International seminar on urban form - ISUF: Conference proceedings PART I

PRAXIS OF URBAN MORFOLOGY

ISUF
Belgrade
30th CONFERENCE

CONFERENCE PROCEEDINGS - PART I

XXX CONFERENCE OF THE INTERNATIONAL SEMINAR ON URBAN FORM (ISUF2023)

PRAXIS OF URBAN MORPHOLOGY

ORGANIZED BY

University of Belgrade - Faculty of Architecture
MorphoLab Research Unit,
and

SNUM
Serbian Network of Urban Morphology (SNUM)

SUPPORTED BY

Република Србија
МИНИСТАРСТВО НАУКЕ,
ТЕХНОЛОШКОГ РАЗВОЈА И ИНОВАЦИЈА

Ministry of Science,
Technological Development and Innovation (Serbia)

IMPRESSUM

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TITLE:
ISUF 2023 PRAXIS OF URBAN MORPHOLOGY: Conference Proceedings Part I

PUBLISHER:
University of Belgrade - Faculty of Architecture

FOR PUBLISHER:
Vladimir Lojanica, Dean

DESIGN & LAYOUT:
Aleksandra Đorđević
Mladen Pešić, Aleksandra Milovanović

PRINTED BY:
BIROGRAF COMP

NUMBER OF COPIES:
100

PLACE AND YEAR OF ISSUE:
BELGRADE, 2023

ISBN-978-86-7924-341-6

INTRO

ISUF2023 PRAXIS OF URBAN MORPHOLOGY

Coming from 20 architects, geographers, planers and historians, to more than 600 individual and institutional members across the globe, ISUF presents the important international organization of urban form both for researchers and practitioners. Due to its orientation to both of these fields, ISUF 2023 presents a great opportunity to rethink the praxis, perceived as process by which theory/idea is enacted, embodied and realized.

The theme for ISUF 2023 is drawn from the previous experience and ideas, directed toward systematization and synthesis of intellectual knowledge.

Following this line of reasoning, the Conference tracks are envisioned to confront the topics that are represented as being opposed in order to open up a debate how to transfer ideas to operational knowledge.

A. Good in Planning, Landscapes and Townscapes

A1. Urban planning vs. Urban design

A2. *Fringe growth* vs. *Urban belt*

A3. Prescription vs. Description

B. Culture Space, Common Space and Personalities

B.1. East vs. West

B.2. South vs. North

B.3. Networks vs. Individuals

C. History of Ideas and Challenges

C.1. History vs. Future

C.2. Preservation vs. Transformation

C.3. Pre vs. Post

D. Programming and Rethinking Concepts

D.1. Strategies vs. Measures

D.2. Education vs. Practice

D.3. Quantitative vs. Qualitative research

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The current volume contains selection of papers collected for the XXX ISUF 2023 Conference on tge recomendation of Sesion/Conference Chairs. The Organisers are grateful to the Reviewers, Session Chairs, and Colleagues and Volunteers who contributed to the organisation and preparation of this conference
The papers' collection and the review process were su pported by the Ex Ordo Conference Management System.

Program – ISUF2023

3TH SEPTEMBER

DAY -1 TOUR

South-west tour

4TH SEPTEMBER

DAY 0
ISUF PRIVATE

MEETINGS

Council Board
Editorial Board

Regional Networks

Popine Monument, Trstenik
arch. Bogdan Bogdanović

Mausoleum of Struggle and Victory at Čačak
arch. Bogdan Bogdanović

5TH SEPTEMBER

DAY 1 CONFERENCE

Keynote Lectures
Paralel Sessions

CITY TOUR

Old/New Belgrade

s

6TH SEPTEMBER

DAY 2 CONFERENCE

Keynote Lectures
Paralel Sessions

7TH SEPTEMBER

DAY 3 CONFERENCE

Keynote Lectures
Paralel Sessions

Closing Session

GALA DINNER

Belgrade rivers

8TH SEPTEMBER

DAY +1 DAY TOUR

South-east tour

OVERNIGHT TOUR

North

9TH SEPTEMBER

DAY +2

Continuation of the North tour

Openning Ceremony
Photo. P. Karanović

Clossing session

North tour / Suboritca

Parallel Sessions
Photo. P.Karanović

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REFLECTION ON THE CONFERENCE

In its jubilee year of 215 years, the University of Belgrade and the Faculty of Architecture as its constituent member had an opportunity to host the 30th International Seminar on Urban Form Conference (ISUF2023).

This year's conference titled Praxis of Urban Morphology presented a great opportunity to discuss the process by which this discipline is enacted, embodied, and realized. The ISUF 2023 organization committee's endeavor was to build on the previous experience and ideas, and to direct activities toward systematization and synthesis at an international level, aiming to embody these ideas into operational knowledge. The conference was developed in a manner to provide a framework for reflecting on ISUF community intellectual knowledge coming both from the practical and scientific arenas. As a part of side activities, a special issue of the Serbian Architectural Journal - SAJ titled Regional Perspectives of urban morphology was prepared with the goal to demystify advancements of intellectual thought from all continents. Accordingly, the presentation will cover the main issues raised by scholars and practitioners both in SAJ contributions and during conference with the overall goal to contribute to the advancement of knowledge in this field, moreover to reconsider and critically examine advancements and perspectives on urban morphology.

Decision to focus the ISUF2023 conference on the Praxis of urban morphology and SAJ special issue on Regional perspectives on Urban morphology, hopefully, yet unintentionally achieving a harmonious integration of these two. Consequently, the resulting journal double issue serve as valuable testimony of longlisting engagement within the study of urban form in various contexts reflecting a specific moment in time and various perspectives on urban morphology, while conference reveals state of current topics and research fields within the urban morphology. Thus, the first one looks at the history, while the second reflects on the future

The very conference included total of 227 presentations with 580 authors (220 present on site), with representation of participants from 43 countries. The conference was developed in 4 tracks: A. Good in Planning, Landscapes and Townscapes, B. Culture Space, Common Space and Personalities, C. History of Ideas and Challenges and D. Programming and Rethinking Concepts.

Conference proceedings were developed in two parts - One available in print and online format that has texts recomended by session or conference chairs and the second with other submitted full papers

.

Editors

ON URBAN FORM

ZORAN NIKEZIĆ

Full Professor, University of Belgrade - Faculty of Architecture

I have been asked to say a few words of introduction on the topic of urban morphology, and I will do that primarily in the context of its role in a limited segment of architectural education in which I had the great pleasure in participating, and later creating.

During my many years at the Faculty of Architecture, I have mainly worked on curriculums for beginners, focusing on questions of knowing WHAT and WHY, on the contents and meanings of architecture in the built environment, looking for the universal in all real-life phenomena. I always insisted that curiosity and understanding must precede any action, design, or other intervention, on KNOWING BEFORE DOING.

Since 1976, when I started, many changes were made, and many roads explored, but, basically, the topic of all these elaborate introductions was architecture and the built environment, presented and explored as a phenomenon, and seen as a form developing under various influences.

Clarification of concepts and meanings was stressed. As a rule, things would be explained – starting from the beginning, from the basics. Precise use of words and graphics was considered important. Information was abundant, instructions scarce, and creativity and independence in research were encouraged.

Keywords or topics were: Morphology, Observation, Analysis, Generalization, Typology, Transformation, Relation between time, place and space, Context, and finally Meaning and Culture.

It's quite natural for students entering the field of architecture to focus, to look at their topics of interest with a magnifying glass, and that was something we tried to encourage.

One of the most important tasks in any beginning was to prevent a specialist approach and widen a mental framework, making room for a complex, integrative, cinemascope picture of contexts, and at the same time, in the background, developing an initial understanding of architecture and the built environment – selecting the essential.

Notions of complexity, structure, integration, dynamics, and a basic historical understanding of phenomena were gradually introduced.

Morphology, of course, was the starting point of choice, the beginning, and the end of every teaching process. Simplified but not far from the truth, all products of architecture are morphologically defined, and, in an environment of other structures define the built environment as a phenomenon.

Obviously, morphology was a major TOOL in understanding architecture and the built environment, more specifically, the urban environment as its most complex product.

Forming TYPOLOGIES was the chosen way of transforming urban morphology variations into functional concepts.

HOW DID WE DO IT?

Students were offered ex-cathedra lectures on architecture and the built environment as phenomena. At the same time, they did on-site research. Lectures were not synchronized with on-site work in order to avoid immediate direct instructions.

A morphological entity was chosen, always a complex part of the city that had various historical layers, various densities, structures, landmarks, and public spaces. We aimed at examples in which complex typologies could be recognized. Students observed, analyzed, classified, and formed structural models, overlapping maps of chosen characteristics of structures and spaces.

The major task was aimed at developing skills needed to recognize and select relevant mainly morphological characteristics of the chosen built environment as products of interacting space and culture. Various features were identified and connected, and relations of elements and wholes were defined. Analytical thinking aimed at rendering a complex entity transparent was required.

Finally, based on different sets of characteristics, students defined their own typologies of buildings, streets, squares, city blocks, clusters, and neighborhoods.

Repetition, feedback, and clarification of these processes were encouraged. The general tendency was to let students learn for themselves, with minimal instructions, each in his or her own way. Creative and critical thinking were encouraged, but of course not compulsory.

THE IDEA WAS TO INITIATE SOME BASIC CONCLUSIONS:

1. That architecture is not free to produce whatever it wants,

2. That it has physical and other restraints, it must fulfill a task, and have a purpose,

3. That it is not alone and has to integrate and participate in the development of a defined space, place, time, and culture, and become part of a process hence forming always new morphologies, and

4. That its structures influence the morphology of the existing environments, they transform it, and are eventually transformed themselves, leaving physical or only virtual traces.

Finally, the study of urban morphology through the efforts of exploring, looking for, and defining typologies, thinking in categories of type or kind, of models or archetypes, was and is an essential tool in understanding architecture as a discipline, as a process, and as a product.

An insight into urban morphology helps us to read the city, and understand its grammar, its patterns, and mathematical foundations. We can read the effects that various forces have in the production of space, recognize identities, potentials, and flaws, understand evolution, and even develop a limited notion of the future. In general, studies of morphology help us do most of the homework that precedes any kind of action in the built environment.

Understanding will not guarantee success, but it will minimize damage. And it will make us better.

KEYNOTERS

IVOR SAMUELS [Architect, Town planner - Independant researcher, UK]

SAJ Special Issue - Regional Perspectives on Urban Morphology

STEFAN JANKOVIĆ [University of Belgrade - Faculty of Philosophy, Serbia]

Emerging peripheries, reassembling realities?
Exploring the New Morphologies and Forms of Urbanisation on Belgrade Peripheries

VITOR OLIVEIRA [University of Porto, Portugal]

The history of ISUF and urban morphology

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DRAGANA ĆOROVIĆ [University of Belgrade - Faculty of Forrestry, Serbia]

Landscape Transformation in the Nineteenth Century Belgrade

FULL PAPERS

A human-centered evaluation of street attractiveness: a methodological innovation integrating multi-sourced urban data

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ABSTRACT

With recent development of analytical tools in the past decade, a series of approaches evaluating perceived street qualities have been developed. Nevertheless, street attractiveness as an important concern of contemporary urban design is still lacking quantitative measurements. As a response, we are attempting to develop an evaluation of the perceptual-based attractiveness of streets which usually depended on subjective experience. With multi-sourced urban data and machine learning algorithms, a human-centered evaluation has been developed to measure street attractiveness from three dimensions: visual quality, network accessibility and functional diversity. Specifically, street view images and machine learning algorithms were applied to quantify visual quality intelligently. Spatial design network analysis (sDNA) was used to measure street network accessibility. The entropy of points of interest (POIs) was used to assess functional diversity on streets. Beijing and Shanghai, two megacities from China were selected for case study. Analytic hierarchy process (AHP) was applied to integrate these three key dimensions to evaluate street attractiveness. Furthermore, the satisfactory accuracy of the approach has been verified by further validation. The analytical approach helps to quantify the degree of street attractiveness comprehensively, owing to the application of multi-source urban data. In short, this study contributes to the development of a human-centered and systematic measurement of street attractiveness across large-scale areas, which benefits planning practitioners to get information more efficiently and precisely. Findings achieved from this study would contribute to bring in a human-oriented perspective into morphometrics and newly developed analytical tools.

Keywords: Street attractiveness, visual quality, network accessibility, functional diversity, multi-sourced data

INTRODUCTION

Humanity-oriented studies on improvement of street quality

In recent years, the improvement of the quality of urban public spaces with a human-centered approach has become one of the current focuses worldwide. Extensive research has been explored on the interaction between urban public spaces and the quality of life. Streets are a vital part of urban residents' everyday public life and essential component of urban public spaces (Madanipour, 1996).

High-quality street spaces not only have the potential to generate urban vitality but it also promotes positive social interactions and outdoor activities. In this context, enhancing the perceptual-based spatial quality of urban streets has become a significant topic in urban research.

Qualitative and quantitative studies on the streetscape quality

Comprehensive evaluation of streetscape quality is a classic topic in the field of urban design. The concept of measuring 'streetscape quality' can be traced back to Theil's 'space score,' which reflects the extent to which design elements perceived by people in motion would lead to a change in their behavior (Thiel, 1961). During this stage, urbanists mostly approach the study of street quality measurement from a one or two perspective of human perception. For example, Lynch and Gel emphasized the visual perception of streets, while Jacobs focused on the walking experience of streets, and so on. Meanwhile, at this stage, research and practice methods for evaluating streetscape quality often involve observation and field studies, questionnaire surveys, or small-scale analyses.

