; however, some scholars place greater emphasis on a specific pillar (Gilmour et al., 2011; Parkin et al., 2003; Radermacher, 1999). For instance, the concept of sustainability originated in the 1980s, primarily focusing on the environment (Mannan, 2012). It played a vital role in maintaining ecological balance (Yadav et al., 2021) and ensuring the long-term ability of the natural environment to accommodate human life in economic development (Chiu, 2004). Hence, the concept of sustainability has been a subject of debate since past researchers have disputed and interpreted it in terms of the constraints imposed by human activities the world over, including determining the maximum population that a specific environment can support and the potential occurrence of a disaster if this capacity is exceeded (Healey and Shaw, 1993; Jacobs, 1999).

In contrast, the definition proposed by the Brundtland Commission defines development as the fulfilment of existing necessities while ensuring that the ability of future generations to fulfil their own needs is not

compromised. The concept of sustainable development, which takes into account environmental, social, and economic perspectives and aligns with the objective of achieving sustainability has been predominantly accepted and used despite the emergence of other definitions (Cerin, 2006). This definition was extremely prominent and promoted by the UN (Vasallo & Bueno, 2021). Sustainability focuses on meeting the core necessities of human beings while persistently striving to satisfy their aspiration for an improved quality of life. Undoubtedly, sustainability encompasses more than just the environmental dimension, as it also integrates the simultaneous concerns of social equity and economic development.

b. Sustainability in housing

Housing plays a significant role in the sustainable development agenda. The concept of sustainability in housing has been clearly established, encompassing the environmental, social, cultural, and economic pillars that are interconnected with one another (Chiu, 2004). Previous research, such as the study conducted by Hui and Ho (2006), has extensively examined sustainability in housing, which includes: (1) providing shelter for the underprivileged; (2) offering eco-efficient housing; and (3) strategically positioning residential units to enhance the surrounding amenities. According to Chiu (2004), housing must fulfil its fundamental requirements and enhance its habitability. The concept of sustainability in housing is associated with the provision of essential facilities such as piped water, sanitation, drainage, transportation, health care, education, and child development, which are crucial for ensuring the well-being, safety, affordability, and security of the occupants. Housing must be strategically planned to become a desirable neighbourhood that offers protection against environmental hazards such as chemical contamination and natural disasters.

Sustainability in housing is also explained in three pillars: environmental, economic, and social. Ironically, the majority of instances consistently indicate that the concept of sustainability in housing is primarily linked to economic factors and, to a lesser extent, environmental considerations (Karuppannan & Sivam, 2011). The economic aspect is ubiquitous, especially when discussing housing affordability (Baker et al., 2015; Sohaimi, 2022) Housing improvement is one of the most important sectors of the economy, which ensures the prosperity of urban development and sustainability. However, some have debated that housing affordability should be defined by integrating social and environmental aspects with the extensively sanctioned economic aspect (Sohaimi et. al, 2023). Attributes of economic housing sustainability are often associated with house size, monthly home-financing instalment, and physical criteria such as the number of bedrooms, bathrooms and construction costs (Ezennia & Hoskara, 2021). In addition to the economic component, there has been a need to investigate other aspects. In fact, in recent years, studies on housing affordability have emphasised consequential relationships among the economic, social, and environmental pillars (Dave et al., 2017; Gan et al., 2017; Mulliner et al., 2016), and this has contributed to emerging sustainability that is considered novel in research on housing affordability (Adabre & Chan, 2020; Ezennia & Hoskara, 2019). There is a dearth of research in Malaysia about housing decisions in relation to sustainability. Therefore, this study aims to address this gap and examine the extent to which young Malaysians consider sustainability while making housing decisions. This article makes a valuable contribution to the field of housing sustainability.

3. Materials and Methodology

The present study employed a mixed-methods approach to provide a comprehensive and all-encompassing outcome, as its objective was to identify housing options from a broad economic, social, and environmental perspective. The data were collected through a survey to address housing decisions from an economic perspective. Housing decisions, particularly those related to social and environmental aspects, are mostly obtained from in-depth interviews due to their ability to yield abstract responses. The study utilised an embedded design, where both quantitative and qualitative data were collected simultaneously and cross-validated throughout the interpretation process.

The study included young professionals in the initial tier of the built environment profession. The criteria for selecting young professionals for this study are as follows: i) The individuals must fall within the age range of 25 to 35; ii) They must possess a minimum of a bachelor's degree; iii) They must be employed

as an engineer, architect, urban planner, or quantity surveyor; and iv) they must either work or reside in Greater Kuala Lumpur.

The researcher managed to obtain four professional bodies: the Institute of Engineers Malaysia (IEM), the Malaysian Institute of Architects (MIA), the Malaysian Institute of Planners (MIP), and the Board of Quantity Surveyors Malaysia (BQSM) through phone calls, emails, and face-to-face meetings for cooperation in obtaining appropriate lists of young professionals. The permission process for cooperation took around three months due to the stringent requirements imposed by several professional organisations over the disclosure of respondents' personal information, including their name, contact number, and email. This was in compliance with the Personal Data Protection Act of 2010 (PDPA), which prohibits such disclosure. The Personal Data Protection Act (PDPA) of Malaysia regulates the handling of personal information in commercial transactions in order to protect individuals' personal data by regulating its processing and ensuring that it is not used for unauthorised purposes. Subsequently, the professional bodies provided the population size for each distinct profession; the researcher was then able to determine the sample size in accordance with Krejcie and Morgan's (1970) formula. The professional bodies reported a total population size of 10,900 individuals, indicating a required sample size of approximately 372.

Subsequently, the professional bodies randomly selected the names of each respondent from their database of graduate member lists. During the course of the procedure, the professional bodies have furnished data on the respondents, which encompasses their full name, contact number, and email address. Upon obtaining the necessary information, the researcher proceeded to engage with all selected respondents for the purpose of distributing questionnaires and conducting interviews. The number of interviews was determined based on data saturation, resulting in 14 interviewees who reached data saturation by providing identical outcomes. The diagram in Figure 1.0 below illustrates the steps involved in the research process.

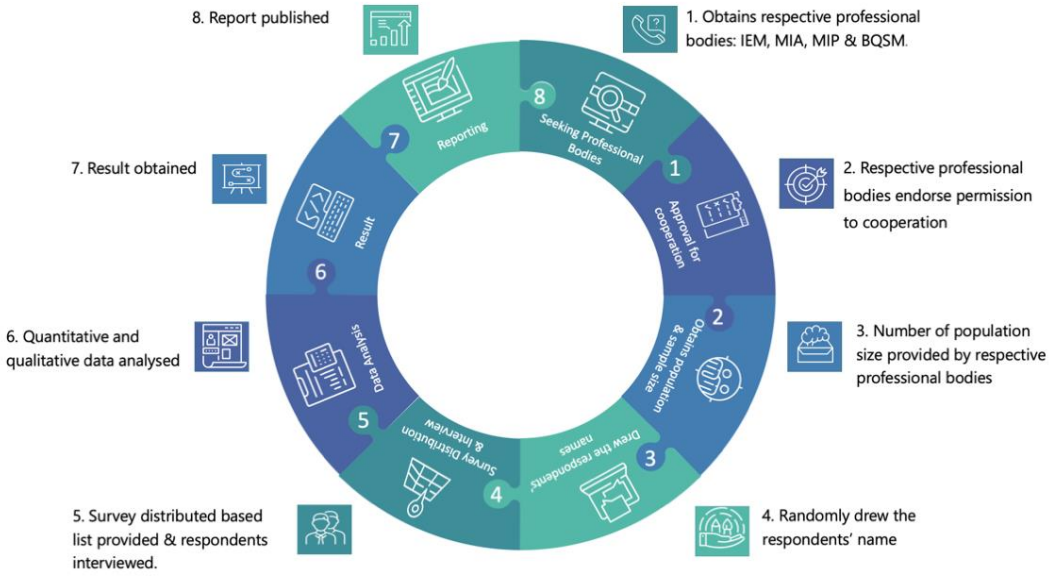


Fig. 1. Research methodology process.

As aforementioned, the study examines three perspectives for determining housing decisions, each employing distinct methods and analyses to address the research questions. The questionnaire is divided into three sections: demographic information, household income data, and household expenditure allocations, while environmental and social perspectives are addressed in the interview questions. The data was assessed using cash budget flow analysis and housing eligibility simulation analysis prior to addressing the discussed outcomes related to the achievement of housing sustainability. Table 1.0 shows the summary of the research method.

Table 1. Research method.

Perspectives	Research Questions	Method	Analysis
Economy	To what extent does the cost of living influence housing decision?	Quantitative: i. Questionnaire	i. Cash budget flow analysis ii. Housing Eligibility Simulation Analysis
Social	How does the social aspect influence housing decisions?	Qualitative: i. In-depth interview	i. Thematic analysis
Environment	What is the environmental aspect of a housing decision?	Qualitative: i. In-depth interview	i. Thematic analysis

The study has employed the residual income model, which defines housing affordability as the presence of a surplus in monthly household income after deducting expenses for households, transportation, and housing. Conversely, housing unaffordability is characterised by the absence of such a surplus. In summary, housing affordability is assessed as follows:

HA = MON.HI – (MON.HE + MON.TC + MON.HC)
= ± balance of HI

Fig. 2. Residual income model.

The variables in the model are explained in Table 2.0, as follows:

Table 2. Variables of housing affordability.

Symbol	Variable	Description	References
HA	Housing affordability	Housing affordability is affordability for homeownership or rental.	Linneman & Megbolugbe (1992)
		Housing affordability is referred to as affordability for renters, homeowners, and prospective homeowners.	DTZ Research (2004)
Mon. HI	Monthly Household Income	The monthly income of the household head and spouse (if both are working) is referred to as the household income.	Arimah (1997)

Mon. HE	Monthly Household Expenditure	The monthly household expenditure is based on the following items: ● Food and non-alcoholic beverages ● Alcoholic beverages and tobacco ● Clothing and footwear ● Utilities (water, electricity, gas) ● Furnishing, household equipment, and routine household maintenance ● Health care (medical or personal life Insurance) ● Communication (telephone and Internet bills) ● Recreational services and culture (entertainment or travel) ● Restaurants and hotels (dining out) ● Miscellaneous goods and services ● Education	Department of Statistics Malaysia (2014)
MON. TC	Monthly transportation costs	Monthly transportation cost on follow items: ● Vehicle financial instalments ● Petrol / Fuel ● Toll fares ● Car parks ● Train tickets ● Services/Maintenance/Repairs ● Others	Scheiner (2016)
MON. HC	Housing costs	Monthly financial commitment for housing, either in the form of mortgage or rental rate	Bramley (1992)

The urgent need to provide environmentally friendly and socially equitable living spaces has driven significant attention to the idea of sustainability in housing decisions in recent years. This conceptual framework explains the essential elements and dimensions that drive sustainability in housing decisions, including economic, social, and environmental factors. Economic factors are the foundation of sustainable housing decisions. The financial cost required for procuring and maintaining a home is referred to as the housing cost, a key variable in this dimension. Household spending reflects the larger financial context in which housing decisions are made, including all financial commitments, such as housing costs, utilities, food, transportation, and other living expenses (Acolin & Green, 2017; Choi & Ramaj, 2023). The third element in the economic component is household income, which indicates the financial resources accessible to the individuals in the household.

The social dimension of sustainability in housing decisions is influenced by the variables of neighbourhood safety and location (Choi & Ramaj, 2023; Hosseini et al., 2016; Jussila et al., 2023; Tan et al., 2018). Neighbourhood safety refers to the security and well-being of residents in their immediate living environment. The second component in the social dimension is the aspect of location, which

pertains to the geographical setting of a housing option. Decisions about sustainable housing should take into account aspects such as proximity to essential services, educational institutions, workplaces, and public transportation. An optimal location minimises travel distances and facilitates convenient access to key resources.

The environmental dimension in housing decisions includes factors such as a clean environment and access to green spaces (Ezennia & Hoskara, 2019; Jiang et al., 2023). The clean environment variable is concerned with the overall hygiene, sanitation, and cleanliness of the living space. In this perspective, sustainability signifies residing in locations with clean air, water, and surroundings. Accessible green areas or spaces reflect the availability of natural spaces, parks, and recreational areas within the living environment. Sustainability in housing decisions promotes access to green spaces, which are crucial for the residents' physical and emotional well-being. Green spaces encourage relaxation, physical activity, and connection to nature, all of which contribute to a higher quality of life and overall sustainability. Figure 3 shows the conceptual framework of this study.

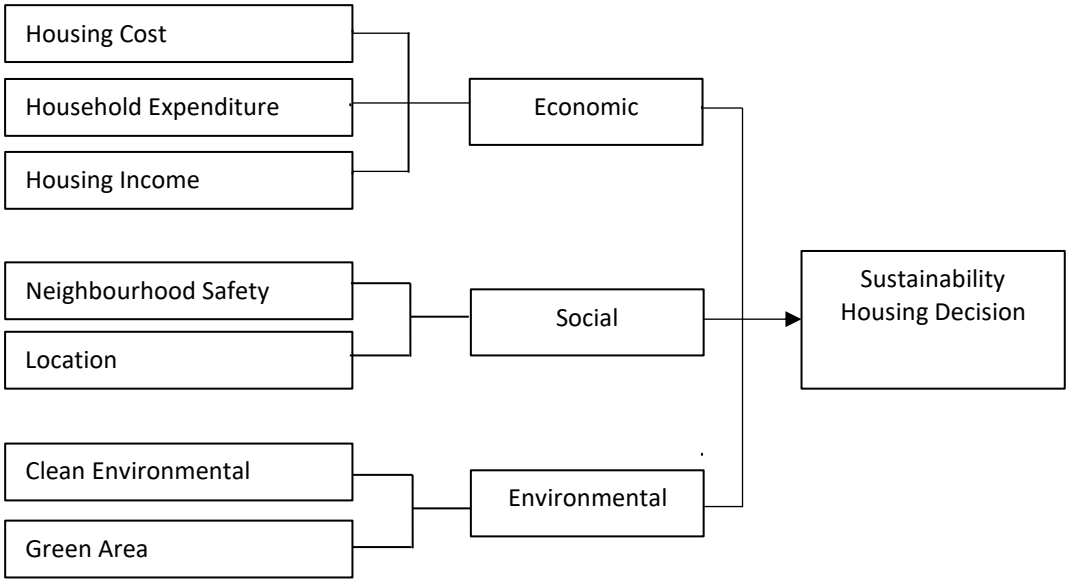


Fig. 3. The conceptual framework of the study.

4. Results and Analysis

The study's findings are elucidated using three dimensions that align with the concept of SDGs: economic, social, and environmental perspectives.

4.1 Housing decision from an economic perspective

From an economic perspective, this study focuses on the ability of household income to cover housing expenses and other household costs when discussing the affordability of housing. Accordingly, Table 3.0 displays the residual income for the three groups, which is calculated by subtracting monthly household expenses without including monthly housing expenditures. The results unequivocally demonstrate that the B40 demographic was underprivileged, as this particular group could only afford monthly housing expenses of up to MYR 680 (USD 161) after accounting for other household expenditures. Meanwhile, the M40 group has more advantages than the B40 group, but they cannot compete with the T20 group. The M40 group has a monthly household income of approximately MYR 3,080 (USD 731), which is half of the T20 group's residual income.

Table 3. The residual income of three income groups.

Groups	Monthly Household Income (MYR)	Monthly household expenditure (MYR) (exclude housing cost)	Residual Income (MYR)
B40	3,100	2,420	680
M40	7,500	4,420	3,080
T20	13,000	6,640	6,360

Note: MYR 1 = USD 0.24

Once the residual income for each household group is determined, a housing eligibility simulation analysis is performed to determine the suitable house price for each household group, taking into account their remaining income. Therefore, Table 4.0 shows an estimation of house prices and monthly house instalments for each household group, calculated using the Home Loan Calculator Malaysia. The simulation was initiated with an assumed interest rate of 4.3%, which is in line with the prevailing rates offered by local financial institutions. The down payment for the house was set at 10%, and the loan duration was estimated to be 30 years. Typically, Malaysians are given the option to have a loan duration of up to 35 years or until they reach the age of 70. However, this simulation assumes a loan period of 30 years, as the respondents included individuals up to the age of 35. From the simulation, it was found that the B40 group was only eligible to purchase a house priced up to MYR 150,000 (USD 35,672) with a monthly instalment of MYR 668.00 (USD 159), which is in the range of B40's residual income of MYR 680.00 (USD 162). Meanwhile, according to a comparable simulation, individuals with M40 and T20 income levels are projected to meet the criteria for purchasing residences valued at MYR 650,000.00 (USD 154,578) and MYR 1.3M (USD 237812), respectively.

Table 4. Estimation of monthly house instalments.

Groups	Residual Income	House Price (MYR)	Monthly House Instalment (MYR)	Down payment (MYR)	Interest Rate	Loan Period (Years)
B40	680	150,000.00	668.00	15,000.00	4.3	30
M40	3,080	650,000.00	2,895.00	65,000.00	4.3	30
T20	6,360	1.3 M	5,790.00	130,000.00	4.3	30

Note: MYR 1 = USD 0.24

The house price data was gathered from the National Property Information Centre's (NAPIC) report and geographically plotted using Google's location services to identify the exact geographic locations. Figure 4 unambiguously demonstrates that the majority of housing prices in the Greater KL area are above MYR 200,000 (USD 47,562), indicating that they are unaffordable for the B40 demographic. There is a scarcity of houses available in Greater KL that are priced at MYR 150,000 (USD 35,672). Alternatively, the B40 demographic may consider acquiring a house in a nearby city like Negeri Sembilan, which is part of Greater KL. However, this option has the drawback of incurring significant transportation expenses for commuting to work. Furthermore, the B40 contemplated the option of renting a residence in Greater Kuala Lumpur.

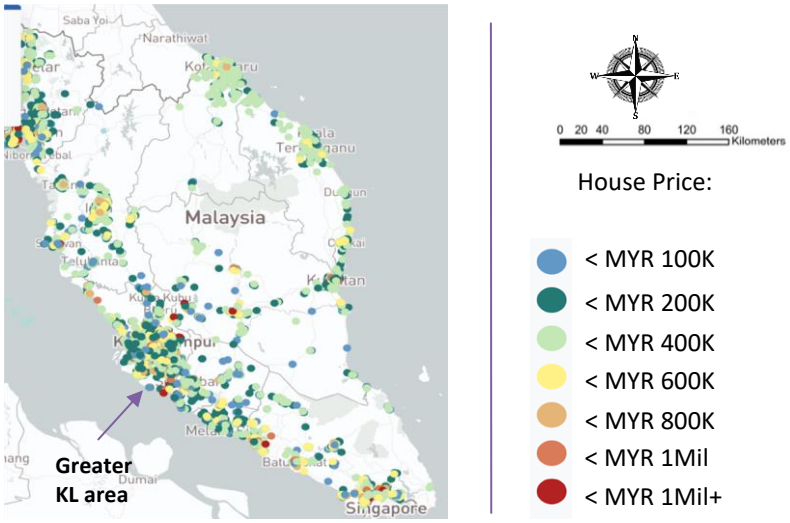


Fig. 4. House price coordinates.

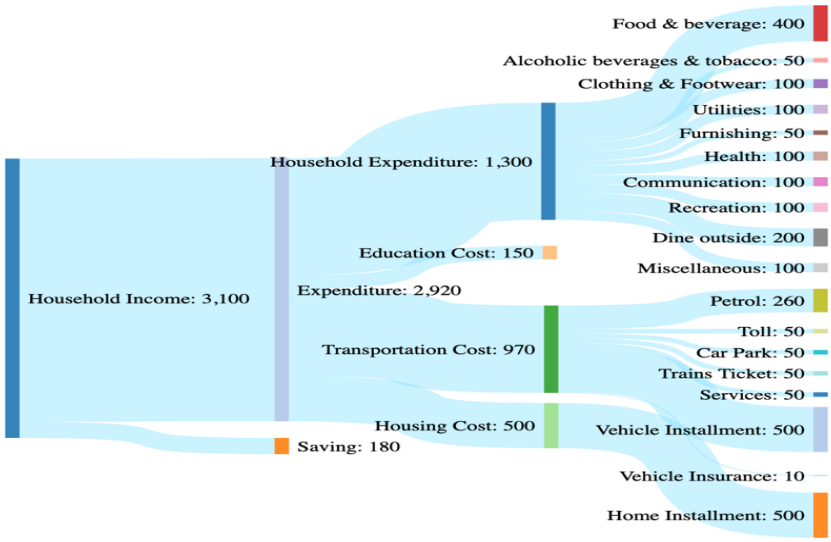
Figure 5 is a Sankey diagram illustrating the distribution of expenditure among young professionals from three distinct household income groups: B40, M40, and T20. The study's survey provided data on both household income and expenditures, which were then categorised separately. Subsequently, an expenditure can be categorised into four distinct areas, i.e., household expenditure, education cost, transportation cost, and housing cost.

The allocation of household expenditures varies depending on the level of household income. Obviously, household income has a direct correlation with the increase in expenditure. The T20 group has the highest expenditure while concurrently maintaining substantial savings of approximately MYR 4360 (USD 1041) per month. Meanwhile, the B40 demographic has far lower incomes, with their monthly savings amounting to a meagre MYR 180 (USD 43). This sum is deemed insignificant, especially when confronted with uncertainty. In other words, it appears that the B40 group lacks the necessary emergency funds to cover unforeseen expenses such as car breakdowns, accidents, disasters, or loss of income. This circumstance has been putting constraints on the B40 group, which can only afford monthly housing costs of up to MYR 500 (USD 119).

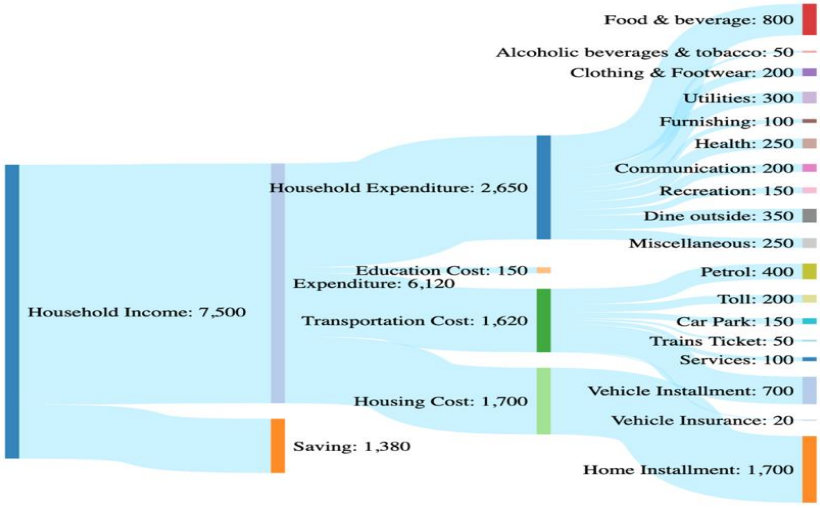
Undoubtedly, all three categories of households reported the highest outflows of money for household expenditures. According to Figure 5, the majority of B40's income is allocated towards household expenditures, which amount to approximately MYR 1,300 (USD 310). Among these expenses, the highest amounts were spent on food, beverages, and dining out, totalling MYR 400 (USD 95) and MYR 200 (USD 48), respectively. Other household expenditures were less than MYR 100 (USD 24). The spending patterns for both the M40 and T20 groups are similar, with both groups showing the highest spending for household expenditure, specifically on food, beverages, and dining out. However, the T20 group has a higher proportion of spending in these categories compared to the M40 group.

Furthermore, young professionals across all household demographics incur substantial transportation expenses, encompassing not just vehicle payments but also additional costs such as fuel, tolls, parking fees, maintenance, and insurance. Figure 5 demonstrates that the B40 group lacks high-end vehicles, as their monthly vehicle instalment is as low as MYR 500 (USD 119), typically associated with local vehicle brands. The M40 group, following the B40 group, has a slightly higher monthly sum of roughly MYR 700 (USD 167). On the other hand, the T20 group has a much larger monthly car instalment of MYR 1500 (USD 387). Figure 5 illustrates the cash budget flow analysis, which depicts the cost of living or household expenditure for B40, M40, and T20.

B40



M40



T20

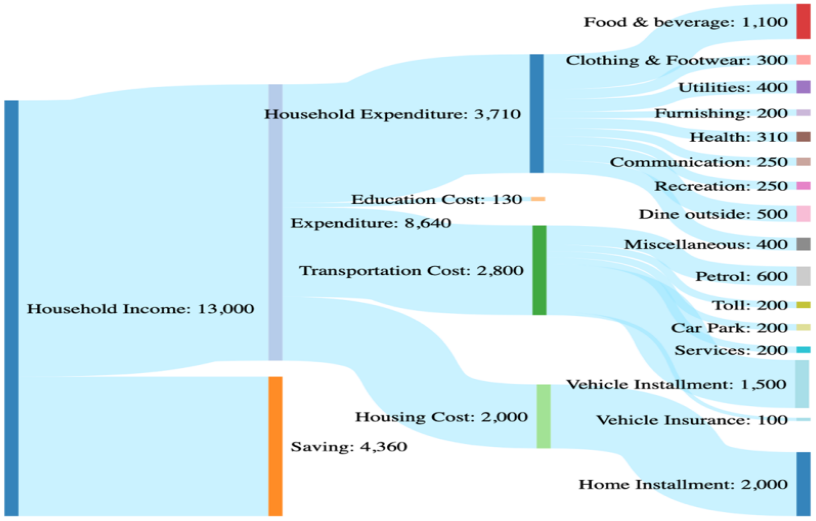


Fig. 5: Household expenditures of B40, M40, and T20.

4.2 Housing decisions from a social and environmental perspective

From a social perspective, neighbourhood safety is the most desirable factor when deciding on housing, particularly among those respondents with children. The respondents in this study have a spouse who is employed, resulting in limited availability to supervise their children at home. These young professional couples adhere to the standard working hours of 9.00 a.m. to 5.00 p.m. in Malaysia. Simultaneously, their children attend school from 7.30 a.m. to 1.30 p.m., and after school, the children either return home or prepare for further extracurricular activities. Therefore, the absence of parents, especially beyond school hours, is a major concern for parents regarding the safety of their children.

As stated in the interview, the majority of participants express discomfort with the influx of foreigners in the residential vicinity. Foreign workers typically encompass unskilled and inexperienced labourers, predominantly employed in the construction, manufacturing, and industrial sectors. Unfortunately, they are often associated with criminal incidents and exhibit aggressive behaviour, including intoxication, physical altercations, disruptive behaviour, and disrespect towards the local residents. Besides, these foreigners reside in homes with a significant number of households; for instance, a residence measuring 650 sq. ft. accommodates as many as eight individuals. Ordinarily, foreigners assume a home as shelter, and thus, they are willing to live in a crowded house. In a different context, young professionals assume a home to sustain their well-being and provide comfort to their families; as a result, they are deterred from cohabiting with the increasing number of foreigners. In addition, the interview revealed that young professionals experience unease when residing in low-cost or affordable housing units, as they are also associated with several societal problems such as substance abuse, excessive noise, vandalism, and inadequate facility management.

Young professionals are eager to acquire a residence in close proximity to their place of employment, with a desired distance of 20 kilometres. The majority of young professionals expressed a preference for residing in close proximity to their workplace due to the need to oversee their children. When both partners are employed, they need to locate a central home site that is equidistant from both workplaces. The affordability of housing in Greater KL is a significant concern due to the exorbitant prices. Alternatively, young professionals also prefer residences in close proximity to public transport in the event that they are where unable to purchase or rent a dwelling near their workplaces. In fact, young professionals heavily depend on public transportation, especially trains such as the light rail transit (LRT). The majority of young professionals have a preference for a comfortable residence with a desirable ambiance and surroundings. However, this criterion has been associated with increased housing costs. This study found that young professionals are unable to afford expensive housing options that provide a good ambiance and environment. Concurrently, they are hesitant to choose low-cost housing due to its poor reputation and atmosphere. On the contrary, they have a tendency to purchase or rent moderate-cost residences that provide a high standard of shared living space. Young professionals generally do not prioritise environmental factors, such as the presence of green spaces, when making housing decisions. Instead, they tend to focus primarily on issues related to cleanliness, such as garbage disposal and maintaining a harmonious living environment. However, those who can afford high-end housing options may take environmental considerations into account.

Table 5. Interviews with respondents.

Decision Factors	Annotation
Neighbourhood safety	"I can afford to buy a house priced at MYR 250,000 or a low-cost house, but I avoid it, as this kind of house has many foreigners involved in crime." (**R1**) "I used to grow up in a low-cost apartment, so I really understand the situation of low-cost houses, which are prone to social problems like drug addiction. I don't want my kids to be exposed to this environment." (**R3**) "If I buy a house priced below MYR 200,000, can we expect how the socioeconomic and neighbourhood are? And who do we communicate with? I really take this seriously about this because I need to set up a proper

	plan for my growing children. So, I want to provide a better environment for my children. Furthermore, if I buy such a house, my children will be exposed to various social cultures or foreigners who occupy that unit, so I am worried about my children's security and safety." (**R9**) "Previously, I rented a low-cost flat unit at Sg. Besi, Kuala Lumpur. Even though the rental rate was most affordable at MYR 450 compared to my current rental house at MYR 650, I was personally unhappy to live there because of a neighbourhood issue. There are foreigners who shared the house with a high density per unit, even mixed between men and women." (**R12**) "When I was looking for a rental house at Pantai Dalam, Kuala Lumpur, I found an affordable unit, but during my visit to the house, I was not willing to rent there because there were scenes of fighting, noise, and parking issues." (**R13**)
Location	"I would not find a house far away from Kuala Lumpur unless it was near public transport. The houses away from public transport will let me think many times before making a decision. Even currently, we have GRAB car services, but personally, this public transportation is costlier than LRT. Young people like me have just finished their studies and have no cars." **(R2**) "One of the challenges in a housing decision is finding the right location so that I and my husband can benefit from it. I believe one of us has to work near the house so that we can manage our children, such as sending them to nursery or school in the future, but a house near the workplace is usually more expensive." (**R4**) "My wife and I rarely find a house close to our workplace. So, I rented a house close to the LRT so I could send my wife on the LRT." (**R6**) "Before we decided to buy a house in Puncak Alam, Selangor, we also did a survey about traffic congestion during peak hour, and we cannot do more on that and just accept the situation as long as we can buy a landed house. However, I admitted that the best house is near the workplace." (**R7**) "Before getting married, I had surveyed a terrace house priced at MYR 200,000 and located in Kundang, near Rawang, Selangor. However, I decided not to buy the house, although the house price is most affordable, and the location, 35 km from my office, was completely inconvenient for me. My preferred housing location is about 20 km to the office, as I have to consider petrol, toll, and time for managing my children and bonding with family. Now I bought a PP1M house with a location that is only 17km to the office." (**R13**)
Clean environment	"I found that the mentality of residents in a low-cost house is that they are not keeping the environment clean, such as by throwing garbage, being noisy, and committing vandalism. I moved to another rental house, although the rental price was higher than the previous one." (**R12**) "In my view, buying a house means we are buying the environment surrounding the house as well, so I bought a house that met my desired criteria, such as a good environment." (**R9**)

5. Discussion

From a multidimensional viewpoint that includes economic, social, and environmental issues, the present study examines the decision-making process pertaining to housing options among Malaysian young professionals in urban areas. This study used a mixed-methods approach, emphasising the importance of comprehensive awareness pertaining to housing options in order to solve sustainability issues that this demographic group faces. Findings from this study have significant implications for the housing industry, urban planning, and sustainability initiatives, providing insight into the complex interplay of factors that influence housing decisions. The results underscore profound economic disparities among different income groups, i.e., B40, M40, and T20, and their impact on housing affordability. The B40 group, characterised by limited financial resources, faces substantial setbacks in bearing housing costs. The study's simulations demonstrate that this particular group generally has the financial means to purchase housing that is priced at MYR 150,000 or less, therefore emphasising the significant gap in affordability across urban locations in Malaysia. In contrast, the T20 group enjoys significantly higher residual income, providing them with a greater capacity to purchase more expensive properties. The M40 group, positioned between these two extremes, faces affordability constraints of their own, further underscoring the need for targeted policies to address income-based disparities in housing access and affordability.

The study also highlights the impact of spending habits on home decisions. Notably, as income levels rise, household expenditure rises, resulting in increased savings among the higher-income group, T20. Conversely, the B40 demographic is vulnerable to unexpected financial challenges as a result of their limited reserves. This situation emphasises the necessity of not only affordable housing but also general financial stability. The potential insufficiency of savings within the B40 group to handle unexpected expenses is particularly alarming since it puts their ability to afford a home at risk. Furthermore, the study emphasises the critical role of neighbourhood safety as a social factor influencing housing decisions, particularly among young professionals with children. The responsibility to ensure the safety of their children in situations of parental absence beyond school hours greatly influences housing preferences. Environmental concerns still exist, despite exhibiting less significance in housing selections. Young professionals want refreshing living environments, but this inclination generally comes at an elevated cost. The study suggests that finding a balance between affordable housing and high-quality communal living conditions is a reasonable compromise. It is worth noting, however, that the majority of young professionals' disregard green spaces in their home decisions. Another important consideration is proximity to their workplaces, with young professionals choosing residential locations within a 20-kilometre radius of work. The critical problem, particularly in urban regions like Greater Kuala Lumpur, is the high cost of residing near workplaces. This emphasises the necessity of addressing both affordability and accessibility in housing options, particularly in high-cost areas.

6. Conclusion

The present study provides comprehensive knowledge of the decision-making process pertaining to housing among Malaysian young professionals in urban settings, shedding light on the interplay of economic, social, and environmental aspects. The economic discrepancies between income categories highlight the importance of tailored strategies to reduce affordability gaps. Furthermore, the findings emphasise the significance of financial stability and residential neighbourhood safety as significant social issues. Proximity to workplaces and public transit options are important practical considerations in housing planning and urban development. This study also emphasises the complex correlation between housing costs, environmental quality, and green areas, with affordability restrictions frequently influencing the decisions made by young professionals. These findings are useful for policymakers, urban planners, and other parties interested in promoting sustainable and inclusive housing options that are aligned with the SDGs. Investigating and developing innovations in sustainable housing design, construction, and technology, as well as their adoption by young professionals, can be a rewarding path. Understanding how new housing solutions match this demographic's preferences might contribute to the creation of more sustainable housing options. Finally, this study on housing decisions among urban young professionals in Malaysia sets the stage for other forthcoming investigations that will enhance public comprehension of this crucial topic. Future studies can target specific aspects of housing decisions,

evaluate policies and efforts, and provide a more holistic view of how educated housing options might enhance urban sustainability.

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Integrating Wind Flow Analysis in Early Urban Design: Guidelines for Practitioners

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ABSTRACT

The research focused on simulating wind patterns in urban planning design offers substantial contributions to both the social and economic aspects of the urban planning and design field. To begin with, it addresses a critical factor in urban development, especially in Mediterranean climates, where natural ventilation significantly influences summer comfort. By incorporating predictive numerical simulations of urban wind patterns, this study provides valuable insights into improving outdoor thermal comfort within urban areas. This holds particular importance in the context of adapting to climate change, as it equips urban planners and architects with informed decision-making tools to create more sustainable and comfortable urban environments. Additionally, this research makes an economic contribution by presenting guidelines for iterative wind simulations in the early stages of designing medium-scale urban projects. Through the validation of a simulation workflow, it streamlines the design process, potentially reducing the time and resources required for urban planning and architectural design. This enhanced efficiency can result in cost savings during project development. Moreover, the study's recommendations concerning simulation parameters, such as wind tunnel cell size and refinement levels, offer practical insights for optimizing simulation processes, potentially lowering computational expenses and improving the overall economic viability of urban design projects. To summarize, this research effectively addresses climate-related challenges, benefiting both social well-being and economic efficiency in the field of urban planning and design, while also providing guidance for more efficient simulation-driven design procedures.

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Highlights:	Contribution to the field statement:
To develop a coherent urban planning approach that aligns with our current challenges, it is imperative to identify and account for the key variables that significantly influence the microclimate. This study aims to provide guidelines for architects, urban planners, and landscapers to conduct iterative CFD simulations during early design stages. These simulations focus on integrating microclimatic parameters, particularly wind flow, by investigating various model sizes and two primary parameters: simulation time and accuracy. This research has underscored two crucial factors: the necessity of considering a broader context in all directions and the adoption of a moderate level of refinement for urban morphology.	-The research focused on simulating wind patterns in urban planning design offers substantial contributions to both the social and economic aspects of the urban planning and design field. -This research effectively addresses climate-related challenges, benefiting both social well-being and economic efficiency in the field of urban planning and design, while also providing guidance for more efficient simulation-driven design procedures

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1. Introduction

The ecological transition intends to redefine the relationship of a sustainable balance between human activities and the environment. It must simultaneously address the challenges of mitigating climate change, as well as the scarcity of resources, the accelerated loss of biodiversity, and the multiplication of health and environmental risks. At the territorial level, the threats arise from both the manifestations of ecological upheavals and the structure of the socio-economic systems within the territory. Territorial analysis should enable a transversal and multi-scalar diagnosis of the environment and the society in which the project takes place, leading to urban and architectural adaptation solutions. Cities concentrate wealth and populations and are responsible for numerous sources of pollution. Analyzing the true impact of cities is challenging, as it is the result of the chosen and desired societal model. Some studies suggest that cities are responsible for 40% of greenhouse emissions, with these urban areas accounting for 70% of energy consumption, a demand that could increase by another 50% by 2050. Presently, over three and a half billion people reside in urban areas globally, and according to the UN, this trend is on the rise. The current urban model not only contributes to the degradation of several planetary boundaries but also heightens certain risks. The challenge of the 21st century will be to accommodate more people in cities while reducing their overall impact and improving the current quality of life. Planning urbanism and architecture in harmony with a territorial project that integrates planetary limits becomes crucial. Preliminary design decisions influence the entire life cycle of a building and the uses of its inhabitants and must not neglect these aspects.

Territorial urbanization has altered the local climate, through land use, urban morphology, the thermo-physical properties of construction materials, roads, and other infrastructures, as well as the heat generated by human activities. These changes induce microclimatic phenomena specific to built environments. Alterations in temperature, relative humidity and airflow influence the well-being of inhabitants, the use of public space, energy consumption and the preservation of biodiversity. Emerging urban design methods are taking into account these microclimatic parameters. The research conducted by Emanuele Naboni on the implementation of an urban regenerative design, as well as the architectural projects undertaken by the sustainable design and engineering agency "Franck Boutté Consultants" reflect a similar multi-criteria environmental analysis approach. The proposed workflow involves an iterative process of simulating various parameters affecting climate, energy, biodiversity, resource consumption and human well-being (Naboni et al., 2019). Although many policies and recommendations advocate for such methodologies, it remains challenging to find concrete examples of their implementation at the urban scale. This type of project remains the prerogative of a few companies or institutions with significant human and material resources. Typically, considerations related to exterior or interior thermal comfort and energy consumption come into play during the final design phases (Mauree et al., 2019). Simulations of microclimatic parameters are essential to validate hypotheses in the early design stages and meet energy consumption requirements (Mackey et al., 2017). Simulations also help integrate future scenarios into project forecasts. However, the difficulty of performing certain simulations, the time required and the specific knowledge needed to interpret results hinder the adoption of these simulations in the architectural and urban professional practice.

In this work, our focus lies on the urban wind pattern, one of the primary factors influencing urban thermal comfort. The main objective is to propose guidelines for carrying out iterative Computational Fluid Dynamics (CFD) simulations for architects, urban planners and landscapers during early design stages. Most of these professionals may not possess the technical knowledge to easily execute accurate simulations. For this, we will use a previously considered case study, the Village Grec, in Leucate, France (Paris et al., 2022) which represents medium urban density housing near the Mediterranean Sea. While all microclimate variables are important, wind flow requires specific attention. Firstly, the urban wind model represents the second most significant parameter in simulating the UTCI comfort index, following the impact of the heat exchange model of the sky (Mackey et al., 2017). Furthermore, CFD simulations are very time-consuming and do not align with design schedules. Finally, wind plays a vital role in achieving and sustaining acceptable comfort levels during periods of high heat in the Mediterranean regions. A previous study on evaluating outdoor thermal comfort through the Physiologically Equivalent Temperature (PET) highlighted the importance of wind accessibility (Paris et al., 2022). Measurement

points with air speed greater than 0.5 m/s are the most comfortable never reaching the very hot zone during the day. In contrast, a measurement point with a consistent air velocity below 0.1 m/s remains in the very hot zone 87.5% of the time. The figure below illustrates the significance of precise wind simulations for each urban context. Data from meteorological stations often provides values significantly higher by 5 to 10 m/s compared to wind speeds measured at specific urban points 1, 2, 3, 4, 7 and 9 (Figure 1). After logarithmic regression of the wind speed, to consider the height difference between the weather station and the measurement site, the values remain very different.

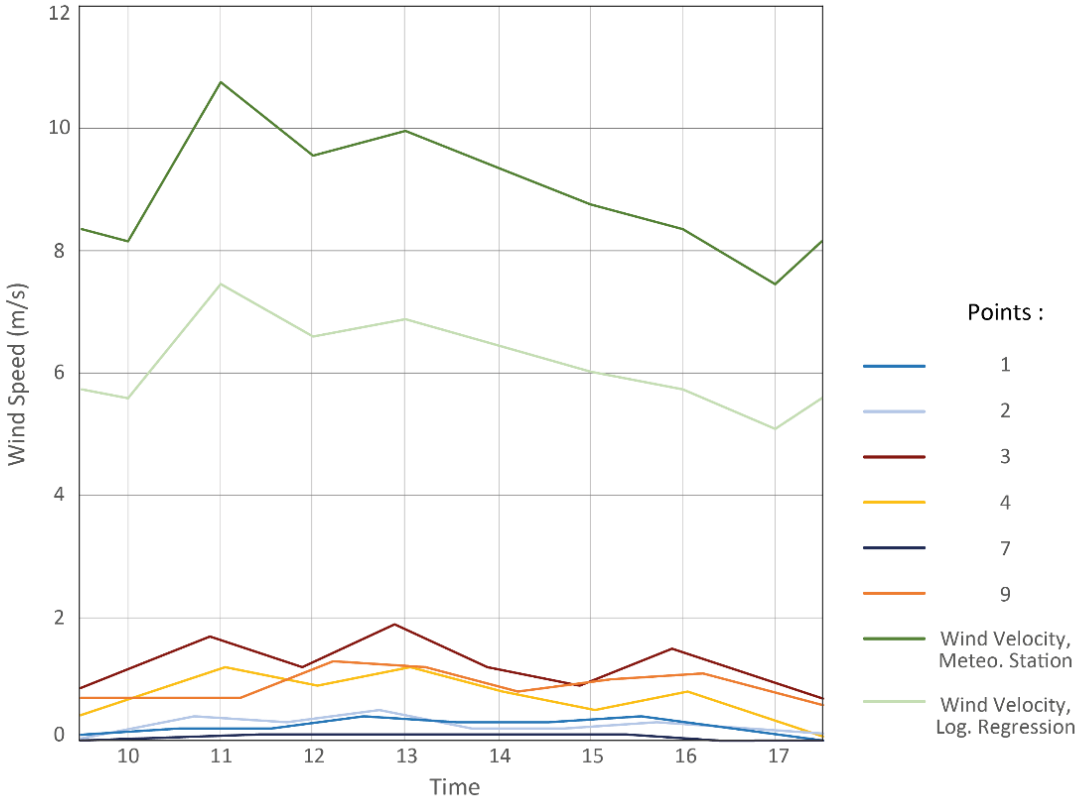


Figure 1. Wind profile on the measuring points and data from the Meteorological Station.

The study carried out here involves simulating the wind flow at the measurement site using wind data from the specific day as input, and then comparing the results obtained with the actual measured values. We examine how varying the context around the measurement points and the level of refinement in morphology impact the time required and the accuracy of the results. Through this validation of a simulation workflow, we will be able to provide recommendations applicable to urban projects of a similar scale.

2. Material and Methods

To offer CFD workflow recommendations to architects, urban planners and other designers, we have established a four stages approach:

- Selecting simulation software based on our criteria
- Configuring the study parameters and selecting the study variables
- Describing the workflow
- Evaluating the results obtained

The study is then conducted by following the steps depicted in Figure 2.

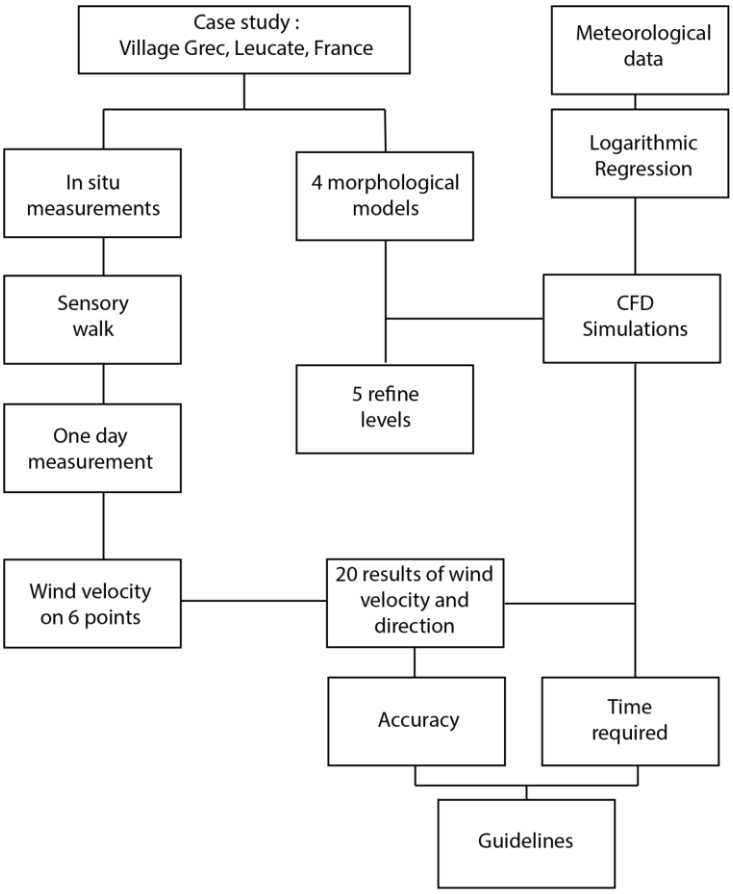


Figure 2. Workflow of the methodology.

2.1 CFD Parametric Simulation Tools

The use of CFD simulation tools in the design of public spaces and buildings is experiencing a rapid increase. This is particularly evident in the proliferation of scientific articles published on this subject over the past two years (Hu et al., 2022). Furthermore, there is a growing demand for coupling radiation and energy simulations. Combining these results enables a thorough evaluation of project assumptions during the design phases. Most of these simulations can be directly visualized through the interfaces of design platforms such as Autodesk Revit, Rhino or SketchUp. Currently, there are more than a dozen plug-ins or applications associated with design programs. Given the recent surge of interest in the integration of CFD simulation into urban and architectural projects, our primary consideration for selecting a CFD simulation tool is based on the study conducted by Hu Y. (2022) on *"Application of CFD plug-ins integrated into urban and building design platforms for performance simulations: A literature review".* Our objectives are to secure a CFD simulation tool that can:

- Be coupled with other simulations relating to the urban microclimate
- Deliver reliable and accurate results
- Handle diverset scales within urban and architectural design
- Be easily customizable to suit specific project requirements

The Rhino modelling software, with its plug-in platform Grasshopper, provides a wide range of CFD plug-ins that have been developed in Open Source. This ensures their continual development and expansion over time (McNeel, 2010). As a result, we have chosen to work with one of the tools available within Grasshopper. The main options include Butterfly from Ladybug Tools, Swift, Eddy3D, proceduralCS, ixCube CFD, GH_Wind, WS-Snake and FlowDesigner. Parametric design platforms like Rhinoceros and Grasshopper offer users greater flexibility in conducting wind simulations. This coupling of simulations with other microclimatic analysis allows for in-depth studies. Moreover, these platforms provide and ideal environment for organizing and expanding the functionality of plug-ins. The three most notable free tools in recent times are Butterfly, Swift, and Eddy3D. All of them utilize the validated external CFD solver OpenFOAM, to ensure accuracy and efficiency (Chronis et al., 2017). These tools

can also be integrated with other simulations. Swift, in particular, stands out for its user-friendly graphical interface making it more accessible for architects, urban planners or landscapers with limited expertise in the field. On the other hand, Butterfly, which appears to be more tailored to engineers (Mackey et al., 2017) is the most widely used plugin on Grasshopper, accounting for approximately 40% of simulations on this platform. In recent years, numerous studies have validated the simulation capabilities of Ladybug tools (Sun et al., 2020; De Luca et al., 2019; Ibrahim et al., 2021) across various scales and with various microclimatic parameters. This validates our choice to opt for Grasshopper in 2023. Among the CFD plugins available on Grasshopper, Butterfly has been extensively used for wind pattern analysis in medium-density urban environments. Many studies published recently employ multi-criteria simulations using Butterfly and other components of the Ladybug Tool. (Chronis et al., 2017; Elwy et al., 2018; Ibrahim et al., 2021; Loh and Bhiwapurkar, 2022). It's important to note that Ladybug Tools supports flexible coupling between Butterfly and other validated simulation modules, such as EnergyPlus/OpenStudio (Roudsari et al., 2013).

2.2 CFD Simulation Guidelines

To conduct precise CFD simulations for urban spaces, a wealth of reference studies have provided invaluable simulation recommendations and guidelines (Blocken et al., 2015; Ferziger and Peric, 2002; Tamura et al., 2008; Tominaga et al., 2008; Toparlar et al., 2017; Franke et al., 2011). These authors provided important information regarding the turbulence model, the boundary conditions, the grid resolution, and the computational domain (Blocken et al., 2012). Butterfly offers a wide range of options for selecting the turbulence model and the mathematical model, allowing us to parameterize the wind tunnel mesh and geometry as desired. Therefore, we will rely on the studies cited above to define the simulation parameters. Some general parameters will be fixed, while others will be variable to be studied. These three parameters will remain unchanged:

- Mathematical model: steady RANS; 169 out of 176 (96%) of CFD analyses processed between 1998 and 2015 used this model. The literature demonstrates that the accuracy of the RANS model is sufficient, and the additional time required for using the LES model is not justified (Toparlar et al., 2017).
- Turbulence model: RNG k-epsilon; the second most popular turbulence model is the standard k-ε model, used in 45 studies out of 176 (25%). Advanced models like the Renormalization Group (RNG) k-ε have shown similar popularity and are increasingly employed (Toparlar et al., 2017; Franke et al., 2004). The most widely used model according to the 2017 study owes its popularity to its exclusivity in certain programs such as ENVI-Met and is not available in Butterfly. Thus, the RNG k-epsilon model is the best available.
- Computational domain: Top, Lateral, Inlet Boundaries: 5H (with H the height of the tallest building) (Tominaga et al., 2008); or a Blockage Ratio <3% ; in order to avoid an artificial acceleration of wind speed (Franke et al., 2004).

These 3 parameters will be study variables in order to see their impact on time and accuracy:

- Wind tunnel size: 1 and 2 meters; in medium urban densities, streets and alleys can be narrow, which limits us from meshing the geometry with dimensions exceeding 2 meters to achieve accurate results while adhering to minimum refinement guidelines (Franke et al., 2011)
- Grid resolution: 0 to 4 refine levels; in the area of interest, it is recommended to have at least 10 cells per cube root of the building volume (Franke et al., 2011; Tominanga et al., 2008). In the case study, the buildings have a volume close to 1000 cubic meters. Therefore, the recommended minimum number of cells is one per cubic meter.
- Residuals reduction: 3 to 5 orders of magnitude; some studies recommend 3 or 4 (Ferziger and Peric, 2002; Tominaga et al., 2008), others 5 (Franke et al., 2004). There appears to be no consensus on this value for CFD urban simulations. Consequently, one of the conclusions involves establishing our position in this regard.

2.3 CFD Workflow

2.3.1 Initial Wind Input

Wind is a crucial parameter in urban physics (Blocken et al., 2015). However, obtaining wind data in a specific context requires either conducting measurements or performing accurate simulations. Most of the available data are derived from weather stations at the nearest airports. Often, these data do not represent the topographical context of the area under study, let alone the flow modifications generated by the urban built environment This discrepancy is evident in measurements conducted in *Village Grec*. There are significant differences between the daily weather data and the values measured between 9:33 a.m. and 5:23 p.m. (Figure 1, Table 1). The provided measurements are averages over 5-minute intervals (Sansen et al., 2021). A first approximation of the wind speed at the station to the speed in the urban space involves applying a logarithmic regression that corresponds to the roughness of the geographical context.

Table 1. Wind speed and direction from the Meteorological Station, wind speed after logarithmic regression, and data obtained at each point, hour per hour during 22/06/2020.

Meteorological station data			**Log Reg.**	**Point 1**		**Point 2**		**Point 3**		**Point 4**		**Point 7**		**Point 9**	
Time	Wind direction *(°)*	Wind speed *(m/s)*	Wind speed *(m/s)*	Time	Wind speed *(m/s)*	Time	Wind speed	Time	Wind speed *(m/s)*	Time	Wind speed *(m/s)*	Time	Wind speed *(m/s)*	Time	Wind speed *(m/s)*
9h	310	8	5,7												
10h	320	7,8	5,5	9h33	0,1	9h43	0,1	9h53	1,1	10h03	0,7	10h23	0	10h13	0,7
11h	320	10,4	7,4	10h33	0,2	10h43	0,4	10h53	1,7	11h03	1,2	11h26	0,1	11h13	0,7
12h	320	9,2	6,5	11h33	0,2	11h43	0,3	11h53	1,2	12h03	0,9	12h23	0,1	12h13	1,3
13h	320	9,6	6,8	12h33	0,4	12h43	0,5	12h53	1,9	13h03	1,2	13h23	0,1	13h13	1,2
14h	320	9	6,4	13h33	0,3	13h43	0,2	13h53	1,2	14h03	0,8	14h23	0,1	14h13	0,8
15h	320	8,4	5,9	14h33	0,3	14h43	0,2	14h53	0,9	15h03	0,5	15h23	0,1	15h13	1
16h	320	8	5,7	15h33	0,4	15h43	0,3	15h53	1,5	16h03	0,8	16h24	0	16h13	1,1
17h	310	7,1	5,0	16h33	0,2	16h43	0,2	16h53	1	17h03	0,3	17h23	0	17h13	0,7
18h	310	7,8	5,5												
Average:		**8,5**	**6,03**		**0,3**		**0,3**		**1,3**		**0,8**		**0,1**		**0,9**

For the CFD simulations of this study, we choose the initial input values:

- Reference wind height: 10 m.
- Wind speed: 6.03 m/s
- Wind direction: 40º North West
- Landscape roughness: 0.5' (very rough)

2.3.2 Model

To quantify the influence of the context and refinement levels on time and accuracy, we analyzed four models. These models depict an expanding environment around the target street (Figure 3). The goal of this method is to understand the influence of the context and its significance in achieving accurate results. Morphology 1 includes only the building to the west of the street, obstructing direct wind from the northwest. Morphology 2 incorporates the second building, forming the streets's walls and creating the urban canyon. The third adds the two buildings to the north of the street, creating a physical barrier for the wind. Finally, morphology 4 encompasses the entire built structure of the *Village Grec*. These different models are represented in Figure 3, labelled from 1 to 4.

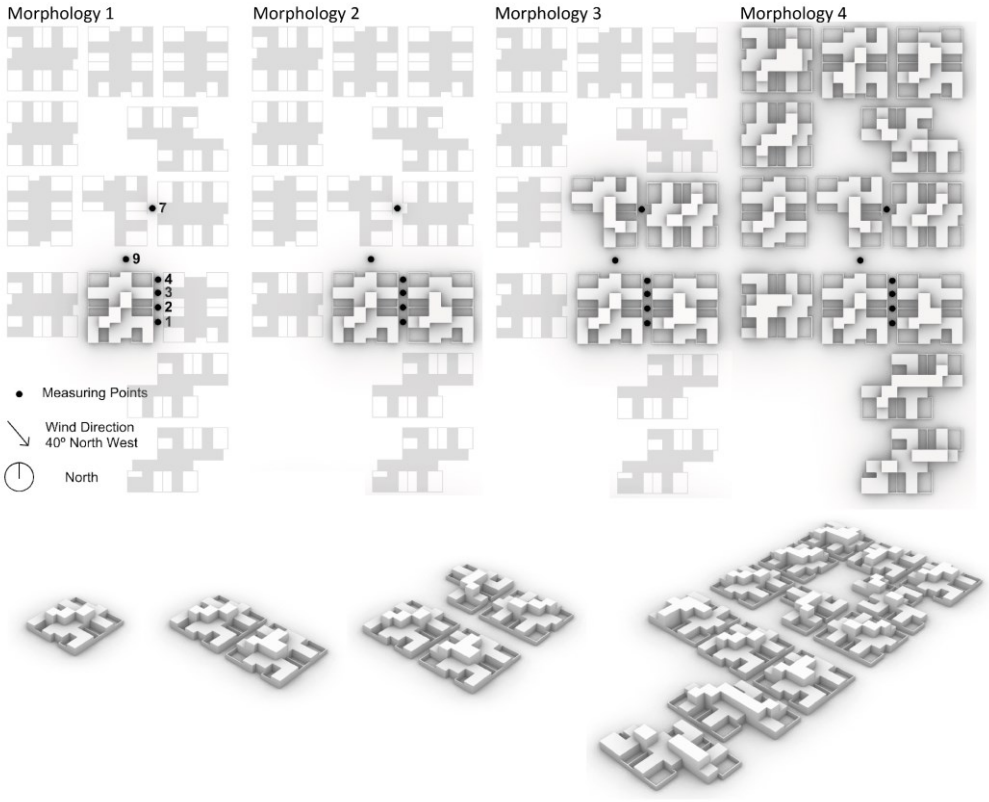


Figure 3. 3D representations of morphologies 1 to 4.

Each of these four morphologies will be refined across several progressive levels, ranging from 0 to 4 (Figure 4). At each level, the base cell size in the wind tunnel is halved, decreasing from 1 meter to 0.0625 meter. Following the recommendations provided in part 2.2, level 0 corresponds to the minimum recommended refinement. Subsequently, cell sizes were further reduced to accurately represent the 1.60-meter-high walls of the patios that form the streets. Field observations (Sansen et al., 2021) and preliminary studies indicate the pivotal role played by these patios in influencing wind patterns.

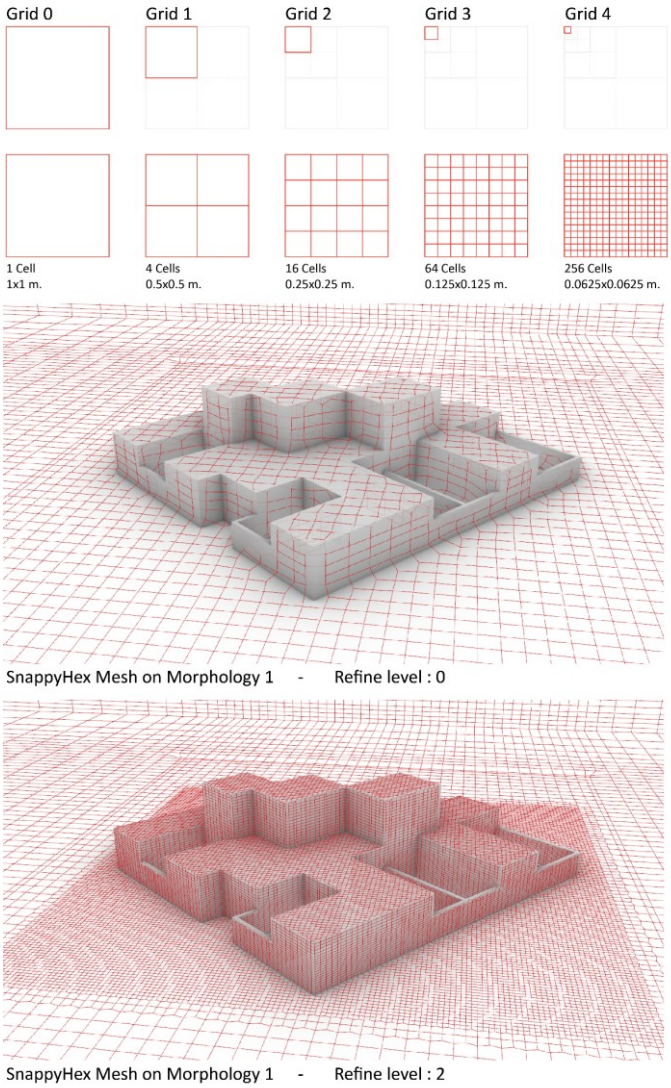


Figure 4. Visual representation of growing refine levels.

2.3.3 Verification Tests

Our goal is to approximate the simulated values to the measured values while maintaining consistent simulation times. To achieve this, we will investigate the following:

- Time required to obtain wind speed results based on different morphologies and levels of refinement
- Convergence of the simulated parameters to ensure the reliability of the results. These parameters include the three wind vectors, the values of k and epsilon, as well as three pressure values. Simulations were initially performed with a 5-order of reduction, and subsequently with 4, for all parameters.
- Root Mean Square (RMS) error according to refinement levels to assess the impact of mesh refinement. This enables us to estimate the discretisation error of each coarser grid compared to grid 4. Verification tests are crucial in determining the accuracy of each simulation.
- Wind speed at measuring points for comparison purposes.

3. Results

The primary objective of this work is to provide guidelines for architects and other designers. As a result, the findings are presented in a format that allows us to draw conclusions regarding simulation parameters and context depending on the time and precision of the results. The initial observation in terms of morphological context is depicted in Figure 5. In this figure, the top image illustrates the wind flow results without soil, while the bottom image shows results with soil. Notably, there are numerous

additional recirculation effects. Although Butterfly does not provide the capability to assign roughness values to the different materials, tests carried out indicate more accurate results with the presence of soil. For this study, all simulations were conducted with both configurations. However, for the subsequent results, only those with the presence of soil were considered.

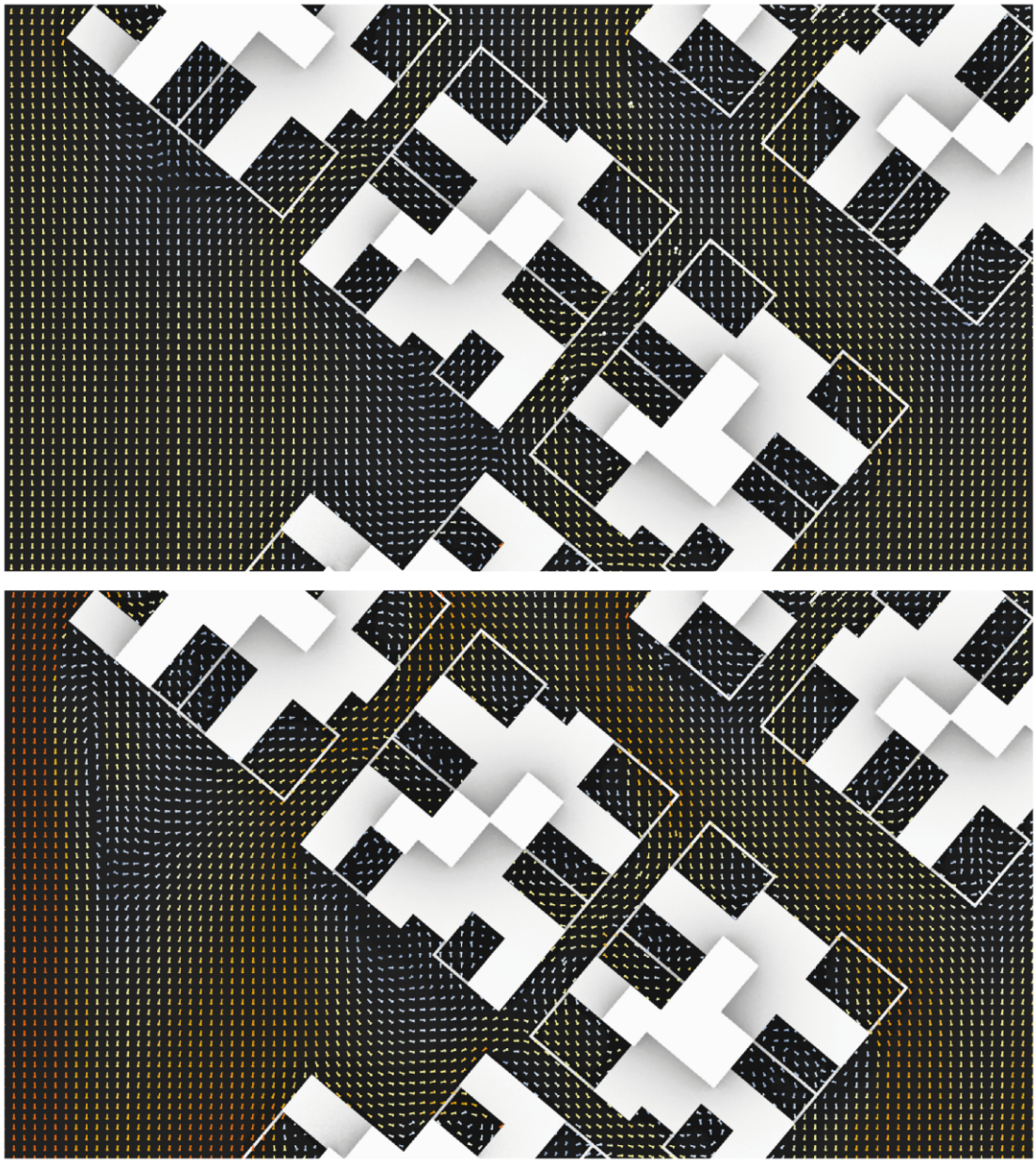


Figure 5. Representation of wind speed vectors for simulations on morphology 4, without soil (top), and with soil (down).

3.1 Time versus Accuracy

The initial comparison step concerns the computation time, which can be divided into two components; meshing time and solution time, representing respectively 10-20% and 80-90% of the total time (Table 2). It is important to note that as the volumetry complexity increases, the solution time becomes dominant over the total time (Maffessanti et al., 2019). Depending on the simulation programs and the associated graphical interfaces, we could also consider parameterization time. However, Butterfly allows many iterations, enabling quick and easy modification of initial parameters or morphology. Consequently, we consider parameterization time insignificant in this study. An exponential increase in time is observed with the refinement of the model (Figure 6). The left side of the figure represents simulation time for a wind tunnel with 1-meter base cells, while the right side depicts results with 2-meter cells. Notably, the

accuracy over the surveyed area remains consistent, albeit with varying levels of refinement. In other words, refinement 2 in part a. corresponds to the same level of precision as refinement 3 of part b. Comparing these two graphs reveals that, at the same level of refinement, the size of the wind tunnel cells has a minimal impact on computation time. For the lower refinement levels (0 and 1), computation time is reduced by 40 to 70%. However, starting from refinement level 2, computation time becomes roughly equal. In quantitative terms, it is evident that the time increases according to the size of the considered context. For non-isolated morphologies, such as 3 and 4, calculation time quickly becomes substantial. For morphology 3, it requires approximately 15 minutes for refinement level 2 and 65 minutes for level 3. For morphology 4, these times increase to 65 and 290 minutes respectively.

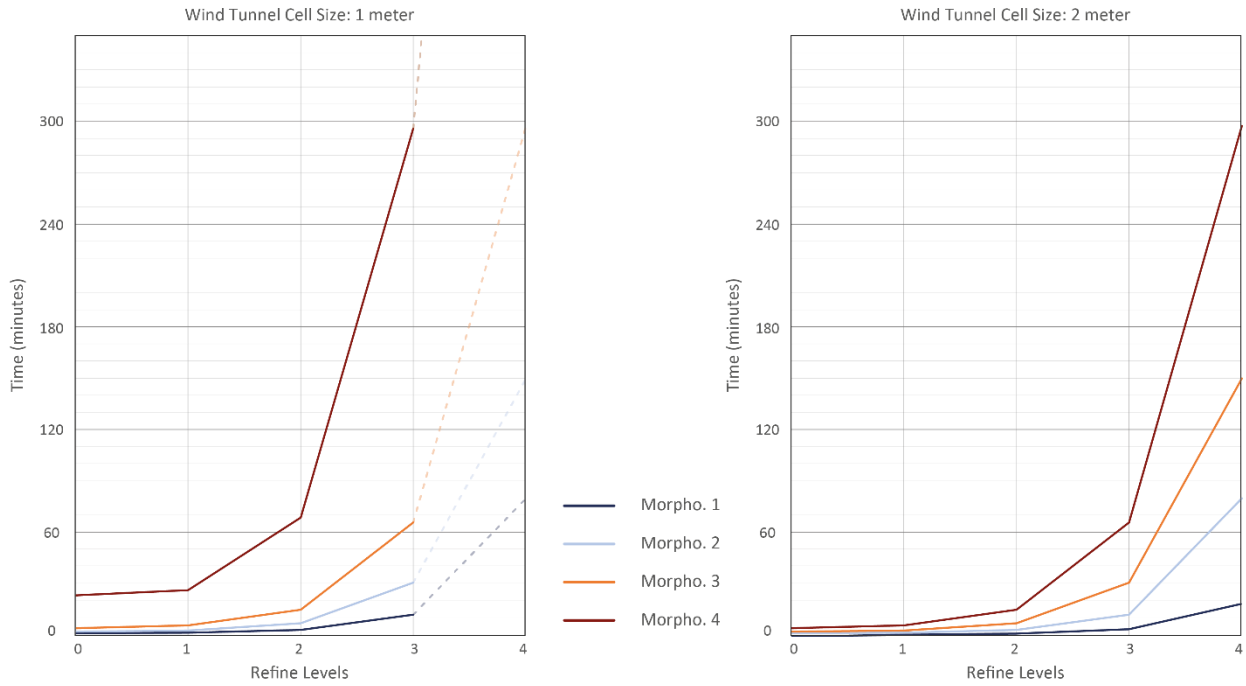


Figure 6. Time versus accuracy diagram.

Based on these simulation times, it can be concluded that refinement levels 0, 1 and probably 2 allow for an iterative process. At refinement level 3, particularly with an extended context, computation time becomes relatively long but remains manageable. However, it can still be considered within the study's scope. On the other hand, refinement level 4, for 1-meter wind tunnel cells, is excluded from the study. The calculation times associated with this level do not permit an iterative process between architectural design and the verification of morphological hypotheses. Approximations and tests conducted indicate that computation times range from a few hours for simple morphologies to several tens of hours for the most complex.

Table 2. Total time to obtain results for all morphologies and refine levels, with 1- and 2-meter Wind tunnel cell size.

Wind Tunnel Cell Size 1 meter	**Refine lvl.**	**Morpho. 1**	**Morpho. 2**	**Morpho. 3**	**Morpho. 4**
		Time (min.)	*Time (min.)*	*Time (min.)*	*Time (min.)*
	0	1,2	2,2	4,2	23,4
	1	1,5	2,9	5,8	26,5
	2	3,2	7,1	15,0	68,8
	3	12,1	30,8	66,0	295,9
Wind Tunnel Cell Size 2 meter	**Refine lvl.**	**Morpho. 1**	**Morpho. 2**	**Morpho. 3**	**Morpho. 4**
	0	0,4	0,6	1,0	3,4
	1	0,4	0,8	1,2	3,8
	2	0,7	1,8	2,6	11,9
	3	2,7	7,2	13,0	59,0
	4	12,8	38,4	65,8	286,7

Only the results for the 1-meter wind tunnel cells are presented below. Given that the values and orders of magnitude are very similar, the conclusions drawn from the subsequent results remain unchanged, regardless of the wind tunnel mesh.

3.2 Residual Reduction

The second stage involves verifying the convergence of the simulation parameters, indicating how much the error has reduced (Franke et al., 2004). In the majority of our simulations, one pressure parameter never reaches the 5th order of magnitude (Figure 7). In a few instances, the first and second pressure parameters as well as the wind vector U(x) never reach the 5th order of magnitude. Consequently, we have chosen to adopt the 4th order of magnitude as a convergence criterion which is considered acceptable for urban simulations (Tominaga et al., 2008).

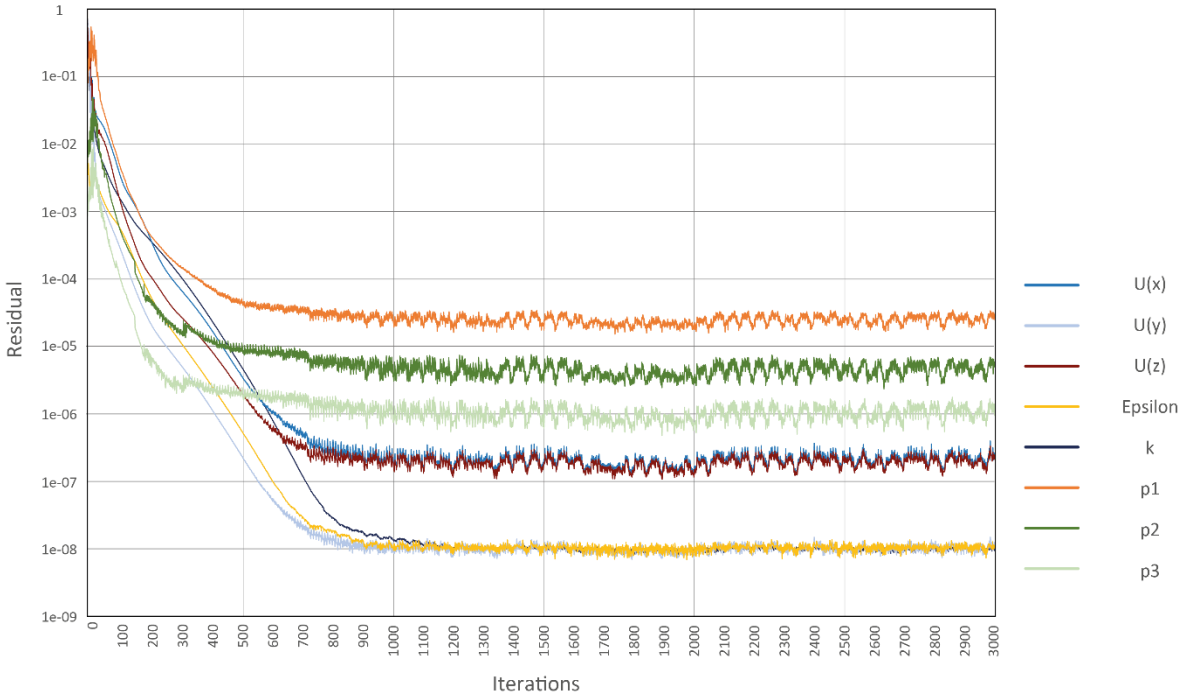


Figure 7. Residual Logarithmic graph for Morphology 2, Refine level 2.

3.3 RMS Error

The third stage of the results analysis concerns the significance of refinement levels, involving the calculation of the RMS error of each grid by comparing it to the most refined (Franke et al., 2011). These calculations were performed for the three wind vectors U(x), U(y) and U(z). It is worth noting that the trends presented for U(z) (Figure 8) are consistent with those obtained for the other two directions. The RMS error was computed based on three sets of different points: a first point grid on the enlarged model, a second on the street, and the last on a 1-meter-wide strip in the center of the street.