In the 21st century, rapid urbanization has necessitated a more refined approach to urban design, with a greater emphasis on humanity-oriented concerns. In this context, urbanists have further established a multi-dimensional connection between street quality and human experiences (Ewing and Cervero, 2010; Speck, 2018). Furthermore, the emergence of new data environments represented by big data and the advancements in urban science represented by artificial intelligence have created possibilities for large-scale and fine-grained measurement of urban street quality.

Based on existing urban design theories and utilizing various techniques, extensive quantitative research has been conducted to measure the streetscape quality from multiple perspectives. Some scholars have gone further to explore the visual perceptual quality of the streets (Naik *et al.*, 2014; Ye, Zeng, *et al.*, 2019; Ma *et al.*, 2021). Some studies have explored the evaluation of street network quality (Koohsari *et al.*, 2016; Ye, Richards, *et al.*, 2019)to what extent the relationship of street integration with WT may be explained by the presence of destinations. In 2003–2004, adults living in Adelaide, Australia (n=2544. Some modern techniques are noticed, such as Depthmap or spatial Design Network Analysis (sDNA) (Li *et al.*, 2022) Other studies have also approached street quality measurement from the perspective of street functionality (Shen and Karimi, 2016; Hu *et al.*, 2020).

Possibility for street quality integration measurement with the help of multi-source data

Since the onset of the 21st century, the swift advancement of novel technologies and urban data has facilitated the evaluation of hitherto unquantified factors (Ewing and Handy, 2009). Emerging high-resolution open data of road networks, points of interest (POI), and building base maps have become important data sources for street research. Additionally, the customization of Python and ArcGIS has accelerated mass data processing time. Meanwhile, Algorithms based on convolutional neural networks (CNN) like SegNet and YOLO, can automatically recognize and extract physical elements from a series of images. Artificial neural networks (ANNs) can help to address the complex relationships amongst the various design elements and the visual quality to achieve an efficient evaluation of this intangible value.

In short, with the rapid development of new urban data, previously unmeasured multiple elements could be assessed, thus bringing opportunities to develop integrated, multi-dimensions quantitative approach for measuring the perceptual-based streetscape quality.

Current gaps and our study to evaluate street attractiveness

In the research on streetscape quality assessment, quantitative research is more confined to a single dimension while qualitative research shifts from a single dimension to a multi-dimensional one, becoming more human-centered. Numerous quantitative studies have extensively investigated the measurement of street quality, with emphasis on aspects such as visual quality, network accessibility, and functional diversity. And most studies focus on only one or two dimensions, lacking a comprehensive framework to evaluate streetscape quality.

In this context, the overall quality of a street, which we call street attractiveness in this paper, needs to be measured in a scientifically valid way. Our study takes a perspective of urban design and evaluates street attractiveness. Our aim is to put forward a holistic, multi-dimension quantitative approach for measuring the perceptual-based street attractiveness which is traditionally reliant on subjective impressions or feelings. This approach can provide a reference and basis for urban design practices.

METHODOLOGY

The aim of this study is to develop a comprehensive quantitative framework for measuring street quality. The study involved four major phases: derivation of evaluation dimensions and indicators, data collection, quantitative calculation, and verification (Figure 1). The identification of analytical dimensions and indicators and the analytical techniques support of subsequent steps are identified through existing studies.

Derivation of evaluation dimensions and indicators

Since the 1960s, urban design scholars have emphasized visual and experiential aspects contributing to the street's sense of place.

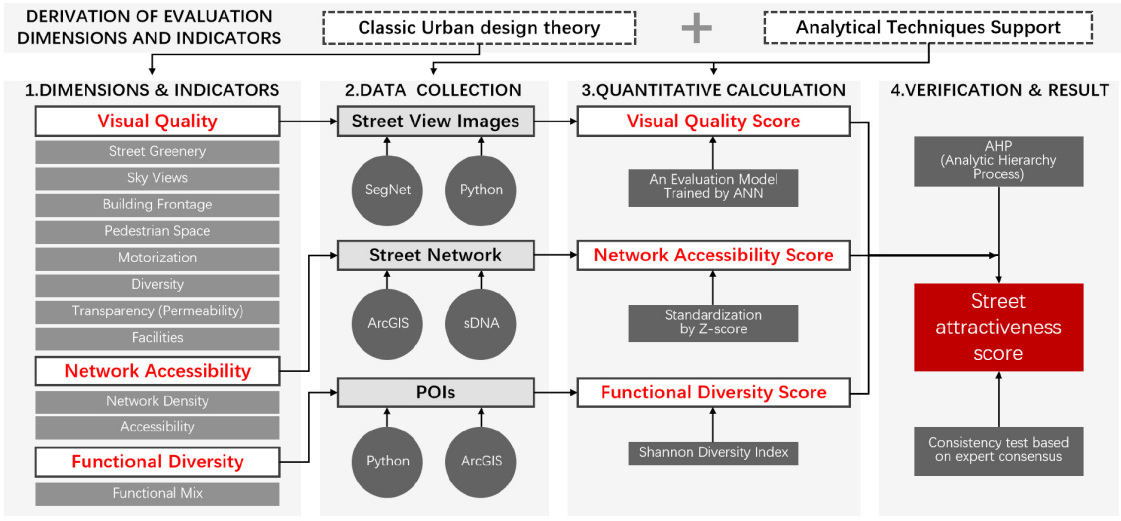

Figure 1. Framework. Photo credit: Chengcheng Huang

The works of Lynch, Trancik, and Gel highlighted visual elements like buildings, form, color, interface, and scale, while Jacobs, Katz, and Scully focused on the importance of walking sensations, density, and accessibility. Lynch, Montgomery, and Southworth further emphasized user experiences, with Southworth introducing the concept of 'walkability' (Southworth, 2005). As a result, visual quality, functional diversity, and network connectivity play pivotal roles in assessing urban street quality.

From this perspective, the sensory experiences of visual quality, functional diversity and network connectivity are consistently recognized as crucial aspects for evaluating the quality of urban streets. From this perspective, the human-centered evaluation of street attractiveness is put forward rooted in existing urban design theories. This evalution encompasses three dimensions: visual quality, network accessibility, and functional diversity. Within the visual quality dimension, we identify eight key elements—street greenery, sky views, building frontage, pedestrian space, motorization, diversity, transparency, and facilities. The network accessibility dimension focuses on network density and accessibility, while functional diversity is encapsulated through functional mix.

The study area: Beijing and Shanghai

Our study took place in the town centers of two major Chinese megacities: Shanghai and Beijing (Figure 2). We focused on the outer ring road area of Shanghai, spanning 680 square kilometers, and the fifth ring road area of Beijing, covering 667 square kilometers. China's historical urbanization process initially prioritized rapid development over street quality, resulting in low-quality urban spaces. However, recent shifts in critical thinking have spurred street renewal movements, especially in city centers, to address this issue. Both Shanghai and Beijing have embarked on large-scale pilot projects to revitalize community streets, aiming to enhance urban quality and neighborhood livability. Shanghai's "Planning Guidance of 15-Minute Community-Life Circle," launched in 2016, emphasizes pedestrian-friendly environments and enriching street spaces. Beijing has followed suit since 2015, focusing on urban public spaces and the quality of street environments. Given these ongoing urban renewal efforts, a quantitative assessment of street visual quality is crucial.

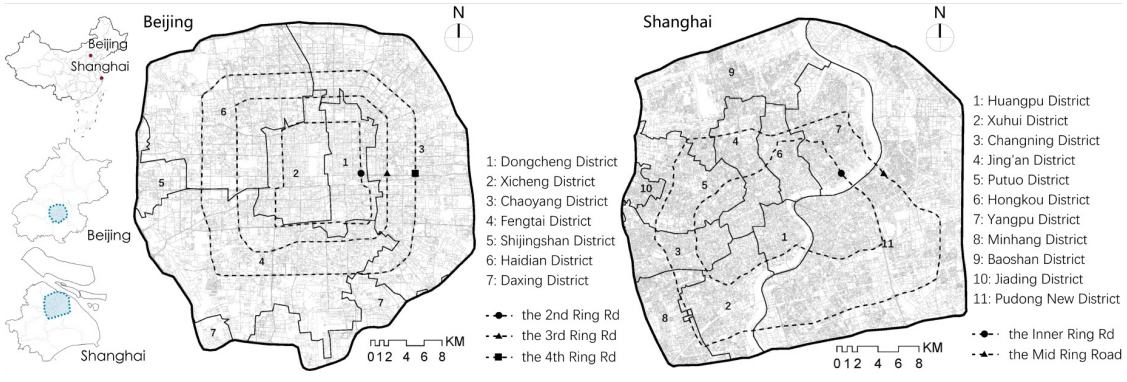

Figure 2. The study area: Beijing and Shanghai. Photo credit: Chengcheng Huang

Measuring streetscape attractiveness via three dimensions

Visual quality

Eight fundamental spatial components of streets were assessed using a combination of Semantic Visual Indices (SVIs) and the SegNet deep convolutional neural network architecture. The first five elements were quantified as pixel percentages for greenery, sky, buildings, pedestrians, and vehicles. Diversity pertains to color variation along the street interface, deviating from the conventional functional interpretation. Permeability was gauged by the pixel percentage of building openings (windows and doors) in street view images. The facilities category was measured by pixels associated with other design elements such as street lights and furniture.

SVIs were sourced from Baidu Maps API and Python, gathered over the 2013 to 2019 timeframe (Figure 3a). Specifically, SVIs were accessed via Baidu Maps API in HTTP URL format. Sampling points were selected at 40-meter intervals, each capturing four panoramic views at 90-degree angles, totaling a 360-degree view (Figure 3b). SegNet, a pre-trained deep convolutional neural network, was utilized to extract the fundamental spatial elements. The SegNet applied herein is a pre-trained model provided by researchers from the University of Cambridge. We did not re-train it for this specific context as an empirical study utilizing this algorithm in Chinese cities performed well (Long and Liu, 2017).

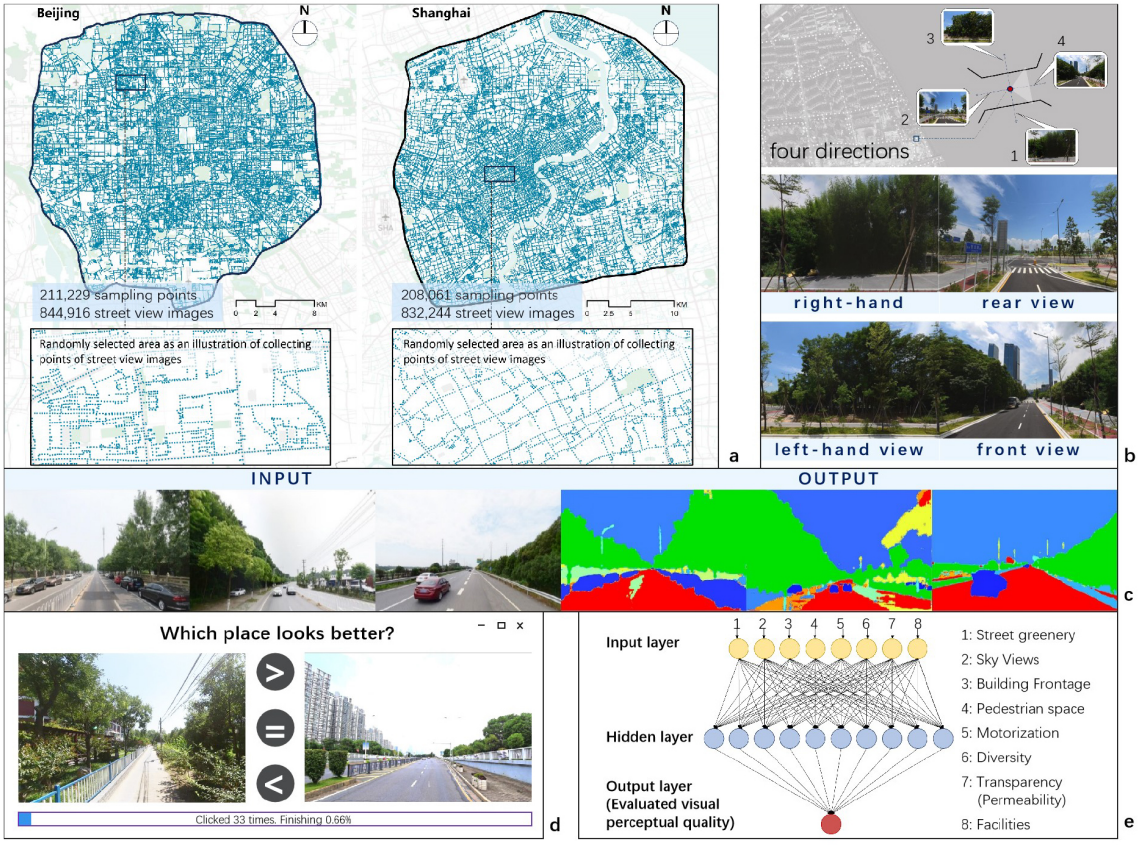

Figure 3. Construction of a visual quality assessment for street attractiveness. Photo credit: Chengcheng Huang

Figure 3c displays SegNet's effectiveness in extracting these spatial attributes. Following this, a Java-based program collected numerous pairwise image comparisons, involving ten experts familiar with Shanghai or Beijing. These experts answered the question of which side appeared better in each comparison (Figure 3d). Elo rating, a widely-used algorithm in one-on-one games, transformed these comparisons into scores. Subsequently, an artificial neural network (ANN) was applied to train an evaluation model utilizing the representative images containing a series of measured design elements and computed scores from the experts' preferences (Figure 3e).