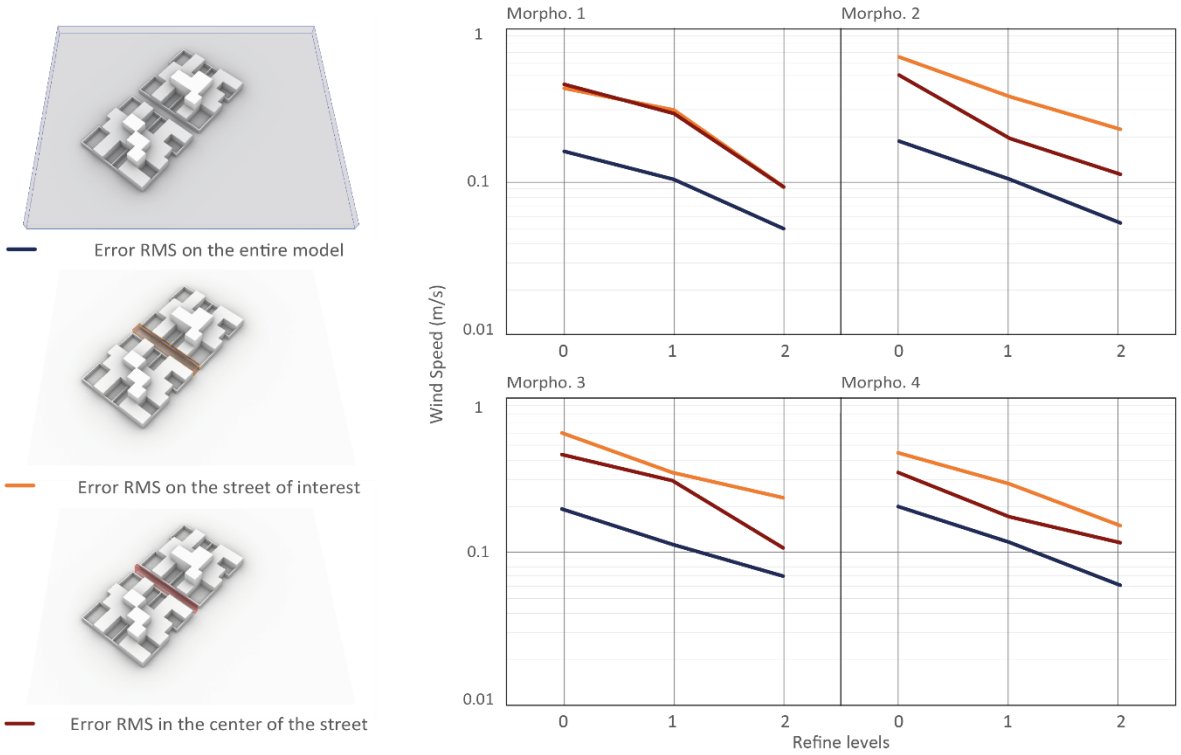


Figure 8. Error RMS graph: velocity U(z), for the 4 morphologies.

As expected, the results demonstrate improved accuracy as the level of refinement increases (Maffessanti et al., 2019). Notably, there is a tenfold improvement between levels 0 and 2, which amounts to approximately 0.1 for all morphologies. We notice a slightly better precision for the values in the centre of the street compared to the entire street. This observation underscores that effects closely associated with buildings are significantly more accurate with higher refinement levels. Furthermore, the results for the entire model are consistently more accurate on average. This can be attributed to the large number of points situated between the village and the wind tunnel boundaries, which are unaffected by the geometry.

Table 3. Root Mean Square error.

		Morpho. 1			**Morpho. 2**			**Morpho. 3**			**Morpho. 4**		
	Ref. lvl	*Model*	*Street*	*Center*	*Model*	*Street*	*Center*	*Model*	*Street*	*Center*	*Model*	*Street*	*Center*
U(x)	*0*	0,2	0,5	0,5	0,2	0,4	0,4	0,2	0,5	0,4	0,2	0,5	0,5
	1	0,1	0,4	0,4	0,1	0,3	0,3	0,1	0,3	0,3	0,1	0,3	0,3
	2	0,1	0,1	0,1	0,1	0,2	0,1	0,1	0,1	0,1	0,1	0,2	0,1
U(y)	*0*	0,5	1,3	1,3	0,4	0,6	0,4	0,4	0,6	0,7	0,4	0,7	0,6
	1	0,2	0,6	0,7	0,2	0,4	0,3	0,2	0,4	0,4	0,2	0,3	0,3
	2	0,1	0,2	0,2	0,1	0,2	0,2	0,1	0,2	0,2	0,1	0,2	0,1
U(z)	*0*	0,2	0,4	0,4	0,2	0,7	0,5	0,2	0,6	0,4	0,2	0,4	0,3
	1	0,1	0,3	0,3	0,1	0,4	0,2	0,1	0,3	0,3	0,1	0,3	0,2
	2	0,0	0,1	0,1	0,1	0,2	0,1	0,1	0,2	0,1	0,1	0,2	0,1

Following the provided guidelines, it is evident that the chosen levels of refinement do not entirely eliminate grid dependence. The results show a reduction of only one order of magnitude, whereas the recommended practice is to achieve a reduction of two orders of magnitude (Ferziger and Peric, 2002; Franke et al., 2007; Tominaga et al., 2008). However, it is important to consider that disciplines accustomed to CFD simulations need much more precise results than those required for a bioclimatic architectural approach during the early design stages.

3.4 Wind Velocity

In the final stage of the results analysis, we compare the values obtained across different morphologies and refinement levels with the measurement points. The wind speed values provided in the table and displayed on the graphs represent the average of measurements taken at each point during the campaign, between 9:30 a.m. and 5:30 p.m. The graphs depict the simulated values at various points for each morphology (see Figure 9), with the shades of color indicating the different levels of refinement. Notably, Point 7 is not considered for the first and second morphologies due to its location outside the geometric model, rendering the values irrelevant.

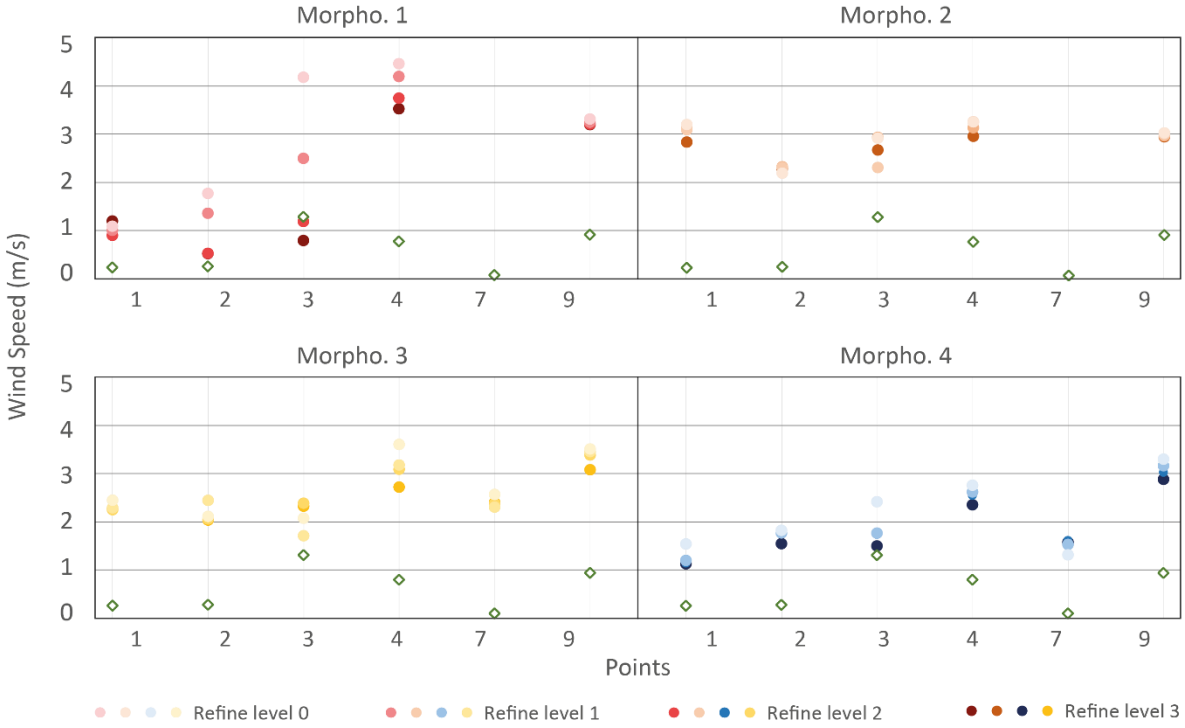


Figure 9. Comparison of the measured wind speed in green, with those simulated.

In the case of morphology 1, although some values closely approach the measured values, the most notable observation is the significant variation in values based on refinement levels. For instance, at point 3, which exhibits the greatest amplitude for all morphologies, the wind speed varies from 4.2 m/s at level 0 to 0.5 m/s at refinement 3. For morphologies 2 and 3, the trends are highly similar. The amplitude between the values at point 3 in these two cases ranges from 3.0 m/s to 2.7 /ms, and 2.1 m/s to 2.3m/s, respectively. In contrast, morphology 4 displays a trend and values that are closer to the measurements. Unlike the first morphology, the variation in values appears to be less dependent on the refinement levels. In this case, the amplitude at point 3 ranges from 2.4 m/s to 1.5 m/s.

Table 4. Wind speed (m/s) was calculated with Butterfly for the 4 morphologies and the 5 refine levels, compared to measures.

Ref. lvl	**0**						**1**						**2**						**3**					
Points	*1*	*2*	*3*	*4*	*7*	*9*	*1*	*2*	*3*	*4*	*7*	*9*	*1*	*2*	*3*	*4*	*7*	*9*	*1*	*2*	*3*	*4*	*7*	*9*
Morpho. 1	1,1	1,8	4,2	4,5	-	3,3	1,0	1,4	2,5	4,2	-	3,3	0,9	0,6	1,2	3,8	-	3,2	1,2	0,5	0,8	3,6	-	3,2
Morpho. 2	3,2	2,2	3,0	3,3	-	3,1	3,1	2,3	2,3	3,3	-	3,0	3,2	2,4	3,0	3,2	-	3,0	2,9	2,3	2,7	3,0	-	3,0
Morpho. 3	2,4	2,1	2,1	3,6	2,6	3,5	2,3	2,4	1,7	3,2	2,3	3,5	2,3	2,1	2,4	3,1	2,4	3,4	2,3	2,0	2,3	2,7	2,4	3,1
Morpho. 4	1,5	1,8	2,4	2,8	1,3	3,3	1,2	1,8	1,8	2,6	1,5	3,2	1,1	1,8	1,7	2,5	1,6	3,0	1,1	1,5	1,5	2,4	1,6	2,9
Measures																			0,3	0,3	1,3	0,8	0,1	0,9

These results underscore the significant influence of the context on the accuracy of the obtained results. Employing the visualization interface (Figure 5), we can elucidate the majority of the findings. In the

case of the first morphology, the obtained values can be attributed to a potent corner effect resulting from the pressure differential between the nearby building walls, particularly close to Point 4. Morphologies 2 and 3 comprise the urban canyon surrounding the measurement points. The corner effect is no longer dominant, and instead, we observe a Venturi effect that elevates the values at Points 1, 2, and 3. Notably, in Morphology 3, there is a general decrease at all points, approximately 10% less compared to the previous morphology. The presence of the two buildings to the North serves as a barrier, reducing the wind speed. In the case of Morphology 4, the entire context slows down the overall speed. What stands out is the presence of buildings to the south of the street of interest, which induces a contrary recirculation effect. This recirculation effect decreases the wind speed at Points 1, 2, and 3, making the results more closely align with reality. Overall, increasing the level of refinement leads to values that are closer to the measurements. However, when we focus on Morphology 4, which appears to be the most suitable, the differences between values at different refinement levels are relatively small. Therefore, Level 2 may be considered satisfactory.

4. Discussion

The simulations carried out and the analysis of results in terms of both time and precision, provide valuable insights for CFD simulation in cases of medium urban density.

4.1 Influence of Context

From observation in Figures 5, and 9 and the data presented in Table 4, it is evident that the context is an essential element for having accurate simulations. Firstly, for simulations related to human scale comfort, the inclusion of the ground is indispensable (Blocken et al., 2011). The ground not only facilitates the coupling of CFD simulations with thermal simulations to yield comfort-related outcomes but also adds a more realistic dimension to wind patterns (Mauree et al., 2019). Furthermore, we have witnessed the substantial influence of the context on result accuracy. In the case of the broader morphology encompassing the study area, the results are in closer agreement with the measurements. Even buildings situated behind the direction of the prevailing wind have a significant impact. Notably, in Figure 5, there is evidence of wind recirculation behind the measurement points, primarily moving in a northward direction. Therefore, it is strongly recommended to ensure the accurate representation of the immediate context by generously expanding the radius of the simulation domain. Achieving this may necessitate multiple simulations. Visualization of the results in software such as Rhino enables a quick assessment of the contextual influence before delving into a thorough analysis of the result values. In our specific case, the buildings have a height of 5.8 meters and are situated within a radius of approximately 60 meters around the street of interest in Morphology 4. Compared to the study conducted by Naboni in 2019, which employed a radius of 150 meters for 40-meter-high buildings, our approach covers a larger influence area. It is important to acknowledge that the models used in this study, as in the majority of comparison studies, adopt a simplified urban morphology represented by blocks without architectural details (Naboni et al., 2019; Maffessanti et al., 2019). Additionally, the vegetation was not considered due to program limitations.

4.2 Choice of simulation parameters

Employing wind simulation in a parametric environment offers the advantage of reducing the initial modeling time, and facilitates the integration of wind considerations into projects analyzing other microclimatic parameters. However, considerable time was still required for accurate simulations. To optimize this process, we recommend the following settings:

- Wind Tunnel Cell Size: 1-meter large. Based on the observations from Figure 6, using larger cells while maintaining the same level of refinement for the studied morphology does not lead to a significant change in simulation time. For the refinement levels 0 and 1, the computation time is reduced by 40 to 70%. However, for refinement level 2, the computation time becomes equal again.
- Cell to Cell Expansion Ratio: 1.2. Likewise, when adjusting this parameter, the time savings achieved are minimal even with an increased value. Increasing the ratio to 1.3 resulted in an

insignificant reduction in simulation time. Therefore, it is advisable to adhere to the literature's recommendations and maintain the suggested expansion ratio (Franke et al., 2004).

- Residual Reduction: 4 orders of magnitude. While the literature often recommends 5 orders of magnitude, it is notable that most simulations fall short of this level for at least one of the six calculated parameters. The parameters subjected to verification are depicted in Figure 7 and encompass the three wind vectors, the values of k and epsilon, as well as three pressure values. In the majority of simulated scenarios, p1, p2 and U(x) attain the 5th order of magnitude after extended periods of simulation. (Franke et al., 2004; Tominaga et al., 2008). It is worth considering that disciplines accustomed to CFD simulations may demand results of higher precision than those necessitated by urban design and architectural detail considerations. Therefore, targeting a 4th order of magnitude for residual reduction is more aligned with practical project timelines.
- Refine Level: 2 or 3. The choice between these levels will depend on both the model size and the complexity and precision of the architectural elements. In our study, Level 2 appears to be the most suitable refinement level. The differences between Level 2 and Level 3 simulations are on the order of 0.1 m/s, whereas the error between the most precise simulations and the measurements averages 1.2 m/s. Additionally, the computation time between Refinement Level 3 and Level 2 is roughly reduced by a factor of 4, providing the opportunity for more iterations.

4.3 Topics to explore

The streets of the *Village Grec* are lined with hedges, approximately 2 meters high. This vegetation is a common feature in most streets. In more open areas, grass covers the ground, and a few trees are scattered about. Integrating this vegetation and its associated roughness parameters into the simulations is likely to reduce simulated wind velocities. Additionally, the roughness of building walls and floors, and architectural facade details o would undoubtedly yield different results. However, the available literature on the precision provided by these elements is limited. The influence of air temperature and buoyancy on the wind pattern was not considered. While previous research suggests that these effects are negligible when urban wind speed exceeds 4 m/s (Magnusson et al., 2014), it would be interesting to incorporate these effects in a case study where wind speeds measured in the urban context are very low. These three elements represent significant avenues for improving result precision. Regarding simulation time, it is essential to focus on refinement. Further analysis on the required areas of refinement should be conducted. Several software uses automatic meshing processes which could be introduced in Butterfly (Ma et al., 2019; Mirzaei et al., 2021).

5. Conclusions

Climate change and its impact on urban microclimates directly and indirectly affect human well-being and energy consumption. To develop a coherent urban planning approach that aligns with our current challenges, it is imperative to identify and account for the key variables that significantly influence the microclimate. This study aims to provide guidelines for architects, urban planners, and landscapers to conduct iterative CFD simulations during early design stages. These simulations focus on integrating microclimatic parameters, particularly wind flow, by investigating various model sizes and two primary parameters: simulation time and accuracy. This research has underscored two crucial factors: the necessity of considering a broader context in all directions and the adoption of a moderate level of refinement for urban morphology. The findings in this paper offer modelling and simulation recommendations that facilitate an iterative design process better suited to real-world scenarios. However, further research is warranted to explore the impact of dense vegetation in a medium-density urban setting, the influence of building materials and facade details, as well as the coupling of microclimatic criteria with other aspects. Given the environmental challenges facing humanity, studies on urban microclimates are essential for mitigation and adaptation to climate change. Numerical simulations serve as essential tools for evaluating various planning solutions in both present and potential future climates. Beyond the need for technical advancements to achieve faster and more accurate results, there is a growing need to integrate this data into the design process. Architects and urban planners require

methods and practical case studies to push the boundaries of their projects. Parametric CFD tools are making their way into the design process alongside other environmental tools. In addition to technical expertise and resource requirements, the integration of these calculations into the design process must be given greater consideration.

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Street Trading and Urban Distortion: Rethinking Impacts and Management Approaches from Urban Planners' Perspective in Enugu City, Nigeria

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ABSTRACT

This study investigates the relationship between street trading and urban planning in Enugu City, Nigeria, within the expanding informal economy of the global South. It particularly focuses on the perspectives of urban planners regarding the impacts and management of street trading. The research employed a mixed-method approach, including personal observation, questionnaires, and in-depth interviews, analyzed through basic statistical methods. Findings reveal that urban planners recognize the socio-economic importance and cultural relevance of street trading, despite its negative spatial externalities. Contrary to prevailing assumptions, planners favour negotiated solutions over forced evictions. This study highlights the need for inclusive urban planning practices that accommodate the socio-economic benefits of street trading while addressing its challenges, contributing to the discourse on sustainable urban development.

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Highlights:	Contribution to the field statement:
-Raises aware on the discrepancy in the stance of planning institutions and planners individually on the management of street vending in Enugu city -Reveals more humane approach to street vending management for Enugu city. -Revealed that planners in planning agencies and those in learning institutions can be humane in their approach to urban management	This research assess the stand of urban planners in planning agencies and those in academia on the management approach best suited for street vending activities in Enugu city, Nigeria. This is born out of the fact that previous studies and reports of eviction and relocation of street venders to a formal market in the city have provide unsuccessful. The findings revealed that the stance of urban planners in planning agencies and those in academia does not differ as they (majority) tilted towards a more humane approach towards the management of street vending in Enugu city.

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1. Introduction

Street trading, a significant component of the informal sector, comprises diverse individuals with varying incomes and wealth. It occurs along urban routes such as alleyways, avenues, boulevards, and major streets, and is situated on sidewalks, incidental spaces, and at bus stops (Brown, Lyons & Dankoco, 2010). Though seemingly erratic and unorganized in certain cities, the spatial pattern of these activities aligns with the flow of human and vehicular traffic (Onyebueke & Anierobi, 2014; Steel, Ujoranyi & Owusu, 2014). The socio-economic and cultural importance of these activities, and indeed the entire informal sector, to urban economies, often results in cultural clashes, with itinerant traders frequently at a disadvantage (Rigon, Walker & Koroma, 2020, p. 17; see also Middleton, 2003; Al-Jundi et al., 2022).

Street trading is believed to contribute to traffic congestion, indiscriminate waste generation and disposal, disorderliness, loss of aesthetics, and devaluation of environmental quality (Middleton, 2003). As the lowest level in the retail hierarchy of typical African cities (Onokerhoraye, 1977; Onyebueke & Geyer, 2011), street traders and their activities are a sensitive issue in urban governance (Smit, 2018). Planners and city administrators often inadvisably apply marketplace regulations, excessive surcharges, new or revised planning schemes (master plans), and zoning to discourage many informal business activities (Crentsil & Owusu, 2018; Onodugo et al., 2016). This repressive "planning hammer" includes harassment, permit revocation, prohibitive fines and detentions, confiscation and destruction of goods, and evictions. Crentsil & Owusu (2018) describe the default stance of planners and city authorities on urban informality, particularly in Accra, Ghana:

"…city authorities have been repetitively unwilling to upgrade these slums, seeing these urban residents as nuisances in the urban space, thus denying them—especially street traders and slum dwellers—rights to space... The policy of decongestion has involved razing and burning unauthorized structures and chasing hawkers from streets and sidewalks where many informal economy operators make their living" (pp. 218, 221). As a result, informal settlements, where most street traders live, face double jeopardy. The underlying power relations that demean them compared to favoured formal enterprises remain unexplored and undiscussed (Rigon et al., 2020).

Street trading has been the subject of numerous research studies in urban planning and urban studies. However, these studies often selectively interrogate the opinions and views of the stakeholders involved—planners, city authorities, street traders, other informal sector workers, and formal sector businesses (Middleton, 2003; Onyebueke & Anierobi, 2014). There is an unspoken presumption that urban planners are focused on spatial order and aesthetic goals that lead to forced evictions, shifting research emphasis towards informal traders or vendors (Crentsil & Owusu, 2018; Onodugo et al., 2016; Recio, 2021; Steel et al., 2014), the general public (Al-Jundi et al., 2022), and city administrators/agency officials, often neglecting the views of professional urban planners. Few studies have specifically focused on understanding the planning perspective on this contentious issue, or on whether planning academics and practitioners agree or differ on the matter.

This study explores the viewpoints of urban planners on the dynamics and impacts of street trading in a contemporary Nigerian city, aiming to develop new urban solutions for planning and managing street trading. The study sets three specific objectives:

1. Examine urban planners' views on the current location patterns and the advantages and disadvantages of street trading;
2. Determine if these views are similar or differ between urban planning academics and practitioners; and
3. Collect ideas and solutions for more sustainable planning and management of street trading.

The transition to innovative planning and urban governance concerning street trading, which affects livelihoods and welfare in informal settlements, is expected to make the planning discipline more humane and accommodating. This approach aligns with the New Urban Agenda and the achievement of Sustainable Development Goal 11, focusing on making cities inclusive, safe, resilient, and sustainable (Recio, 2021; Rigon et al., 2020). Such disciplinary shifts are crucial for enhancing the voices and urban citizenship of street traders (Brown et al., 2010; Onyebueke & Anierobi, 2014). Furthermore, distinguishing between the perspectives of urban planning as an institutional practice and as practised by

professionals may shed light on why ideological and ethical positions differ on socio-politically charged issues like street trading in urban planning (Moroni, 2020).

2. Literature Review

2.1 Definition and Characteristics of Street Traders or Vendors

Street trading, a significant part of the informal sector, accounts for a large portion of employment within this sector (Doyin, 2013). Street vendors engage in activities such as repackaging and selling goods including snacks, food items, non-food items (like clothing, recharge cards, household items, electronic gadgets, etc.), and offering services such as hairdressing, manicure/pedicure, and shoe repairs (Nkrumah-Abebrese & Schachtebeck, 2017). Participants in street trading span various age groups, including adults and children, with women making up over 70% of this workforce (Mitullah, 2004; Nkrumah-Abebrese & Schachtebeck, 2017). The decades-old definition of the informal sector by the International Labour Organization (ILO) still aptly describes the nature and structure of these activities, characterized by easy entry and exit, reliance on local resources, family ownership, small-scale operations, labour-intensive methods, adapted technology, alternative skill acquisition outside the formal education system, unregulated and highly competitive markets, and often lacking legitimacy and adequate government support (Onyebueke & Anierobi, 2014). Other attributes of these businesses include minimal capital investment, and low levels of education and skill among operators, many of whom are recent rural-to-urban migrants (Bhowmik, 2003; Bogoro, 2016).

In Nigeria and other African countries, street trading is an integral part of the retail structure. It maintains supply chain linkages with traditional main markets, large industries, and major sales outlets (Recio, 2021; Steel et al., 2014). These businesses are not only socio-economically and culturally embedded in the African urban system but are also physically or spatially entrenched. Street shopping areas are often situated in or near places with high pedestrian and vehicular traffic (Watson, 2018; Nkrumah-Abebrese & Schachtebeck, 2017; Onyebueke & Anierobi, 2014). Unlike larger retail outlets such as urban markets and central super/hypermarkets, street vendors actively pursue potential customers to increase patronage. This practice has led many traders to occupy attractive but unauthorized vacant sites or even to abandon established shopping centers located away from high-traffic areas, as observed in the Azikiwe-Dhamidja Shopping Belt in Enugu, Nigeria (Onyebueke & Anierobi, 2014). The relationship between street traders and urban authorities is often fraught with issues, stemming from the challenging work environment and conflicting uses of public spaces (Nkrumah-Abebrese & Schachtebeck, 2017; Racaud, Kago & Owuor, 2018), which will be explored in more detail later.

2.2 Contributions and Complications of Street Trading

Street trading, a key part of the informal sector, significantly contributes to urban and national economies, particularly in the global South (Bromley, 2000; Mitullah, 2004; Bhowmik, 2005). In Nigeria, for example, over 80% of total employment is attributed to the informal sector, with a large portion of this workforce engaged in street trading (Onyebueke & Geyer, 2012). This vocation is not only a vital source of livelihood but also offers opportunities for entrepreneurship training, household income generation, and potentially mitigating urban poverty and social inequality (Donovan, 2008; Chen, 2012). Steel, Ujoranyi, and Owusu (2014) acknowledge street traders as crucial, cost-effective intermediaries in distributing goods and services, linking the formal and informal sectors to maintain low living costs and expand consumer choices. A study in sub-Saharan Africa also highlighted the growing preference for open-air food vendors, a trend expected to continue (Corrie et al., 2022).

However, street trading also presents various challenges. Matamanda, Kalaoane, and Chakwizira (2023) note the spatial dynamics of informal trading, indicating a mix of resilience and opposition to formal retail stakeholders. Issues include competition with formal shops, the untidiness of trading spaces, and contributions to traffic congestion and obstruction, particularly when situated near road junctions or on major avenues (Bogoro, 2016). These aspects are often cited by opponents of the informal sector as factors that degrade urban aesthetics, image, and economic competitiveness (Donovan, 2008). Furthermore, street trading is associated with the “working children” phenomenon, leading to adverse effects on child operators,

including potential truancy and heightened risks for girl children, such as sexual abuse (Osaiyuwu et al., 2022; Ugochukwu et al., 2012; Bello & Osunde, 2022).

Street traders themselves face several operational challenges. The formal economy's failure to recognize the value of street trading leads to tensions and conflicts in many African cities, particularly regarding permit issuance, taxation, and operational conditions (Bandauko & Mandisvika, 2015; Matamanda & Chinozvina, 2020; Resnick, 2020; Matamanda et al., 2023). The Bellagio Declaration identifies six common global problems faced by street traders: lack of legal status and the right to vend, inadequate space or poor location, restrictive licensing, high regulatory costs, harassment including bribes and evictions, lack of services and infrastructure, and insufficient representation or voice (Mitullah, 2004). Understanding these contributions and challenges is crucial for planning authorities when developing management approaches for street trading in cities.

2.3 Street Traders-Urban Planners Relationships

Street trading activities are usually unregulated and disorganised, and consequently, several physical, social and environmental menaces ensue (Racaud, Kago & Owuor, 2018). City authorities relate street trading with insecurity, congestion, and chaos (Racaud, Kago & Owuor, 2018). These distortions in the urban landscape have informed the repressive measures of evictions, prohibitive fines and detentions, confiscation and destruction of their goods, among others. Potts (2008) opined that there is a lack of distinct regulatory framework and political recognition for street trading by the government, and this makes vendors susceptible to harassment by city authorities in a number of African capital cities. Spire and Choplin (2018) showed how Accra urban management officials have used decongestion and beautification as a reason for the relocation of street vendors from strategic segments of the city. Thus, despite the size and its contribution to decreasing social and economic exclusion, local authorities still refuse to identify with street trading (Chen et al., 2016; Skinner, 2008).

Notwithstanding what appears to be incessant repressions, city authorities have been urged to embrace a more humane approach to the management of street trading and urban informality. In fact, informality has been underlined as one of the the outstanding challenge of planning sustainable cities in the 21st Century (UN-HABITAT, 2009). This report further showed that the traditional methods of urban planning have been unsuccessful in enhancing efficient, equitable and sustainable settlements in both Global North and South (Onodugo et al., 2016; Moroni, 2020). Whether allocating trading spaces or carrying out evictions and relocations, urban planners acting in both institutional and professional settings tend to evaluate their decisions and actions from either two ethical positions – the consequentialist viewpoint that prioritizes the outcome or the deontological equivalent that downplays the outcome but magnifies the intrinsic logic or rationale of the interventions (Moroni, 2020). Whatever the case may be, there is an evolving worldwide consensus as epitomized by the 1995 Bellagio International Declaration of Street Vendors and other global resolutions by street vendors, vendors associations, city governments, and national/international organizations for urban planning to be more inclusive, collaborative and deliberative (Mitullah, 2004; Onodugo et al., 2016; Moroni, 2020). For instance, India has transitioned from a stance of excluding street vendors to one of accommodating and regulating them under the fundamental right covenant of the national constitution through the implementation of the National Policy on Street Trading in 2004 (revised in 2009) (Steel, et al, 2014; WIEGO, 2012). In light of the above, this study investigates the possibility of rethinking the management approach for street trading control in Enugu City by urban planners and academics.

3. Study Area and Methodology

3.1 The city of Enugu, Nigeria

Enugu, the capital of Enugu state in the Southeast geopolitical zone of Nigeria (see figure 1 below), was established from the old Anambra State on 27 August 1991. Its name, derived from the Igbo words Énú and Ụ́gwụ́ ("hilltop"), reflects the city's hilly terrain. Located at 6°30' North of the Equator and 7°30' East of Latitude, Enugu consists of three local governments: Enugu North, Enugu South, and Enugu East. As the state capital, it hosts major economic activities and administrative offices, including the state secretariat and various specialized agencies. The city, with a total land area of 7,161 km², developed following coal mining in 1915 (Onyebueke & Ndukwu, 2017).

Street trading in Enugu is a manifestation of the populace's survival efforts. The growing prevalence and pattern of street trading warrant attention. This includes hawkers along major transportation routes and neighborhoods, and stationary vendors occupying spaces outside designated commercial areas or public spaces. Notable areas like Abakpa, Mkpokiti, Mayor, and the Ogbete market-Holy-Ghost axis are evolving into neighborhood markets. Despite frequent evictions, traders persistently return, diversifying and expanding their trade (Onodugo et al., 2016). Parts of Ogbete layout, Obiagu, Ogui layout, and Abakpa layout have transformed into mini-markets, creating a distinct impression for newcomers. Other places include garriki (agbai road axis) and major (Agbani road axis) shown in figure 2.

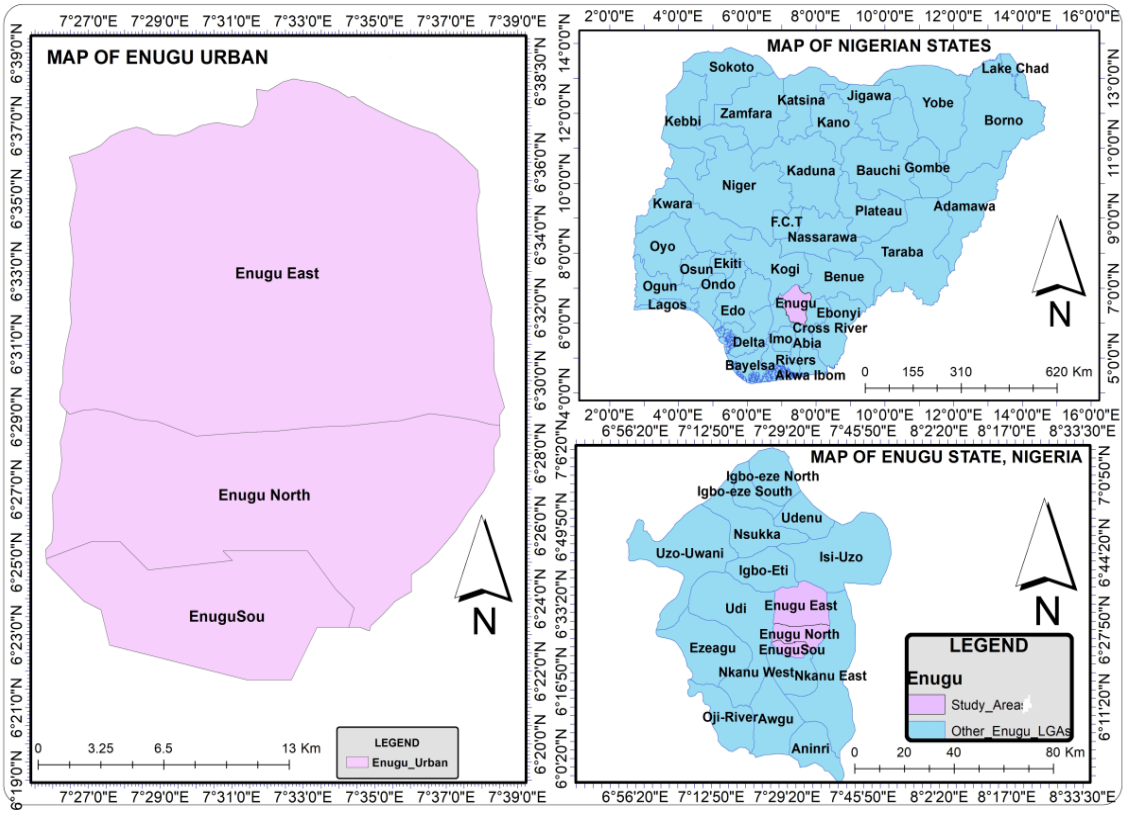


Figure 1. Maps showing the Study Location.

3.2 Study Methodology

The study employs both qualitative and quantitative research methods. The sample frame was drawn from the Nigeria Institute of Town Planning, Enugu State Register. Primary data collection involved semi-structured questionnaires, in-depth interviews, and direct observation. Direct observation helped establish the existing locational pattern of street trading in Enugu Metropolis. Semi-structured questionnaires and in-depth interviews were used to gather town planners' perceptions of street trading activities in Enugu urban.

The sample included 70% of registered town planners from academic institutions and 80% from urban planning agencies, totalling 35 individuals. Of these, 34 questionnaires were returned and analyzed. Respondents were selected based on a minimum of ten years of urban planning experience to ensure knowledgeable insights into street trading management. This approach aimed to consolidate responses from the questionnaire, focusing on planners' awareness, perceptions, and potential planning solutions for street trading. The questionnaire was designed to ensure anonymity, limiting open-ended questions to reduce handwriting recognition risks. A paper-based format was used to facilitate participation without the need for internet access. Consent information was provided as a preamble to the questionnaire, allowing respondents to freely agree or disagree with participation. Ethical considerations for interviews included informing potential interviewees about the research aims, researchers' identities, interviewees' rights, use of recording devices, and consent for interview venue and timing. This information was communicated via social media, adhering to principles of informed consent and transparency (Bryman, 2012; Social Research Association-

SRA, 2003). Privacy and non-disclosure of participant identities were ensured by using pseudonyms. All data collected, from both questionnaires and interviews, were secured from external access.

4. Findings and Discussion

4.1 Profile of Respondents

The analysis of the questionnaire responses from urban planners in Enugu Metropolis provides a demographic breakdown of the participants. The gender distribution among the respondents is predominantly male, with 70.59% male and 29.41% female, indicating a male-dominated profession in this region (Table 1). The age distribution of the respondents is varied, with the majority falling within the 40-49 age bracket (47.05%), followed by 20.59% in the 50-59 age range, 17.65% in the 30-39 age range, 11.77% aged 60 and above, and a small percentage (2.94%) in the 20-29 age group (Table 1).

In terms of educational qualifications, the respondents demonstrate a high level of academic achievement in the field of urban planning. Only a small fraction (2.94%) holds an OND/HND, while a significant portion has higher degrees: 29.41% possess a B.Sc degree, 41.18% have a Master's degree, and 26.47% have earned a Doctorate in urban planning. This composition suggests that the respondents have sufficient academic experience to provide informed perspectives on street trading in Enugu Metropolis. The work experience of the respondents further underscores their expertise in the field. A notable 26.47% have 10-14 years of professional experience, 23.53% have 15-19 years, 14.71% have 20-24 years, 11.76% have 25-29 years, and another 11.76% have 30 years or more of experience in urban planning (Table 1). This distribution indicates that most of the registered town planners surveyed have attained a significant number of years in professional practice, providing a robust basis for their insights and opinions on the subject of street trading and its management in the urban context of Enugu.

Table 1. Background data on Urban Planners Administered Questionnaire.

		Academic Institutions		**Planning Agencies**		**Total**	
Sex		**Freq.**	**Percentage**	**Freq.**	**Percentage**	**Freq.**	**Percentage**
	Male	10	76.92	14	67	24	70.59
	Female	3	23.08	7	33	10	29.41
	Total	13	100	21	100	34	100
Age	20-29	1	7.69	0	0	1	2.94
	30-39	-	-	6	28.6	6	17.65
	40-49	4	30.77	12	57.14	16	47.05
	50-59	4	30.77	3	14.26	7	20.59
	60 above	4	30.77	-	-	4	11.77
	Total	13	100	21	100	34	100
Education	OND/HND	-	0	1	4.76	1	2.94
	BURP	2	15.38	8	38.10	10	29.41
	MURP	2	15.38	12	57.14	14	41.18
	PhD	9	69.23	-	0	9	26.47
	Others	-	0	-	0	0	-
	Total	13	100	21	100	34	100
Years in Practice	0-5	1	7.69	2	9.52	3	8.82
	6-11	2	15.38	7	33.33	9	26.47
	12-17	1	7.69	7	33.33	8	23.53
	18-23	4	30.77	1	4.76	5	14.71
	24-29	3	23.08	1	4.76	4	11.76
	30 above	2	15.38	2	9.52	4	11.76
	Nil	-	-	1	4.76	1	2.94
	Total	13	100	21	100	34	

Source: Researchers' Field Survey, 2019.

The interviewees were selected from those who have practised the town planning profession for more than ten years as shown in Table 2 below. Each of the interview session lasted for about 45 minutes. The sessions

were all recorded using a recording device (android phone) and saved into a separate memory for security purposes. This was later written out for clarity and data presentation. However, the recording was listened to over and over again to gain familiarity and an in-depth understanding of the comments and answers. Due to the interrelationship between the questions in the questionnaire and the interview schedule, the presentation of data was married together for a better understanding and coherent conveyance of the findings.

Table 2. Interviewee Profile.

Participant	Organization	Current position	Gender	Total work experience
AC1	University of Nigeria, Enugu Campus	Senior Lecturer	Male	26 years
AC2	Enugu State University of Science and Technology	Senior Lecturer	Male	23 years
AC3	University of Nigeria, Enugu Campus	Senior Lecturer	Male	19 years
AC4	University of Nigeria, Enugu Campus	Senior Lecturer	Male	25 years
AC5	Enugu State University of Science and Technology	Senior Lecturer	Male	17 years
TP1	Enugu State Ministry of Lands and Urban Development	Deputy Director, Town Planning Department	Male	27 years
TP2	Enugu South Town Planning Authority	Chief Executive	Male	15 years
TP3	Enugu North Town Planning Authority	Town Planning Officer	Female	16 years
TP4	Enugu East Town Planning Authority	Town Planning Officer	Male	12 years
TP5	Enugu Central Town Planning Authority	Town Planning Officer	Male	18 years

Source: Researchers' Field Survey, 2019.

4.2 Impact of Street Trading

The study's analysis of urban planners' perceptions of the impact of street trading in Enugu reveals a mixed view. A small percentage (5.9%) of urban planners perceive street trading as having only a positive impact, while 11.8% view it as solely negative. However, the majority (82.3%) recognize that street trading has both negative and positive impacts (Table 3). The identified negative impacts include traffic congestion, an unsightly environment due to illegal and unevenly placed temporary structures (like kiosks, canter tables, umbrellas, etc.), noise pollution, indiscriminate waste disposal from consumed products, encroachment on pedestrian bridges due to uncontrolled goods display, devaluation of properties (as it defaces the environment, reduces aesthetic quality and serenity), disorderliness in the environment, urbanization and overpopulation in city centers with inadequate formal employment, and environmental management problems. Disorderliness was noted as a significant negative impact, with 67% of respondents (both from academia and planning agencies) identifying it. Among planners in academia, 53.85% attributed the majority of negative impacts to issues like traffic congestion, unsightly environment, waste disposal, and disorderliness, along with exposing traders to road accidents and encouraging child abuse (Bogoro, 2016; Racaud et al., 2018). The majority of planners in planning agencies (76.19%) also highlighted disorderliness, along with child abuse (Bello and Osunde, 2022), followed by unsightly environment, waste disposal issues, environmental management problems, and the risk of road accidents to traders, with 71.43% of respondents (for each parameter) agreeing to these impacts.

These findings indicate that street trading activities significantly impact the urban environment negatively. Despite government attempts at resolution through evictions and frequent harassment, these measures have failed to curb street trading, which continues, often more intensively, in public spaces in Enugu City.

Furthermore, statistical analysis using the Chi-Square test revealed no relationship between the responses of town planners in planning agencies and those in planning institutions regarding the impact of street trading activities in Enugu. This suggests that their responses are independently asserted and not influenced by their workplace (Table 3). This finding indicates a broad consensus across different professional contexts in recognizing the multifaceted impacts of street trading in the urban environment of Enugu.

Table 3. Impact of Street Trading.

Constructs		Academic Institutions		Planning Agencies		Total		Statistics
Impact of Street Trading	**Categories**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Chi-Square**
	Economic	9	69.23	10	47.62	19	55.88	1.548
	Social	10	76.92	8	38.10	18	52.94	
	Environmental	12	92.31	17	80.95	29	85.29	
	Nil	-	-	1	4.76	1	2.94	
Dimensions of Impact	Positive	-	0	2	9.52	2	5.88	5.0581
	Negative	1	7.69	3	14.29	4	11.76	
	Both	12	92.31	16	76.19	28	82.35	
	Total	13	100	21	100	34	100	
Negative Impacts	Traffic congestion	7	53.85	13	61.90	20	58.82	0.954
	Unsightly environment	7	53.85	15	71.43	22	64.71	
	Noise pollution from hawkers and trading activities	6	46.15	14	66.66	20	58.82	
	Indiscriminate waste disposal	7	53.85	15	71.43	22	64.71	
	Hinders proper use of pedestrian bridges	4	30.77	14	66.66	18	52.94	
	Devaluation of property value	4	30.77	10	47.62	14	41.18	
	Disorderliness in the environment	7	53.85	16	76.19	23	67.65	
	Unfair competition in the economic industry	1	7.69	5	23.81	6	17.65	
	Ruins the city image	5	38.46	14	66.66	19	55.88	
	Threatens security/ safety in neighbourhoods	4	30.77	11	52.38	15	44.12	
	Encourages informality	6	46.15	11	52.38	17	50	
	Causes urbanization and over population especially in city centres	6	46.15	11	52.38	17	50	
	Poses environmental management problems	6	46.15	15	71.43	21	61.76	
	Exposes trader to road accidents	7	53.85	15	71.43	22	64.71	
	Encourages child abuse	7	53.85	16	76.19	23	67.65	
Positive Impacts	Source of income	6	46.15	5	23.81	11	32.35	1.256
	Means of employment	6	46.15	4	19.05	10	29.41	
	Source of government revenue	4	3.08	4	19.05	8	23.53	
	Easy purchase	5	38.46	5	23.81	10	29.41	
	Offers cheaper goods	5	38.46	5	23.81	10	29.41	
	Fosters self-independence and entrepreneurial skills	5	38.46	5	23.81	10	29.41	
	Gives the trader a sense of belonging	6	46.15	3	14.29	9	26.47	
	Reduces crime rate caused by idleness due to unemployment	5	38.46	8	38.10	13	38.24	
	Causes urbanisation	2	15.38	4	19.05	6	17.65	
	Improves the people standard of living	5	38.46	4	19.051	9	26.47	

Source: Researchers' Field Survey, 2019.

Urban planners, particularly those in academia, recognize the positive impacts of street trading on social relations and the economy. They view it as a vital source of income for the unemployed and an alternative income source for vendors. Additionally, it indirectly contributes to government revenue through the purchase of daily tickets, albeit this is often not properly accounted for. Economically, street trading fosters growth, while socially, it promotes independence, entrepreneurial skills, and a sense of belonging, and can reduce crime rates associated with idleness or unemployment. It also makes goods more accessible and affordable for people across all income levels (Nkrumah-Abebrese & Schachtebeck, 2017; Racaud et al.,

2018). These perceptions align with neo-liberalism theory, emphasizing the sector's ability to support entrepreneurial endeavours with minimal formal control.

Urban planners interviewed about street trading in Enugu city shared various opinions. For instance, AC4 from the University of Nigeria noted that street trading is neither inherently good nor bad, but its impact depends on its operational mode and associated activities. An orderly operation of street trading could lead to greater appreciation and promotion of the activity. Some planners view street trading as an escape route from poverty for the masses, a survival mechanism for those not accommodated by the government or formal sector. High shop rents in commercial areas and the practice of richer vendors using market stores as warehouses while trading in outer spaces exacerbate the prevalence of street trading (TP4, TP2, AC5, AC4, and AC3).

Several interviewees (TP4, TP2, AC5, and AC3) believe street trading compensates for deficiencies in physical development plans. If included in these plans, street vendors might not be seen as a nuisance. The excessive prevalence of street trading is partly attributed to the government's inability to provide adequate and affordable commercial centres. Most urban planners agree that incorporating street traders into physical development plans would change the perception of them from being nuisances to being beneficial. However, others (AC1, AC2, TP1, and TP3) contend that even if included in development plans, street traders may retain their spatial habits and patterns. TP1 and AC2 point out that government reluctance to strictly implement existing physical development plans, often for political reasons, is a significant issue, rather than the insufficiency of the plans themselves.



Figure 2. Street trading on a pedestrian walkway, along Mayor Road and Garriki Areas in Enugu, Nigeria. (Source: Researchers' field survey, 29/ 9 / 2019).

4.3 Planning Panacea for the management of Street trading activities in Enugu city

Street trading in Enugu Metropolis exists in two modes: mobile (street hawkers) who move goods from one place to another seeking customers, and immobile street trading where vendors position their goods at a fixed point, occasionally moving around as needed. According to Table 4, 5.88% of town planners are familiar only with the mobile mode of street trading, 14.71% are familiar with the immobile mode, and a significant majority (79.41%) are aware of both modes existing in Enugu Metropolis (Doyin, 2013). This awareness indicates that most planners recognize the dual nature of street trading activities.

When exploring town planners' perceptions of solutions to the challenges posed by street trading and examining practice and policy dimensions for its management in Enugu, 64.86% believe that street trading should be integrated into planning designs. Additionally, 56.78% suggest that it should be governed by policy, 10.81% recommend segregation, 5.41% advocate for encouragement, and 16.22% suggest eliminating street trading activities. Those favouring retention, incorporation into physical development designs, policy guidance, and encouragement propose various strategies, such as:

- Increasing the setback standard by 3 meters from the fence to the road on both sides to accommodate street traders comfortably, thereby reducing conflicts with other land uses and frequent evictions. This approach has been adopted in countries like the United Kingdom and South Africa. This can be in form of providing mini neighbourhood markets to create designated spaces for street

traders.Emphasizing inclusive and participatory planning processes, ensuring representation of the population's interests in development plans.

- Implementing laws, policies, and regulations to effectively manage street trading, including operational modes and timings within the cityscape. Regulating operating hours to ensure street trading activities do not disrupt other urban functions.
- Initiating enlightenment programs to educate street vendors about the negative impacts of their trade and encourage compliance with regulations, while also addressing environmental issues like waste management.
- Emphasizing inclusive and participatory planning processes, ensuring representation of the population's interests in development plans.
- Suggesting policy reforms, such as regulating operating hours, area restrictions, and vendor registration, alongside development control measures to organize street trading activities within designated areas.

The Chi-Square analysis indicates that the stance of urban planners on the regulatory approach to street trading in Enugu city is not influenced by their workplace, with a p-value of 8.1235 (Table 4). This finding suggests that planners' views on managing street trading are consistent and independent of whether they work in academia or planning agencies. The consensus on incorporating street trading into urban planning indicates a shift towards recognizing and legitimizing these activities within the urban fabric of Enugu.

Table 4. Planning Panacea for Street Trading in Enugu City.

		Academic Institutions		**Planning Agencies**		**Total**		**Chi-Square**
Question	**Categories**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	1.2617
Location Mode for Street Trading	Mobile	-	-	2	9.52	2	5.88	
	Immobile	2	15.38	3	14.29	5	14.71	
	Both	11	84.62	16	76.19	27	79.41	
	Total	13	100	21	100	34	100	
Planning panacea for Street trading management	Should be encouraged	1	7.69	1	4.76	2	5.88	8.1235
	Should be guided with policy	6	46.15	11	52.38	17	50.00	
	Should be segregated	-	-	4	19.05	4	11.76	
	Should be incorporated in planning designs	9	69.23	13	61.90	22	64.71	
	Should be eliminated	2	15.38	4	19.05	6	28.57	

Source: Researchers' field survey, 29/ 9 / 2019).

Alternatively, other planners (AC1, AC2, TP1, TP3) recommend eliminating street trading. They propose shifting to a production-oriented economy to create jobs for both educated and uneducated individuals, which could absorb unemployment, including among street vendors. Other suggestions include regular and strict eviction of vendors, revising the master plan for functional cities, constructing new market centres, and providing low-cost shops in neighbourhoods to accommodate vendors who cannot afford traditional market spaces. While some of these measures have seen limited success in the past due to the resilience of street vendors and government limitations, they offer a comprehensive approach to urban planning and street trading management.

5. Conclusion and Recommendations

This study on street trading in Enugu city reveals a complex interplay of economic, social, and urban planning challenges. Street vendors, employing both mobile and immobile structures, significantly impact the city's aesthetics. Despite efforts by urban planners to manage these activities, street trading remains prevalent and continues to grow, often leading to environmental concerns. However, the research highlights a growing recognition among urban planners of the economic and socio-cultural benefits street trading brings, particularly in light of increasing unemployment and economic hardships.

The study suggests a paradigm shift in approach, akin to successful models observed in countries like India, acknowledging street trading as an integral part of functional mixed land use in developing cities. Key

recommendations include the integration of structured trading spaces in urban designs and the adoption of inclusive planning methodologies. Such strategies aim to mitigate environmental challenges while leveraging the economic and social advantages of street trading. Additionally, the research underscores the potential for applying these findings to other Nigerian cities, aiming for a unified approach to managing street trading. This could involve assessing standards for accommodating street trading in Enugu's physical and socio-economic context.

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From Urban Vulnerabilities to Resilience: Lessons from Messina's Integrated Risk Approach

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ABSTRACT

In the city of Messina, the multiplicity of vulnerable situations is a distinctive feature and is representative of the pervasiveness of the risk conditions present in the Italian territory. The critical residential tissues are part of an extended geography in which, to the conditions of seismic and hydro geomorphological vulnerability, are added additional criticalities including altered natural resources, abandoned infrastructure, brownfields, quarries, and unregulated landfills, etc. Despite this, for Messina, there is still no urban planning tool capable of interpreting in an integrated way the risks present, which instead continue to be addressed on an emergency basis and individually, without considering the interactions that are generated and of further damage. For these reasons, Messina was chosen as a prototypical case study, at the national level, to start an experimentation aimed at developing an urban planning tool capable of a new integrated approach to risk interpretation and management. In this process, a decisive role was aimed at building an updated knowledge of the territory through the identification of widespread critical conditions using multiple GIS tools and thanks to the interaction of some analytical-specialist readings from different sources. The results of this process are represented in a system of maps that are strongly integrated with each other and constitute a working document for the interdisciplinary group drafting the General Urban Plan.

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Highlights:	**Contribution to the field statement:**
- Hazards are increasing due to human impact, especially in climate change and recent catastrophic events. - Messina is a case study for resilient urban policy, involving collaboration for risk adaptation. - The "Integrated Risk Map" synthesizes various risks for effective mitigation. - The "Integrated Risk Map" is a dynamic tool for strategic resilience in Messina.	- In-depth study and construction of a knowledge framework of the vulnerability factors and risks present in urban areas and urbanised territories. - Integrated planning of risks for the mitigation of their effects and the resilience of urban areas.

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1. INTRODUCTION

The concept of risk characterizes cities around the world as an outcome of the processes of uncontrolled urbanization, the decommissioning of productive areas, the resulting high land consumption, the overexploitation of resources, air, water and soil pollution, hydro, and geomorphological vulnerabilities, further accentuated by climate change. The increase in urbanization along coastal areas is a problem as timely as ever since it is precisely along the coasts that the effects of climate change and all other related and interdependent risks are most apparent. In the international scene, the concept of risk has undergone several changes in meaning and significance in recent years aimed at recognizing an increasingly broader and more complex spectrum of this term, officially acknowledging the advances that were being conducted as they were being conducted in scientific debates at the international level. This development can be seen immediately when considering reports from major international specialist conferences. "The exposure of populations and infrastructure to hazards has increased significantly in recent decades, mainly due to urbanization and unsustainable development in hazard-prone areas. Globalization, urbanization and an increasingly interconnected world also increase the likelihood that disaster impacts will cascade across systems." (GAR, 2022) Therefore, the contribution intends to place itself in these research areas by asking the following question: how and to what extent can the risk conditions generated by many interrelated hazards on a coastal territory be addressed to develop urban integrated hazard mitigation plans? Building on these reflections, this article aims to illustrate a pilot project initiated in 2017-2018 and developed by the Italian government mission structure "Casa Italia" and the Municipality of Messina (Sicily, Italy) to test an integrated risk planning approach. A first and important phase of experimentation took place within the process of drafting the Preliminary Urban Plan (called Schema di Massima, approved by Municipal Council Resolution No. 197 of 10/04/2018) that the Municipality of Messina has initiated using the advice of Prof. Arch. Carlo Gasparrini and other external professionals; the authors took part in the working group (Anna Terracciano as technical-operational coordinator, Giovanna Ferramosca as trainee). Since 2022, a process of updating the Preliminary Plan has been underway for which information cannot yet be provided. In this complex context, an integrated reading of the risks present is proposed with the aim of overcoming the sectoral modes typical of traditional Specialist Studies, but also to become the main tool on which to outline the strategic and priority objectives capable of targeting the vision of a "resilient and anti-fragile city," based on adaptive and pro-active tactics and design actions.

These aspects are thus illustrated within this contribution:

1) The definition of materials and methods for the construction of a spatial knowledge framework aimed at returning an Integrated Risk Map, understood as a dynamic and updatable tool, developed and to be interrogated in GIS environments.

2) The definition of the Guidelines for the Environmental and Settlement Systems of the new General Regulatory Plan of Messina, in which is central the role of Blue and Green Infrastructure understood as the new incremental frame on which to base the urban and environmental regeneration of the city as well as the mitigation of risks.

3) The definition of design scenarios in which the SUM - Minimum Urban Structure (to be further defined in the continuation of the drafting process of the Plan itself) is central to the design of the Plan and the design of the city itself, as well as to the processes related to risk management.

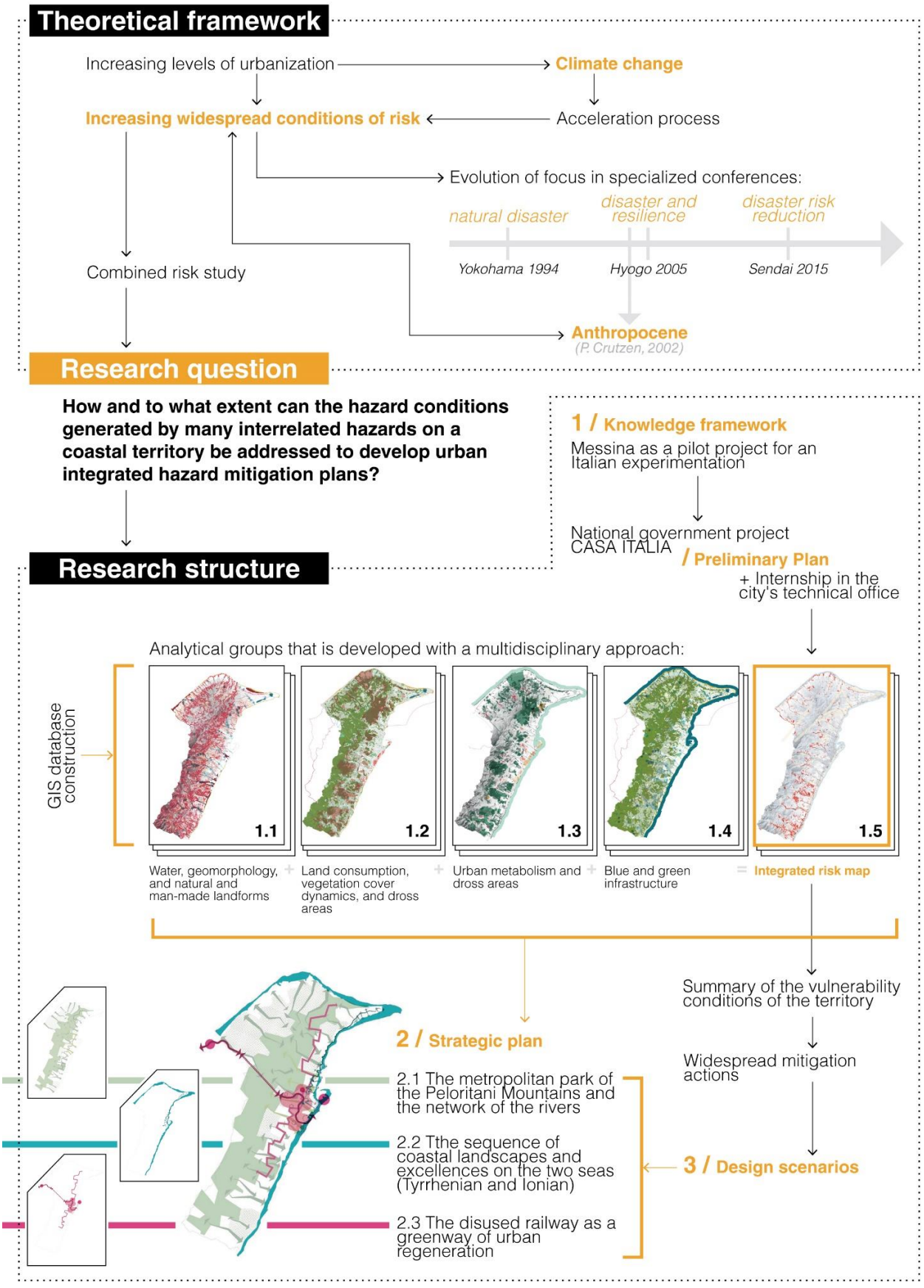


Figure 1. Theoretical framework and methodological process of the research.

1.1 The theoretical frame of reference

Most of the humanity now lives in urbanized areas. According to the latest 2018 United Nations Report, 55% of the world's population resides in urban areas. By 2030, the share of the world's population living in urban areas is expected to reach 60%, while by 2050 it is estimated to reach the 68% threshold; in Europe as of 2018, the population concentrated in urban areas was 74%, while in Italy the threshold is 90%. (WUP, 2018) It is evident that "The future of the world's population is urban." (WUP, 2018) We are thus facing a progressive and uncontrolled *planetary urbanization* (Brenner and Schmid, 2011) that makes people and resources increasingly vulnerable as they become more exposed to an increasing number of global risks (Simpson et al., 2021; Sterzel et al., 2020; Helbiz, 2013). The concept of risk is constitutive of our cities, which is the reason that, as Jabareen (2015) suggests, we should now speak of "risk cities" as a practice that can make a significant contribution to the understanding not only of risk and its social, spatial, structural and physical aspects on our contemporary cities but also on the way cities cope with uncertainties and vulnerabilities.

The now-established awareness of risk as a human construct and the definitive overcoming of the idea of natural disaster as an *act of nature* leads to the view that hazards of exclusively natural origin are only those related to natural events such as earthquakes, tsunamis, and volcanic events for which historically we tended to associate the term hazard with "natural phenomena" because they were characterized by sudden or acute impact (UNDRR, 2020). These natural hazards, on the other hand, intersect and overlap with multiple anthropogenic hazards, namely those produced by the ways in which cities have been built and how their *metabolism* has been consolidated (Wolman, 1965; Gasparrini, 2017): hydraulic and hydrogeological risk; soil, water, and air pollution; microclimatic hazards; ecosystem depletion and desertification; and also landslides and floods, which are usually considered natural in origin but are in fact induced and amplified by anthropogenic action (Jabareen, 2015; Sterzel et al., 2020).

Taking into consideration what has happened in the Specialist Conferences at the international level, the change of focus on the issue of hazards becomes evident. From the one held in Yokohama in 1994 and the subsequent review done in 2004, it appears that the focus is still on natural disasters. With the Millennium Declaration of 2000, the protection of the common environment and vulnerable people was set as the main goal by aiming to "intensify cooperation to reduce the number and effects of natural and man-made disasters." In the Report prepared during the Conference held in Hyogo in 2005, attention is paid for the first time to the contribution of human action in exacerbating conditions of vulnerability. Finally, in the 2015 Sendai Framework, the scope of disaster risk reduction was further expanded to include both natural and man-made hazards and the resulting environmental, technological and biological hazards.

The following definitions, produced by the United Nations General Assembly, reflect the evolution over the decades of the field of disaster risk reduction toward a broader scope of hazards leading to events with both short- and long-lasting effects (UNDRR, 2020; GAR, 2022):

- *Hazard* is the human process, phenomenon, or activity that can cause loss of life, injury or other health impacts, property damage, social and economic disruption, or environmental degradation.
- *Exposure* is the assets of interest subjected to risk (such as the environment, economy, buildings, or people).
- *Vulnerability* is the condition determined by physical, social, economic, and environmental factors or processes that increase the susceptibility of an individual, community, assets, or systems to the impacts of hazards.
- *Capacity* is the combination of all available strengths, attributes, and resources within an organization, community, or society to manage and reduce risks and strengthen resilience (UNGA, 2016).

When hazards are combined with vulnerability and exposure, disasters are more likely to occur because exposure increases impacts and vulnerability reduces capacity to deal with them. In fact, disasters are described as "major disruptions in the functioning of a community or society at any scale due to

hazardous events that interact with conditions of exposure, vulnerability, and capacity, resulting in one or more human, material, economic, and environmental losses." (UNDRR, 2020) To support the work set out in the Sendai Framework, UNDRR also developed the "Hazard Definition and Classification Review" within which it sought to apply the *all-hazard* approach (Sendai Framework, 2015; UNGA, 2016; UNDRR, 2020), which aims to broaden the range of hazards considered, overcoming the limitation of considering only those traditionally understood to be of natural origin. More than 300 types of hazards are identified and described in the document (grouped according to the following types: Meteorological and Hydrological, Extraterrestrial, Geohazards, Environmental, Chemical, Biological, Technological, and Societal). However, the limitation of this work lies in not considering so-called cascading or other complex hazards (Simpson et al., 2021; Pescaroli & Alexander, 2018; Helbing, 2013), which are the result of complex human activities (the same limitation is also present in IPCC reports). Other evidence is found by examining the Global Risks Report, compiled annually by the World Economic Forum (WEF) from 2006 to the present. In this time frame, not only has what is considered a risk changed, but it is evident how the range of possible declinations of this term has increased. For illustrative purposes, in the first 2006 Report, the risk landscape is dominated mainly by terrorism, pandemic influenza and other viral diseases, and the rising cost of oil. Problems related to climate change only begin to emerge as a potential risk of a global nature that is assumed to become irreversible in the next 10-20 years; in the 2023 Report, on the other hand, the major risks pertain to, on the one hand, the rising cost of living and an ever-increasing erosion of social cohesion and polarization of society (passing through pandemic crises and global conflicts), and on the other hand, the increased exploitation of natural resources, the exponential growth of natural disasters and extreme weather events, and the failure to mitigate climate change.

The combined reading of these studies confirms to us how emergent the issue of hazards is, and how much more so for territories that have suffered most from anthropogenic transformations that have exacerbated and exacerbated their effects (Simpson et al., 2021; Sterzel et al., 2020; He & Silliman, 2019). The outcomes of this interaction can be seen primarily in climate change and increasingly frequent catastrophic events over the past two decades. Between 1970 and 2000, reports of medium- and large-scale disasters averaged around 90-100 per year, but between 2001 and 2020, the number of such events increased to 350-500 per year (GAR, 2022). The UNFCCC (United Nations Framework Convention on Climate Change) defines climate change as “a change in climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and adds to natural climate variability observed over comparable time periods.” The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), issued in 2022, also reports alarming information. Global climate change is increasingly increasing its effects on marine ecosystems, freshwater and ecosystem services, settlements and infrastructure, health and well-being, and economies and culture, especially through complex stresses and events. The impacts noted are mainly attributable to climate change, including impacts from extreme events. The Report also illustrates how compound risks have become more frequent in all regions of the world, with widespread consequences; climate change impacts are concomitant with and interact with other significant societal changes that have become even more evident since AR5, including global population growth and urbanization, significant inequalities and demands for social justice, rapid technological change, land and water degradation, biodiversity loss, food insecurity, and global pandemic.

In light of the above, it is evident that the cyclical natural changes in environmental systems, which have always been noted, have been overlaid by the decisive and invasive contribution of anthropogenic activity why it seems appropriate to assign the term *Anthropocene* (Crutzen, 2002) to the current geological era, which is in many ways dominated by humans and seems to allude to the power of humans to disrupt the Earth's ecological processes. (Shiva & Shiva, 2020) In a short article published in the journal Nature in 2002, the Dutch chemist-atmospheric scientist drew everyone's attention to how humanity's rapid expansion in numbers and per capita exploitation of Earth's resources has continued unabated over the years. In the past three centuries, not only has the human population

surpassed 6 billion (and is expected to reach 10 billion in this century), but it is the leading consumer of Earth's resources. What we are witnessing today, therefore, is a change that is proceeding at a very fast pace due to the superimposition of anthropogenic contribution to natural and cyclical climate change. (see Figure 1)

1.2 Italy's widespread vulnerable conditions

The Italian territory is characterised by many vulnerability factors, some of natural origin, and many others of anthropic origin.

As reported by the "Soil Consumption, Spatial Dynamics and Ecosystem Services Report" (2022), drawn up by the National System for Environmental Protection (SNPA), soil consumption in Italy continues to transform the territory at a high rate. In the last year, in fact, new artificial coverings have covered an additional 56.7 km^2 (corresponding, on average, to more than 15 hectares per day); another 8.2 km^2 have gone from reversible to permanent soil consumption, further sealing the territory. (Munafò, 2022) Another fundamental fact concerns the relationship between land consumption and population dynamics; in fact, the link between demography, urbanization and infrastructural processes is not direct and there is an increase in artificial surfaces even in the presence of stabilization, and in many cases decrease, of residents. The urbanized areas on our territory in 2018 were 8,628 km^2, in 2020 they increased to 8,721 km^2. (Munafò, 2022) In this context, Italy is highly vulnerable, precisely because of the pervasive and continuous anthropisation of the territory in areas at risk.

The "Report on the Promotion of Safety from Natural Risks of the Housing Stock", prepared by Casa Italia (2017), reports that 57.2% of residential buildings are in areas of high seismic vulnerability. The municipalities affected by high and very high landslide hazard areas and/or medium hydraulic hazard are 7.275 (equal to 91,1% of Italian municipalities). Landslides are extremely widespread phenomena in Italy, considering that 75% of the national territory is mountainous-hilly. Of the approximately 900.000 landslides registered in the databases of European countries, 620.808 are registered in the Inventory of Landslide Phenomena in Italy (IFFI) and affected an area of 233.700 km^2 (equal to 7.9% of the national territory). It is estimated that in the last fifty years, there have been more than 10.000 victims due to hydrogeological and seismic phenomena, causing economic damages of about 290 billion euros, with an annual average of about 4 billion and with values increasing over time (Dipartimento Casa Italia, 2017).

From the work carried out by Casa Italia in the reconnaissance of all available data (coming from the studies of CNR, ISPRA, ISTAT, ENEA, INGV and MIBACT) to build an integrated mapping of risks for the whole of Italy, the "Map of natural risks of Italian municipalities" was created, edited by Istat. Although the aim was to provide an up-to-date framework of variables and indicators for Italian municipalities, to allow an overall view of the risks of exposure to earthquakes, volcanic eruptions, landslides and floods, the work is still a mere superimposition of separate information that cannot really interact with each other to return an integrated picture but only a summation of information.

It is clear, therefore, that the acceleration imposed on this critical framework by climate change poses an urgent need to rethink the way in which vulnerability conditions are interpreted through more synergetic models of analysis. For this reason, in September 2016 the Government launched the Casa Italia project, a multi-year plan to promote the country's security in the face of its multi-hazard condition. Casa Italia is a mission structure, established by the Prime Ministerial Decree (D.P.C.M.) of 23/09/2016 for the implementation of a project to take care of the housing stock, the territory, and urban areas for the purpose of greater protection of citizens and public and private assets. In June 2017, the "Report on the Promotion of Safety from Natural Hazards of the Housing Stock" was published, with which the intention was (1) to address risks in an integrated manner, according to a multi-hazard approach, focusing attention not on individual risks but on the places where people live, analysing the different sources of risk that may affect a specific place and their mutual interactions; (2) to identify the most effective intervention strategies, also exploiting the opportunities offered by new

technologies. The city of Messina is identified as a case for experimentation. (Dipartimento Casa Italia, 2017)

1.3 The territorial context researched: Messina

The complexity of the multi-risk condition, both territorial and social, addressed in the in-depth study of the Prototypal Case of the Municipality of Messina, has as its main objective of analyzing the feasibility of project scenarios to support the housing decompression of at-risk areas (Dipartimento Casa Italia, 2017). Thus, with the agreement stipulated between the Mission Structure of the Presidency of the Council of Ministers, the Municipality and the National Institute of Urban Planning (INU), the foundations were laid to draw up an Action Plan, thus creating the indispensable premises for a resilient urban policy, capable of prefiguring a new habitability of the city based on virtuous adaptation to risk conditions (General Report of the Outline, 2018).

Messina is a medium-sized city with just under 224.000 inhabitants and a very large municipal territory (211 km^2). Although the population is steadily decreasing, -2.433 inhabitants (-1,08%) since 2021 and -18.260 units (-7,54%) since 2012 (messinaincifre, 2022), land consumption continues to increase: in the two-year period 2019-2020, 28 hectares were consumed, equal to approximately 318 m^2 per inhabitant. (Munafò, 2022) The territory includes a large section of the Peloritani Mountains, characterised by a marked orography, which in short reaches altitudes above 1.100 m above sea level and from which derives the dense presence of river courses (about 70) of torrential character, commonly called '*fiumare*', the main reason for the widespread hydro-geological risk condition. Although the research focuses only on the municipal territory of Messina, some data concerning the entire Metropolitan City are significant. 10% of the territory is affected by landslide risk, that is just over 310 km^2 out of 3,266 km^2; considering landslide and hydraulic risk together, out of 108 municipalities (of which the Metropolitan City is made up) as many as 91 are affected by both risks, i.e. over 84% of the territory. (Triglia et al., 2018) It has a high level of seismic hazard and was completely razed to the ground by the violent earthquake of 28 December 1908 and the subsequent tsunami. According to the "Italian Tsunami Catalogue" available on the INGV website, the coastal territories bordering the Strait of Messina are historically among those in Italy most affected by tsunamis both in terms of frequency and intensity. The damage from the earthquake and tsunami - equivalent to 11th and 10th-degree effects on the MCS scale (Mercalli-Cancani-Sieberg 1930 macroseismic scale) - was recorded in an area of about 600 km^2 with between 70% and 100% destruction of the built heritage. (Tinti et al., 2004)

Historically, the town-planning and settlement history of the city of Messina has been determined by a cyclical relationship between the numerous catastrophic events and the following reconstructions that followed one another over time in an alternation of new planning instruments and spontaneous processes of re-urbanization. After the earthquake of 1908, the city was rebuilt with a high land consumption plan, which envisaged urban growth processes along some streams directed towards the hillsides and confirmed and amplified by the settlement dynamics of the second half of the 20th century, through a succession of oversized plans, including the one still in force, with a pervasive consumption of hillside land and a progressive cementing of some riverbanks. These choices have led to a widespread condition of hydrogeological, hydraulic, and seismic vulnerability that has triggered numerous landslide and flooding events over the years, up to the tragic 2009 landslide in Giampilieri (a suburban area located south of the city centre) that caused 37 deaths. There is therefore an intense cumulation and mutual amplification of the dimensions, complexity, and extension of the factors of danger, exposure, and vulnerability, which undermine the physical security of the territory and human settlements. Added to this is the technical backwardness and lack of integration of the risk maps made available by the superordinate public bodies. (Gasparrini and Terracciano, 2021)

Thus, since the destruction at the beginning of the 20th century, the city has collected a sequence of urban planning decisions that have played a pervasive role in the construction and consolidation of these critical issues. In fact, following the seismic event, it became necessary to build housing for the

evacuees in a short time, which is why a specific Barrack Plan (called Piano Baraccato) was drawn up, the first phase of the Reconstruction Plan established with the enactment of law no. 12 of 12/01/1909, which established the urgency for the city to equip itself with a new Regulatory Plan, entrusted in the same year to engineer Borzì, and drafted between 1909 and 1912. Reconstruction operations were strongly conditioned by the insufficient availability of free areas, as the city was completely overrun by rubble, so that areas outside the then built-up area were identified to accommodate temporary barracks. The overall total of barracks built came to more than 7.600, grouped into 'Villages' or 'Quarters'; their maximum duration was set at five years but many of these areas are still there today. These precarious settlements were the subject of Regional Law No 10 of 1990 specifically dedicated to Messina and, more recently, of Decree-Law no. 44 of 2021 for the rehabilitation of shantytowns. At present, the city of Messina is first in the list of projects selected for the National Innovative Programme for Housing Quality (called P.I.N.Q.U.A., part of the National Recovery and Resilience Plan - P.N.R.R.), with projects concerning the rehabilitation of redevelopment areas and areas destined for urban housing financed for approximately 129 million euros, thus standing as a candidate to become one of the pilot territories in Italy for new regeneration experiments. (Brisku et al., 2023) The complex interplay between the reconstruction phases and the consequent urgency to satisfy the housing emergency of the survivors, together with the need to respond to the demand for housing for the most disadvantaged segments of the population, led to a conspicuous intervention of the public hand, while the settlement types of the public city implemented followed the criteria and rules defined by specific national laws[1] .