Network accessibility

In our study, we used a street path-center line map extracted from route data in Baidu Maps as the base street network database. The Road Network Quality index integrates two influencing indicators: road network density and spatial syntax-based accessibility. Firstly, unlike traditional road network density indicators, we calculate the road network density around each road segment within a 500-meter radius. Secondly, for the spatial syntax-based accessibility indicator, we employed sDNA analysis to calculate the measure of betweenness centrality within a radius of 1200 meters. This indicator quantifies the number of times road segment x is crossed by the "shortest" paths between any other two road segments y and z within the specified analysis radius, reflecting the potential of the road segment as a traversable movement pathway. Lastly, to eliminate dimensional disparities, the study standardized both indicators using the z-score normalization technique. The indicators were then accorded equal weightage to compute the Road Network Quality index for each street.

Function diversity

With the help of Python and AutoNavi's Map API, 211229 PoIs in Beijing and 208061 PoIs in Shanghai were collected from within the case area to compute diversity (Figure 4). AutoNavi is one of the largest map service providers in China, providing accurate, geo-referenced data on the built environment and related urban facilities. In order to achieve a human-oriented measurement of diversity, we did not employ the traditional land-use categories based on functions in plots or street blocks. Rather, we attempted to develop a more fine-scale approach, integrating the total quantity of urban facilities and the diversity index of urban functions represented by these facilities.

In this study, diversity was measured using the Shannon-Wiener index. We chose to use the Shannon-Wiener index, originally developed in ecology, to measure diversity because this index has shown good performance in urban planning and management. The Points of Interest (PoIs) were classified

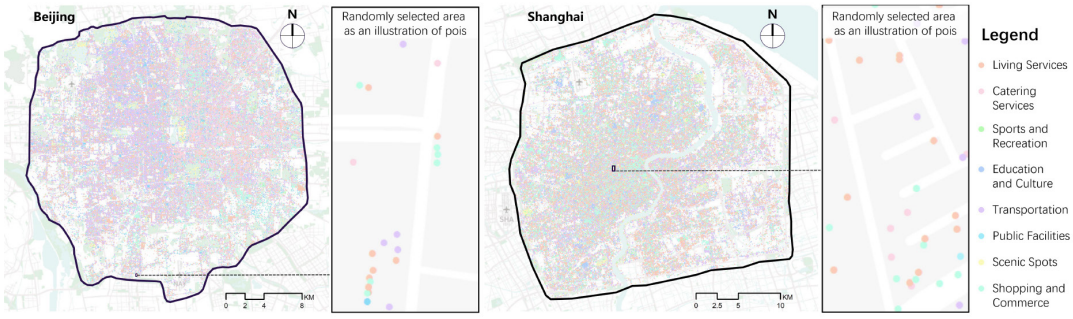

Figure 4. *Distribution of Points of Interest (POIs) in Beijing and Shanghai. Photo credit: Chengcheng Huang*

into eight functional categories: Living Services, Catering Services, Sports and Recreation, Education and Culture, Transportation, Public Facilities, Scenic Spots, and Shopping and Commerce.

Attainment and verification of comprehensive street attractiveness score

In order to provide a comprehensive evaluation of street attractiveness from the perspectives of visual quality, network accessibility and functional diversity, the study employed the Analytic Hierarchy Process (AHP). More than twenty experts with backgrounds in planning and architecture, as well as master's and doctoral students, were engaged to rate the three dimensions. Below are the weights for each dimension (Table 1).

Table 1. *Weights of three dimensions for measuring street attractiveness. Table credit: Chengcheng Huang*

Dimensions for measuring street attractiveness	Weight
Visual quality	0.377
Network accessibility	0.352
Functional diversity	0.271

In this study, the effectiveness of the evaluation results was assessed by comparing them with the consensus cognitive results of a professional panel. Firstly, we invited the experts with relevant professional backgrounds in Beijing or Shanghai to mark on any map at least 5 areas within the designated research scope where they perceived better street experiences. And we have collected a total of 98 marked areas in Beijing and 105 marked areas in Shanghai, some of which overlap. Next, we marked the locations of each intended area on ArcGIS, using the geometric center points of these areas as reference points. Thirdly, we independently calculated the heatmaps of high street attractiveness areas based on the experts' cognitive perceptions and the street attractiveness measurement framework proposed in this study. Finally, we evaluated the effectiveness of the research results by comparing the similarity between these two heatmaps.

RESULTS AND DISCUSSIONS

The measurement of three key dimensions for evaluating street attractiveness

Visual quality

The measurement results of street visual perceptual quality in the main urban areas of Beijing and Shanghai are depicted in Figure 5.

For Beijing, the Third Ring Road exhibits higher visual quality scores than the average within the Fifth Ring Road, showing an "inner lower, outer higher" spatial distribution. Specifically, Xicheng, Haidian, and Chaoyang districts have contiguous areas of high street attractiveness, while Fengtai and Daxing districts show relatively lower levels. Haidian district, with higher visual quality scores, boasts important cultural landmarks like the Yuanmingyuan and the Summer Palace, along with prestigious universities. Similarly, the Chaoyang and Xicheng districts feature significant concentrations of high-end historical areas with distinctive architectural charm. Overall, Beijing's main urban areas have a

few clusters with high street attractiveness scores in Haidian, Chaoyang, and Xicheng districts, while most high street attractiveness segments are scattered in a dot-like or linear pattern.

In Shanghai, the western urban areas have higher scores compared to the eastern areas across the Huangpu River. The inner ring exhibits higher street attractiveness scores than the middle ring, which, in turn, has higher scores than the outer ring, creating an "inner lower, outer higher" pattern. Notably, Changning, Hongkou, Jing'an, and Yangpu districts have notable clusters of high street attractiveness, while Pudong district shows relatively lower scores. Xuhui district features a high-end historic community (Hengshan-Fuxing Road), known for its attractive and continuous streetscape. The Yangpu district stands out with a significant concentration of high-end universities, resulting in higher design scores for the surrounding streets. Conversely, areas with lower scores, like the eastern part of Shanghai in Pudong New Area, were developed under functionalist planning, often overlooking human-scale visual quality. Overall, Changning, Hongkou, Jing'an, and Yangpu districts stand out as major hubs of high street attractiveness, featuring clustered and continuous patterns.

Both Shanghai and Beijing demonstrate an "inner lower, outer higher" pattern in terms of street visual quality scores. However, compared to Shanghai, Beijing's overall scores are slightly lower and lacks contiguous high attractiveness clusters.

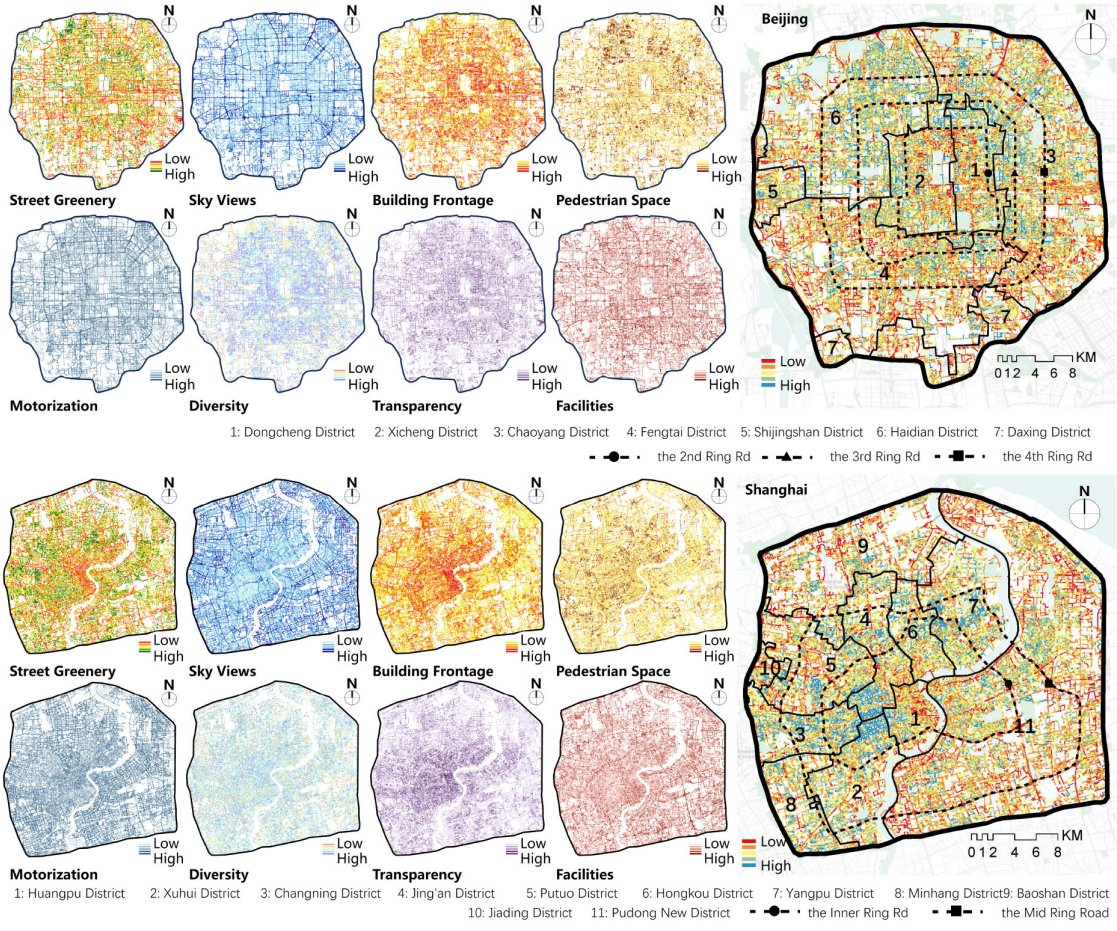

Figure 5. *Results of visual quality in Beijing and Shanghai. Photo credit: Chengcheng Huang*

Network accessibility

The measurement results of street network accessibility for the main urban areas of Beijing and Shanghai are shown in Figure 6. Beijing's road network density and accessibility display a clustered high-density distribution across districts. The central districts of Dongcheng and Xicheng have relatively high and balanced overall values. In contrast, peripheral areas like Haidian, Fengtai, Chaoyang, and Shijingshan exhibit greater variation in network density, with both high and low-value regions. Beijing's accessibility pattern forms a "high on the outside, low in the middle, and ring-like" trend, with Dongcheng and Xicheng districts displaying continuous high-value walkability. For Shanghai, the road network density and accessibility exhibit higher and more balanced overall values in the western urban areas along the Huangpu River, while the road network scores in the eastern urban areas show significant variations. In terms of street attractiveness, the scores in the western urban areas of Shanghai are significantly higher than those in the eastern areas. The overall distribution shows a clustered and continuous pattern of high street attractiveness. In summary, compared to Shanghai, the overall street network accessibility in Beijing is slightly lower and lacks contiguous high attractiveness clusters.

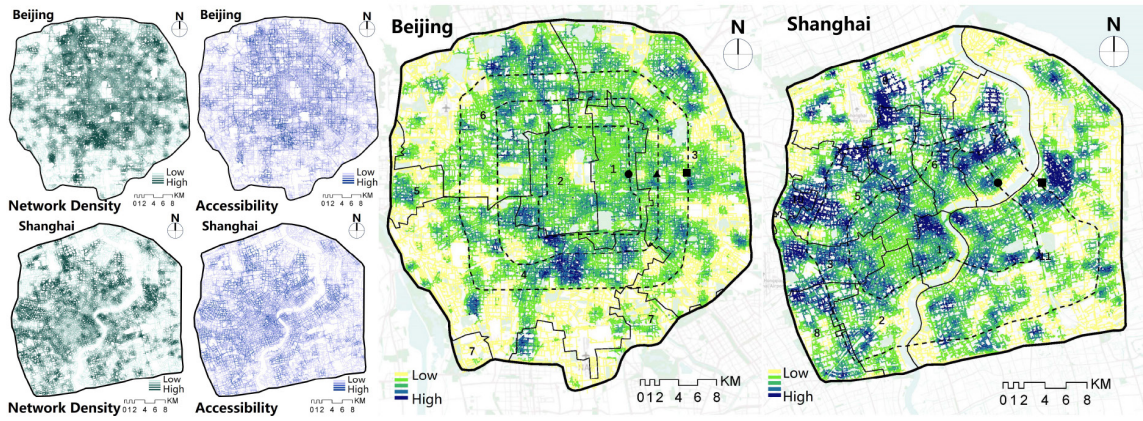

Figure 6. *Results of network accessibility in Beijing and Shanghai. Photo credit: Chengcheng Huang*

Function diversity

The measurement results of functional diversity in the main urban areas of Beijing and Shanghai are depicted in Figure 7. In Beijing, there is a generally higher level of functional diversity within the Third ring, exhibiting a spatial pattern of "higher in the center, lower on the outskirts". Specifically, Dongcheng, Xicheng, Haidian, and Chaoyang districts have extensive and contiguous areas with high functional mix, while Fengtai and Daxing districts have relatively lower overall functional mix. In Shanghai, the level of functional diversity is generally higher within the inner ring, with the western bank areas significantly higher than the eastern bank. The western bank areas have a large number of contiguous regions with high functional diversity, while the high functional diversity areas on the eastern bank are mainly concentrated near the Huangpu River.