2. MATERIALS AND METHODS

2.1 Integrated risk readings. Methodology and fields of application

2.1.1. Knowledge Framework

The first phase of the research has a twofold objective. The first is to construct a broad framework of knowledge on the characteristics of the territory that can provide the appropriate basis for developing development strategies for the territory, with risk mitigation as the focus. A multidisciplinary approach is employed, involving specific professional figures (town planners, geologists, agronomists, GIS technicians, cartography technicians, administrative technicians, photographers) and using data from sectorial studies for certain issues (CUAS 2013, Habitat Map of the Sicilian Region, Habitats of the European Corine Biotopes manual, SITR Sicily Region, ENEA). All data collected from other pre-existing studies and those produced specifically for the new outline were collected in a GIS framework and organized into database families to be able to read all information both separately and together, as well as to ensure real-time access to reliable and implementable data (Sendai Framework, 2015). The overlapping reading of the risk information and its location were the basis for building the next steps as well. The second is to understand how far the hazard factors studied for the Outline were in line with the main scientific references on risk; the “Global Risk Report 2023” (WEF) and the “Hazard Information Profiles” (UNDRR), a supplement to “UNDRR-ISC Hazard Definition & Classification Review - Technical Report”.

The analyses were organized into five families:

1.1 *Water, geomorphology, natural and man-made landforms.* It contains all the information concerning the landslide hazard and the hydraulic hazard exacerbated both by the steep slopes that naturally characterize the territory and by the enormous man-made landforms, the seismic hazard, and the phenomenon of coastal erosion.

1.2 *Land consumption, vegetation cover, dynamics, and dross areas.* It contains all the data relating to land consumption not only resulting from the urbanization processes of recent decades but also

[1] Reference is made to Luzzatti Law No. 254 of 1903, Law No. 43 of 28 February 1949, known as the Fanfani Law and whose interventions were managed by the INA-Casa Institute, Law No. 167 of 1962 and the introduction of the Economic and Popular Housing Plans (PEEP), Law No. 60 of 1963 and the related Gescal Plan.

that resulting from large forest fires, the abandonment of large areas with an agricultural vocation, and the abandonment of many productive areas or areas with non-residential uses.

1.3 *Urban metabolism and dross areas.* It contains all information related to urban metabolism processes, i.e., all areas and artefacts in a state of decay or abandonment (including production areas and mobility infrastructure), all residential areas in a state of severe decay (low quality of life, lack of public infrastructure), disused or illegally used quarries and landfills.

1.4 *Blue and green infrastructure.* It contains all the information on the interruptions or degradation of ecological corridors, i.e., all those sealed areas along the coast or along the slopes of the Peloritani Mountains that should instead be safeguarded.

1.5 *Integrated risk map.* It contains a summary of all the data on hazards analyzed in the previous maps and allows us to read the risks in an integrated manner, thus understanding that today it makes sense not to think of risks individually but in their combination, to be able to tackle them more effectively and find mitigation solutions that look at the complexity of the problems.

For the construction of this last map, further synthesis readings were developed to further understand and deepen all the risk factors that characterize the territory under study: (x) the Geologist's Specialist Study and (xi and xii) the first matrix experimentation for the Integrated Risk Map developed within the thesis work (developed by Ferramosca G., Orefice O., Prisco C. and Spera S. as part of the degree course in Territorial, Urban and Landscape-Environmental Planning P.T.U.P.A. (a.y. 2017/2018) of the DiARC Department of Architecture of the University of Naples "Federico II") "Messina territorio co-stretto. Integrated approach to risks to plan the resilient city".

x. The "Map of risks of natural origin" consists of a joint reading of the risks deriving from:

a) the morphology of the territory and the composition of the soils, identifying all the areas affected by landslide hazard (source: ENEA and the Geological Study) and the buildings exposed to this vulnerability, the areas subjected to steep slopes, the areas with slopes between 34° and 55°. The Geological Study[2] reports that the upheavals were concentrated not only in the presence of sparse scrub vegetation or along bare surfaces but also within terraced slopes with dry-stone walls characterized by sparse cultivation and walls in a state of decay. These conditions, together with slope inclinations of more than 34°, are at the root of the disruptions caused mainly by poorly tap-rooted root systems of citrus groves, which contribute to the spreading and loosening of the soil. Large complex landslides are considered to be of high hazard due to their imposing size and state of activity, characterized by slow, almost continuous movements. (Geological Survey, 2018).

b) the structure of the territory, through the mapping of active faults capable of and with very high hazard (ENEA and ENEA Study, 2013) and the buildings exposed to this vulnerability.

c) the water system, identifying the areas affected by hydrogeological hazard (PAI, 2011) and the relative buildings exposed to such vulnerability, the areas where soil liquefaction phenomena have occurred and those where there is a potential risk of liquefaction, and the areas affected by the phenomenon of coastal erosion. As far as hydrogeological vulnerability is concerned, in the mountainous areas of Messina, it is noted that even in conditions of not particularly intense meteorological events, considerable damage can occur. This is due to the concomitance of land collapses and landslides, which complicate the containment of the event and make it safe, thus increasing the risk to people and property. At the same time, one must also consider the constant and capillary practices of unauthorized building, and the uncontrolled exploitation of the soil and its resources, which greatly contribute to generating conditions of vulnerability. As far as the last

[2] Geologist Paolo Pino was appointed for the Specialist Study by D.D. No. 155 of 19/01/2018. All the documents produced (bearing the initials SG) for the Outline prepared in 2018 can be consulted at the following link: https://comune.messina.it/servizi-terr-urban/schema-di-massima-prg-2018/

The data taken as reference for the drafting of the Outline dates back to the update of the Basin Master Plan for Hydrogeological Structure - PAI adopted by D.P.R. no. 118 of 21/03/2011 (available at the following link: https://www.sitr.regione.sicilia.it/pai/bac102-fiumedinisi. htm) and subsequent integrations carried out by means of a study on the state of geomorphological hazard in the Municipality of Messina dated 31/07/2014, an activity aimed at the Environmental Safeguard Variant in collaboration with the Territorial Planning and Soil Defence Service of the A.R.T.A. The latest update was approved by D.S.G. no. 393 of 23/12/2021 and the elaborations will be used for the future update of the Outline ("Schema di Massima).

phenomenon is concerned, the long coastline of Messina is highly critical due to a multiplicity of factors, mainly of an anthropic nature, which over time have led to the fragmentation of ecosystems and the degradation of contexts. In addition, there is a progressive phenomenon of erosion of the sandy shores with phenomena of severity along the Tyrrhenian side, while on the Ionian side, the compromised areas are more reduced (Geological Study, 2018). (see Figure 2)

xi. The "Map of ecological-environmental risks", which consists of a joint reading of the risks arising from:

a) from the plan residue, i.e., abandoned, and unrealized standard areas.

b) from the ineffectiveness of governance in the housing field, which manifests itself in areas with degraded conditions, historical villages in the hillside areas that are being abandoned and buildings of cultural-historical value in a state of abandonment and/or degradation.

c) the lack of effective governance for water cycle management, identifying areas without sewerage sub-services, areas without water sub-services, areas with sewage plants that discharge wastewater directly into the sea, and the location of purifiers

d) the inefficiency of waste cycle management, identifying disused landfills and areas with illegal waste spills (source: Messina Ambiente s.p.a.)

e) the strong pressure of transport on the urban environment, by sea, rail, and road.

f) the improper use of the land, identifying forested areas affected by fire (source: Copernicus) abandoned terraces for agricultural use (Agronomic-Forestry Study, 2018), disused areas and buildings of the production chain, disused railway transport lines and their abandoned stations, riverbanks improperly used for roading (but also as extensions of private appurtenances of homes, for the spillage of usual waste, etc..), stretches of coastline with banned bathing (Region of Sicily, 2017). (see Figure 3)

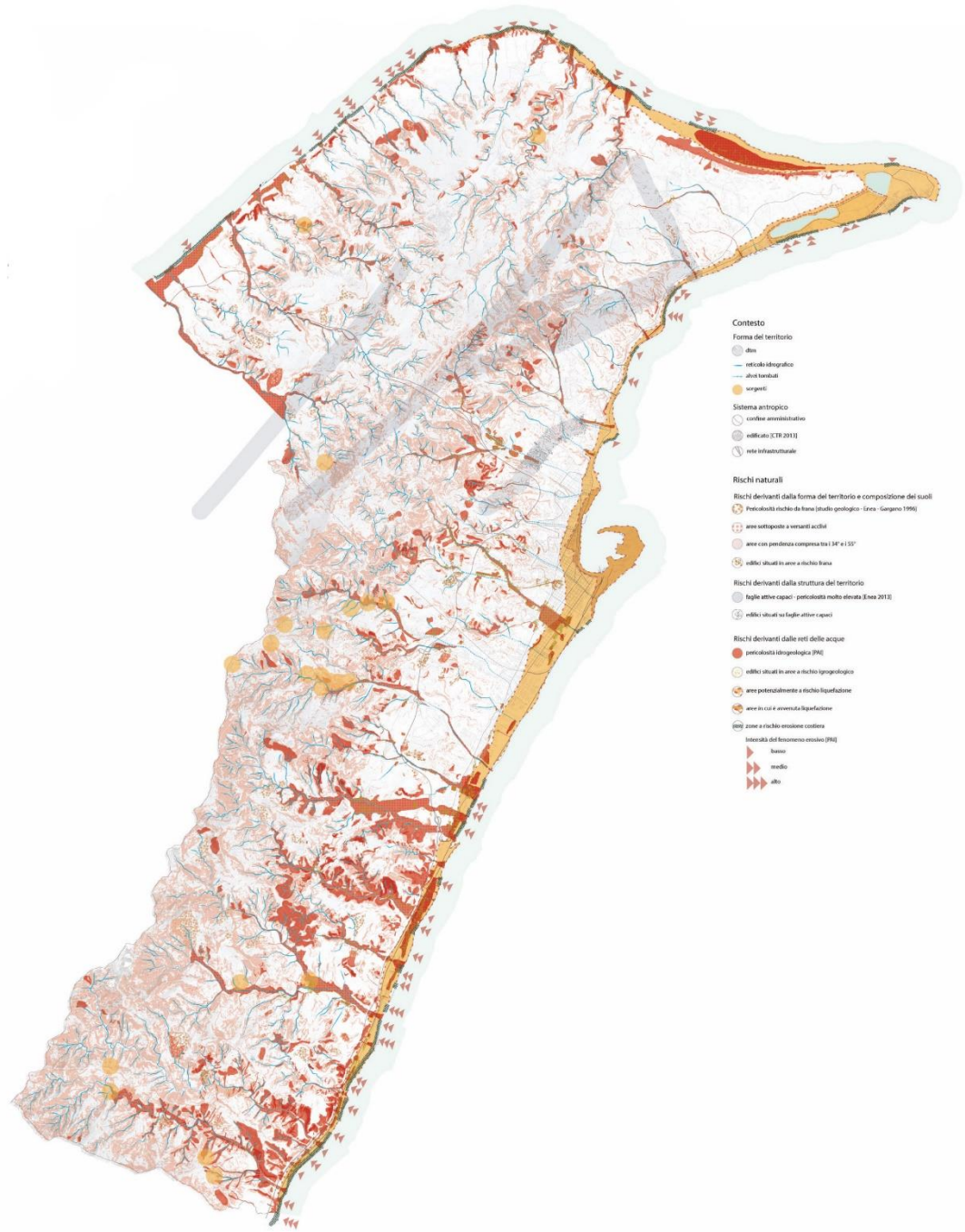


Figure 2. Natural risks.

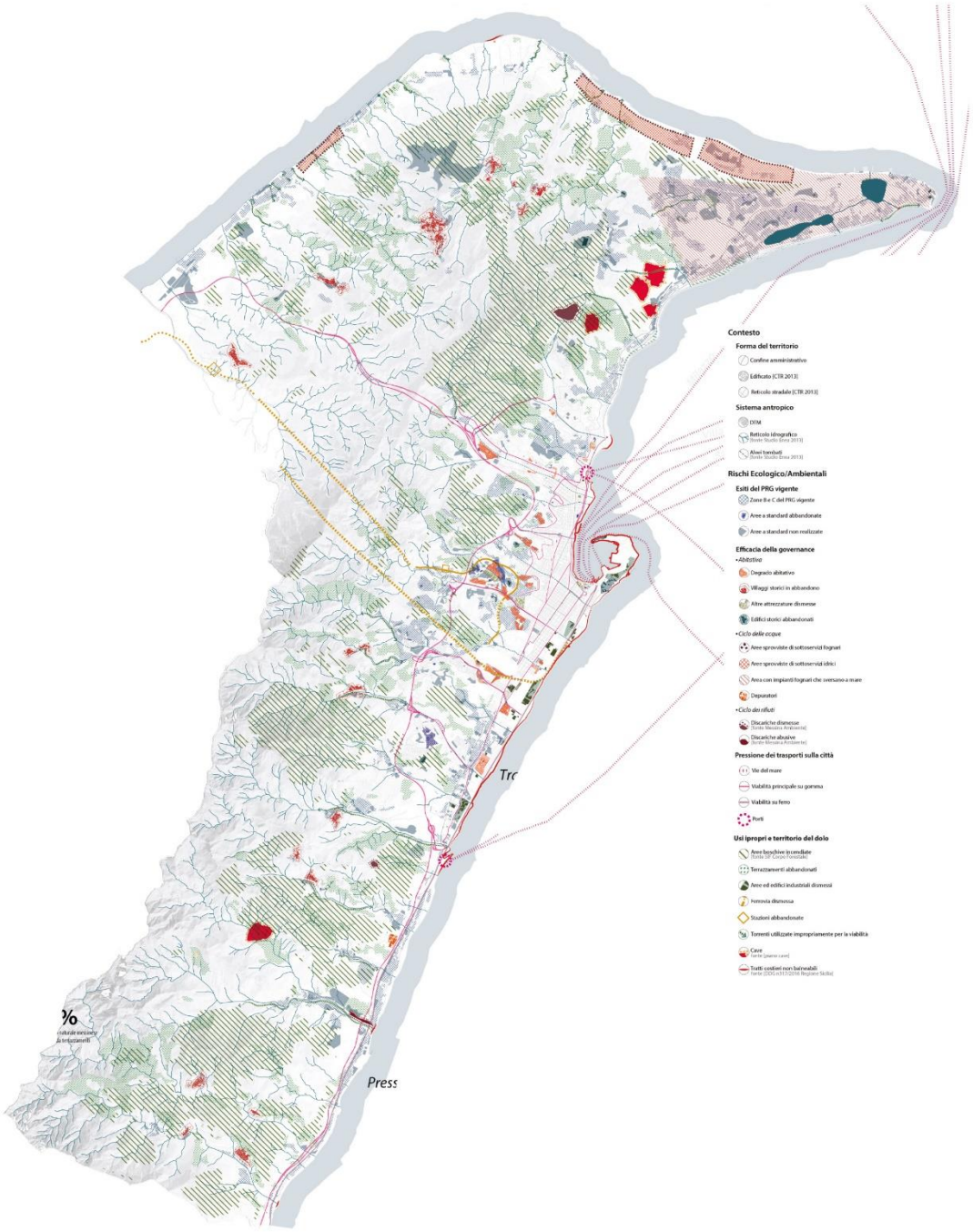


Figure 3. Ecological-environmental risks.

xii. The "Map of risks of an economic-social nature", which consists of a joint reading of the risks arising:

a) by the crisis in production cycles, which has taken the form of the abandonment of terracing for agricultural production, the decommissioning of large industrial areas, and the failure to create areas for production under the current PRG. (Agronomic-Forestry Study, 2018).

b) from the crisis of the housing cycle that has generated so-called 'dormitory' residential areas (i.e., with no services for the community), areas mainly intended for seasonal, and tourist use, hillside villages subject to depopulation dynamics and with difficult accessibility.

c) the analysis of the physical qualities of public housing.
d) from the improper uses and the perception of insecurity, which take the form of the identification of areas with poor accessibility, with inadequate or difficult viability (especially in cycle-pedestrian mode), with improper and precarious roads.
e) the criticalities of the infrastructure system, consisting of a dense network of tracks with static structural problems. All these mappings were superimposed with the perimeters of the nuclei of local identity. (see Figure 4)

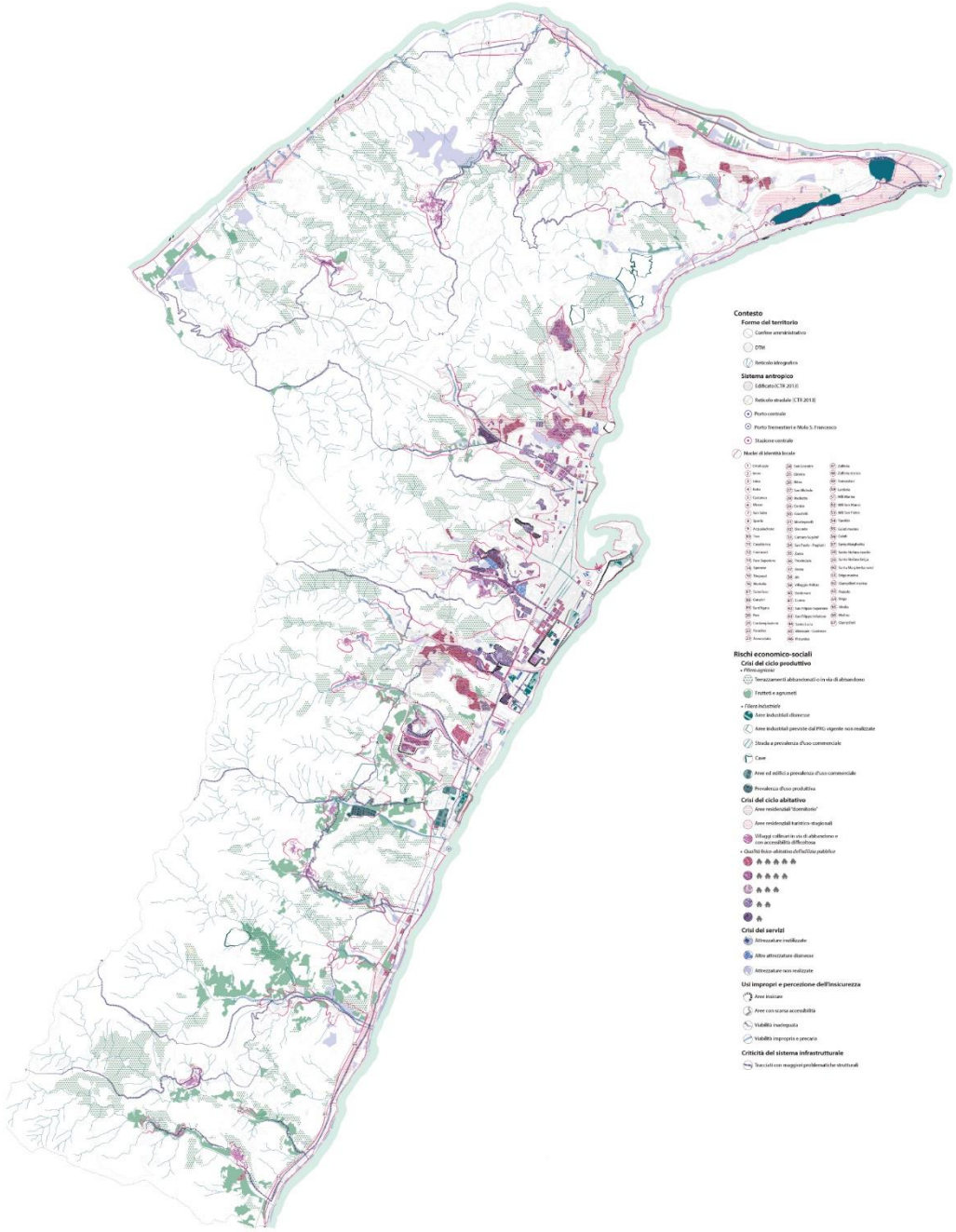


Figure 4. Economic-social risks.

With the construction of these integrated readings of vulnerabilities in the "Schema di massima", a particularly critical picture emerges in which a large part of the territory is subject to two or more risks at the same time.

With the hydro-geological risks, an initial experiment of a multi-risk matrix was constructed, through which it was possible to identify the areas and buildings most affected by multiple exposures, preparatory to the realization of the Integrated Risk Map. (see Figure 5) This matrix crosses seismic hazard with hydraulic and landslide hazard, while the methods for assigning the feasibility/susceptibility class are standardized to homogeneous areas for geological hazard, hydraulic and hydrogeological vulnerability, and seismic hazard. The presence of at least one high or very high hazard is sufficient to determine a polygon with a high-risk level. The coincidence of the same area of territory of several high geological hazards entails greater restrictions, although the risk class remains the same. The indications of limitations and constraints arise from and make specific reference to the type of hazardous phenomenon that determined the assignment of the risk class. Therefore, the overlapping of several hazard areas results in more limiting factors and defines polygons with mixed characteristics (Geological Study, 2018). Following these criteria, the "Integrated risk and building susceptibility map" is drawn up, which makes it possible to highlight sub-areas that are unsuitable for building because they are subject to unacceptable natural hazards (red areas), and areas that are suitable 'on condition' of preventive risk mitigation measures (consolidation, regulation, drainage, etc.) or specific preventive technical measures, adaptations and precautions to be observed during the building phase (orange areas). (see Figure 6) In the light of this mapping, the building stock subject to multiple risks is 4% of the total, corresponding to approximately 2.644.000 m^3; of these, 18,856 m^3 are churches and religious institutes (0,7%), 184.623 m3 are productive buildings (6,7%), 2.526.682 m^3 are residential buildings and services (92,6%, of which 86.000 m^3 are barracks). For a large proportion of these buildings, within the strategies of the Schema di massima, it is assumed that they can be relocated to non-risk areas and that the freed areas are redeveloped and renatured.

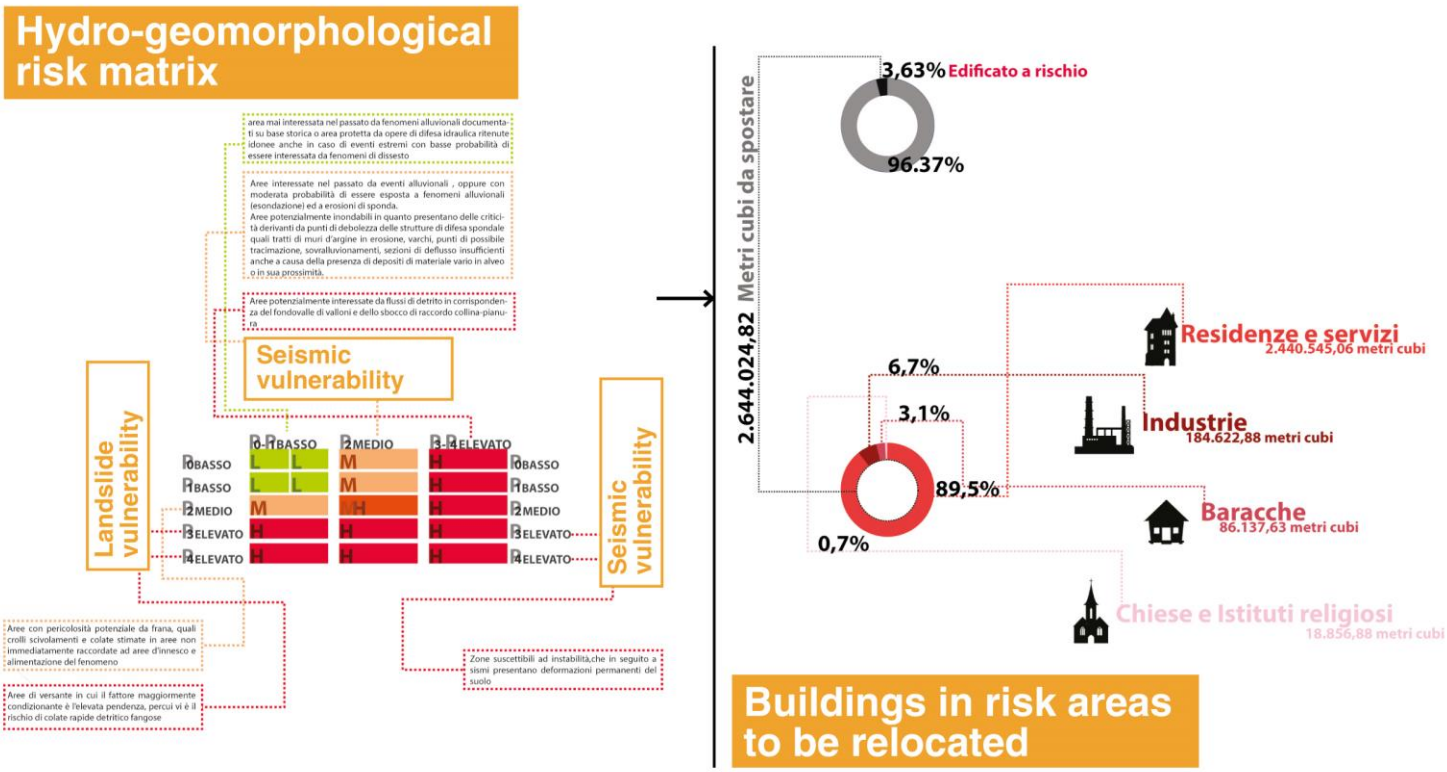


Figure 5. Integrated risks map construction matrix.

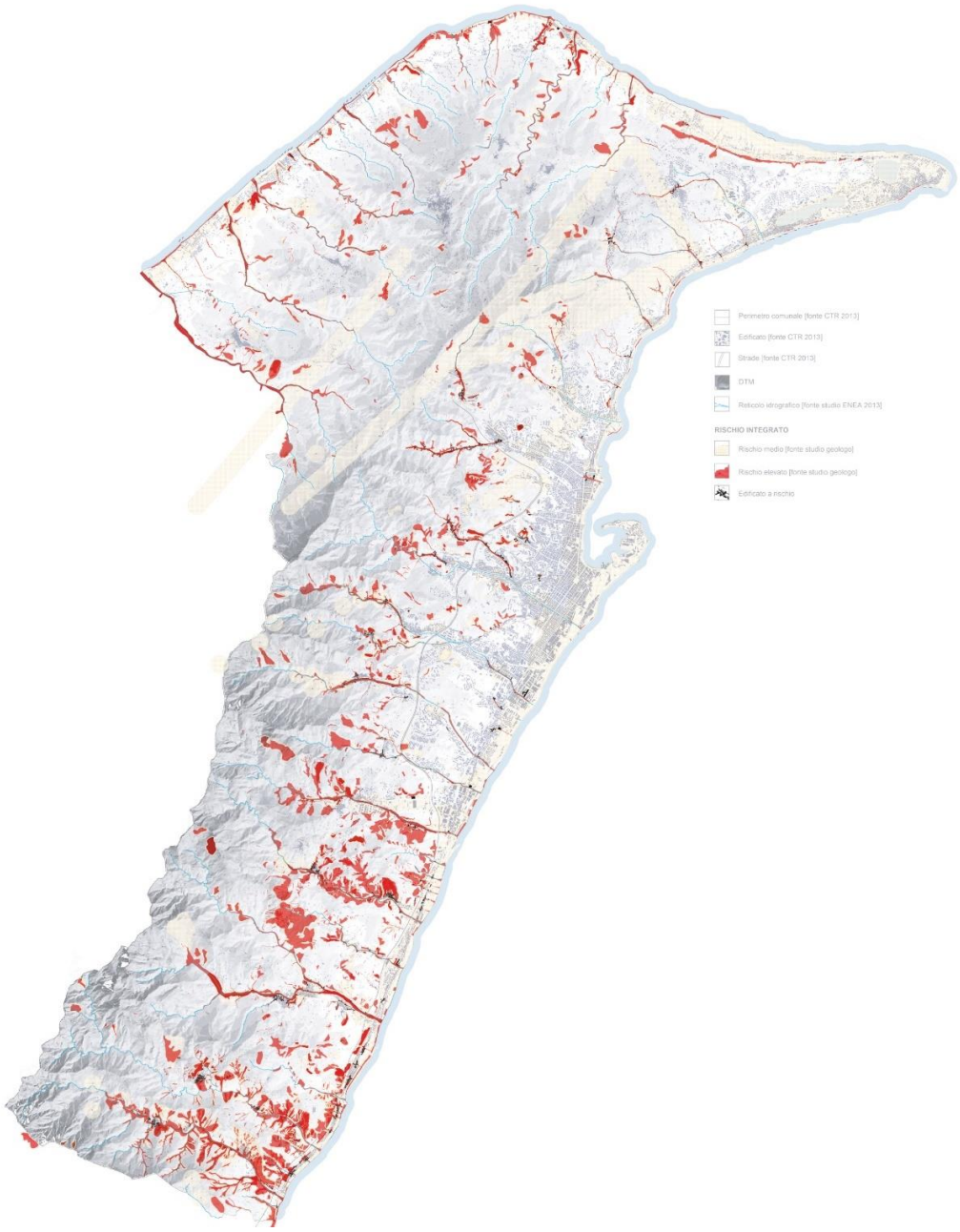


Figure 6. Integrated risks map.

To achieve the second objective, on the other hand, the analyses were sought by consulting the "Global Risk Report 2023" (WEF, 2023) and the "Hazard Information Profiles" (UNDRR, 2021). The former identifies 32 global risks, organized into six categories (Economic, Environmental, Geopolitical, Societal, and Technological); the latter identifies 302 risks, organized into clusters (Meteorological and Hydrological, Extraterrestrial, Geohazards, Environmental, Chemical, Biological, Technological, Societal). (see Figure 7) Comparing the type and content of the analyses carried out for the drafting of the Maximum Outline (Schema di massima) for the city of Messina and the risks recognized by the two main organizations active in this scientific field, it emerges that the latter, although in-depth and valid for phenomena on a global scale (as explicitly stated in the WEF document), show some shortcomings in recognizing certain danger factors that derive either from the interaction of two or more concomitant dangers or from phenomena that are not mentioned at all and that mostly pertain to the social sphere.

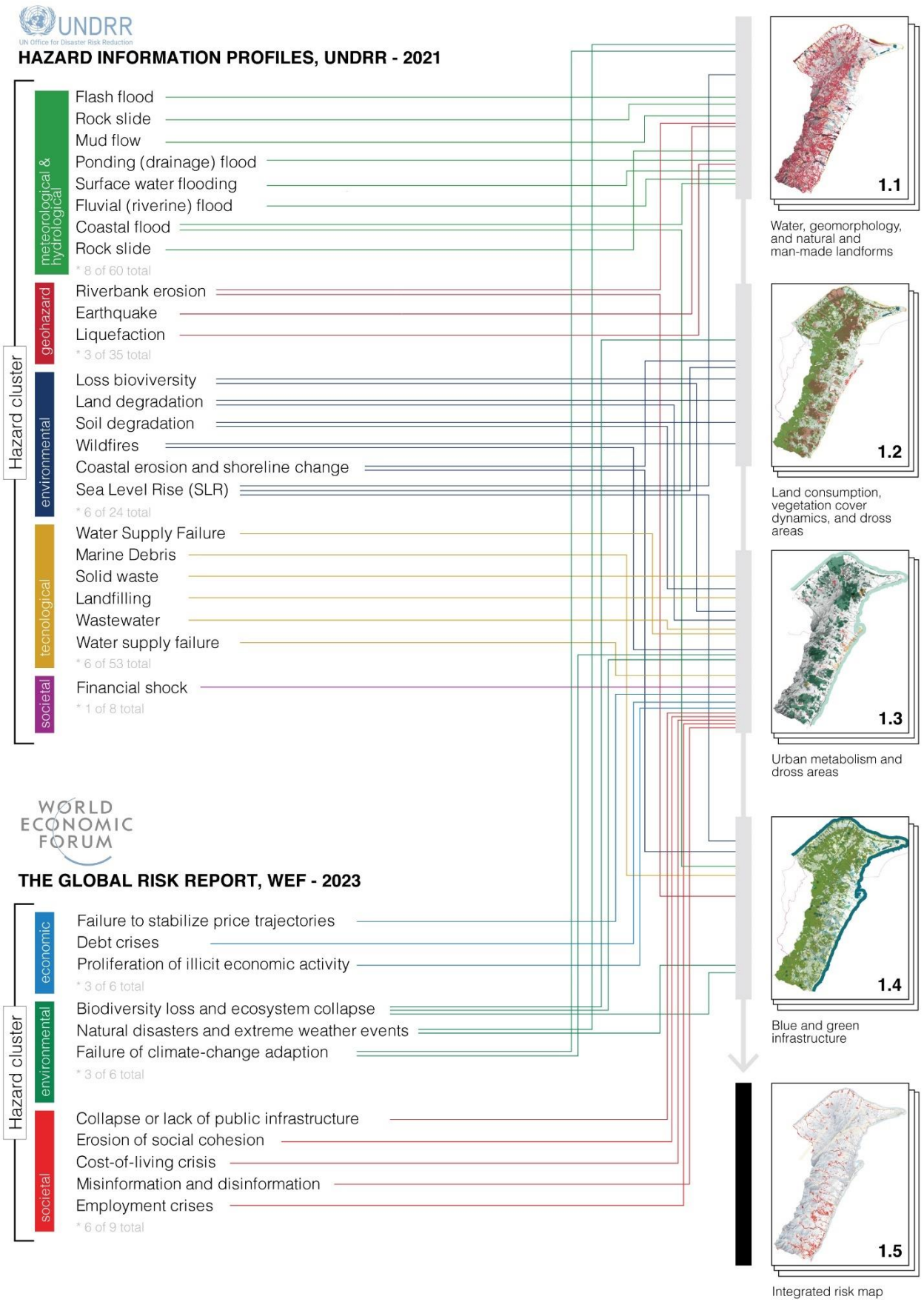


Figure 7. Comparison with UNDRR and WEF risk clusters.

3. RESULTS AND DISCUSSIONS

3.1 Guidelines for environmental infrastructure design: landscapes and intersystem actions

The construction of the "Integrated Risk and Susceptibility Map for Urban Regeneration" is thus intended to be the dynamically updated reference for a strategy to combat and adapt to a multiplicity of ecological-environmental, social, and economic risks. It is a multi-scalar, metropolitan and local strategy, which is mainly based on the creation of a network of Blue and Green Infrastructure (GBI)[3], starting from the existing ones, capable of counteracting fragile conditions and, at the same time, maximizing biodiversity and the production of ecosystem services also in urban areas (Gasparrini and Terracciano, 2021).

Reducing climate risks and increasing resilience to the impacts of climate change are objectives enshrined in the Paris Agreement and the Sendai Framework of Reference (UNISDR, 2015) to which the Italian government adhered along with many other governments during the 21st Conference of the Parties held in Paris in 2015. By defining such goals and priorities on a global scale, the Sendai Reference Framework emphasizes the reduction of risk, exposure and vulnerability and the strengthening of resilience at all levels through the "implementation of integrated and inclusive socioeconomic, environmental, technological and institutional measures" (Spano et al., 2020). The metropolitan city of Messina also adhered in 2017 to the Bologna Charter for the Environment with the objective of promoting sustainable development models, thus also hinging on the goals proposed by the United Nations 2030 Agenda, drafted in 2015.

3.1.1 Strategic plan

The second phase of the research proposes a Strategic Vision for the City of Messina capable of achieving a vision of a resilient and anti-fragile city. Such a city vision is built through three Strategic Projects, defined within the disciplinary framework of reference outlined (paragraph 1.1) and constructed within a dimension of innovative and updated knowledge of the territory, based on the integrated interpretation of risks, as outlined (paragraph 2.1). The first focuses on "The metropolitan park of the Peloritani Mountains and the network of the rivers", the second focuses on "The sequences of coastal landscapes and excellences on the two seas (Tyrrhenian and Ionian), the third focuses on "The disused railway as a greenway of urban regeneration".

The main strategic lines are: (1) to combine in a sustainable way the reduction of hazard and exposure to risks, (2) to widely reduce the vulnerability of buildings and building fabrics to natural and anthropogenic risks, (3) to reorganize the water cycle and urban drainage, (4) to safeguard regenerate and qualify soils, (5) improve air quality and the urban microclimate, (6) create a network of environmental infrastructure of landscape quality, (7) promote new forms of circular economy and collaborative social processes oriented towards green and adaptive urban regeneration. The principles inspiring these strategic guidelines are aimed at combating soil consumption, increasing soil permeability on a widespread basis, recycling water and abandoned soils also by enhancing urban and peri-urban agricultural uses, radically rethinking sub-services, spreading urban drainage and plant densification works, also to reduce the fragility conditions accentuated by climate change (for which the Mediterranean is a *hot-spot*).

The Schema di massima of Messina is thus supported by some underlying strategies that build its rules and projects, within a broader reference scenario on a national and European scale, in which the relevance assumed by the interpretative and design dimension linked to blue and green infrastructures (Mell, 2015, 2018) is central, with their role as eco-landscape load-bearing framework for a new urban regeneration capable of providing adaptive and dynamic solutions, within a systemic and multi-scalar approach.