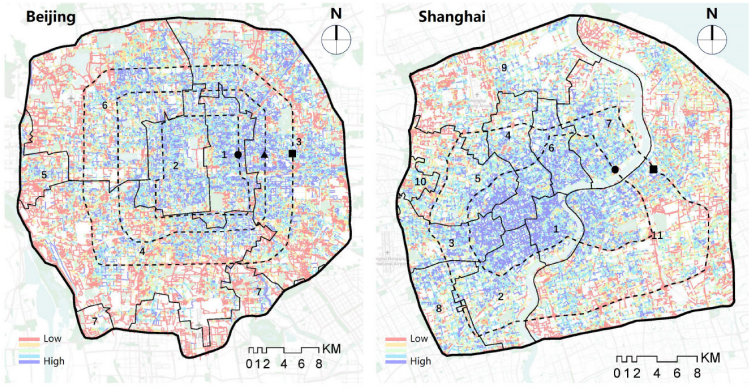

Figure 7. *Results of function diversity in Beijing and Shanghai. Photo credit: Chengcheng Huang*

Quantitatively measuring street attractiveness

Overall, both Beijing and Shanghai exhibit a pattern where the attractiveness scores of streets are generally higher in the inner ring compared to the outer regions. Additionally, in Shanghai, there is a significant difference in scores between the western and eastern banks of Huangpu River, with higher scores on the western bank (Figure 8).

Specifically, in Beijing, the high-scoring areas are mainly concentrated in Dongcheng District, Xicheng District, Haidian District, and Chaoyang District. Within these districts, the high-scoring clusters in Dongcheng and Xicheng are focused on historical preservation projects. In Chaoyang District, the high-scoring areas are located within key development zones in the city core. Haidian District is characterized by a large number of universities. In Shanghai, the high-scoring areas are primarily concentrated in Huangpu District, Xuhui District, Hongkou District, and Yangpu District. The high-scoring clusters within these districts are centered around their historical preservation zones. Pudong New Area has its high-scoring regions mainly distributed within its central development zone.

Compared to Beijing, Shanghai has a larger number and more concentrated distribution of highly attractive streets. The main urban area of Shanghai is characterized by a significant presence of contiguous clusters with high-quality streets.

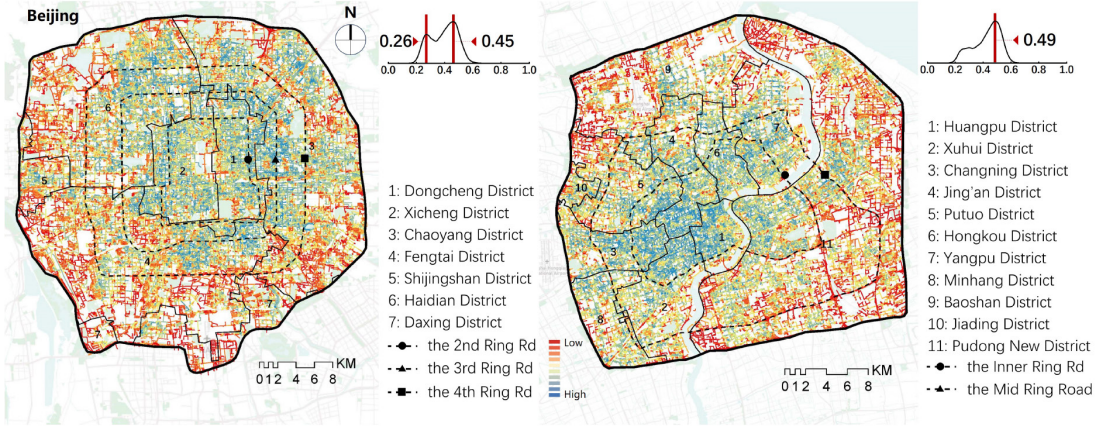

Figure 8. *Results of street attractiveness in Beijing and Shanghai. Photo credit: Chengcheng Huang*

Verification the analytical results

The heatmaps of high street attractiveness areas based on the experts' cognitive perceptions and the street attractiveness measurement framework proposed in this study are shown in Figure 9. Overall, the high street attractiveness areas perceived by the experts are mostly contained within the high street attractiveness areas computed in this study. Specifically, for Beijing, the computed results are consistent with the experts' perceptions, indicating that the areas surrounding the Second Ring Road have higher street attractiveness. Additionally, a number of other scattered areas also show anastomosis. For Shanghai, the computed results generally follow the same trend as the experts' perceptions, with Puxi being rated higher than Pudong, and extending along both banks of the Huangpu River in the southeast and northwest directions. Moreover, the historical area of Shanghai (Zone A) and the cluster of universities (Zone A) are consistently identified as high street attractiveness areas. In conclusion, the consistency between the computed results and the experts' consensus demonstrates the effectiveness of the proposed street attractiveness quantification method in this study.

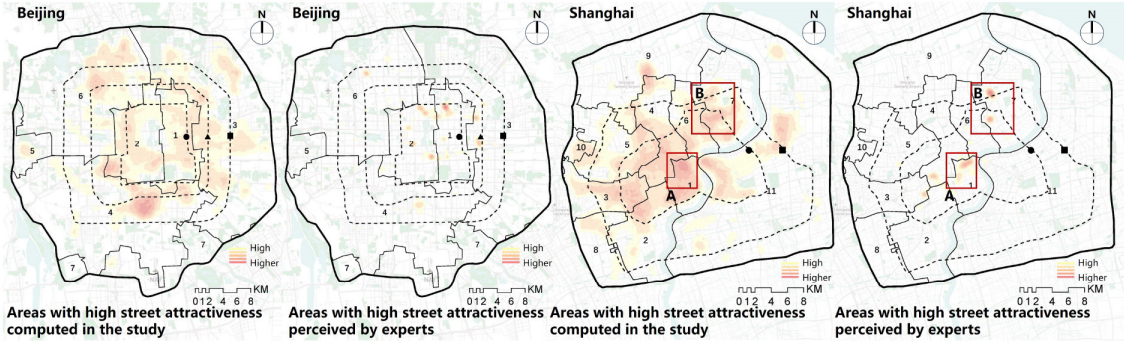

Figure 9. *Verification of the results of street attractiveness. Photo credit: Chengcheng Huang*

Bridging Theory to Application: Comprehensive Measurement of Urban Street Quality

This study integrates classical urban theories to create a comprehensive framework for measuring street attractiveness through human perception. We address limitations in current evaluations which often overlook overall perceptions by considering visual quality, network accessibility, and functional diversity. Leveraging new data and technology to simplifies the evaluation process, we quantitatively assess street attractiveness in Shanghai and Beijing, aligning with human perception. Our findings hold significant policy and design implications for rapidly developing urban areas. We advocate for a shift toward human-oriented urban design using large-scale, high-resolution data. Firstly, our framework evaluates urban streets comprehensively, highlighting low-quality areas like Pudong New Area in Shanghai and areas beyond Beijing's Third Ring Road. Prioritizing human-centered street improvements in these regions is crucial. Secondly, scores for each dimension guide optimization efforts. For instance, in Shanghai's historic Huangpu District, while network accessibility scores are higher, visual quality remains low, necessitating targeted improvements. Lastly, regular updates enable consistent monitoring of human-scale urban design quality over the long term.

Limitation

This study has some limitations to address. While it offers a rapid assessment of visual quality, network accessibility, and functional diversity, it does not fully replace traditional qualitative spatial analysis methods and omits factors like sound, smell, and noise. Human emotions and the sense of community are also neglected. Though it provides a fast evaluation as a valuable supplement to existing methods, further efforts are needed to enhance its capabilities. Additionally, differences may exist between the preferences of the public and experts, making it essential to collect large-scale data from local residents, workers, and visitors to bridge this gap.

CONCLUSIONS

This study created a framework for measuring human-perceived street attractiveness by blending classical urban design theories with new technologies and urban data. The framework comprises three dimensions: visual quality, network accessibility, and functional diversity, along with related indicators. By integrating PoIs, eye-level SVIs, machine learning, and street network analysis, we effectively assessed street attractiveness in central Beijing and Shanghai. We anticipate that this innovative, people-centric approach can enhance street renewal initiatives through collaborative efforts between current research and emerging data and technology.

ACKNOWLEDGEMENTS

This research was funded by National Natural Science Foundation of China (52078343, 51708410), Natural Science Foundation of Shanghai (20ZR1462200), Fundamental Research Funds for the Central Universities (22120210540), and Shanghai RisingStar Program (NO.23QB1404300).

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The reconstruction of French bombed cities and the open block

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ABSTRACT

During World War II many French cities faced heavy destruction from the bombardments which sometimes erased entire city centres or large parts of them. The question for the architects of their post-war reconstruction was how to rebuild these centres and what to retain from past urban form. In terms of built form configurations one of the main changes between pre-and post-war urbanism is the evolution from closed and compact urban blocks inherited from the historic fabric towards more open urban blocks under the influence of Modernism. The present study focuses on the impact of different building configurations such as pavilion or courtyard types on the intelligibility and navigability of these cities. Using figure-ground maps of both urban blocks and building footprints within them the paper uses the speed of tracing a route between two points and the choice of routes in a goal-oriented navigational task to compare the impacts of increased openness in these urban configurations. Using spatial cognition and morphology indicators this research approach provides a means to better understand how the positioning of built form within urban blocks affects their syntactical intelligibility. The findings indicate that the creation of fragmented open space within blocks by less compact and more open building configurations blurs the perceptibility of public space, greatly reducing both the overall syntactic intelligibility and the ease of navigating these urban layouts.

Keywords: bombed cities; intelligibility; open block; spatial cognition

INTRODUCTION

How to reconstruct

At the wake of World War II, many cities face the challenge to urgently reconstruct their town, fully or partially destroyed by the bombs. It coincides with new ideas about cities propagated by the International Congress on Modern Architecture (CIAM) presented in the Charter of Athens in 1933. It challenges the traditional approach to city by advocating more radical changes. The moderns want a more airy, more rational and hygienic urbanism with more open building configurations in opposition to the traditionally dense historical fabric. The conservatives on another hand want to preserve and restore the character of the past city. If the creation of a new urbanism ex-nihilo asserts itself in its disconnection with the past, recreating the original character of a city is more contentious. Many have argued that the character of a city is conveyed through its architecture language, and the question of style is at the heart of the reconstruction. The essence of the town's character is also intricately tied to the physical features of its urban layout, encompassing the configuration of streets, plots, and buildings (Kropf, 1996). The interplay among these three components influences the town's identity depending on how buildings are positioned within urban blocks and how these blocks form the overall street layout. Looking at these relationships, the main change that occurred between pre-and post-war urbanism is the evolution from closed and compact blocks to the open blocks (Berghauser Pont and Haupt, 2007).

A morphological comparison of pre- and post-WWII of bombed city centres has shown an overall increase of public space from a quarter to a third (Vialard, 2023). This trend is a continuation of the 19th century transformations exemplified in the work of Haussmann in Paris. However, there is a significant difference between Haussmannian *percées* and postwar reconstruction. Urban *percées* were interventions in an existing fabric with a spatially limited repertoire, primarily the creation of new streets and the widening of existing streets (Vialard, 2021). The reconstruction after WWII offered new and much greater opportunities for morphological transformation, as some city centres were almost fully destroyed with few remnants of their former traditional fabric. Wartime destruction provided a state resembling the "tabula rasa" advocated by the Modernists, which, combined with a more holistic approach to reconstruction planning, generated a wide range of urbanistic responses. Unlike individual compensation that prevailed for urban reconstruction after WWI, there was a collective approach to the reconstruction following WWII with the introduction of two new mechanisms. Firstly, victims of destruction were required to join a collective of war damage to negotiate compensation (Voldman, 2011); secondly, land consolidation became the tool to remodel entire areas that had been destroyed (Chabrol, 2010; Clout, 1999). Land consolidation enabled a more global rethinking of street layouts with the boundary between private and public domains able to be renegotiated. Furthermore, such re-arrangements of urban blocks were also accompanied by new patterns of subdivision into plots, allowing new built form configurations. Thus, supervised by the state with the newly created Ministry of Urban Reconstruction (MUR) the simultaneous reshaping of land ownership, development processes and built form were able to proceed more holistically than previous incrementalist approaches premised on fragments that suited individuals (Vayssière, 2009). The impact of the postwar processes was thus two-fold: an enlargement and regularisation of the traditional public spaces of streets and squares combined with a dramatic transformation of the form, type and area of accessible open space within urban blocks themselves.

The architects of the reconstruction

The final reconstruction resulted from negotiations between urbanists, architects, local authorities, and war damage collectives. The negotiations and decisions occurred at multiple levels: the definition of the street layout, the subdivision of the urban block into plots (parcellation) and finally the configuration of buildings on plots. The morphological decisions and their implications were important, and debates on how to better reconstruct – all agreed to rebuild a healthier, more practical city – meant that the morphological propositions varied greatly from the more traditional approaches to more Modernist.

The "moderate" modernist August Perret, a major figure of the reconstruction in charge of works for Le Havre, was able to implement the most "complete" design by controlling three key elements: the new grid, plot parcellations and built form configurations. In Tours and Orleans, the partial destruction of the historical core led to a conservative and spatially constrained solution. The purely Modernist plans of the housing estates were implemented in *extra-muros* neighbourhoods close the train station, which had been the strategic target of the bombing. In other cities, multi-party negotiations led to more compromised solutions at the level of the plan or the internal configuration of urban blocks. A good example is the reconstruction of Dunkirk which was 82 percent destroyed. The plan proposed by the urbanist Theodore Levreau for the reconstruction of Dunkirk retained the overall street structure. It was seen as 'conservative' by the modernist chief architect Jean Niermans, who wished to replace curvilinear streets with rectilinear ones. Levereau attempted to widen streets even more but was restrained by the City Council from achieving the extent he preferred (Ménager and Benedict,

1995). In Saint-Nazaire, the 19th Century gridiron extension served as a base for the new gridiron plan established by Noël Le Maresquier, supporter of the *tabula rasa*. The new neo-classical inspired grid with its main axis, Avenue de la République, was re-oriented to be parallel instead of perpendicular to the docks (Dieudonne, 2001). The use of land consolidation allowed the multiplication of wider streets (20m), and the prioritization of the reconstruction of the block rather the individual plots (le Guen, 1953). Small blocks were consolidated into larger ones creating less dense street grid structure. In Lisieux, the choice of plot subdivisions and built form configurations was also the source of debate. The layout of block 26 in Lisieux indicates the different approaches to block design and built form configurations (figure 1- middle right) ranging from traditional individual plots with buildings fronting the street to communal buildings setback but with continuous fronts to types of horizontally stepped built form configuration relative to the block boundaries. The final design includes the addition of small green areas to recreate the street edge.

Overall, the main Modernist influence on the proposed street layouts was in the change of scale of street widths rather than in the overall plan configuration that remained largely inspired by classical composition. Modernist thinking is more evident in how built form was arranged within urban blocks: new types of configurations, such as the freestanding 'pavilion' (centrally located built form), parallel 'street' (linear or slab-like forms) and the 'court' arrangements, with outer rings of built form along block edges liberating the centre (Martin and March, 1972). Each of these configurations is associated with differing degrees of compactness and openness (Berghauser Pont and Haupt, 2004) which impact their legibility.

The opening of the block

Figure 1. illustrates the different types of urban blocks present in the selected towns. The pre-WWII urban blocks, inherited from the very fine-grained fabric of the Middle Ages (1.a) or structured by the 19th century *percées* (1.b) show how public space is framed by built form. In the medieval tissue, "*the street does not exist without the buildings that define it, and the buildings are built on plots that form the framework of their evolution"* (Castex et al., 1975: 158). *The* 19thcentury Haussmannian block is characterized by triangular shapes and straight boundaries, resulting from *percées*, widening and re-alignments. Exemplified in Paris, similar transformations were implemented all over France and were already associated with an increase in urban public space (Vialard 2021).

The post-WWII blocks illustrate different approaches to urban reconstruction. Two main observations concern firstly, the placement of buildings in relation to plot boundaries, and secondly, as the street edge became less defined by built form, the addition of controlling features to the design of streets became necessary. The Modernist block (according to CIAM principles) eliminated the role of buildings in defining the spatial edges of streets by placing buildings in the centre of blocks liberating the resulting gap between them and the edges of the block to become open space. Between these two opposing models, a range of alternative configurations exists which provide different levels of openness to the interiors of urban blocks.

During the reconstruction period, urbanists and architects proposed a range of semi-open blocks, usually designed to accommodate parking and garages within them, in line with the post-war shift to car-based mobility advocated by many advocates of Modernist urbanism. The difference with the traditional courtyard was in the shared property of that open space. A single communal space replaces the traditional multiple individual internal spaces within urban blocks. Internal open space thus becomes associated with the broader urban space system rather than with individual plots of land.

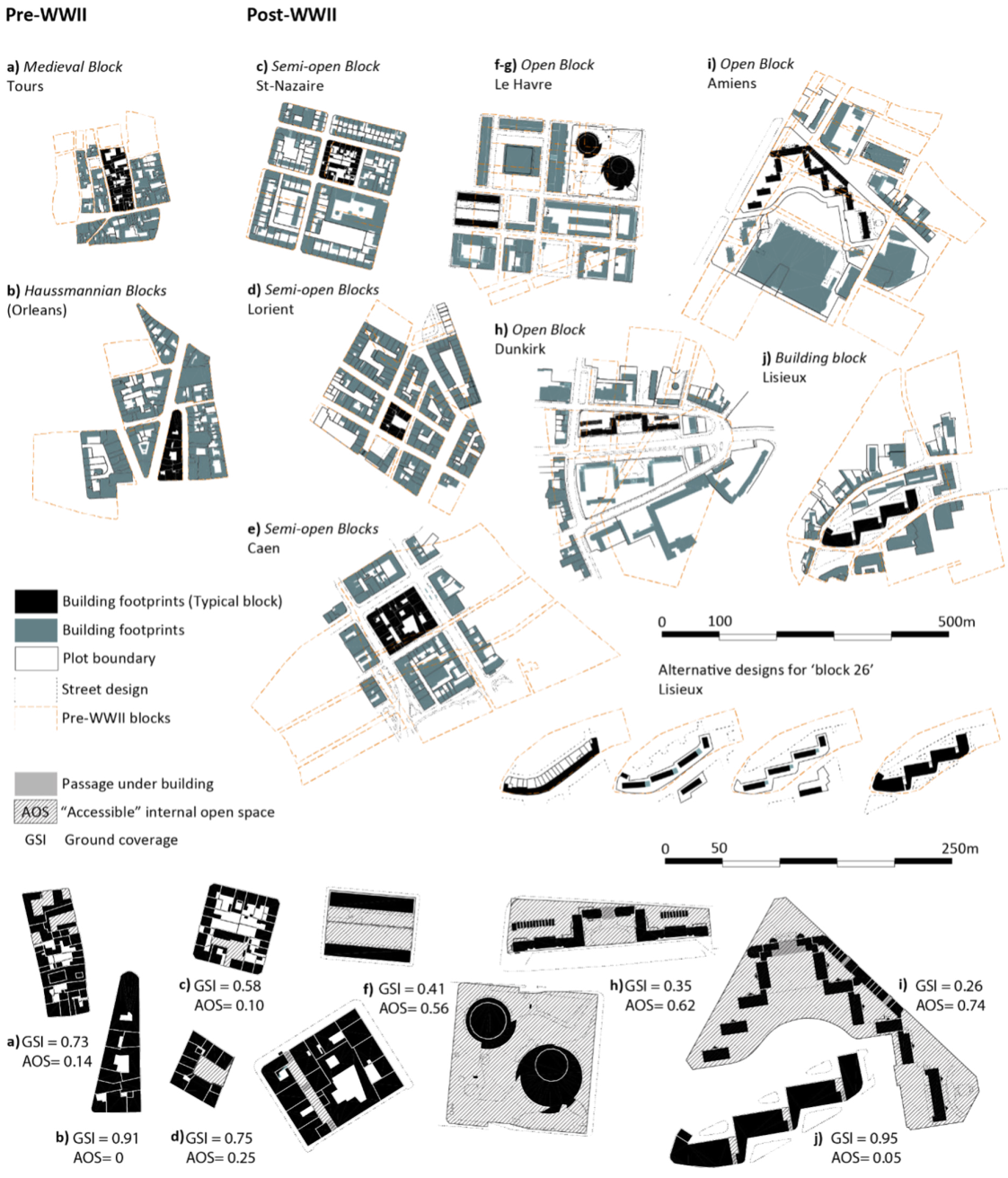


Figure 1. *Types of Blocks and building configurations in 9 French bombed towns. Middle-right: alternative designs proposed for 'Block 26' in Lisieux - adapted from Gourbin (2011).*

A further move saw these new communal internal spaces fully traversing urban blocks (1.e&f) and providing potential alternative routes through the urban fabric when accessible to the public spaces of streets and squares.

With similar high plot-building ratio or ground coverage (over 0.9), the Haussmannian block (1b) and the building-block (1j) are opposed in their approach to public space – the former is an urbanism structured by positively formed public space, the latter is an urbanism structured by solid forms in space (Ellis 1986). In the first instance, the building follows the alignment of the cadastral boundaries of the street, and in the second instance, the public space is the residue created by the stepped building forms which obliterates the street by removing its linear spatiality by breaking down its edges. This can impact its legibility and the ways it may be navigated. Using similar stepped buildings configuration in Dunkirk (1h) and Amiens (1i), the ground coverage ratios (less than 0.4) indicate a different relationship with the open space. Buildings are either placed parallel to the block boundary forming the street façade punctuated by voids (1h), or rotated relative to the street boundary increasing the deconstruction of the street edge even further. While in Lisieux (1j) the rationale for stepping the buildings is to preserve the existing curving street, it is at odds with re-constructed street alignments in Amiens. The open space that surrounds the built forms such as slab blocks and towers in parks destroy the primacy of streets as public spaces and building facades as public-private interfaces with-buildings as objects taking centre stage in an increasingly undiffentiated field of open space, some of which is publicly owned, some of which may be privately owned with often limited visual cues about which is which. How, then, these new building configurations by challenging the enclosure of the street impact impact the navigation and intelligibility of the new layouts.

METHODOLOGY

The selected methodology combines a wayfinding task using figure-ground maps, to test participant's decision-making, with the associated configurational and morphological properties of the built environments represented by the maps. Maps are used as proxies for real-world environments. The value of using maps is related to the ways decisions about urban reconstructions were made, which was essentially through the plan rather than considerations of first-person experiences in the street. Following the Ordinance of April 21, 1945, Development and Reconstruction Plans (PAR - *Plan d'Aménagement et de Reconstruction*) became the main tool to guide the reconstruction of bombed French cities.

Navigation task

To assess the impact of changes to urban built form and fragmentation of open space on wayfinding in reconstructed bombed city centres, 20 participants were asked to draw what they think is the shortest path between two points on a series of figure-ground maps. Giambattista Nolli's mapping of Rome in 1748 is one of the most well-known early examples of using figure-ground maps to represent urban space, though such representations were popularised in the contemporary era by the work of Venturi et al (1972) and Rowe and Koetter (1978) as powerful tools to represent and analyse the disposition of built and un-built urban space. For this paper, these modes of representation have been adapted to contrast public space and private domain through mapping urban blocks and the built form footprints within them. The two series of urban block maps illustrate the pre- and post-WWII

city centre cadastral layouts of the selected cities, where it is assumed most built form pre-WWII was built to cadastral boundaries of streets. The third series of maps illustrate the figure-ground of built form post-WWII. The comparison between the post-WWII maps of blocks and built form footprints allows assessment of any differences in speed of tracing and choice of routes between the two modes of representation (Figure 2.).

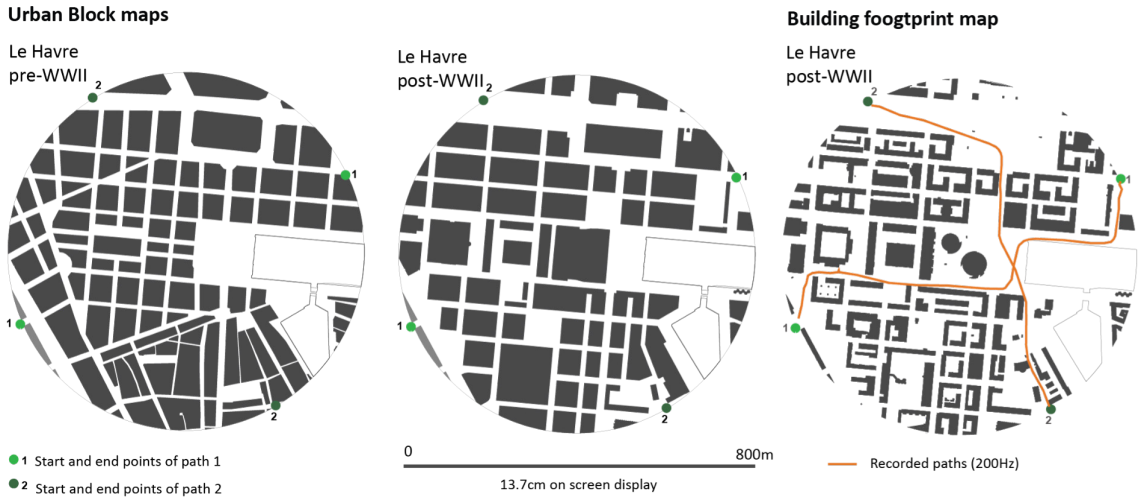


Figure 2. *Graphic task setting: figure and ground maps for urban blocs pre- and post-WWII and building footprint map post-WWII for Le Havre, implemented on a digital tablet.*

Participants used a specialised digital pen to trace their chosen routes through the maps on a digital tablet. This type of set-up was designed originally to measure minute tremors due to Parkinson's Disease (Tolonen & al., 2015). The speed of tracing, or velocity, captures the cognitive effort linked to solving the tracing tasks inherent to the wayfinding problem given to participants. The speed of the tracing is inversely related to the cognitive effort required to navigate the map. The choice of route results from participants' assessments of what is perceived by them as the shortest path between the origin and destination points provided on the maps by researchers. The set-up is intended to provide a proxy for urban layouts to provide clarity about direct routes as well as suitable alternative path-ways through them. One key impact of the open block on navigation is seen when participants draw paths through internal open spaces within blocks rather than solely using the public spaces of streets and squares that frame urban blocks.

Axial intelligibility

Axial intelligibility is a measure that integrates all these accessible open spaces and provide a syntactic measure of their relationship. The axial map (Figure 3.) converts the open spaces depicted in figure-ground maps into a sequence of axial lines. These axial lines can be assimilated into a set of lines of sight that link all the open spaces together (Bafna, 2003). Connectivity value is the number of axial lines intersecting an axial line, indicating how many adjacent open spaces are directly connected to any one space (i.e. a local measure). Integration value indicates how many steps away an

axial line is to all the other axial lines, indicating the degree to which each line is "integrated" into the whole system (i.e. a more global measure). Values are computed using specialized software called Depthmap (Turner, 2001). Axial intelligibility is the resulting correlation value between the local and global measures, meaning that it is an index of the degree to which the structure of the wider street network can be inferred from its localised instances (Hillier et al., 1987). A strong correlation (usually above adjR2>0.70) between these two attributes implies street networks that are cognitively more legible. It is argued that therefore that a more legible network is also more easily navigable because of this implied part-to-whole relationship being more clearly readable.