[3] Blue and green infrastructures are reflected in the European Union's extensive production of policies and strategies over the past 10 years, the 2009 White Paper on Adaptation to Climate Change (European Union 2009) and the European Biodiversity Strategy. climate change (European Union 2009) and the European Biodiversity Strategy (European Union 2010), not to mention the 2013 Green Infrastructure Strategy. It is the significance of these networks that has suffered in recent years from an essentially environmental perspective, out of step with the multidimensional complexity that has been emerging in the European landscape. (Gasparrini and Terracciano, 2020)

On the whole, the "Guidelines for the Environmental Infrastructure Project" (see Figure 8) aim at the safeguard, protect and requalification of the natural and anthropic landscapes characterizing and qualifying the city and the territory of Messina through the strengthening of the great territorial ecological connections and matrices and, at the same time, the consolidation and strengthening of the widespread system of urban permeability, the protection of biodiversity and the eco-sustainability of the cultivation systems and landscape qualities determined by age-old agricultural traditions, with not only an environmental but also an economic impact due to the tourist vocation, of which the agrarian landscape is an essential component, are based on the interaction of the following factors:

- the acknowledgement of addresses, prescriptions and constraints contained in the super-ordinate Plans and in the national and regional laws concerning specific sectors and components of the territory, as recalled in Chap. 2, starting from the PTPR Regional Territorial Landscape Plan - Area 9 for Messina and the PAI.
- the evaluation of the interpretative outcomes of some specialized analyses drawn up to support the PRG to represent an updated cognitive framework of the territory and of the risk conditions, as contained in the Geological Study (called SG documents) and in the Agricultural-Forest Study (called AF documents).
- the evaluation of the interpretative outcomes of some analyses developed to represent the environmental components characterizing and qualifying the Messina landscape as contained in all the A5 documents of the Environmental System.
- the outcomes of the first evaluations for the identification of the Urban Regeneration Areas (called ARU) contained in the elaborated P2.2 Settlement and Services System. Project Guidelines.

In these "Guidelines for the Design of Environmental Infrastructure", major strategic fields for multiscalar and inter-systemic actions are identified:

- *the Peloritani landscape-nature patches*, for which measures are planned to enhance the wooded landscape as a large core area of a larger metropolitan park in Messina that extends as far as the coastal, historic, and consolidated city, through the safeguarding of natural and high-natured features, as well as the progressive recovery and restoration of burnt wooded areas using native species.
- *the fiumare landscapes* for which mitigation programs and actions are envisaged for the hydraulic risk and the overall integrated risk system through operations for the improvement of surface waters, the progressive renaturation of natural torrents and the reconversion as tree-lined avenues for those tombed in urban contexts, the elimination of improper uses along the riverbeds, the redesigning of roadbed sections, the reclamation and redesigning of the mouths of the riverbeds in the sea, together with the preservation and enhancement of the Ganzirri and Faro lake landscape and the hydraulic devices built by the British Army in the early 19th century.
- *the landscape-rural matrices* for which measures are envisaged to enhance the agrarian landscapes by safeguarding the connotative features of the agrarian slope landscapes along the river valley hinterlands, the agrarian landscapes on the valley floor characterized mainly by arable crops and irrigated wood crops such as citrus groves and the coastal agrarian landscapes in the sub-plains areas, together with the encouragement of a process of consolidation of agricultural terraces in use and the restoration of those in a state of abandonment, through the promotion of traditional production within rural development policies and plans.
- *the linear coastal landscapes* for which coastal reconfiguration interventions are envisaged through erosion mitigation operations, beach nourishment and redevelopment of sandy shores and the related dune systems through naturalistic engineering techniques together with the preservation, enhancement, and implementation of the back-dunal vegetation by reinforcing the Mediterranean maquis and the Posidonia seagrass beds to overcome their degraded and fragmented condition.
- *the urban ecological constellation* for which regeneration, valorization, and implementation of the existing and potential system of micro and macro-green spaces are envisaged in order to rethink the relationship between the city and open spaces, encourage sustainable management for soil and water,

thus also contributing to implement the endowment of urban standards for a new offer of multifunctional and leisure time spaces through the following declinations.

- *the urban and peri-urban landscapes* for which actions are envisaged to secure and ecologically oriented regeneration of certain critical tissues such as disused urban service areas and buildings or those destined for incongruous and temporary uses, environmentally critical settlements, areas, and buildings for industrial and craft activities that have been partially or totally disused, together with the more general design of ARU urban regeneration areas.

3.2 Guidelines for the design of the settlement system: urban and environmental regeneration areas (ARU)

3.2.1 Design scenarios

In the "Settlement System. Guidelines and Executive Prescriptions" also contains an initial identification of the Urban and Environmental Regeneration Areas (ARU) to be subjected to "Executive Prescriptions". These Areas were identified through the interaction of different interpretative insights:

- the enumeration of high-risk buildings and textiles, as inferable from the "Integrated map of risks and susceptibility to urban transformation", to be affected by demolition interventions without reconstruction in situ and compensatory relocation in safe areas of Messina's territory, without consumption of new soil.
- the location of areas of greatest urban, building, and social decay attributable to precarious and unstructured settlements where more intensive urban transformation and regeneration interventions are needed.
- the identification of parts of the unconsolidated fabric in need of redevelopment and densification to achieve more structured and qualified physical and functional arrangements.
- the selection of waste and derelict areas and buildings requiring recycling and reuse to outline new physical, social, and functional life cycles.
- the identification and extension of ARUs refers specifically to those parts of the territory affected by interventions that require detailed urban coordination and public evidence procedures due to their complexity and urban relevance.

Among these, as a result of the reflections developed, the ARU1 - Areas of high risk exposure and settlement decompression and incremental renaturation - are of particular relevance, in which the buildings and building fabrics falling within the high-risk areas, identified by the "Integrated map of risks and susceptibility to urban transformation", are included, i.e. in which the particular critical condition of exposure to hydrogeological, hydraulic and seismic risks entails the need to provide incentive and rewarding devices of an urban, financial and fiscal nature, useful to solicit compensatory transfers - in ARU2, 3 and 4 - of the volumes to be demolished and demolished, hydraulic and seismic risks entails the need to provide incentives and rewards of an urban, financial and fiscal nature to encourage compensatory transfers - in the ARU2, 3 and 4 areas - of the volumes to be demolished and not rebuilt on site, through planning over time that hinges on the "Register of volumes", on the coordination of the planning and management of interventions with the aforementioned ARUs and on the provision of interventions for the renaturation of the areas affected by demolitions.



Figure 8. Guidelines for the Environmental Infrastructure Project.

4. CONCLUSIONS

With the inclusion of this case study in the Casa Italia experimentation program, the intention is to provide the drafting of the general land-use plan (in Italy abbreviated as PRG) with the knowledge and tools to make urban planning choices that aim at a vision of a "resilient and anti-fragile city" (Taleb, 2013; Blečić and Cecchini, 2016), having as a reference the capacity of a territory to respond with awareness to conditions of stress and change, particularly extensive and intense in the territory of Messina, connected to the interaction of a multiplicity of risks of an environmental nature, thus reducing exposure and vulnerability, without compromising its identity, but rather revitalizing and updating it from a spatial and social cohesion point of view (General Report of the Outline, 2018).

The proposed contribution - in terms of the hypotheses supporting the study, the methodology deployed, the tools used, the experimental framework within which it is set, and the results achieved - fits perfectly into that strand of research that investigates methods and practices, starting from the multiple risk conditions of a territory, in particular a coastal territory, to develop urban plans with an integrated approach to risk mitigation.

The participation as a prototype case of the Municipality of Messina in the Italian Government's mission structure Casa Italia, in which the process of drafting the Preliminary Urban Plan is hinged, constitutes a very important reference on a national and international scale for the drafting of latest-generation Urban Plans that aim at a vision of a resilient and anti-fragile city. In fact, the process illustrated in this contribution builds an exemplary case study in which the sectorial methods typical of traditional Specialised Studies are surpassed. In fact, the Plan's structuring choices are based on the knowledge and awareness acquired through an integrated approach to the risk dimension, in which strategic and priority objectives are based on adaptive and proactive tactics and planning actions. The results achieved can in fact constitute a virtuous model for the Plan, necessarily based on the paradigm of urban and environmental regeneration, the fight against land consumption and the mitigation of risks (including those arising from climate change). This contribution in fact provides:

1) the definition of materials and methods for the construction of a knowledge framework of the territory aimed at returning an Integrated Risk Map, intended as a dynamic and updatable tool, developed and to be interrogated in GIS environments.

2) the definition of the Guidelines for the Environmental and Settlement Systems of the new Urban Plans in which the role of the Blue and Green Infrastructures is central, understood as the new incremental frame on which to base the urban and environmental regeneration of the city as well as the mitigation of risks.

3) the definition of design scenarios in which the SUM - Minimum Urban Structure (to be further defined in the continuation of the drafting process of the Plan itself) is central in the design of the Plan and in the design of the city itself, as well as in the processes related to risk management.

This involved: (a) a circular process between knowledge construction and strategy definition, whereby differentiated objectives and project actions are defined in relation to the risk condition of the areas in question; (b) a multi-scalar approach that leverages mainly on the creation of a network of blue and green infrastructures (Mell, 2015, 2018), starting from the existing ones, capable of counteracting fragile conditions while maximizing biodiversity and the production of ecosystem services, also in the urban context. One of the most innovative aspects - which, however, needs the widest possible sharing among citizens and support in the political action of local administrations - is the identification of the Urban and Environmental Regeneration Areas (ARU) in the "Settlement System. Guidelines and Executive Prescriptions", in which the ARU1 "Areas of high exposure to risks and settlement decompression and incremental renaturation" are of particular relevance, which include buildings and building fabrics falling in high-risk areas, i.e. areas in which the particular critical condition of exposure to hydrogeological, hydraulic and seismic risks entails the need to provide incentive and rewarding devices of an urban planning nature, financial and fiscal nature, useful to solicit compensatory transfers - in the ARU2, 3 and 4 areas - of the volumes to be demolished and not rebuilt on site, through a programming over time that hinges on the "Register of volumes", on the planning

and management coordination of the interventions with the aforementioned ARUs, and on the forecast of interventions for the renaturation of the areas affected by the demolitions. Further innovative elements that define the Urban and Environmental Regeneration Areas (ARUs) and that can therefore constitute a valid model to be followed in similar cases are:
- the localization of the areas of greatest urban, building, and social decay attributable to precarious and unstructured settlements where interventions of more intense urban transformation and regeneration are needed.
- the identification of the parts of the unconsolidated fabric that need redevelopment and densification interventions to achieve more structured and qualified physical and functional arrangements.
- the selection of discarded and abandoned areas and buildings that require recycling and reuse interventions to outline new physical, social, and functional life cycles.

Finally, for the continuation of the research work for the drafting of the new General Regulatory Plan for Messina, in agreement with the Civil Protection, the definition of the Guidelines for the Minimum Urban Structure (SUM), destined to guarantee adequate escape routes, gathering areas and shelter in the emergency phase following calamitous events, must assume greater centrality. The SUM, in this perspective, must also coincide with the network of the primary public space of the urban identity on which to converge as a priority adequate public resources and actions for the growth of social and cultural awareness on the part of local communities, and not only constitute an eventual escape route in relation to a potential calamitous event.

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Revitalizing Urban Governance: Integrating Smart Growth and Decolonial Perspectives for Municipal Empowerment in Shaping Growth Across Egyptian Desert Landscapes

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ABSTRACT

This article explores the connection between Smart Growth and the decolonization of urban growth management in Egypt, examining the impact of former colonial influence on present urban policy and practices. Drawing insights from the urbanization of Egyptian desert areas before and after the New Urban Communities Program (NUCP), it scrutinizes how historical influences adversely affect contemporary approaches, inducing socio-economic impacts. The primary objective is to identify the root causes of misguided urban growth management practices, arguing that mono-institutional and sectoral development is rooted in Egypt's quasi-colonial history preceding the NUCP. The research employs a comprehensive methodological approach, using descriptive qualitative methods to investigate the growth of emerging cities based on Smart Growth principles and quantitative analysis to assess population decongestion resulting from the NUCP. It evaluates the implementation of Smart Growth principles during the NUCP and pre-NUCP, offering insights into adverse management practices. Despite the NUCP's goal to alleviate congestion, only 1.6 percent of the population was decongested by 2017. The research highlights the need for a new municipally guided growth model, emphasizing indigenous and locally validated approaches. This model aims to rectify inefficiencies in current urban management practices, fostering a responsive and sustainable approach aligned with local community needs.

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Highlights:

-Study shows limited population movement from Nile Valley despite the 40-year-old NUCP; highlights need for specific urban planning reforms.
-To achieve Smart Growth the review of NUCP suggests the empowerment of local communities in decision-making concerned with developing new growth areas.
-Research proposes governorate-led, sector-integrated, participatory planning for tailored urban development.
- National efforts in decolonization are yet to be accompanied by empowering local decision-making revitalizing indigenous development models for inclusive growth and decentralized governance in urban expansion.
-Aims to enhance planning expertise for holistic growth and local economic development, supporting Smart growth in new areas.

Contribution to the field statement:

This study contributes by examining the relationship between smart growth principles and the decolonization of urban growth management in Egypt, revealing how colonial legacies continue to influence current urban policies and socioeconomic dynamics.
This study advocates for a new urban growth model based on revitalizing indigenous and context-specific approaches in Egypt, addressing the inefficiencies of current strategies and proposing more community-centred development methods.

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1. Introduction

A post-colonial verification of local urban growth policies contributes to ensuring their compatibility and efficiency in promoting inclusive frameworks that foster localized, inclusive, efficient and contextually relevant urban growth strategies. In the case of Egypt, I argue that the realization of Smart Growth appears to be hindered by the lack of efforts to deconstruct inherent colonial practices and their persistence during the post-colonial era, which influences the way urban growth is guided and managed. This research identifies a gap within the Egyptian context regarding the verification of urban management policies and their alignment with a context-specific production of urban growth.

Colonialism has been identified as a historical force that triggers urban transformations and influences the urban structure (Das, Nag, & Mitra, 2020). In the construction of postcolonial geographies, it is crucial for decolonial, anti-colonial, or postcolonial urban policies to address colonialism and its underlying legacies that have shaped the norms and dynamics of urban growth. By doing so, governments can avoid structural contradictions and promote more context-specific, participatory, and inclusive approaches to growth management.

Colonial endeavours have often disregarded the invaluable knowledge and resources of indigenous communities. Instead, they have chosen autonomous approaches to governance, constructing housing and urban spaces that cater to specific social groups without incorporating local planning mechanisms. This approach not only perpetuates the marginalization of indigenous and local communities but also undermines the sustainable and context-specific development of urban areas. It is crucial to recognize and actively involve local communities in the planning and decision-making processes to create inclusive and equitable urban environments.

Although colonial activities have significantly declined in many parts of the global south since the end of WWII, their impacts continue to pose challenges to sustainability worldwide (Gerend, 2018). Colonialism has played a role in contributing to land-use changes, biodiversity loss, and climate change (Adger et al., 2001). The roots of the ecological crisis can be traced back to colonialism and its associated patterns of inequality and centralized power (Gerend, 2018; Lightfoot et al., 2013; Reo & Parker, 2014) Colonial policies have shaped urban landscapes with segregation, exclusion, and privilege based on race, power, and class (King, 2006). In the post-colonial era, the legacy of colonial urban policy is ingrained in active planning and management practices, influencing institutional structures, legislation, and administrative processes (Rakodi, 1986).

Egypt, designated a British Protectorate in 1882, operated in a quasi-colonial manner, with the British discreetly overseeing and managing its affairs. During this period, the British exerted influence over the economy and deployed their military forces. Predating such a colonial influence, Egypt's development of municipalities as local organizing institutions for the built environment was already underway. The establishment of municipal councils as locally represented bodies for organizing the built environment at directorate levels was evident before Egypt's designation as a British Protectorate in 1882 and parallel to the establishment of the Egyptian Parliament in 1866 (Badr, 2017; Rageh, 2007; Allam and Abdelazeim, 2000). Since then, municipalities maintained a longstanding history of progress until they were dismantled and reinstated as Local Administrative Units by 1960 (Law No. 124/1960) (Alhowaily, 2020).

During the quasi-colonial era, colonial urban planning resulted in inadequate transfers to the Egyptian city promoting patterns of segregation within societies and inducing problematic and unfavourable goals that altered societies in a permanent fashion (Libchaber, 2019). In this article, I argue that such inadequate transfers have been persisting with influence on institutional structures and programs managing urban growth. I problematize the underperformance of the present New Urban Communities Program (NUCP) in Egypt in decongesting the densely populated Nile Valley and Delta regions. I argue that the underperformance can be partly attributed to the legacy and influence of colonial planning policies deeply embedded within institutional and legislative structures. These policies are characterized by centralization, sectoral planning, insufficient institutional capacity, and fragmented, non-integrated approaches. The central argument emphasizes how these policies undermine the incorporation of Smart Growth, as a proactive strategy that addresses social inclusivity and environmental justice (Khodeir, Elsisy, & Nagy,

2016). Smart Growth has become a central policy aimed at creating developments that serve society, the economy, public health, and the environment. It represents a paradigm shift in deconstructing policies of unchecked and misguided urban growth while promoting the development of economically stronger and socially diverse communities. By integrating and implementing the principles of Smart Growth alongside other fundamental subsystems that contribute to the umbrella of sustainability, it has the potential to effectively combat urban sprawl and address climate change in an integrated, comprehensive, and interchangeable manner (Freilich, Sitkowski, & Menillo, 2010). In the following discussion, I aim to elaborate on how post-colonial policies and practices can undermine Smart Growth, with a particular focus on three specific Smart Growth principles that are most affected: first, making development decisions predictable, fair, and cost-effective; second, encouraging community and stakeholder participation in development decisions; and third, intensifying and directing development toward existing communities.

1.1. The Encouragement of Community and *Stakeholder Participation in Development Decisions*

Citizen participation helps reinforce urban development plans and ensures the presence of community support when making difficult decisions (Duany et al., 2010). Encouraging community and stakeholder participation in development decisions at the local level helps reduce reliance on top-down approaches that have limited capacity to recognize the diverse needs and aspirations of the local community and indigenous growth patterns. A postcolonial city is prone to be influenced by the legacy of colonialism and its construction of knowledge (Radcliffe, 1997), where inclusive attempts to indigenize urban space can be undermined by external control of power and capital (Davey, 2021). Colonialism enforces social change through cultural domination as a colonial city resembles "a distinct settlement form resulting from the domination of an indigenous civilization by colonial settlers" (Horvath, 1969). In the lack of proper urban representation in placemaking, the indigeneity of urban growth patterns becomes absent or less intertwined with the local urban fabric.

1.2. Make Development Decisions Predictable, Fair and Cost-effective

Fair and cost-effective allocation of resources, considering social equity and spatial justice, is a key component of sustainable regional planning policies (Soja, 2013). In a colonial city, where economic exploitation takes precedence, land and resources are often consumed without transparency, consistency, and verification of development decisions. In the post-colonial era, governmental organizations with superior authority and jurisdiction may inherit such practices, which conceal and withhold development decisions from the scrutiny and input of the local community. This prevents critical examination of the costs associated with development projects by the local community.

1.3. Intensifying and Directing Development toward Existing Communities

Directing development away from existing communities results in a disconnect between new developments and the needs of indigenous communities, their culture, and socio-economic conditions. This approach may also indicate an intention to economically separate the new development from the existing power dynamics of the old community, redirecting it outside their jurisdiction and control. The physical distance from existing communities can be exacerbated by the creation of gated communities and the physical segregation of social classes. It is important to highlight here that in formerly colonized countries, colonial capitalism was intertwined with racial segregation (Lightfoot et al., 2013). Traces of this policy can be observed in the planning and construction of new settlements during the postcolonial era, where the segregation of social classes is promoted to generate exclusive economic benefits for certain state authorities and market powers.

Table 1) provides a summary and further elaboration on how colonial/post-colonial associated policies/practices can impact the three specific Smart Growth principles discussed above. The impacts will be addressed while investigating the pre-NUCP and NUCP eras.

Table 1. Exploration of the main Smart Growth principles impacted by colonial policies/practices.

Smart Growth principles		Colonial/post-colonial associated policies/practices
(j)	Encouraging community and stakeholder participation in development decisions.	• Centralized and mono-institutional development with superior authority and jurisdiction, often lacking coordination with the local community. • Exclusion of local vision and objectives, with a failure to consult the collective wisdom of the local community and potential stakeholders in guiding urban growth. • Prioritization of colonial/post-colonial interests over local interests. • Use of imported masterplans for new settlements, enforcing them without local verification and often overriding local needs.
(I)	Make development decisions predictable, fair and cost-effective.	• External institutions and economic factors play a dominant role in managing and realizing urban growth, often overriding local structures. • Mono-institutional planning and development, without sufficient collaboration between different stakeholders. • Top-down decision-making and non-participatory governance and master planning processes. • Lack of bottom-up decision-making and consultation with the local community. • Open-ended concession and exploitation without proper regulation.
(g)	Intensifying and directing development toward existing communities.	• Spatial segregation favours more affluent classes and contributes to social disparities. • Lack of spatial justice in the distribution of resources and services. • Absence of integrated regional projects that consider existing communities and their growth potential. • Unbalanced development schemes resulting from exclusive exploitation of suburban land.

Source: Author

2. Material and Methods

This research commences with a systematic literature review on Egypt's establishment of new cities in both desert and non-desert areas throughout its modern history. Using qualitative research methods, the study aims to understand the objectives, growth patterns, and institutional and governmental frameworks that drive the development of these new cities. Furthermore, the research investigates the principles of Smart Growth implementation to identify any contradictory urban management policies that may be influenced by colonial practices and evaluate their potential to hinder Smart Growth. In this study, the focus is on examining the underperformance of Egypt's New Urban Communities Program in its aim to alleviate congestion in the densely populated Nile Valley and Delta regions. It is argued that this underperformance can be attributed to the longstanding influence of colonial planning policies, which have deeply influenced the institutional and legislative structures of the program. These structures are characterized by centralized decision-making, sectoral planning approaches, inadequate institutional capacity, and a lack of integration and cohesion in planning strategies.

In a quantitative approach, the research analyzes the national demographic census to provide insights into the population of Egypt's new urban communities. This analysis includes the percentage of the population in relation to the total population and its distribution across urban and rural areas. The demographic census used in the study is sourced from the Central Agency for Public Mobilization and Statistics (CAPMAS) and is based on the agency's most recent detailed census from 2017.

The research examines newly constructed towns and cities in both desert and non-desert regions, incorporating a historical context that references the colonial and post-colonial periods. By analyzing this information and the resulting findings, the research proposes a new urban policy model aimed at effectively managing growth in both the Egyptian desert and non-desert areas. This model seeks to

eliminate potential practices associated with the colonial era and emphasizes the importance of reforming the institutional structure.

The research categorizes Egypt's construction of new cities into two eras: The Pre-New Urban Communities Program (Pre-NUCP) and the New Urban Communities Program (NUCP) (Figure 1). While the objectives of building new cities should have differed significantly between these two eras, this article aims to identify similarities and draw associations between the practices during the colonial and post-colonial periods. The discussion will also emphasize the impact of colonial policies/practices on the main principles of Smart Growth.

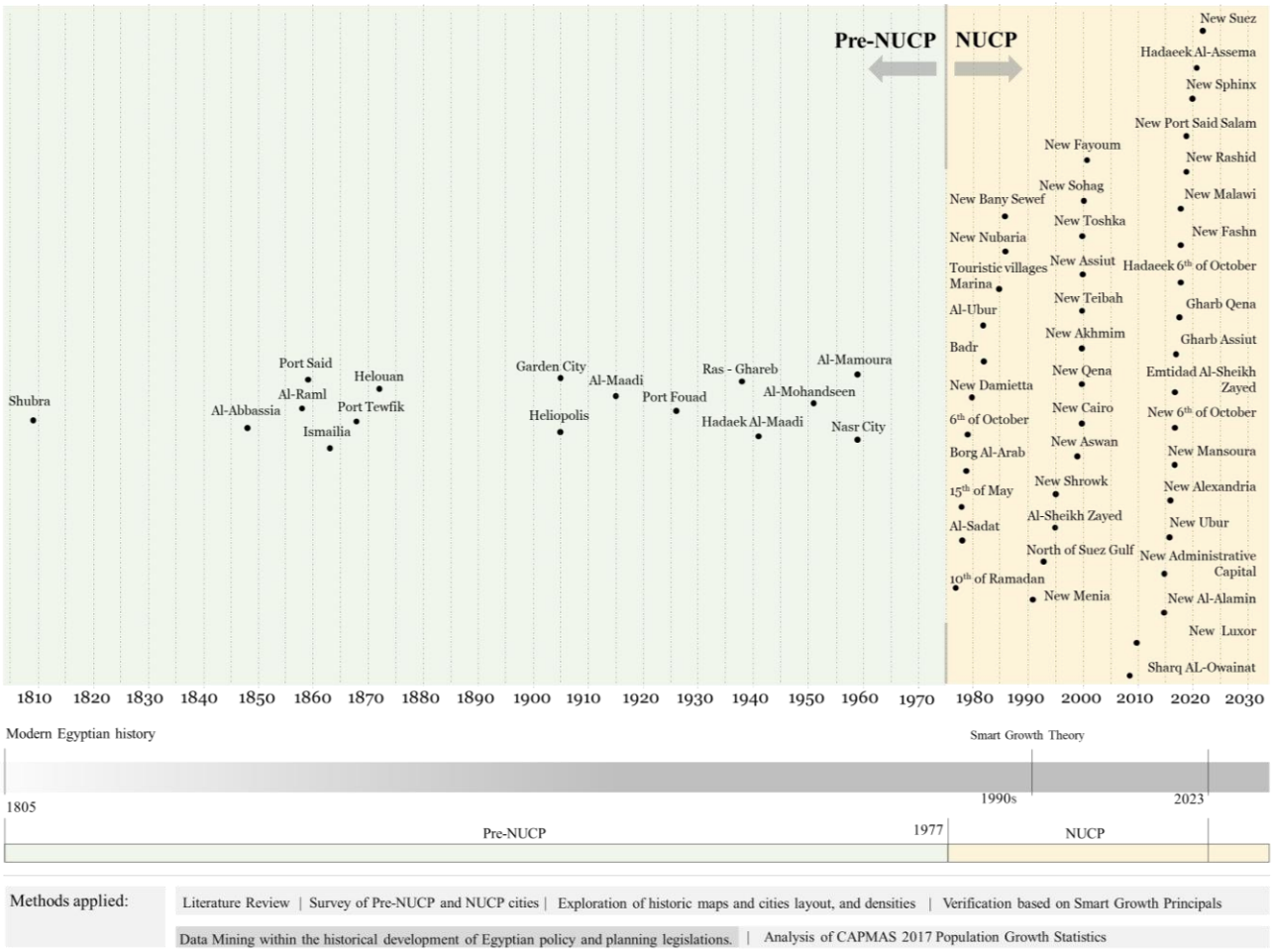


Figure 1. Survey of Pre-NUCP and NUCP cities and the research methods applied for investigation. Source: Author.

3. Results

The following two sections aim to highlight the results of the literature review regarding the development of Egyptian cities and towns during two eras: the pre-NUCP and NUCP. Additionally, the pre-NUCP section investigates the colonially influenced cities and post-colonially influenced cities.

3.1. Egypt's Pre-NUCP Colonially Influenced Cities

This part attempts to present a thorough review of the establishment of new desert cities, towns, and suburbs before the NUCP era and during Egyptian modern history. Despite the considerable effort put into the review and investigation of these settlements, it is possible that many others could not be listed, for either being relatively small urban extensions or since these settlements are not sufficiently cited in the literature. Figure 2) presents the mapping of pre-NUCP cities.

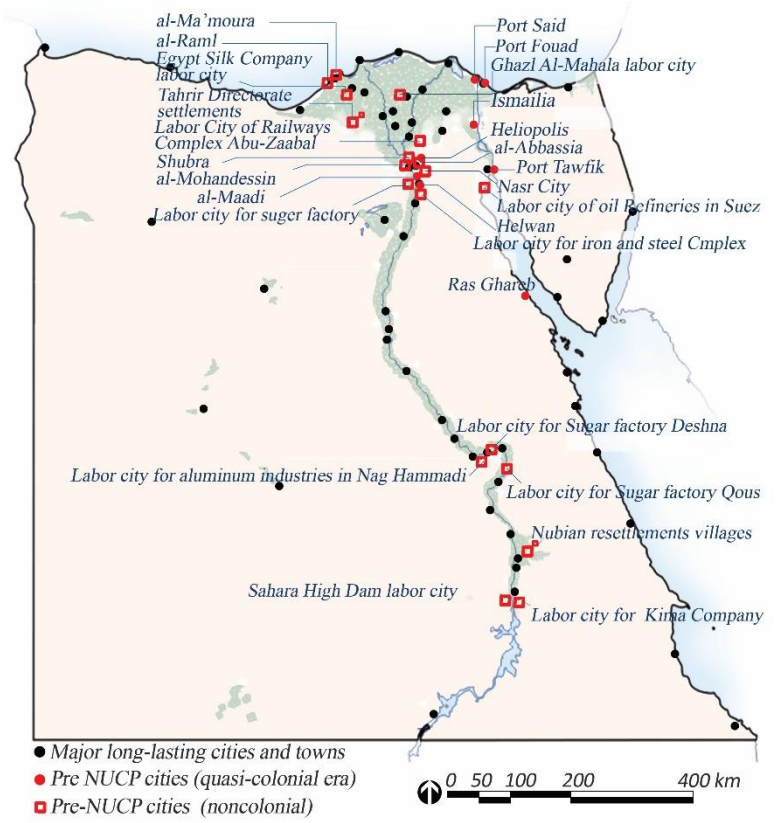


Figure 2. Egypt's pre-NUCP cities.

For centuries, Egypt's earliest settlements adhered to a consistent pattern along the Nile Valley, leveraging the water source, transportation corridor, and fertile areas along the Nile coasts. These communities relied heavily on agriculture having access to freshwater and fertile land. Throughout its modern history, the transition from this pattern to urbanization in remote desert areas seems to have been influenced not only by technological advancements in transportation but also by diverse socio-economic factors, including those attributed to foreign and quasi-colonial interests. One of the key arguments made by Mitchell (1988) is that colonial urban development in Egypt was not just about physical infrastructure or the spatial reorganization of cities; rather, it was deeply intertwined with power structures, ideologies, and the imposition of new forms of governance by the colonial authorities. Colonial Powers transformed cities reorganizing social hierarchies, land ownership, and the creation of distinct zones that segregated different populations based on ethnicity, class, and nationality (Mitchell, 1988).

Cairo, the old traditional and compact city, has witnessed various urban extensions and suburban developments throughout its history. In many Arab cities, social, economic, legislative, and functional changes have contributed to the introduction of new architectural and urban forms (Mohamed, 2021). One such development during the precolonial era was Shubra. In 1809, Shubra was chosen as the location for a new palace for Muhammad Ali and was further developed to the north of Cairo on fertile agricultural land. Over time, it gradually merged with Cairo after being connected by tramways in 1904. In addition to Egyptians, Shubra gradually experienced increasing dominance of European occupants, mainly Italians, Greeks, Armenians, and French, until the colonial era (Afifi, 2016).

In cosmopolitan Alexandria, Reimer (1988) illustrated, referencing the remarkable work of Ali Mubarak's al-Khitat, that unlike many urban expansions in Alexandria that were contiguous to the main city, er-Ramleh or al-Raml emerged as a suburban development near a small village called al-Ramlah (Reimer, 1988). Situated ten km away from downtown Alexandria, this area began gaining importance and attracting residents due to soaring land prices in Alexandria and the limited opportunities for expansion within the established city. Initially, al-Raml was illegally occupied by the Franks despite the regulations imposed on its location due to its military importance. However, when they were not easily

relocated, al-Raml was soon spared from military use. It was physically planned to accommodate the increasing population and connected by railway to Alexandria, allowing people to commute with ease (Reimer, 1988). The railway connection was made through a concession granted to a British national named Sir Edward Firmin. In 1862, he established a joint-stock company named Strada Ferrata tra Alessandria e Ramleh, later recognized as the Alexandria and Ramleh Railway, operating under a concession from the Alexandria Municipality (Raafat, 2018). The railway, which was electrified in 1904, played a significant role in al-Raml's development and helped to subdivide the suburbs into districts that were clustered around the stations.

Within the Suez Canal Region, the development of Port Said, Ismailia, Port Fouad, and Port Tawfik was not solely a result of the Suez Canal project. It was also a crucial part of the creation of a new canal built by the Khedive Ismail Pasha, known as the Sweet Water Canal or Isma'iliyya Canal, which branched from the Nile Delta and traversed the desert to reach the hinterland of the Suez Canal region (Mitchell, 1988). It is important to emphasize that the Universal Company of the Maritime Canal of Suez, with the French being the most prominent and influential stakeholders, had a major influence in the development of both Ismailia and Port Said, having obtained concessions from the Egyptian Government (Crosnier-Leconte, Ghitani, & Amin, 2006). Additionally, during the early stages of their growth, both cities operated independently of any municipal jurisdictions associated with state municipal jurisdictions. Port Said was established in 1859, while Ismailia was transformed from an old village into a city in 1864 (Carminati, 2019). The planning of both cities revealed a colonial influence, particularly evident in the design of the European neighbourhoods and Arab quarters. There were noticeable disparities in the quality of urban design and housing types between these areas (Abbas et al., 2006).

The development of the Isma'iliyya Canal propelled the reclamation of vast desert lands for agriculture. Simultaneously, it spurred the urban development of settlements, both rural and urban spanning from Cairo to Port Said. The canal played a vital role in establishing a new regional capacity, which served as the economic foundation for the newly established cities in the Suez area, including Ismailia, Port Said, and Port Fouad (Rageh, 2007), as well as several new towns and villages such as al-Qassasin, Fayd, al-Qantara and others (Sims, 2014). Another integral aspect was the construction of a railway line parallel to the new Ismailia Canal, which served to connect the newly developed cities and villages. This railway line facilitated efficient connectivity between these areas and the old urban centres.

In Cairo, after the development of Shubra, new developments emerged with the increasing migration to Cairo. These included al-Waily, Qoubba, Zamalek, Garden City, al-Helmia, and Sakakini. Many of these areas benefited from the development of railway and tram networks, which contributed to a thriving real estate market. During this period, numerous private companies began purchasing land in the peripheral areas of Cairo. They developed infrastructure and built housing stocks for sale or rent to individual customers. Some notable companies involved in these developments were the Egyptian Delta Land & Investment Company, Cairo Electric Railways and Heliopolis Oases Company, the Qubba Company for Development, and al-Dokki Land and Investment Company (Mahrous, 2006).

Concessions were granted to companies of European origin, the English were to develop the suburbs of Maadi south of Cairo, a Belgian investor was to build Heliopolis to the east, and an Italian company was to develop al-Mokkatam Hills (Hegab, 1985). Furthermore, railways and tramlines were prosperous, during this era, and the development of a railway network along water canals helped establish a development corridor south of Cairo including the cities of al-Maadi, Ma’sarah and Hamamat Helouan. The latter was built in 1879, at a location about 25 km to the south of Cairo. The city was dependent on a railway line built in 1872 to provide a connection with Cairo. Hamamat Helouan was annexed to Cairo Tanzim Organisation from its establishment until Helouan had its first Municipal Council in 1891 The establishment of the railway preceded the establishment of the suburbs in 1871 (Israel, 2018), and the Junction of Helouan Railway, holds the distinction of being the oldest suburban station in Cairo region. The first tram network in Cairo was inaugurated in 1894 (Dobrowolska & Dobrowolsky, 2006), Just two years later, seven tram lines were operational, including one that connected downtown Cairo and the al-Abbassia area. This line was later extended to the new city of Heliopolis.

Concessions were granted to European companies during this period. The English were granted concessions to develop the suburbs of Maadi, located south of Cairo. A Belgian investor was responsible for the development of Heliopolis to the east, while an Italian company took charge of developing al-Mokkatam Hills (Hegab, 1985).

During this era, the construction of railway networks along water canals played a crucial role in establishing a development corridor south of Cairo. This corridor included the cities of al-Maadi, Ma'sarah, and Hamamat Helouan, which were built in 1879, approximately 25 km south of Cairo. The city of Hamamat Helouan relied on a railway line built in 1872 to connect with Cairo. It was annexed to the Cairo Tanzim Organization until Helouan established its first Municipal Council in 1891. The establishment of the railway preceded the establishment of the suburbs in 1871 (Israel, 2018).

The first tram network in Cairo was inaugurated in 1894 (Dobrowolska, A., and Dobrowolsky, J., 2006). Just two years later, seven tram lines were operational, including a line that connected downtown Cairo with the al-Abbassia area. This line was later extended to the new city of Heliopolis.

The Egyptian Delta Land & Investment Company took the initiative to purchase land adjacent to the railway tracks to plan the development of al-Maadi. Similarly, the development of al-Koubbeh to the Northeast was influenced by its spatial proximity to the railway. The Qubba Company for Development also purchased approximately 100 feddan of land in that area. As the suburbs continued to expand, they eventually merged with the existing settlements of Cairo.

Although both al-Maadi and Heliopolis were established in 1905 and had similar scales, they can be differentiated in terms of their contribution to the existence of more diverse and extensive activities, facilities, and infrastructure. Garden City, located south of the new centre of Cairo, had an organic plan with winding streets, primarily serving residential purposes. On the other hand, al-Maadi was primarily comprised of villas and some local businesses (Ilbert, 1981).

3.1.1 Egypt's Pre-NUCP Post-Colonially Influenced Cities

After the British domination of Egypt had gradually subsided during the 1940s, Egypt's post-colonial cities and towns started to emerge. After Cairo became a municipality in 1949 (Abu-Lughod, 1971), the growth of new districts and cities have been municipally regulated such as al-Awaqaf City, later known as al-Mohandeseen, and Nasr City (Allam and Abdelazeim, 2000). However, national plans were aimed at industrial development and the creation of labour cities that were integral to new industrial complexes located in close proximity to existing cities or villages within the Nile Delta. Some notable examples of these cities include Ghazl al-Mahala labour city, Egypt Silk Company Labor city in Kafr al-Dawar, and the Labor City of Railway Complex in Abu-Zaabal (Rageh, 2007).

When examining the location of these cities on historical maps, it is important to note that they were not constructed in desert areas, but rather on agricultural land near newly established factories or existing cities and villages. One such example is the development project of the Tahrir Directorate, situated west of the Nile Delta, which aimed to expand agricultural land by creating new irrigation canals and establishing new villages. This project played a crucial role in increasing agricultural space and productivity.

Following 1952, the responsibility for the development of numerous new cities primarily fell on a government company known as Sharikat al-Ta’meir Walmasakin al-Shabeia (The Construction and Popular Housing Company). It is important to note that the development of these cities was not solely a result of President Nasser's new scheme, but rather a continuation of the policy that had already established new developments like Ghazl al-Mahala Labour City and Kafr al-Dawar Silk Company City in the preceding era (Rageh, 2007).

Consequently, the policy of constructing new settlements within the Nile Valley continued, but there was a gradual shift towards developing desert areas to fulfil the housing needs of major industrial projects. For instance, the Sahara Labor City, established around 1960 in Aswan, was designed to accommodate both Egyptian and foreign workers involved in the construction of the High Dam (Reynolds, 2017). Similarly, the Labor City for Aluminum Industries in Nag Hammadi was established around 1971. Overall, the development of these new settlements was implemented as an integral part of the agricultural

and industrial development strategy (Rageh, 2007). Because these industrial settlements are small-sized towns intended to serve the industry and specifically tailored to meet the needs of temporary residents and labourers, they are not included in the survey of pre-NUCP cities listed in (Figure 1).

3.3. Egypt's NUCP Cities

In contrast to the diverse planning and development institutions responsible for Egypt's pre-NUCP cities, all of Egypt's New Urban Communities (NUCs) established during the NUCP era (Figure 3) fall under the responsibility of NUCA, the New Urban Communities Authority. However, the idea of building new cities through a system synonymous with concessions still persists, with the top-down, non-participatory establishment of cities. NUCA is a national government body that operates under the Ministry of Housing, Utilities, and Urban Communities. It was established as the driving force behind conquering the desert and implementing the New Urban Communities Program (NUCP), the government's primary program for planning future housing supply and managing urban growth in Egypt. The NUCP represents a much more centralized development model not only representing the regulator but also the planner and owner of public land.

According to the New Urban Communities Law, the sole responsibility for planning and developing new settlements outside of existing cities and villages is designated to NUCA, as stated in (Article No. 1 of Law No. 59/1979). Although these settlements may be situated within the governing jurisdiction of Local Governorates, NUCA holds the authority to select suitable sites and prepare both general and detailed plans in accordance with the General State Plan. Figure 3) illustrates the locations of Egypt's new cities, also referred to as NUCs, developed by NUCA. According to law, NUCA has the exclusive right to plan and development of new settlements outside the current cities and villages, even if these settlements are located within the jurisdiction of Governorates, as stated in (Law No. 59/1979, Article No. 1). NUCA has the authority to select suitable sites for new settlements, as well as plan and prepare general and detailed plans in accordance with the General State Plan.

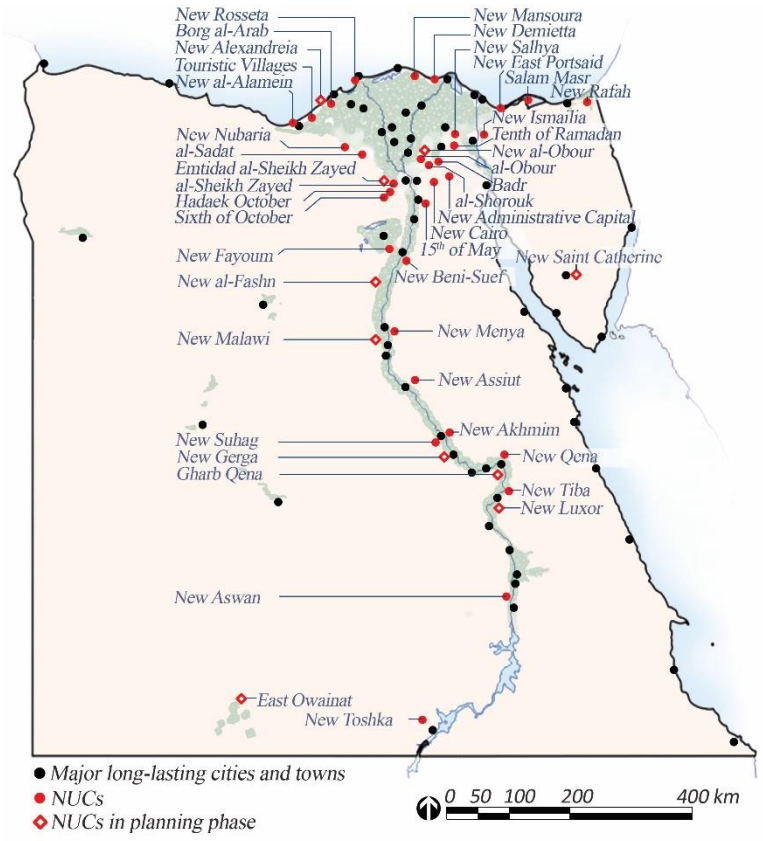


Figure 3. Egypt's NUCP new cities.

Based on the proposal of the Ministry of Housing, Utilities, and New Urban Communities, once the basic components of NUCs are completed, they can be annexed to the local governance units to fulfil their responsibilities (Article 50). Without this proposal, NUCs remain independent of the local supervision of the municipalities in the hosting governorates and are not subject to administrative or financial annexation by the governorates (Article 50). The funds of the Authority belong to the State's Private Funds and are not included in the General Budget of the State or the Governorate (Law No. 59/1979, Articles No. 31 and Article 50). Foreign planning firms were entrusted with providing plans for new cities due to their expertise and practical experience in the field of planning (Hegab, 1985). The names of NUCs combine the name of the nearby established city with the addition of the word 'new,' or 'el-gedeeda' in Arabic, such as New Mansoura, New Qena, and New Aswan. For example, New Mansoura, or 'al-Mansoura el-gedeeda' naming implies a top-down perspective on the location of the new settlement but does not sufficiently highlight the local contextual name of the NUC, which ought to be derived from the local history culture, geography, narratives, or community preferences.

It's worth emphasizing that many of the first-generation NUCs were initiated by foreign consulting firms (Sims, 2014). According to Law No. 59/1979 law, NUCA is not obliged to include community and stakeholder participation in development decisions during the planning process of NUCs. Unfortunately, the existing urban local administrative system lacks inclusivity and fails to facilitate local participation (Ibrahim & Singerman, 2014). If the decision is that the social and economic dimensions are not to be subject to community consultation, the environmental challenges are critically important to address, and the involvement of public participation in environmental decisions is crucial (Hegazy et al., 2017).

Currently, there are a total of 40 New Urban Communities (NUCs), with 7 NUCs currently in the planning phase. Most of these NUCs are physically separated from their original cities and are located in desert areas. The initial goals of the New Urban Communities program, as stated by Abdel-Kader and Ettouney (2009), included addressing the lack of urban land for development and the housing shortage, improving the deteriorating urban fabric, weak infrastructure, and facilities, as well as overcoming low-quality living conditions. Although the progress achieved over the construction of NUCs is significant in terms of the physical expansion of urban structure and infrastructure, Many NUCs at present are notorious for expanding in low housing densities contributing to urban and suburban sprawl (Gouda, Maryamsadat, & Houshmand, 2016). Furthermore, notable drawbacks are manifested in failing to achieve their target population, maintaining a balanced socio-economic ratio, assisting lower-income groups in attaining relative independence and autonomy, and creating a sustainable and high-quality living environment, as pointed out by Abdel-Kader and Ettouney (2013). Egypt, as a predominantly rural country, has 57.8 percent (54,558,420 inhabitants) of its population living in rural areas and 42.2 percent (40,240,470 inhabitants) living in urban areas, as reported by CAPMAS in 2017 (see Figure **4**).

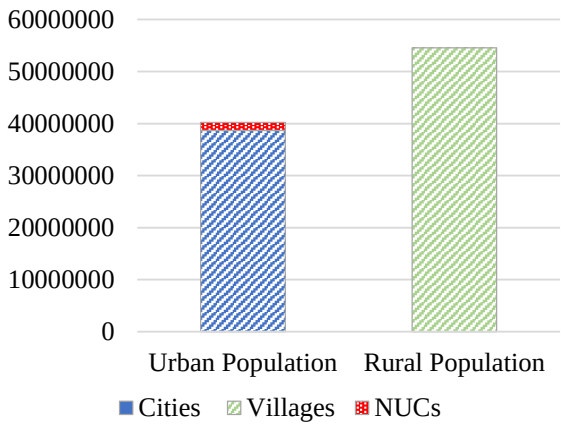


Figure 4. Urban and rural population in comparison to NUCs population in 2017
Source: (CAPMAS, 2017).

In 2006, after 27 years since the initiation of NUCP, the population of NUCs amounted to 783,103 inhabitants (Sims, 2014), which accounted for 1.1 percent of the total national population at that time. Surprisingly, 11 years later, after 40 years of building NUCs, all NUCs in Egypt recorded a population of 1.6 percent of the total inhabitants of Egypt, with 1,583,517 inhabitants out of 94,798,827 in 2017 (CAPMAS, 2017). This percentage is consistent with the findings presented in the study by Hegazy and Moustafa (2013) and the data provided by CAPMAS (2017), which estimated the earlier population in all NUCs in 2006 to be 1.06 percent of the national population. The detailed population numbers per NUC are presented in (Figure 5). The largest population numbers are concentrated in the cities of 6th of October, New Cairo, and 10th of Ramadan. Among the least populated cities are New Teibah, New Fayom, New Sohag and New Aswan. The latter, despite being initiated in 1999, has the lowest population number.

It is crucial to emphasize that the detailed national population census from CAPMAS 2017 enumerates the permanent population residing in NUCs. However, the daily commuting population to NUCs, although significant, is not included in this census. This discrepancy might explain the population estimate of NUCs reported on NUCA's website, which is equivalent to 8.9 million per capita by 2023.

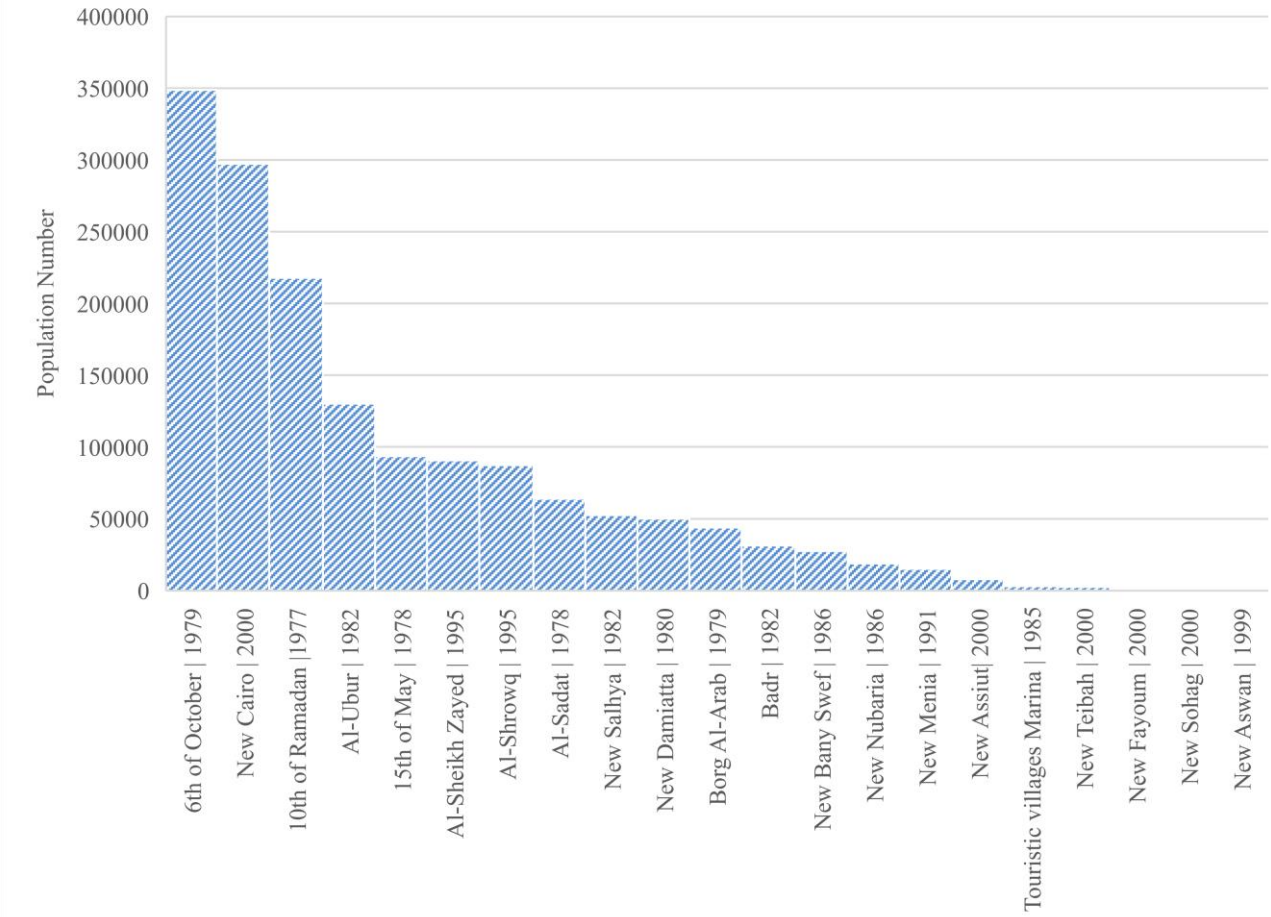


Figure 5. The population of NUCs recorded by the detailed census conducted by CAPMAS in 2017
Source: (CAPMAS, 2017).

Furthermore, the NUCP primarily focuses on decongesting the urban population rather than the rural population. If we consider all NUCs to be urban, their population represents only 3.9 percent of the total urban population in Egypt, as shown in the preceding (
Figure **4**). These numbers provide compelling evidence that the NUCP, during 40 years of building new cities, is significantly underperforming in terms of decongesting Egypt's rural areas. The continuation of such an unchecked policy clearly indicates the program's incompatibility with the national objective of meeting the needs of a larger segment of Egyptian society. The rate of national population growth, in

relation to the population growth of NUCs, is illustrated in (Figure 5), presenting that the national population nearly tripled between 1986 and 2017, the NUCs have shown limited ability to cope with such exponential growth.

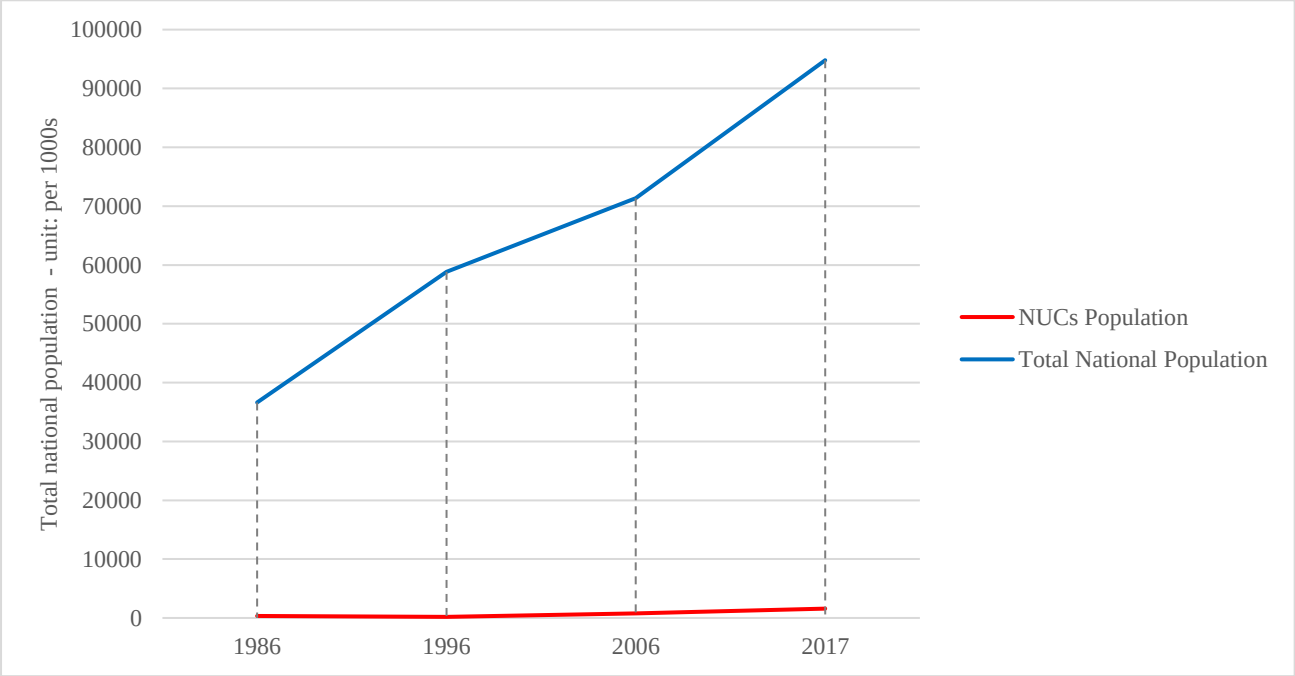


Figure 6. CAPMAS 10-year interval national population census compared to NUCs.
Source: Compiled by author based on (CAPMAS, 2017; and Alhowaily, 2020).

Due to the legal detachment of the subordinated NUCs apparatuses of NUCA the jurisdictions of local governorates, predicting development decisions from a regional perspective and coordinating the development of NUCs become extremely challenging. In other words, development often neglects the inside-out approach, where 'inside' represents the heart of existing cities and 'outside' represents the new growth frontiers of NUCs. It's essential to note that, as of the publication of this article, Law No. 116/2011 has been in effect dismantling elected popular councils in all governorates (article 1) and replacing them with temporarily appointed councils by the Prime Minister, based on the presentation of the Ministry of Local Development and the Governors. In this way, the governance mechanism and legal structure offer limited transparency and local verification of future decisions.

Since NUCA is a state authority and not an enterprise or corporation entrusted by the municipal level at governorates, economic decisions and activities are top-down and centralized, lacking joint verification and mutual review from multiple stakeholders, particularly at the local level or even shareholders in the case of being an enterprise. Consequently, community and stakeholder participation in development decisions is legally restrained on the level of governorates, thus, the local validation mechanisms that these decisions will be predictable, fair, and cost-effective are limited. Legally, according to Article 50 of Law No. 59/1979, NUCs are supposed to be transferred to the local governorate and integrated into its governance and financial structure, subject to approval by the Housing Utilities and Urban Communities Ministry and the completion of their basic components. However, in reality, such transfers have never taken place, resulting in NUCs operating without the involvement of participatory governance and municipal jurisdictions during the planning, construction, and operational phases.

To intensify and direct development towards existing communities, it is crucial for the NUCP to prioritize rural development. Until recently, in 2018, NUCA was legally prohibited from establishing NUCs within areas undergoing re-planning in existing cities and villages under the control of governorates. However, with the approval of the cabinet and the competent authority of the corresponding area, NUCA has been

granted this authority. This change is evident in Law No. 1/2018 Amendment to Law No. 59 for the year 1979, Article 1.

4. Discussion

This research examined different urban policies related to the construction of new cities in Egypt, focusing on both the colonial and post-colonially influenced eras. The unique nature of planning new cities in Egypt arises from the impact of various governance and planning systems that have been employed under changing geopolitical and economic conditions. Each era had its pros and cons; however, the NUCP era is still questionable in terms of meeting its initial planning objectives and responding to local development needs. It is essential to emphasize the importance of assessing how good urban governance aligns with the existing legal and institutional frameworks in Egypt. Proactive measures should be taken to address inadequate institutional arrangements, limited comprehension of legislation, and ineffective management structures for urban development, (Elsisy et al.,2019).

Decolonization is interpreted as the process of achieving political independence and the transfer of authority from colonial powers to local and native governing bodies (Ashar, 2015). There is no doubt that Egypt has already made this shift to a large extent on the national level. However, it is vital to address the legislative and institutional methods of managing urban growth at the local level and review their efficacy in reinforcing indigenous and local representation. Egypt's approach to spatial strategic planning has been inconsistent when it comes to preserving and promoting the progressive development of indigenous knowledge and expertise. This inconsistency hampers the establishment and sustainability of municipal institutions, which are crucial for effectively managing and regulating urban growth (Alhowaily, 2020).

Population growth rates in NUCs in relation to old cities and villages can be considered as one of the indicators for the decolonization of urban policy. Those rates reveal that these cities do not cater to the specific housing needs of most Egyptians. With only 1.6 percent of the total inhabitants decongested from the Nile Valley and Delta until 2017 (CAPMAS, 2017), the performance of the NUCP in attracting the population is significantly underperforming and contributing to various socio-economic impacts of overcrowding in old cities and villages.

According to the (CAPMAS, 2017) census concerning the population growth rate, Egypt's population is growing at a rapid pace with a 2.56 percent average population growth rate between 2006 and 2017. The country nearly adds an equivalent size of the population of Ireland or New Zealand every two years, and Finland or Denmark every three years (Ikram, 2018). This underscores the necessity for new cities to efficiently accommodate population growth, especially considering the limited agricultural land already facing encroachment from uncontrolled urban sprawl. Egypt has recently paid special concern to linking NUCs within their proximate existing cities especially within the Greater Cairo Region through various transit systems (Kafrawy, Attia, & Khalil, 2022), a step that ought to accelerate population growth in NUCs. Additionally, NUCA started to offer denser urban models of urbanization in the New Administrative Capital and many other NUCs.

However, to effectively channel development towards the existing communities within the congested Nile Valley and Delta, post-colonial new city planning must depart from the colonial legacy of establishing new towns and cities that primarily benefit a narrow segment of society. This approach disregards the collective well-being and the need for coordinated growth management between existing and emerging urban patterns. Greater attention should be paid to the needs of the broader societal segment, which remains predominantly rural rather than urban.

The NUCP's primary limitation, before the 2018 legal amendment (Law No. 1/2018), was its inability to engage in rural development projects and initiate integrated urban development initiatives that revitalize rural housing in both rural areas and their desert hinterland. This responsibility lies within the domain of the GRPAD Authority, which oversees agricultural development in desert regions. The question remains whether the NUCP or GARPAD, the General Authority for Rehabilitation & Agricultural Development Projects, should undertake this role in a centralized and non-integrated manner, or whether it should fall under the responsibility of governorates and their local planning and governance structures, adopting a

decentralized yet coordinated approach. In this manner, new cities hold the potential to make significant contributions to the implementation of Smart Growth principles and foster community and stakeholder participation in development decisions, thereby rendering these decisions more predictable, fair, and cost-effective.

During the colonial era, many Egyptian towns and cities were built with concessions granted to foreign entities. Similarly, during the national era, the NUCP has exclusive rights to build NUCs without adopting an integrated and inclusive model of development that addresses local interests. Developing a new town without local authority and coordination poses significant challenges to coordinated growth, self-organization, and the involvement of governorates' urban and rural centres in mutual growth dynamics. It also eliminates opportunities for consultative decision-making in a participatory approach and reinforces top-down planning and governance. In order to balance growth and de-growth dynamics, there is a need to shift the focus toward establishing and promoting a dynamic and inclusive urban political environment. (Vansintjan, 2018).

Not all colonially influenced cities in Egypt were inherently flawed in their approach to addressing social integration between classes. For instance, Heliopolis was initially designed with two separate oases, one for the working class and the other for the more affluent classes. However, in response to the financial crisis of 1907, it evolved into a relatively integrated entity to save construction and infrastructure costs (Ilbert, 1981). On the other hand, while several architectural features in Heliopolis were culturally appropriated from traditional Islamic architecture, its architecture demonstrates the potential for having sensitivity towards local identity. This sharply contrasts with many of today's New Urban Communities (NUCs), which implement standardized social housing models across various contexts and climate regions without considering climate or local identity. This lack of consideration is evident in NUCs in Cairo and Aswan (Alhowaily, 2022).

During the pre-NUCP quasi-colonial era, the planning of new cities in Egypt was influenced by foreign interests rather than local ones. In this era, the needs of foreign target groups took precedence over the needs of the local Egyptian community. Similarly, during the NUCP, the decision-making process for new urban communities follows a centralized approach that utilizes a limited and ineffective toolbox in addressing the local development needs. The focus remains on targeting a narrower segment of society. In both eras, we observe separate and mono-institutional governance mechanisms that operate independently without the obligation to share the benefits of growth with the governorates or municipalities in which they operate. Furthermore, land governance policies are based on unverified and outdated planning theories, leading to segregation and monotonous land utilization (Alhowaily, 2022).

5. Conclusion

Egypt, having endured various colonial eras, has experienced significant political transformations and instabilities throughout its colonial and post-colonial history. The national efforts in the decolonization of urban growth policy and practices are yet to be accompanied by empowering local decision-making and building context-specific frameworks and strategies for urban development. Decolonization is a complex process that involves actively dismantling the legacies of colonization in governance. This includes critically examining historical injustices, acknowledging and addressing grievances, and challenging the limitations of former Eurocentric approaches to justice (Asadullah, 2021). Efforts to harness collective intelligence in customizing housing and infrastructure to respond to the socioeconomic needs of local communities will help accelerate the population growth rates in new towns and cities. With an achievement of only 1.6 percent of the total population decongested to NUCs until 2017, and after nearly 40 years of initiating the NUCP, Egypt's New Urban Communities Program has significantly fallen short of reducing population congestion in the Nile Valley and Delta.

This is a wake-up call to review and re-evaluate the management policy for building new cities in Egypt in terms of compatibility with addressing community needs and serving the wider section of Egyptians. To initiate Smart Growth, new efforts should consider reviving indigenous and consistent models of development that reflect a decentralized approach to governance. This approach would prioritize spatial equity and inclusive development while offering local feedback verifying and adjusting centralized, non-

municipal decision-making processes. While authorities may have more power of enforcement and response to decision-makers during times of uncertainty and instability, municipalities offer a rather significant long-term impact and efficiency in actively managing collective growth.

The suggested model for planning and developing new growth territories in desert areas aims at the implementation of a pilot project to develop a new city under the jurisdiction of a governorate, yet with economic influence comparable to NUCA and with land jurisdiction belonging to the governorate. This approach would leverage the expansion and intensification of planning and management expertise at different municipal levels among the old and new territories reinforcing sustainable urban development.

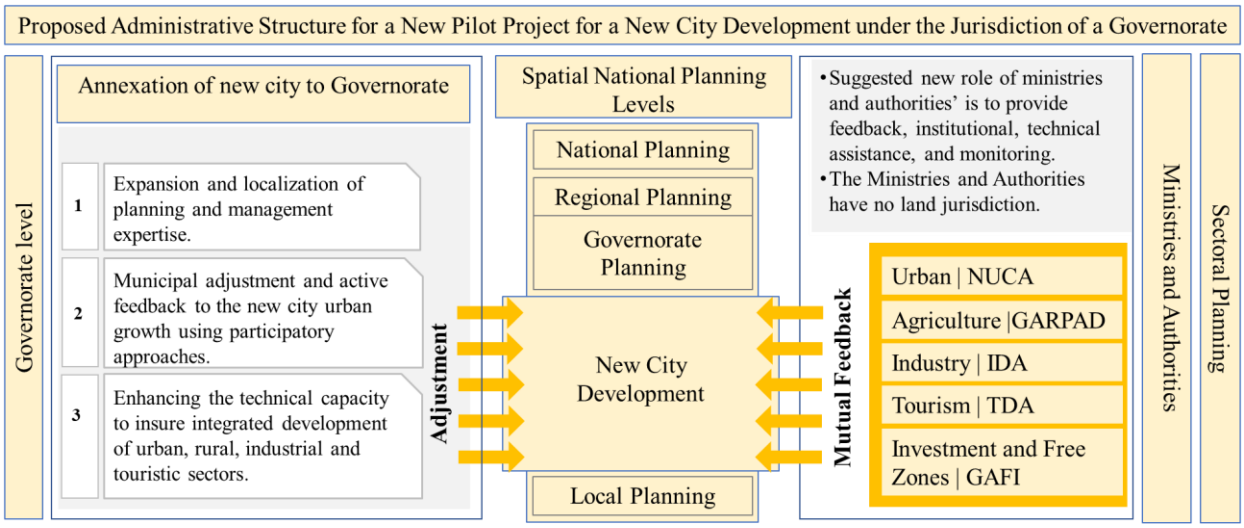


Figure 7. New City development model based on mutual feedback and adjustment at the national and local level.

In this model, the governorate would play a leading role in driving internal growth dynamics towards achieving the desired development objectives. Unlike the limited tunnel vision that focuses solely on urban growth for a new city and does not prioritize the integration of other regional aspects of growth, the suggested model envisions the governorate having a bottom-up adjustment role in the spatial strategic planning of a new city. This would involve taking active control of planning and development over both desert and arable areas, with comprehensive coordination between the sectors of urban development, transportation, industry, agriculture, and tourism.

The governorate's capacity would ensure adjusting and tailoring national and regional plans to local needs, considering regional dynamics and fostering participatory and collective decision-making. On the other hand, ministries and their subordinate authorities, besides their essential role in developing national and regional plans, will ensure the delivery of mutual feedback on the harmony and integration of spatial strategic planning plans and objectives at all planning levels. Further research can explore the financial model of building a new city under the governorate jurisdiction and promotion of local economic development along the existing and new growth frontiers.

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Conflicts of Interest

The author(s) declare(s) no conflicts of interest.

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

Ethics statements
Studies involving animal subjects: No animal studies are presented in this manuscript.
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Alhowaily A. has contributed to all aspects of the work reported in the manuscript, including conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing - original draft preparation, writing - review and editing, visualization, supervision, project administration, and funding acquisition. All author(s) have read and agreed to the published version of the manuscript.

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Original scientific paper

Liveability Considerations: Towards Designing Sustainable Public Housing in Niger State, Nigeria

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ABSTRACT

This study investigates liveability in the context of sustainable public housing in Niger State, Nigeria, where existing housing efforts have fallen short of residents' satisfaction. Recognizing the critical link between liveability indicators and environmental sustainability, this research aims to identify key liveability variables that could be integrated into the design and construction of sustainable public housing. Employing a mixed-method approach, the study involved cluster sampling for selecting housing estates and units, followed by the administration of 910 questionnaires containing 102 questions on liveability variables. Analytical techniques, including Hierarchical Cluster Analysis, Factor Analysis, and Multiple Regression Analysis, were used to group, refine, and validate the liveability variables. The results revealed 21 significant variables that collectively could achieve a 92.9% satisfaction rate among residents if incorporated into public housing design. These findings underline the potential of addressing liveability in the pursuit of sustainable housing solutions, offering insights for urban planners, architects, and policymakers. By focusing on the residents' perspectives, the study contributes to a more user-centred approach in public housing development, promoting long-term satisfaction and reducing the need for post-occupancy alterations.

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Highlights:	Contribution to the field statement:
-Liveability Variables for housing in the area identified. -Sustainable housing design variables identified. -The housing environment study approached from 3 basic construct-Housing Units (HU), Housing Estate (HE) and Housing Estate Neighbourhood (HUN). -Analysis achieved through Satisfaction Rating and Multiple Regression Analysis (MRA). -Data Collection was Residents' Centred.	Liveability study in the study area is greatly enhanced leading to the identification of variables that can be applied in the provision of sustainable residences. This would lead to outright stoppage or minimize incidences of alterations which result in more cost and loss of architectural value.

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1. Introduction

Public housing estates in Nigeria are the dwellings that are provided to public officials by the national, state, or local government (Bashari et al., 2019; Saliu et al., 2023). However, housing issues have had a detrimental influence and the nation's housing sector now has inadequate housing standards among the many concomitant concerns of urbanization (Nwachukwu et al., 2023; Owusu et al., 2023). This is corroborated by Pane et al. (2023) that the negative impact of urbanization is that population growth outweighs economic and industrial development processes in especially urban areas leading to problems such as housing needs, limited land, marginalized local communities, and environmental degradation. Therefore, despite efforts by different levels of government to provide decent public housing by succeeding administrations, the bulk of public housing in Nigeria's urban centres shares the general lack of infrastructure in these housing schemes (Ibimilua and Ibitoye, 2015; Owusu et al., 2023). Similarly, since the State's establishment in April 1976, the government's attempts to provide public housing in Niger State have not produced many positive outcomes. Public housing shortages in the major towns of Minna, Bida, Suleja, and Kontagora seem hard to overcome due to continuous rural-urban migration, particularly among public officials. These housing estates in the state are dominated by widely practised illegal and uncontrolled development trends with buildings created without taking into account zoning, subdivision regulations, or current building and health laws. This is why all the urban areas in the state are experiencing unplanned and uncontrolled growth, which has left extensive population living in residential environments with overstretched urban infrastructure, including electricity and water supplies, and growing environmental problems like air pollution, polluted waterways, inadequate clean water supplies, untreated sewage, chemical contamination of soils, piles of uncollected and decaying garbage, loss of forests and green space, and poor roads. In order to meet the demand for housing from the populace, the state government needs to identify a sustainable public housing strategy that calls for the implementation of a thorough urban management reform. This will lead to public housing that prioritizes the built environment and space quality, addressing concerns like safety, usability, and physical aesthetics, with a focus on how public spaces, transportation infrastructure, and residential areas are designed.

As a result of the decrease in residential environments in urban areas, the term "liveability," which comes from the word "liveable," has gained popularity. It denotes that something, such as a dwelling, is conducive to comfortable living (Lowe et al., 2013; Alderton et al., 2019; Alidoust, 2023; Covato and Jeawak, 2023; Owusu et al., 2023). According to Thanoon and Haykal (2020), liveability is the state of the built environment that takes into account the needs and expectations of residents in order to improve the environment's aesthetic appeal and enhance people's quality of life overall. They emphasized once more how the term has expanded to encompass a wide range of concerns that add significance to the idea of liveability, including accessibility, walkability, comfort, safety, and service availability. This assertion is supported by Levi and Lopez's (2013) perspective, which maintains that liveable environments are places that people enjoy and that meet their needs by fostering their well-being and supporting a sustainable ecosystem. However, from the standpoint of design (American Institute of Architects [AIA], 2005) contended that liveability was better defined in a limited setting, where a liveable environment recognizes its own unique qualities and places great importance on the design processes that help control growth and change in order to enhance but maintain those qualities. Accordingly, the liveability of public housing depends on a variety of factors that combine to make it an appealing place to live as well as features that support neighbourhood satisfaction, a sense of community, and environmental sustainability (Fernando and Coorey, 2018; Nastar et al. 2019). Thus, to sum up, liveability is the term used to describe the attributes and traits that contribute to a residential setting's desirable quality of life and allow its inhabitants to live comfortably there. However, sustainability refers to the capacity to meet present-day needs without jeopardizing the ability of future generations to meet their own (Dempsey et al., 2009). It is the process of carrying out operations in a way that effectively conserves resources and satisfies current population demands without jeopardizing the ability of future generations to meet their own needs.

The study on Liveability has assumed a very important concern and thus serves as a substitute tool for making decisions on the implementation of the design, planning, and construction of urban environments, it is believed, therefore, that more interest on its study and application by all players in

the built environment can result in creating living environments that are suitable for the residents to live in. In the long run, residents do not necessarily have to make changes, once built, to make such places suitable to live in. Further, in Niger State Public Housing, the changes or alterations made to public housing after they have been occupied by the users are evident and are termed re-configurations, conversions, addition, and extension of spaces (Isah et al., 2015). These changes can lead to the loss of architectural composition of the housing and the aesthetic landscape the housing is meant to convey to give the users a feeling of satisfaction in owning a house. There is also the cost and pain such changes can bring to the housing owner in trying to make the houses liveable after paying huge sums of money to acquire them. However, since indicators of liveability have been linked with environmental sustainability (Lowe et al., 2013), the aim of the study is to identify the liveability variables in the study area so that they can be applied in the design and construction of sustainable public housing.

2. Literature Review

2.1 Liveability Studies in Nigeria

According to Omuta(1988), the employment, housing, amenity, educational, nuisance, and socioeconomic dimensions of a city are just a few of the mental perceptions that are combined to form its environmental issues, which then translate into a spatial expression that represents the liveability of the city. Additionally, the quality of the local environment and, consequently, its acceptance, are determined by how well these criteria have been met. The collection of outside factors that affect the life of an individual or group residing in an environment is what Omuta (1988) defined as the environment. According to the study, the quality of the environment will vary depending on where you are because this collection of external conditions varies. The study further assumed that the surroundings of specific types of people affect their social lives, how they view their neighbourhood, and how happy they are to live there.

According to Asiyanbola et al. (2012), the deterioration of the environment, which is a reflection of poor management, including the control of urban activities and the ability to foresee future changes, is a factor in the liveability issue. The report stated that the urban canters' essential services and amenities were mostly in a state of decay, and that residents' dissatisfaction with their living environments contributed to the area's low liveability. Accordingly, the issue of liveability is best illustrated by the worsening environmental conditions, which are a result of inadequate management, including the control of city operations and the capacity to foresee future developments. The quality of the roads, garbage collection, public transportation, cleanliness, street lighting, security, crime rate, pollution, water supply, interpersonal relationships, school quality, shops, drainage system, and power supply are some of the basic facilities and amenities that study identified as being important enough to measure residents' satisfaction and determine whether the urban centers are liveable places. According to the study, the majority of urban centers' basic amenities and facilities are in poor condition, and the people who live there are not happy with their living environments. As a result, the area's liveability is not to the residents' satisfaction. Also, Babalola et al. (2022) stated that the degree to which a place's attributes can meet the needs of its inhabitants in terms of their economic and socio-cultural needs, their health and well-being, and the preservation of the ecosystem and natural resources is referred to as the liveability of the environments. The study found that there are numerous hazards to liveability in a mountain-based environment, including mining on the mountain, hazardous erosion, and trouble getting water for domestic use which amongst others lead to wall/building cracks, insomnia, and noise pollution.