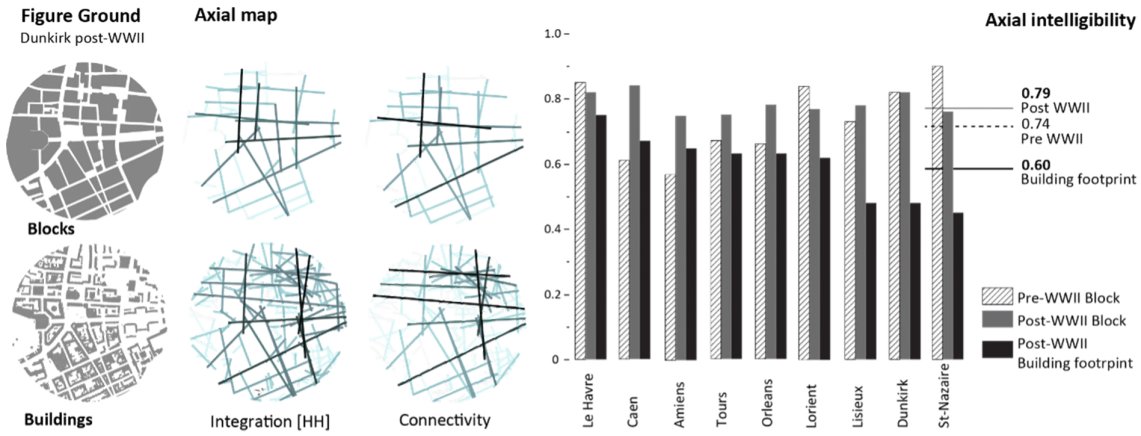


Figure 3. *Axial maps with integration and connectivity values for Dunkirk: darker colour indicates higher value – Axial intelligibility for pre- and post-WII block layout and building footprints.*

The changes in values for axial intelligibility measure the evolution of the open space structure between the different historical periods for the cities studied. It shows a slight overall increase of intelligibility from the pre- to post WWII layouts (Figure 4.). Measuring the configuration of the built form footprints shows greater variations between different cities ranging from 0.45 to 0.75, and on average much lower than the post-WWII block layouts (from 0.79 to 0.60). Three cities in particular, Dunkirk, Lisieux and Saint Nazaire, show a relatively low increase in axial intelligibility. The axial maps drawn from the block and built form figure-ground maps show an increased complexity in the latter, best exemplified by Dunkirk in Figure 4. The multiplication of shorter lines of sight between built form within urban blocks offers more possibilities for route choice but brings more complexity to the interpretation of the connections between spaces and how they are related to each other and the overall street network, hence they become harder to navigate. Fragmentation of the urban blocks with the addition of internal open space seems to lead to less legible layouts by blurring the limits of the streets and the public space.

RESULTS AND DISCUSSIONS

This section looks at two types of results: the velocity or speed of tracing while navigating the different cities and types of maps, and then the choice of route by the participants. The hypothesis is that

openness of the post-WWII urban blocks will slow down the speed of tracing by offering more choices, increased cognitive load, even if they ultimately provide shorter and more direct routes because of their internal open spaces being accessible to the public space network. The choice of route should highlight when and where the internal open space of urban block was selected by participants, further highlighting the impact of opening up the blocks on possibilities for route choices.

Diversification of publicly accessible space

The definition of publicly accessible space for the purposes of movement through the city centres studied in this paper depends on its relationships with cadastral boundaries and built form. A primary distinction is made between the public space of streets and squares and open space within urban blocks: *public space (PS)* is the un-built space outside the cadastral boundaries that form streets and squares under public ownership, and is inclusive of footpaths, roadways and landscaped areas of all kinds (which are not distinguished in the maps, although in reality they would impact on route choice). *Interstitial open space (IOS)* is the open space located within the cadastral boundaries of urban blocks but outside the built form within those blocks, generally under private ownership. There are two types of interstitial open space. First, "*accessible*" interstitial open space (AIOS) shares a boundary with the public space. Some of these spaces are between the boundary of public space and the built form within blocks (due to setting back or staggered of built form footprints), many of them form connections between two or more edges of the urban blocks they form part of. However, this type of space is not always necessarily publicly accessible as it may be gated or have a change of level at the boundary, but it remains sufficiently visually accessible from public space to appear in the figure-ground maps as a possible route choice. In some cases, interstitial open space is accessible by openings or passages within a street façade (Figure 1 – bottom). These subtle properties are not necessarily captured by the figure- ground maps and constitute one of its limitations. Second, *non accessible interstitial space* is fully enclosed by the built form footprint and appears on the figure-ground maps as such, and would be excluded as a potential route choice by participants. Figure 3 illustrates the proportion of different categories of spaces found in the different towns with the example of the building map for post-WWII Caen.

Overall, most cities have a third of their ground surface dedicated to public space (i.e outside the cadastral boundaries of streets, squares and parks etc, as defined above). It is a significant increase in comparison to pre-war layouts with public space forming only a little of over a quarter of their ground surface area. The notable exceptions are Le Havre (45%) and Caen (42%) with even higher amounts of public space. Both cities saw more comprehensive changes to their urban layouts and had implemented systematic widenings of their streets. In contrast, Tours and Orleans have remained as more traditional cities with only partially remodelling, due to having only been partially destroyed and thus able to continue to make a clearer distinction between the private and the public domain, with the private domain remaining the major part. Lisieux and Lorient have a significant proportion of accessible interstitial open space within their urban blocks which can compete with the public space in their city centres.

The amount of interstitial open space within the urban blocks denotes another process, which relates to the configuration of built form on the land parcels within them. The percentage of accessible interstitial open space ranges from 12% to 32% of the overall area of the ground surface within each study area. Looking in more detail to how much of the ground surface area of each urban block comprises interstitial open space: Lisieux, Lorient and Saint-Nazaire show that more than 40% of the block area is given to "accessible" interstitial open space (Figure 4). These figures show the different

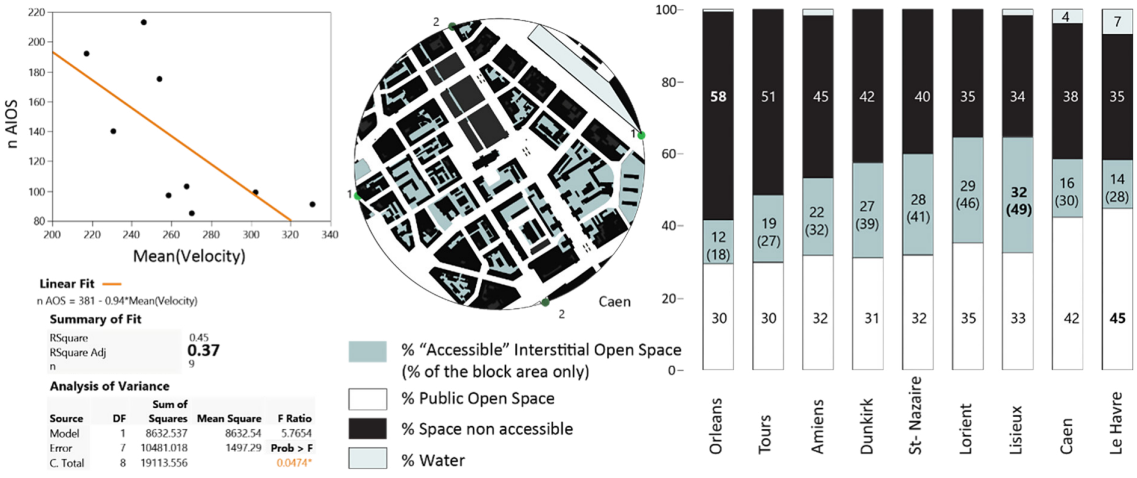


Figure 4. *Types of open and accessible spaces in postwar towns.*

balance between what is truly given to public space and the "diluted" interstitial open space of the urban blocks and the extent to which these can create a blurring of the boundary between public and private domains.

Impact on speed of tracing and distance

Comparisons between the participants' navigation of pre- and post-WWII block figure-ground maps has shown that overall the reconstructed layouts are more syntactically intelligible, and therefore, more easily navigable, at least in the form of maps: participants demonstrated overall faster navigation through the post-WWII layouts (Vialard, 2023). Including all types of map, higher values of axial intelligibility are correlated overall to higher speed of tracing (AdjR^2= 0.15, n=27, p=0.0279*) but not with length. More intelligible layouts result in faster wayfinding task completion by participants, without necessarily tracing the shortest possible routes. When looking at the block and built form maps separately, the relation is not strong nor significant for built form maps. It is explained by the complexity of the axial maps of the built form layouts which bring another layer of complexity.

Not all cities offer the same opportunities for shorter routes in the built form maps. Layouts like Amiens offer greater opportunities (-12.4%) while others offer limited changes, like Caen and Orleans (Table 1). The length of the selected routes shortens on average by 2.8 percent when participants work with built form maps compared to their tracing routes through block maps of post-WWII layouts (table 1). Variations exist within the sample, with the maps of Amiens (-8.9%), Lorient (-6.8%) and Le Havre (-5.8%) allowing participants to select shorter routes the most, while the maps of Caen, Dunkirk and Tours have almost no impact on participants' ability to select shorter routes. However, when compared to the optimum paths – the shortest paths for post-WWII blocks and building maps – some built form layout maps offer greater opportunity for shorter routes, like Amiens (-12.4%), while others remain more limited, like Caen and Orleans. The difference at stake here is the opportunities offered by the configurations of some layouts and the actual choices made by participants to utilise these opportunities to shorten their routes traced. Speed of tracing is related to cognitive load and axial intelligibility rather than actual travel time for any chosen route. Therefore, comparatively slow-

er speeds of tracing are influenced by the combination of two factors discernible from figure-ground maps: increased fragmentation of interstitial open space within blocks (n AIOS) and decreased axial intelligibility (% increase of Axial intelligibility).

Table 1. *Average speed of tracing for 20 participants with percentage increase of velocity and distances.*

Towns	Mean Velocity (pre-WII)	Mean Velocity (post-WII)	Mean Velocity (building)	Increase from pre- to post-WWII	Increase Velocity Block to building	Increased Path length	Increased Optimum length
Amiens	276	300	268	8.7	-10.7	-8.9	-12.4
Caen	315	361	331	14.6	-8.3	0.5	0.0
Dunkirk	280	331	302	18.2	-8.8	-0.1	-3.6
Le Havre	260	300	270	15.4	-10.0	-5.8	-2.6
Lisieux	264	282	217	6.8	-23.0	-3.5	-5.7
Lorient	317	271	259	-14.5	-4.4	-6.8	-6.2
Orleans	253	264	231	4.3	-12.5	2.4	-0.2
St-Nazaire	286	310	254	8.4	-18.1	-2.5	-3.9
Tours	290	276	246	-4.8	-10.9	-0.6	-4.7
average	282	299	264	6	-12	-2.8	-4.4

Impact on path choice

As previously mentioned, the lengths of the routes are slightly shortened in the building maps compared to the block maps (Table 1). It indicates that the choice of alternative routes outside the traditional public space while not important is related to the notion of shortening the distance and using a more direct route. It is confirmed by the strong relationship between the amount of shortcuts used and the shortening of distance ($AdjR^2$= 0.86, n=9, p=.0002*). There are two types of impact of more internal open space: enhancing the existing street network and parks system, or creating new alternative route through the blocks. This happens in blocks that have a high proportion of open space.

In order to assess the impact of the openness of built form configurations, segments of the path were categorised into 4 types: 1) *Through* routes are when the path goes through interstitial space between built form within blocks, creating an option that was not available otherwise; 2) *Peripheral* routes that use the interstitial open space located at the block periphery resulting from setting back the new built form; 3) *Free* routes are when segments of route are passing through unbuilt open space but contained with plot boundaries, such as parks; and 4) imprecisions in the tracing which were discounted. Table 2 shows the percentage of each type of alternative routes outside the public space and the routes are shown in Figure 5.