Lawanson et al. (2013) stated that affordability and accessibility to basic necessities are the two main factors that Africans consider when determining liveability. The theory that a city is a dynamic living organism that continuously reinvents itself for the benefit of its residents was adopted by this study and as such, balance is necessary for a city to function properly. The study went on to assert that the African definition of liveability places more emphasis on communal living, good neighborliness, and open living arrangements; while centering on the sustainability of life with regard to access to basic necessities. The study came to the conclusion that while religious freedom, tolerance for others, and

the preservation of cultural heritage were all deemed important, infrastructure was a key indicator of urban liveability.

Using low-income housing in Niger State as a case study, Mohit and Iyanda (2015) investigated city liveability and housing in Nigeria. They identified several important dimensions of liveability evaluation by the respondents, such as housing characteristics, economic vitality, neighbourhood amenities, and safety situations. In another study, Iyanda and Mohit (2015) examined the use of confirmatory factor analysis (CFA) with a focus on five underlying dimensions and a measurement scale in the liveability assessment of public low-income housing in estates. These five measurement constructs—housing unit characteristics, neighborhood amenities, economic vitality, environment of safety, and social interaction—were confirmed. The empirical findings validated the theoretical model by demonstrating that each of the eighteen items/indicators was essential in determining the liveability of public low-income housing. The study concluded that the use of CFA applications in evaluating the liveability of public low-income housing has potential.

2.2 Liveability Linked with Sustainability

In order to generate data that would influence public perceptions and contribute to the creation of sustainable, liveable, and healthy communities, Lowe et al. (2013) collaborated with the Department of Health of the Victorian State Government and the University of Melbourne to undertake a research program. According to this study, there is a connection between the concepts of liveability and social determinants of health because environmental sustainability is a crucial element of both liveability and health. Additionally, the research highlighted the close relationship between liveability and healthy communities, highlighting that similar factors influence both. Accordingly, the study found that liveability is a subset of sustainability (refer to Figure 1) and that none of its characteristics are in opposition to the goals of sustainability.

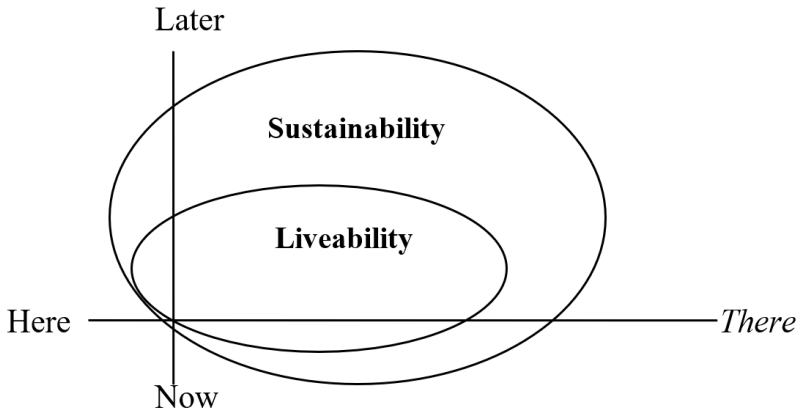


Figure 1. Liveability as a subset of sustainability (Lowe et al; 2013).

Davern et al. (2023) noted that because of a close connection between liveability and sustainability, the Australian Urban Observatory (AUO) saddled with measuring liveability of Australian cities amongst its mandate, has a comprehensive collection of aggregated, place-based urban liveability indicators linked to the Sustainable Development Goals, social determinants of health and urban planning. The study stated further that AUO was developed to translate research evidence to improve observation, understanding of inequities, and action through policy, planning and advocacy to create equitable, sustainable, healthy and liveable places. Also, Pandel et al. (2010), stated that a residential built environment is influenced by people's physical and mental health and is created through the interaction of lifestyle and the designated area. The study noted that the built environment's effects on people's physical and mental health have an effect on how well residents function, which in turn has an effect on how liveable the area is. Accordingly, AIA (2005), reasoned that since architects are in charge of creating the built environment, a sustainable framework for creating more liveable communities was developed giving architects the tools they need to put together the principles that

create more liveable communities by determining how well the living conditions in towns, cities, and neighbourhoods support people's health and safety.

Also, Khorrami et al. (2021), stated that the liveability standards in urban planning can significantly reduce the incidence of diseases like cancer and mental illnesses by improving urban lifestyle and socioeconomic status, which are major contributors to the rising burden of these conditions. Higgs et al. (2021) also stated that the development of liveable neighbourhoods can reduce important modifiable risk factors for diseases like cardio-metabolic disease, in part by increasing opportunities for physical activities. These findings are consistent with a growing body of research that suggests that liveable cities have the potential to promote sustainable lifestyles as well as health. Furthermore, according to Chi and Mak (2023), liveability is a crucial aspect of city planning and is essentially related to the general health of people and communities. It is evident from the above that liveability and sustainability are closely related to the point where liveability-determining factors in a housing environment can also be applied to sustainable housing.

2.3 The Liveability Principles in Sustainable Built Environment Design

Sustainability is the capacity to meet present-day requirements without jeopardizing the potential of future generations to do the same (Abbakyari et al., 2023; Star, 2023). A procedure is said to be sustainable if it can be repeated without having a negative impact on the environment by conducting activities in an extremely efficient and resource-conserving manner (Abbakyari et al., 2023). Sustainability requires balancing social, economic, and environmental needs in order to maximize the likelihood of maintaining human well-being over the long term. Thus, affordable building materials and technologies, local climate, and soil conditions should all be taken into account in sustainable design (Rusch and Best., 2014). The study went on to say that cultural influences are important because they affect how people use buildings and the systems they contain.

One way that sustainability is expressed is through sustainable housing, which is defined as housing that considers the long-term environmental, social, cultural, and economic balance of the housing stock and its occupants as well as the economic development of all income groups (Rusch and Best., 2014). Also, Abbakyari et al. (2023) pointed out that sustainable housing development is defined as housing that satisfies current needs without impairing the ability of future generations to satisfy their own needs. Further, sustainable housing should be affordable, and the planning and construction processes should be used to strengthen communities and the abilities and talents of individuals (Rusch and Best., 2014). In the study, housing is seen as key to sustainable development since housing is one of those fundamental social conditions that determine not only the quality of life and welfare of people but also that of places. Therefore, the location of homes, their quality of design and construction, and their integration into the social, cultural, and economic fabric of communities all have a significant impact on people's daily lives, health, security, and well-being. Because homes are physical structures with a long lifespan, these factors also have an impact on future generations. Additionally, Star (2023) stated that the following steps should be taken into account by the philosophical sustainable design approach: respecting natural systems (emulating the function of the element of nature); individualism (respecting the diversity of individuals); nature (ecosystem principle); the Cycle of Life (nature's balance); natural resources (preservation principle); and the process (holistic thinking principle). Also, Pane et al. (2023) indicated that sustainable housing is positively correlated with variables such as social, environmental, community development, and economic variables as such housing should promote environmental preservation, economic development, and social equality.

The Government of Ireland (2009) states that the goal of sustainable residential development is to create high-quality homes and neighborhoods that people genuinely want to live in, work in, and raise families in. These are places that will function well now and in the future for our children and their children's children. This suggests that the concept of sustainable housing involves the timely and economic integration of community facilities, schools, jobs, transportation, and other amenities with the housing development process (Government of Ireland, 2009). The study outlined design guidelines based on sustainability principles to include: "*Prioritise walking, cycling and public transport, and minimize the need to use cars; Deliver a quality of life which residents and visitors are entitled to*

expect, in terms of amenity, safety and convenience; Provide a good range of community and support facilities, where and when they are needed and that are easily accessible; Present an attractive, well-maintained appearance, with a distinct sense of place and a quality public realm that is easily maintained; Are easy to access for all and to find one's way around; Promote the efficient use of land and of energy, and minimize greenhouse gas emissions; Provide a mix of land uses to minimise transport demand; Promote social integration and provide accommodation for a diverse range of household types and age groups; Enhance and protect the green infrastructure and biodiversity; and Enhance and protect the built and natural heritage."

Additionally, according to Abu Hassan et al. (2011), sustainable housing development should assess building forms for housing performance as well as measure the area developed in accordance with sustainability criteria, specifically environmental, social, and economic, as well as site/land uses, communication, and transportation. It is the type of housing that prioritizes enhancing well-being by comprehending people's needs in their living and working environments. It necessitates the integration of numerous sustainability factors, including location, construction materials, aesthetics, security, and well-being, all of which have an impact on present and future generations.

3. Materials and Methods

3.1 The Study Location

The study was conducted in Niger State, Nigeria; however, the housing estates selected for the study were located in Minna, Bida and Kontagora. Niger State is located in the North-Central geo-political zone of Nigeria (see Figure 2) and was created in April 1976 from the former North-western state, with Minna as the state capital. The State is placed between latitude $8^0$20" and $11^0$20" North and longitude $3^0$40" and $7^0$40" East. The total land area of the state is 76,363 square kilometres representing approximately 8% of the total land area of Nigeria. Niger State is bounded by the Federal Capital Territory at the southeast, Kaduna State at the North, Kwara and Kogi States at the North West. The State has a boundary with the Republic of Benin to the west. The State comprises of 25 Local Government Areas (LGAs) and is one of the largest States in Nigeria in terms of land mass. The State had a population of 3,311,375 persons by the provisional result of the 2006 National Population Census.

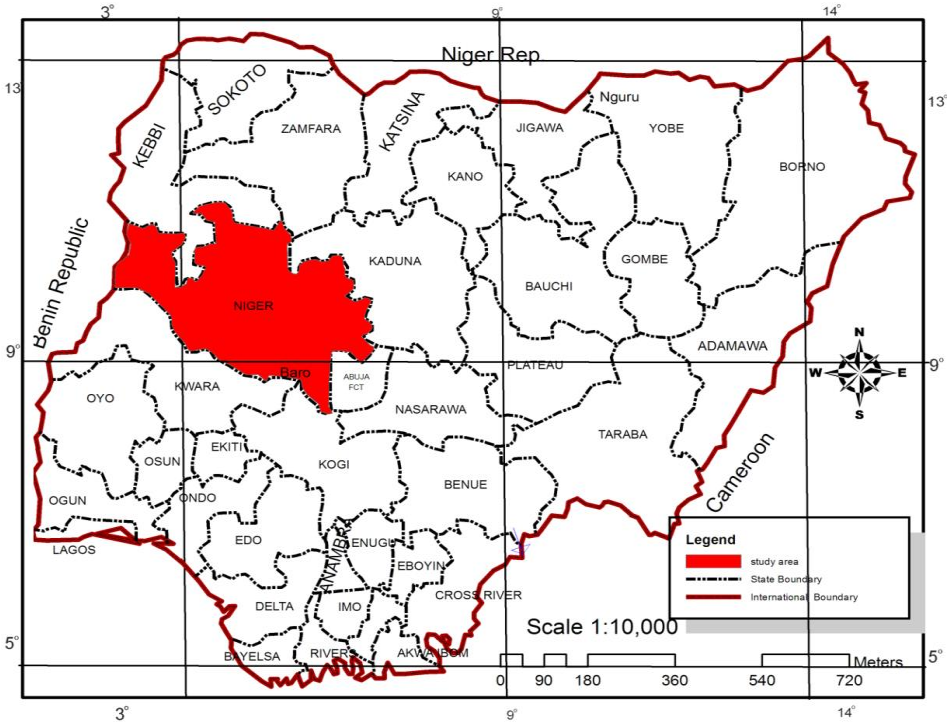


Figure 2. Location of Niger State in Nigeria.

3.2. Data Collection

The questionnaire, which included two parts and questions based on liveability indicators and dimensions identified from the literature, was the primary instrument utilized for data collection. The respondents' demographic characteristics, including gender, age, level of education, household size, and residential environment characteristics, such as dwelling unit size, tenure type, length of residence, and former housing type, were in the first section termed personal data and general information. The second section which was the data on the Residential Environment (shown in Table 1) was made up of questions about satisfaction assessments of the residential environment built on three-level hierarchical constructs of Housing Units—HU, Housing Estates—HE, and Housing Estate Neighbourhoods—HEN (Fernando and Coorey, 2018 used a 3-level construct). Each of the levels had a minimum Cronbach's alpha of 0.70.

Table 1: Three-level constructs with their liveability dimensions and indicators upon which questions were based.

Level Construct	Liveability Dimensions	Liveability Indicators Identified
Housing Unit	Sizes of spaces	Sizes of Plot, Living Room, Dining Room, Kitchen, Bedrooms, Storage, and Outdoor Activity Setback; separation between houses; House's distance from the road
	Physical quality of Building	Walls, ceilings, roofs, windows, doors, floors, and the provision of toilets.
	Ventilation and Natural Lighting	Natural ventilation and lighting in the living room, dining room, bedrooms, kitchen, and toilets/bathrooms.
	Noise Sources	Noise from vehicles, nearby buildings and neighbours' activities, noise from equipment.
	Affordability	Cost of property, rent for a house, water and electricity costs, the rate for land usage, and the price of public transportation.
Housing Estate	Public services available in the housing estate	Green Space for Relaxation; Children's Play Area; Internal Road Network; Car Parking provision; Walkways for Pedestrians; Police Post; Street Lighting; Estate's Medical Facilities; Shopping Centres/Corner Shops; Facilities for education in the Estate.
	Relationship, management, security, and land usage.	Mix Land Use, Housing Type Mix (Types of House Units), Management of Waste, Estate Maintenance, Management of Security, and Good Neighbourliness in the Estate
Housing Estate Neigh-bourhood	Distances from these neighbourhood facilities to the estate	Places of employment, educational institutions, medical facilities, shopping facilities and Local market, public libraries, recreation facilities, fire stations, and police stations
	Facilities in the neighbourhood	Local Public Space, Main Electricity, Water Supply, Public Transportation Access, Major Access Road, Pedestrian Walkway, Petrol Station, Repair Shop, and Public Toilets.
	Noise, security and identity	Noise in the neighbourhood, environmental cleanliness, distance from the highway, proximity to activities that produce noise, vegetation buffering the highway, and the state of public safety; Feeling of Identity and Belonging.

3.3 Sampling Technique

The sampling technique for the study was cluster sampling and systematic random sampling techniques. The cluster sampling first involved the grouping of the study area into three clusters in line with the Independent National Electoral Commission (INEC-the Nation's electoral umpire) senatorial division of Niger State. This resulted into Niger South (with 8 Local Government Areas-LGAs), Niger North (with 9 LGAs), and Niger East (with 8 LGAs) covering all the 25 LGAs the State is made up of. The next step was the selection of one town from each of the three clusters based on being the headquarters of the senatorial division, a local government headquarters and as well having the highest number of housing estates. This resulted in the selection of Minna, Bida, and Kontagora. Another cluster of housing estates with fully completed and occupied housing units was formed in each case from which four and two each were randomly selected in Minna (Four selections being the State

Capital), Bida and Kontagora. Finally, the selection of housing units within the selected housing estates was done using a systematic random sampling technique whereby the 1st, 3rd and 5th selections were done alternately along and across the streets until the entire housing estate was covered in each case.

3.4 Data Analysis

The first aspect of data analysis was carried out for the purpose of identifying the key liveability elements for public housing delivery. To successfully achieve this, the number of variables in the dataset generated in the study had to be whittled down using Hierarchical Cluster Analysis (HCA) and Factor Analysis (FA). So, HCA was used to group variables into clusters based on similarity and FA was employed to reduce the number of variables in each cluster to those variables that were responsible for the greatest proportion of variance in the data.

The Hierarchical Cluster Analysis (HCA) was used to determine key number of variable clusters based on similarity. Rather than use K-Means or Two-Step Clustering, HCA was the preferred technique because of its ability to handle the clustering of variables, as opposed to the other clustering techniques which are used primarily for the clustering of cases, not variables. The determination of the optimal number of clusters was carried out through a trial-and-error process. Solutions were sought for a range of clusters, beginning from three and ending at seven. Within this constraint, a number of other settings were varied. These included the cluster method and the interval measure. The choice was found to lie between three cluster methods (between-groups linkages, nearest neighbour and furthest neighbour). In the case of interval measures, the choice lay between the squared Euclidean distance and Pearson correlation.

Factor Analysis was then employed to reduce the number of variables in each cluster to a manageable number, representing those variables that were responsible for the greatest proportion of variance in the data. A simple procedure was followed; the appropriateness of the cluster for factor analysis was checked using the Kaiser-Meyer-Olkin (KMO) statistic; thereafter the extraction of factors was carried out based on their eigenvalues. The final stage consisted of identifying what variables best fit the factors that had been extracted and rotated. Extraction of factors employed the Principal Components Analysis (PCA) method, while extraction was based on the Direct Oblimin approach. This approach had a number of advantages over other comparable techniques such as Varimax; chief among these advantages was the production of a structure table which allowed the underlying structure of the data to be seen.

Finally, a further analysis on the identified liveability variables was done to determine the major variables which affect liveability. The Stepwise method of Multiple Regression Analysis (MRA) was employed to investigate the cogency of the identified liveability variables by measuring how well the variables predicted the Resident Perceived Satisfaction Index (RPSI) which was the average satisfaction of residents with the housing. MRA utilised a total of twenty-one (21) out of the 26 variables spread over 21 different models and excluded five of the variables which were outliers. The stepwise method of regression was used to develop 21 different models, which were then studied to see whether the variables could predict the RPSI, as well as which particular variables had better prediction ability.

4. Results and Discussions

4.1 The **Socio-economic Characteristics of Occupants:** -Given that 14% of respondents have completed secondary education and 85 percent have post-secondary education, the respondents' level of literacy is quite high indicating that the understanding of the questionnaire's content was quite good. According to the respondents' housing tenure, the majority (70 %) of them own their houses. 95 % of inhabitants have lived in the houses for at least two years or more, according to data on length of stay in the houses, which is a significant indicator of how well they know about the residential environment. On changes made to the housing units, up to 73 % of the occupants have made changes to their houses, showing the sizes of the houses in the estates have significantly changed from the initial plans. Rarely is aesthetics a factor in these modifications; they are typically made to accommodate changing family demands, particularly the addition of new spaces.

4.2The Result of HCA: Through minute study and comparison of both graphical and tabular outputs, the following combination was found to provide optimal results: the number of clusters was set at seven (7), Furthest neighbour was chosen as the cluster method while Pearson correlation was employed as the interval measure as shown in Figure 3. The HCA identified 26 variables out of 102 variables covering an average of 64% of the variability in the liveability of public housing.

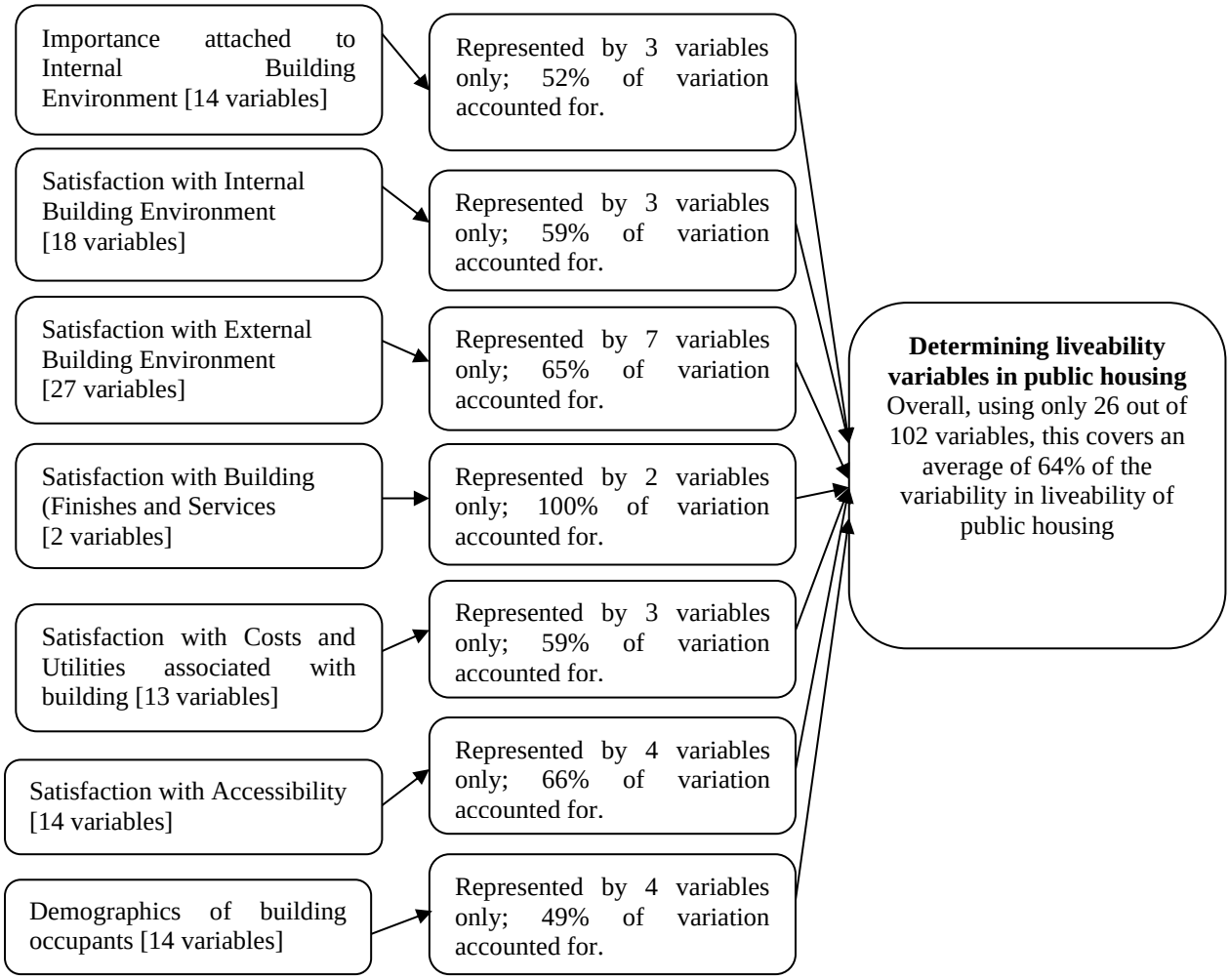


Figure 2. Clusters resulting from Hierarchical Cluster Analysis (HCA) conducted on 102 variables.

4.3 The Result of FA: -Since the FA was done cluster by cluster, the analysis for cluster 1 is briefly discussed as an example, while the pattern matrix tables for all the other clusters are shown revealing their key variables. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was above 0.6 for Cluster 1, while the significance value for Bartlett's Test of Sphericity was much lower than 0.5 (See Table 2). These were indications that the data were appropriate for factor analysis.

Table 2: KMO and Bartlett's Test for Cluster 1.

Test	Test parameters	Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.851
Bartlett's Test of Sphericity	Approx. Chi-Square	2955.974
	df	91
	Sig.	0.000

The result of the extraction of factors is presented in Table 3; three factors were extracted. The three factors cumulatively accounted for 52.413% of the variance in the data contained in Cluster 1. Inspection of the scree plot for Cluster 1 revealed that only three factors could be seen as being above the elbow; all other factors were below the elbow.

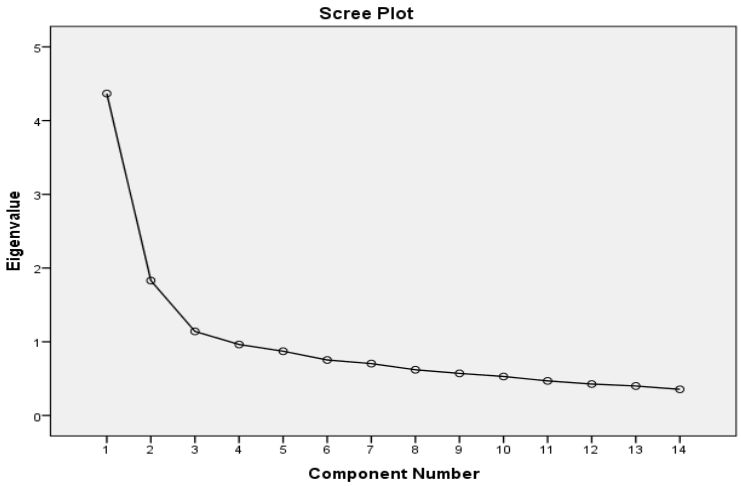


Figure 3. Scree plot for Cluster 1.

Rotation of the results obtained yielded the pattern matrix, which was presented as Table 3. This pattern matrix had been set to exclude small values that are less than 0.3 and to sort all values in order of size. The three variables that correspond to the factors extracted were easily identified as variables that possess the highest values within each column. To be eligible, a variable must also be minimally related to the other extracted factors. The three variables that match these criteria in Cluster 1 were distinguished by boldface type in the table, and are (i) Importance attached to Relaxation Space (0.777), (ii) Importance attached to Sleeping Area (0.836) and (iii) Importance attached to Outdoor Cooking Area (0.537).

Table 3: Pattern Matrix selecting the key variable in Cluster 1.

Variables	Component		
	1	2	3
Importance attached to Relaxation Space	**.777**		
Importance attached to Garden Space	.701		
Importance attached to Children's Play Area	.692		
Importance attached to Car Parking Space	.651		
Importance attached to Courtyard	.505		-.371
Importance attached to Storage Area			
Importance attached to Sleeping Area		**.836**	
Importance attached to Toilet/Bath Area		.818	
Importance attached to Indoor Cooking Area		.668	
Importance attached to Living Area		.615	
Importance attached to Guest Reception Area			-.840
Importance attached to Guest Sleeping Area			-.738
Importance attached to Outdoor Cooking Area			**-.537**
Importance attached to Dining Area		.323	-.537

Notes: Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
Rotation converged in 8 iterations.

Table 4: Pattern Matrix selecting the key variable in Cluster 2.

Variables	Component		
	1	2	3
Satisfaction with Physical Quality of Walls	**.830**		
Satisfaction with Physical Quality of Windows	.814		
Satisfaction with Physical Quality of Doors	.796		
Satisfaction with Physical Quality of Floors	.791		
Satisfaction with Physical Quality of Roof	.734		
Satisfaction with Natural Lighting in Living/Dining		**-.824**	
Satisfaction with Natural Ventilation in Living/Dining		-.798	
Satisfaction with Natural Ventilation in Kitchen		-.779	
Satisfaction with Natural Ventilation in Bedrooms		-.779	
Satisfaction with Natural Lighting in Kitchen		-.749	
Satisfaction with Natural Lighting in Bedrooms		-.747	
Satisfaction with Natural Lighting in Toilets/Bathrooms		-.592	
Satisfaction with Size of Storage			**.823**
Satisfaction with Size of Setback for Outdoor Activities			.774
Satisfaction with Size of Dining Area			.693
Satisfaction with Size of Kitchen			.642
Satisfaction with Size of Plot			.571
Satisfaction with Size of Bedroom			.538

Notes: Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
Rotation converged in 8 iterations.

Table 5: Pattern Matrix selecting the key variable in Cluster 3.

	Component						
	1	2	3	4	5	6	7
Satisfaction with Medical Facilities	**.708**						
Satisfaction with Maintenance	.693						
Satisfaction with Street Lighting	.637						
Satisfaction with Shopping Centres/Corner Shops	.628						
Satisfaction with Educational Facilities	.512					.470	
Satisfaction with Security Management	.438	.305					
Satisfaction with Waste Management	.396						
Satisfaction with Environmental Tidiness in Neighbourhood		**.756**					
Satisfaction with Vegetative Buffer from Highway		.693					
Satisfaction with Public Security in Neighbourhood		.660					
Satisfaction with Neighbourhood Noise		.648					
Satisfaction with Proximity to Noise Generating Activities		.613					
Satisfaction with Distance of Neighbourhood Highway		.518				.477	
Satisfaction with Noise from Equipment			**-.843**				
Satisfaction with Noise from Vehicles			-.795				
Satisfaction with Noise from Adjoining Buildings			-.745				
Satisfaction with Noise from Neighbours Activities			-.676				
Satisfaction with Green Area for Relaxation				**-.871**			
Satisfaction with Play Area for Children				-.823			
Satisfaction with Car Parking Facilities				-.768			
Satisfaction with the Distance of the House from the Road					**.808**		
Satisfaction with the Size of Living Area					.633		
Satisfaction with Distance between Houses					.626		
Satisfaction with Good Neighbourliness						**.697**	
Satisfaction with Sense of Belonging/Identity in Neighbourhood		.410				.628	
Satisfaction with Housing Type Mix							**.786**
Satisfaction with Land Use Mix				-.322			.507

Notes: Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
a. Rotation converged in 8 iterations.

Reduction of the number of variables in Cluster 4

It was unnecessary to apply factor analysis to reduce the data in Cluster 4 because the membership of the cluster consisted of only two variables. These variables were (i) Satisfaction with the Physical Quality of the Ceiling, and (ii) Satisfaction with the Physical Quality of the Toilet Provision.

Table 6: Pattern Matrix selecting the key variable in Cluster 5.

Variables	Component		
	1	2	3
Satisfaction with Property Cost	**.871**		
Satisfaction with House Rental	.816		
Satisfaction with Water Rates	.655		
Satisfaction with Public Transport Cost	.608		
Satisfaction with Electricity Bills	.604		
Satisfaction with Land Use Charge Rate	.539		
Satisfaction with Major Access Road in Neighbourhood		**.890**	
Satisfaction with Internal Road Network		.884	
Satisfaction with Main Water Supply in Neighbourhood			**-.824**
Satisfaction with Local Public Space in Neighbourhood			-.736
Satisfaction with Main Electricity Supply in Neighbourhood			-.729
Satisfaction with Public Toilet in Neighbourhood			-.669
Satisfaction with Public Transport Access in Neighbourhood			-.601

Notes:Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
Rotation converged in 8 iterations.

Table 7: Pattern Matrix selecting the key variable in Cluster 6.

	Component			
	1	2	3	4
Satisfaction with the distance of the Estate to a Fire Station	**.779**			
Satisfaction with distance of Estate to Public Library	.777			
Satisfaction with distance of Estate to Recreation Centre	.707			
Satisfaction with distance of Estate to a Police Post	.633			
Satisfaction with Police Post	.567			
Satisfaction with distance of Estate to Local Market		**.736**		
Satisfaction with distance of Estate to Shopping Centre		.685		
Satisfaction with Pedestrian Walkway		.524		.385
Satisfaction with distance of Estate to School			**-.857**	
Satisfaction with distance of Estate to Work Place			-.811	
Satisfaction with distance of Estate to Hospital		.490	-.660	
Satisfaction with Petrol Filling Station in Neighbourhood				**.832**
Satisfaction with Pedestrian Walkway in Neighbourhood		.342		.769
Satisfaction with Repair Workshop in Neighbourhood	.389			.581

Notes:Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
a. Rotation converged in 8 iterations.

Table 8: Pattern Matrix selecting the key variable in Cluster 7.

	Component			
	1	2	3	4
Type of Religion	**.628**			
Number of People Living in House	.624			
Gender of respondent	-.623			
Length of Stay in the House	.458			
Type of Tenure of House	.436			.373
Age of Respondent		**.807**		
Marital Status of Respondent		.744		
Level of Education of Respondent		.481	-.376	-.343
Pervious House Type Occupied	-.405		-.637	
Name of housing Estate		.341	.628	
Size of House			**.566**	
Changes to House	.368		-.461	
Nature of Employment				**.672**
Number of Cars Owned				.648

Notes: Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
a. Rotation converged in 8 iterations.

The overall structure of the variables extracted began from seven related groups of variables that collectively describe perceptions of liveability in public housing estates within the study area. Specific smaller collections of variables were then identified from each of these seven groups; this identification was based on these smaller collections of variables having almost the same power of describing the liveability status of public housing as the initial complete seven groups of variables as seen in the result of HCA conducted in Figure 2. This was because rather than collect information on 102 variables; an identical level of information could be obtained using only 26 variables as listed in Table 9

Table 9: Key Liveability variables resulting from HCA and FA conducted.

	Housing Components	Liveability Elements
1	Internal Building Environment	Spaces for Relaxation, Sleeping and Outdoor Cooking; quality of Walls, natural lighting in Living/Dining and Size of Storage.
2	External Building Environment	Provision/access to Medical Facilities, Green Area for Relaxation, Distance of House from Road, Environmental Tidiness; design must encourage Good Neighbourliness, Housing Type Mix and prevent Noise from Equipment,
3	Finishes & Services	Physical quality of Ceiling and Toilet Provision
4	Associated Costs and Utilities	Affordability of Property Cost, provision of Major Access Road in Neighbourhood, and Main Water Supply in Neighbourhood,
5	Accessibility	Reasonable distance of Estate to a Fire Station, Local Market, School, and Petrol Filling Station in Neighbourhood
6	Occupiers' demographics	Design affected by Type of Religion, Age of Respondent, Changes to House, and Nature of Employment

4.4 The Result of MRA: -The finding from the results in Table 9 is that all of the twenty-one models would predict the RPSI at relatively high levels of R^2. This revealed that all of the 21 variables were positively correlated with the RPSI, and could be used to predict 92.9% of the variation in the RPSI successfully.

Table 10: Result of MRA developed for strength of Liveability Variables.

Model	Independent variables	R	R^2	Change in R^2	Change in F-statistic
1	62	.604	.364	.364	338.221
2	62, 69	.726	.527	.162	202.245
3	62, 69, 85	.809	.655	.128	218.265
4	62, 69, 85, 039	.844	.713	.058	117.577
5	62, 69, 85, 039, 93	.868	.754	.041	98.610
6	62, 69, 85, 039, 93, 034	.888	.788	.034	94.616
7	62, 69, 85, 039, 93, 034, 91	.902	.813	.025	77.514
8	62, 69, 85, 039, 93, 034, 91, 54	.913	.834	.021	75.632
9	62, 69, 85, 039, 93, 034, 91, 54, 79	.923	.853	.018	71.639
10	62, 69, 85, 039, 93, 034, 91, 54, 79, 045	.931	.866	.013	58.283
11	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97	.938	.879	.013	63.539
12	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73	.944	.892	.012	65.299
13	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82	.949	.900	.009	50.194
14	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037	.953	.907	.007	45.190
15	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88	.956	.914	.007	43.668
16	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56	.959	.919	.005	34.338
17	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56, 044	.961	.923	.004	31.341
18	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56, 044, 77	.962	.926	.003	23.546
19	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56, 044, 77, 042	.963	.928	.002	12.420
20	62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56, 044, 77, 042, 009	.964	.929	.001	8.487
21	**62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56, 044, 77, 042, 009, 003**	**.964**	**.929**	**.001**	**5.008**

Dependent Variable: RPSI (Resident Perceived Satisfaction Index)
Predictors: (Constant), 62, 69, 85, 039, 93, 034, 91, 54, 79, 045, 97, 73, 82, 037, 88, 56, 044, 77, 042, 009, 003

The identification of liveability elements for public housing resulted into six components which the built environment designers could adopt to ensure the liveability of public housing. These six components comprised of (i)Internal Building Environment—the focus here is on spaces for Relaxation, Sleeping and Outdoor Cooking; Ensure satisfactory quality of Walls, natural lighting in Living/Dining and Size of Storage; (ii) External Building Environment—this focuses on satisfactory provision/access to Medical Facilities, Green Area for Relaxation, Distance of House from Road, Environmental Tidiness; the design must encourage Good Neighbourliness, Housing Type Mix and prevent Noise from Equipment; (iii) Building Finishes and Services—the focus here should be on the satisfactory physical quality of Ceiling and Toilet Provision; (iv) Associated Costs and Utilities—this focuses on affordability of Property Cost, provision of Major Access Road in Neighbourhood, and dependable Main Water Supply in Neighbourhood. (v) Accessibility—the focus is on ensuring a reasonable distance of the Estate to a Fire Station, Local Market, School, and Petrol Filling Station in the Neighbourhood. The sixth component which is the Occupiers' demographics contains variables such as Type of Religion, Age of Respondent, Changes to House, and Nature of Employment that were eliminated by the MRA because they were outliers.

5. Conclusions

The study identified the liveability variables for the delivery of public housing in the study area. These variables contained within five components, are recommended for the built environment designers to adopt to ensure sustainable public housing in the study area. These 21 variables are contained within five components of External Building Environment; Internal Building Environment; Building Finishes and Services; Associated Costs and Utilities; and Accessibility. The research established that 73% of the residents have done one form of change in order to make the residential environment more liveable. The variables, if taken into account in the design and delivery of public housing, will result in sustainable housing stock that meets the satisfaction of the residents. This would also discourage unguarded alterations made to the housing units and environment once occupied by the owners.

Therefore, it is recommended that public housing delivery in the study area requires attention to be paid to environmental users' requirement before the professionals' expertise are brought to bear.
Finally, the dimensions and indicators that captured the concept of liveability in the study area are revealed in the study thereby providing literature to buttress the existing efforts on liveability studies in the area. This also gives guidance to the players in the environment as to what the liveability requirements of the residents are with respect to residential provisions.
The study also reveals a very efficient method for satisfaction assessments of the residential environment. This assessment method is based on a three-level hierarchical constructs of Housing Units, Housing Estates, and Housing Estate Neighbourhoods. This way, assessments of the residential environment can effectively be carried out anywhere.

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Conflict of interests
The authors declare no conflict of interest.

Data availability statement
The data that support the findings of this study are available.

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