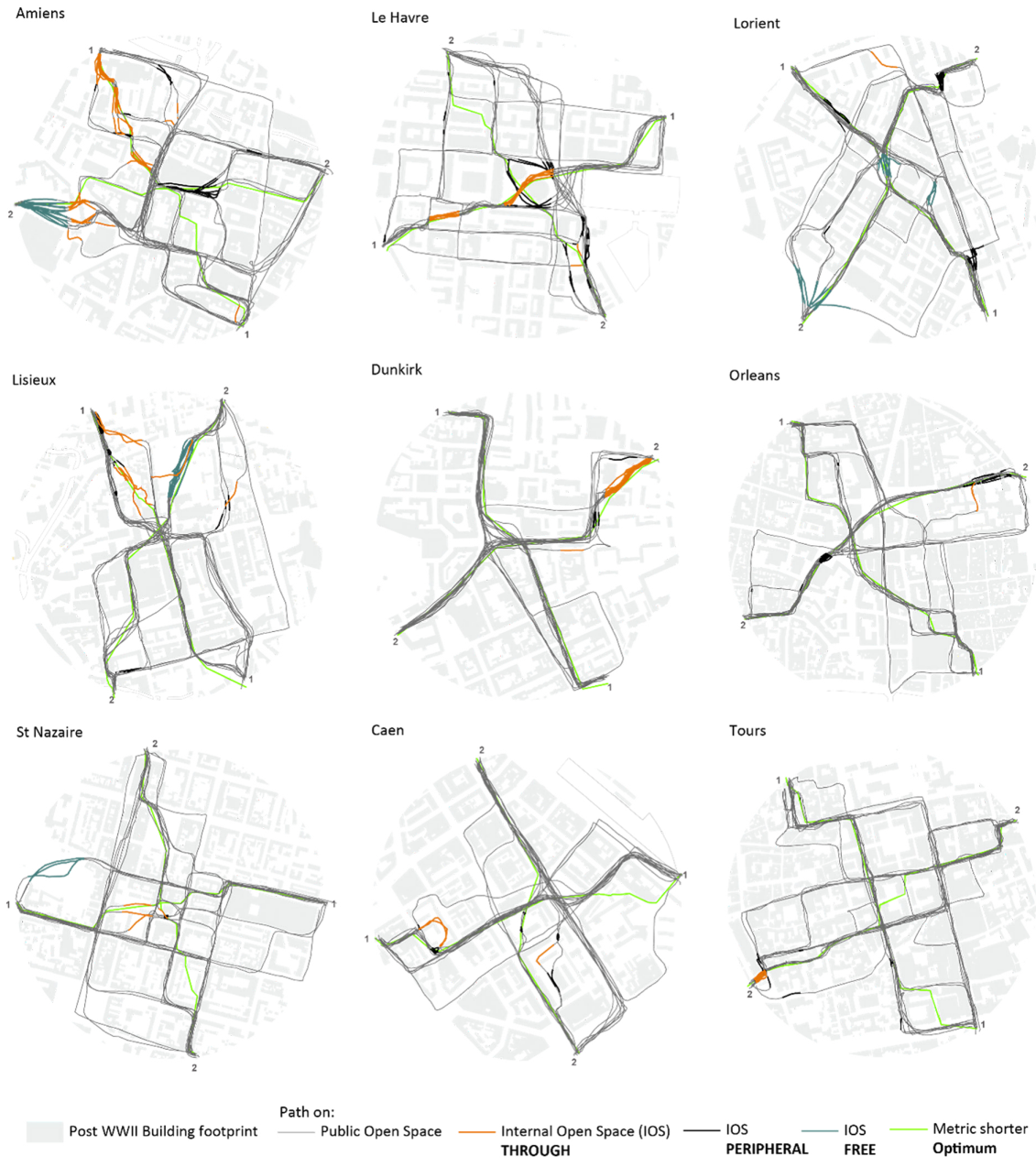
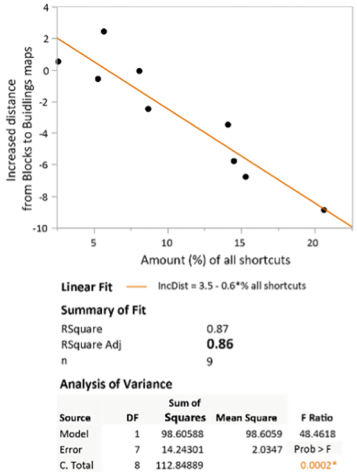


Figure 5. *Impact of internal open space on route choice and optimal metric shortest routes.*

Table 2. *Types and amount (%) of shortcuts and their impact on the path length. Linear regression between the mount of shortcuts and the decrease of distance.*

Towns	% Through	% Periphery	% Free	% all shortcuts	Increased distance
Amiens	8.7	3.8	5.7	**18.2**	-8.9
Caen	1.4	1.2	0.0	**2.5**	0.5
Dunkirk	6.0	1.3	0.0	**7.3**	-0.1
Le Havre	6.4	6.9	0.0	**13.3**	-5.8
Lisieux	3.6	2.6	5.6	**11.9**	-3.5
Lorient	0.3	4.9	7.4	**12.6**	-6.8
Orleans	0.3	3.6	0.0	**3.9**	2.4
StNazaire	1.0	0.4	1.8	**3.1**	-2.5
Tours	1.7	0.5	0.0	**2.2**	-0.6
average	**3.3**	**2.8**	**2.3**	**8.3**	**-2.8**



On average, the opening up of the block to provide various forms of interstitial open space is associated with an 8 percent increase in participants' choice of routes beyond just the public spaces of streets and squares (Table 2). The proportion of the different shortcuts taken by the participants across all maps is as follow: three percent of the routes used *through* interstitial open space between built form, creating new routes, three percent of participants selected routes with *peripheral shortcuts* using the interstitial space at the edges of blocks, and two percent of selected routes freely cut through large unbuilt spaces. The maps of four cities seem have presented greater impacts in terms of the above route choice behaviours than others (above 10%): Amiens, Lorient, Le Havre and Lisieux. However, they represent different patterns of behavioural choice by participants. Amiens, for instance, has more of the *through* interstitial open spaces (8.7%) which are associated with two large redeveloped blocks, typologically close to 'towers-in-the-park' – see Figure 1i. Le Havre is equally impacted by both through shortcuts (6.4%) as intended by the architect (Figure 1f.), and peripheral ones (6.9%). A good example where it occurs is the central square with the free-standing buildings splitting the routes towards both its centre and edges (Figure 1f.). Lorient illustrates another behaviour with most of the shortcut cutting freely through unbuilt urban blocks such as parks.

CONCLUSIONS

In this sample of city maps, there has been an increase in both traditional public space and publicly accessible space within urban blocks. Public space has been increased by creating more actual public space (wider streets, more public squares, parks, etc) which has increased the syntactic intelligibility of these cities in terms of their representation as figure-ground maps. In theory, this has made them easier to navigate. Of course, since many of these changes to public space were made also in the name of increasing accessibility for private motor vehicles, the addition of treatments to prioritise car movement is likely to have constrained actual ease of navigation by pedestrians in these cities, a mobility issue that is not able to be captured by these methods. Some of the other limitations include the absence in the figure ground representations of topography and stairs, and the presence of physical barriers such as gates, fences…which will impact the choice of route. Some of these physical

features have indeed become a way to manage the open space and help to define the street edges in the absence of built edge. Despite their impact on changing the degree of accessibility of the open space, not captured in the figure-ground, some of the visual connection across space often remain.

In terms of what the methods in this paper can measure, the increase of interstitial open space within urban blocks has had a much different impact. The opening of formerly compact, closed urban blocks to Modernist-influenced built form configurations has made navigating these cities more complex, at least as far as their representation via figure ground maps is concerned. For some participants, the potential to shorten their route through the city centre presented by the *through* and *peripheral* shortcuts of interstitial open spaces within blocks created opportunities for new ways to navigate the city at the cost of cognitive effort. But for many of the participants, the traditional public space of streets and squares remained the preferred route, as they did not necessarily take the opportunities offered by the interstitial open space.

The distinction made between the different types of shortcuts needs to be related back to the building configurations and their relationships with the space of the streets. The 'court' (Martin and March, 1972) does not bring additional open space to the street, only with the addition of passages which allow *through* shortcuts while preserving the integrity of the street. The 'street' configuration is linked mainly to *through* shortcuts with the building still contribute to definition of the street. In some instances, the setback of the buildings can bring additional "openness" to the street and start to challenge its structural role. The size of the void produced by theses combined open spaces questions the legibility of that space as linear and structural or as an urban element. The 'pavilion' when concerning a single building generates *peripheral* shortcuts opportunities which start to challenge the legibility the streetscape; additional pavilion types make it even harder to read with the addition of *through* shortcuts opportunities. To conclude, the intelligibility of an urban environment is from both its street structure and its building configuration. The degree to which they overlap will transform the experience.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the technical support and material provided and adapted to this study by Manus Neurodynamica.

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Toponyms and urban morphology, the imbued meaning of street names within circumstances of urban change: The case of Turnagain Lane, London.

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ABSTRACT

Cities are in perpetual modification as a continuum over large expanses of time, with urban growth proceeding according to the measures and laws of a historical evolutionary process. Within the broad research field of urban morphology the fine grain attention to the details of historicity can be extended to the less tangible aspects of associated place and street names, the legacy and/or redundancy of their imbued meaning set within the transforming specific urban condition. Street names are predominantly assigned to people or important events and as such can often be rewritten as socio-political contexts change; conversely, as the urban fabric evolves, street names depicting specific geographical features may be prone to redundancy in meaning. This paper explores the potential at the intersection of urban morphology and toponymic research through analysis of diachronic evidence to assess a pertinent case study street configuration. The study reveals how an original denotation of place is an evolving layer within the palimpsest of urban transformational processes. The implications are that toponyms contribute evidence in morphological research as elements that label urban places particularly when they carry description of a past urban arrangement.

Keywords: Toponyms, street names, urban morphology, Turnagain Lane.

INTRODUCTION

> *"The city… does not tell its past, but contains it like the lines of a hand, written in the corners of the streets, the gratings of the windows, the banisters of the steps, the antennae of the lighting rods, the poles of the flags, every segment marked in turn with scratches, indentations, scrolls." (Calvino 1978, 11)*

Understanding the urban past begins with an explanation of the concept of historicity, which in the context of urban morphology, is the historical expressiveness of the creations of previous societies denoted by the form detail embodied in the townscape (Conzen, M.R.G., 2004a; Larkham, 1996; Whitehand, 2007). The historical expressiveness of the townscape is considered an 'invaluable source of experience' (Whitehand, 2010) and has been given great significance by urban morphologists. Historicity is visual and omnipresent and is the key attribute of a townscape that requires management (Larkham, 1996; Whitehand, 2007); it is where the layering of historical grain reveals the depth of a town's development, as each period manifests its distinctive material residues of its past into the landscape (Birkhamshaw and Whitehand, 2012; Conzen, M.R.G., 1960; Smailes, 1955).

Historical stratification and resultant historicity is most intense at the parts of the town having had the longest history within an urban area (Conzen, 2004b); this is usually the traditional kernel or 'old town' (Conzen, 1988). By recognising that 'the past provides the key to the future… the spirit of a society is objectivated in the historico-geographical character of the urban landscape and becomes the genius loci' (Whitehand and Larkham, 1992, 6), the distinctive spirit of a place. Townscape analysis gives understanding to 'the complexity of the regional structure and morphological character' (Conzen, M.R.G., 2004b, 53), its geographical viewpoint is concerned with conceptual developments in the urban landscape in terms of its integrated historical context (Whitehand, 1987).

Studies of place names and physical elements offer insights into history, memory, and location, and play a role in deciphering commemorative patterns and heritage and has not often been directly explored in cultural and historical-geographic studies regarding their symbolic-material integration (Fuchs, 2015). Toponomastic scholars have researched their subject mostly through a synchronous approach (specific historical period) with less studies of a diachronic manner (observing street naming changes over time), suggesting a limited historical perspective and exploration in the field (Rusu, 2021b). As with diachronic analysis, the street name may have lost its original meaning, or if its significance has become detached due to specific events, nevertheless it provides a continuous layer in the rich palimpsest of the city evolution (Augustins, 2004).

> *" The shift from synchrony to diachrony, from code to chronology, takes us from sign system to the narrative, and at times the drama of history." (Ferguson 1988, 388)*

The "city-text" viewpoint depicts the urban landscape as a palimpsest which portrays the streets as a surface that has documented the historical processes of establishing, removing, and revising power dynamics and identity frameworks within the city's street naming practices (Rusu, 2021b). Historicity is revealed in the townscape and is a key aspect of urban morphological research requiring attention. It specifically encapsulates the relevance of mapping the diachronic transformations of an urban area focusing on the historically persistent elements in the townscape, 'History comes into play as soon as towns and territory are considered as dialectic factors in a diachronic process'." (Cataldi, 2005, 123).

TOPONYMS

> *" The city is classified into different levels of resolution, based on the description that 'urban morphology' provides for the shape of a city. The higher the level of resolution, the more details will be visible and the more morphological features will be described. The text of the city is constructed through dialogue among these metafunctions at one level and among different levels." (Hosseini, 2022, 3)*

Toponomastics (the study of place names) holds significance within onomastic research, relating to the study of the history and origin of names. Manifested through both names and physical entities, elements like place, landscape, memory, and heritage are interconnected and must be comprehended as a unified socio-spatial process. History and memory, representing the past, play a vital role in shaping places as well as providing the intangible and tangible foundation for present-day lives and identities (Fuchs, 2015). Street names play a pivotal role in imbuing spaces with a variety of symbolic meaning, whether products of authority, markers of identity, and historical references (Rusu, 2021).

Street names

Historically, streets have served the role of facilitating the flow of trade, fostering social interactions, and enabling communication, they 'differ in length, width, function and location, or in other words in their importance' (Stiperski et al, 2011, 181). The true essence of streets lies in their character as shared public spaces of competing private and public interests, playing a pivotal role in shaping communities, providing a structure for urban functions, as locus of social communication and signification and its communal traditions (Kostof, 1992; Anderson, 1986). An important aspect of 'townscape morphology' developed by M.R.G. Conzen was the definition of how streets and their block patterns are the most persistent of forms within the townscape, and are more resistant to change than building fabric, land and building utilisation (Conzen, 2004a, 51).

Street names (Odonyms) are commonplace elements within the urban environment and hold significant symbolic significance (Oto-Peralias, 2018) and have primarily been analysed within the domain of human geography as toponymic tools for marking urban environments, imbuing the landscape with 'symbols, values, and meanings' (Rusu, 2021a, 2). The 'names of streets, squares, parks and lanes provide insight into a community's interpretation of its past' (Stiperski et al, 2011, 181). Streets achieve this by imprinting collective memories and political declarations onto the landscape, thereby weaving distinct narratives of historical evolution (Rusu, 2021a). Street names bestow significance upon urban areas and serve as integral indicators of the city's cultural identity, they sustain traditions while also recording shifts and alterations, holding substantial cultural implications (Ferguson, 1988).

> *"Everyday objects and sites such as buildings and parks can present hidden stories or dissonant expressions of history otherwise easily overseen." (Fuchs, 2015, 13)*

From a comprehensive survey of eight European cities, Stiperski et al. (2011) classified city toponyms into several categories and groups that included: 'persons, geography, historical events, crafts and trades' (p185). Geographic locations typically include landscape features such as rivers and hills, or description of a particular streets position (ie. railway station, market, riverbank), which may be either extant or no longer exists; or denoting a specific appearance or trait (Stiperski et al, 2011). In older urban centres street names comprise local or descriptive names that denote streets linked in some way to their surroundings (Ferguson 1988). In the past, street names were commonly vernacular in nature, serving a distinct navigational function (ie. Turnagain Lane) and often linked to the local topography or historical context (Oto-Peralias, 2018).

City-text

City-text is framed within the historical dimension of street name analysis as an 'outcome of a cumulative inscription process over a long period of time, whereby street-name indicators also reflect features of this long-term process' (Oto-Peralias, 2018, 192). City-text as a theoretical framework is rooted in semiotics, providing researchers with the tools to decipher linguistic urban landscapes (Rusu, 2021a). Street names are a component of the larger city-text and hold many readings that are 'instrumental and functional, historical and cultural, structural and semiotic, synchronic and diachronic. These competing yet complementary perspectives make street names a model for the interpretation of culture' (Ferguson 1988). When viewed through the lens of a city-text and understood as a palimpsest open to re-inscription and layering, street-naming structures are inherently unstable and subject to historical circumstances (Tucci et. al., 2011), they serve as a collection of commemorative choices established by local governing bodies vested with the authority to name streets (Oto-Peralias, 2018), change or even remove them!

THE CASE OF TURNAGAIN LANE, LONDON

> *"…to understand change, we need also to understand what endures." (Whitehand and Morton, 2006, 2065)*

Turnagain Lane is a small, somewhat inconsequential street located in the ward of 'Farringdon Without' in Central London; It is however a street dating back to the 13th Century and contributes to the historic street network of London (City of London, 2021). It is also an example of how ancient names given to streets, places, buildings, and even districts and towns, persist in the contemporary urban form despite the successive layers of change which threaten to remove them from their original condition or purpose. Turnagain Lane, as its name literally implies, required the traveller to turn back to find another way as the route led directly into an impassable obstacle, in this case the Fleet River (Figure 1, Agas, 1561). It was a 'dead end' street 'as the name suggests in Tindale's words in 1531, "a turnagaine lane which they cannot goe through"' (Harben, 1918); its derivative names stretching several centuries including 'Turnback Lane', 'Windagaine Lane', 'Wendageyneslane', and 'Wandayeneslane' (Harben, 1918).

The Fleet River was a notable tributary to the Thames, with its source several kilometres inland at Hampstead, running to enter the great river at Blackfriars (Wheatley, 1891, 52). The river has had many names over the centuries, however its etymology is derived from the Anglo-Saxon fleotan to float; and the Saxon fleot, a flood (Thornbury, 1878, 416). The river was however to be commonly referred to as the 'Fleet Ditch' since as early as the thirteenth century it was deemed 'impure' (Thornbury, 1878, 416); as the city of London rapidly developed it became notorious as a virtually open sewer, a place to discard all forms of waste (Wheatley, 1891, 52). The condition of the ditch remained largely unchanged until the Great Fire of London in 1666, which claimed all the small timber structures that lined its banks (Figure 1, Hollar, 1667). The necessity to rebuild the entire district was a timely opportunity to address the primitive condition of the river; and in 1670 (Wheatley, 1891, 53) the authorities duly undertook to engineer the river into a 'New canal' stretching from the Thames to the Holborn Bridge (Figure 1, Olgilby, 1676). The cleansed and dredged waterway was constructed with new stone and brick wharves, providing landing places for barges to navigate (Wheatley, 1891, 53) as well as creating a traversable edge of 'two large streets, divided by the ditch' (Harben, 1918). Turnagain Lane was now released from its cul-de-sac status, but at the same time obviating the meaning of its name! Despite the upgraded alignment, the sanitation of the Fleet Ditch remained atrocious, and was eventually 'abandoned as incapable of improvement' (Thornbury, 1878, 419). The section of the 'New Canal' between Holborn Bridge and Fleet Bridge was 'bricked over' in 1737 to create Farringdon Street (Figure 1, Rocque, 1746), upon which the new Fleet Market was sited (Harben, 1918; Thornbury, 1878, 497).

Farringdon Street formed a new formal connection with Turnagain Lane and this urban condition remained largely unchanged for a few decades until a series of major engineering constructions were undertaken to realise a new urban thoroughfare that would run from south to north. Blackfriars Bridge, the third crossing of the Thames was opened to traffic in 1769 (Roberts and Godfrey, 1950) and connected through to Holborn via Farringdon Street. Chatham Place, a public square acting as a formal civic landmark on the north bank of the river combined with New Bridge Street, being the southern section of the Fleet Ditch, to complete the roadway and finally subvert the river into a subterranean sewer (Horwood, 1792).

The morphological sequence described so far affected only the western end of Turnagain Lane; transformed from its status as an impasse, to a though-fare connecting to one of London's modern urban roads of the Eighteenth Century. The next arterial improvement to affect Turnagain Lane was at its

Figure 1. *Dichromic development of Turnagain Lane 1561-2023.*

1-Turnagain Lane / 2- Fleet River 3- Holborn Bridge / 4- Snow Hill / 5- Fleet Canal / 6- Fleet Market/ 7- Skinner Street / 8- Farringdon Street / 9- Holborn Viaduct / 10- London, Chatham and Dover Railway / 11- Holborn Viaduct Railway Station / 12- Holborn Viaduct Development (14-21 Holborn Viaduct 32-33 & 34-35 Farringdon Street). Figure adapted from survey maps of London: Agas, 1561; Hollar 1667; Olgilby 1676; Rocque 1746; Greenwood, 1830; Weller, 1866; Ordnance Survey, 1916; City of London, 2021.

eastern end, with the formation of Skinner Street resulting from the straightening of the road alignment between Holborn and Newgate in 1802 (Harben, 1918). The old urban block formerly edged by Turnagain Lane was now dissected, with Snow Hill truncated. The eastern section of Turnagain Lane requiring a connection to Skinner Street was diverted in a new perpendicular geometry in-between the new buildings erected to substantiate the urban character of the realigned city approach (Figure 1, Greenwood, 1830). Despite these changes, Turnagain Lane had still maintained its status as a thoroughfare.

The truncation of the lane occurred between 1866- 1869 due to two simultaneous developments that resulted in the eastern section being built over, 'the construction of Holborn Viaduct and the Fleet Valley improvements' (City of London, 2021, 40), and the overlay of the new London Chatham and Dover Railway Line. Crossing the River Thames adjacent to the existing Blackfriars Bridge the rail line penetrated through the urban fabric; first through the Snow Hill Tunnel connecting to Farringdon, and latterly arriving at a terminus at the new Holborn Viaduct, opened by Queen Victoria on the same day as the new rail bridge in 1869 (Thornbury, 1878, 502). Replacing the short-lived Skinner Street, Holborn Viaduct was built to greatly improve the gradient of the passage between Holborn and Newgate, it spanned high over Farringdon Street that was now able to penetrate further north (Weller, 1866). The new Holborn Viaduct Railway Station was a very large building mass with solid brick sidewalls forming the elevated platforms. The station had now erased the entire eastern section of Turnagain Lane, and the brick buttress walls now completed blocked the passage. The lane was once more rendered as a cul-de-sac; regaining its original meaning, albeit now geographically inverted (Ordnance Survey, 1916).

The status of the lane has persisted with minor adaptation up until 2023, when the approval (Ref. 21/00755/FULMAJ) of a major scaled commercial development at 14-21 Holborn Viaduct 32-33 & 34-35 Farringdon Street, has resulted in the demolition of surrounding buildings and the resumption of the lane, pending the construction of the edifice 'as part of the development proposal Turnagain Lane will be stopped up and the existing crossover will be removed' (Greater London Authority, 2021) . The development application for planning approval while acknowledging that Turnagain Lane has heritage value, further qualified stated that it is 'considered to have a low level of historic and evidential significance as these routes are low quality in terms of visual amenity, accessibility, and permeability, [its] significance has been diminished by past alterations' (City of London, 2021, p.2). However, the application process for the development received various heritage related objections, including how the City of London had downplayed the significance of Turnagain Lane [and Newcastle Close] as 'rather murky service access roads', and the London and Middlesex Archaeological Society further pointed out that 'The proposal does not take the opportunity to reactivate these streets through sensitive and re-imaginative' development' (Fox, 2021, 13).

> *"The application also completely dismisses the history of Turnagain Lane and Newcastle Lane. Holborn Viaduct, which replaced Holborn Bridge, was built between 1863 and 1869 and bisected Turnagain Lane, which originally ran from Snow Hill to the Fleet dike. The lanes have medieval origins dating back to the C13." (Anthony, 2021, 10)*

Despite these heritage concerns being raised, the planning authority overruled all objections stating 'Turnagain Lane and Newcastle Close are considered to have a low level of historic and evidential

significance as these routes are low quality in terms of visual amenity, accessibility, and permeability. Their significance has been diminished by past alterations' (City of London, 2021). While it is fair to observe that the condition of Turnagain Lane has diminished, reduced to a service yard for adjacent buildings, the new building could incorporate through design, some aspect of its memory, for example, aligning the entrance to the new building with the line of the historic throughfare, maintaining significance of place. While the development incorporates a new accessible public route, its design does not overtly suggest a reinterpretation of the laneway, time will tell!

> *"It is considered that the total loss of Turnagain Lane and its associated heritage significance would be outweighed by the merits of the proposed scheme which include the provision of high-quality office building, enhanced public realm that would be attractive, accessible, greened, and inclusive and include interpretation of the history of the area. The public realm works would include reference to Turnagain Lane, further details of these works would be secured by condition." (City of London, 2021, 74)*

DISCUSSION

This paper suggests the importance of understanding urban transformational processes of a city according to its historicity as a basis to perceive continuities in urban form. Cognition of the historical stratification in the urban landscape leads to the awareness of the myriad of instances of historicity that defines a place; how the historical features fit together is vital and should not be treated in isolation (Whitehand, 2007, 4).

Street names inherently convey a historical aspect that warrants lasting commemoration, whatever their historical origin, these names derive their significance from symbolizing a community's emblematic identity (Augustins, 2004). The case of Turnagain Lane has shown the persistence of a small street, that has survived several centuries during which time the toponym defining its raison d'etre as a route had been completely altered during the course of time, and by a peculiar morphological process regained its imbued meaning, until its ultimate disappearance under an imminent belligerent urban development. It represents the apparently inconsequential and often unnoticed fine grain aspects of urban form that are ubiquitous in every village, town and city; that conglomerate into the rich patina of historicity; the specificity of which worthy of study, analysis and interpretation.

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Women's safety and urban form: a perspective from Kochi (India)

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ABSTRACT

The world is urbanising fast. Official estimates report that around 70% of the global population will live in cities by 2060. While this phenomenon is assumed to be beneficial, social inequality and safety issues are on the rise. Among the latter, women's safety in the urban environment is a topic of particular concern due to rising numbers of assaults, especially in South Asia. However, systematic investigations of the relationship between women's safety in cities and urban form lack. In this paper, we explore such a relationship in Kochi (India) by correlating 24 urban types (UTs), i.e. distinctive patterns of urban form, obtained from previous work, with four scores of women's safety (i.e. presence of people in streets, feeling safe, visibility, gender diversity), extracted from an open dataset by Safetipin, a social organisation focusing on gender issues in the urban space. Four UTs out of 24 are consistently correlated with the set of four scores. Three of such UTs are inversely correlated, with two of them presenting sparse, relatively low-density urban fabrics with very small or very large buildings; one UT shows a very fine grained, relatively dense, mainly residential fabric with very small buildings. Conversely, one UT shows a positive correlation with safety. It is characterised by a compact, fine grained and more orderly urban fabric with averagely sized buildings hosting multiple functions.

Keywords: women's safety, urban morphometrics, correlational study, Kochi, India

INTRODUCTION

The world is undergoing a process of fast and unprecedented urbanisation. Official estimates report that 68% of the total population will live in urban areas by 2050 (UN-DESA, 2018). While such a concentration is considered to be beneficial due to the agglomeration of economic activities which will supposedly benefit the wider population (ODI, 2008), inequality (UN-HABITAT, 2008) and violence – especially towards women – are on the rise in many global megalopolises (UN Women, 2017). While this is a worldwide phenomenon, it seems disproportionately affecting South Asia and, in particular, India (BBC, 2018; Narayan, 2018). Indeed, most of the literature on women's safety in urban settings focuses on case studies located in Indian cities, such as Delhi (Viswanath and Mehrotra, 2007; Datta 2020), Kolkata (Sur, 2014) and Ahmedabad (Mahadevia and Lathia, 2019), among several others.

Viswanath and Mehrotra (2007) conducted more than 30 audits and a survey of 500 women in Delhi to assess what contributes to women's perception of safety. Findings show that inadequate infrastructure, such as underground parking lots, lack of adequate lighting and social norms are among

the main factors. The article ends with a discussion on the need for more evidence-based measures to improve women's safety and create inclusive public spaces in Delhi. In the same city, Datta (2020) used various participatory techniques, including time-mapping, workshops, WhatsApp diaries, and interviews, to examine the "smart safe city" concept and its meaning for women who are digitally and physically marginalised. Findings highlight the relationship between technology, gender, time, and violence in urban spaces and the need for more inclusive urban planning to address the specific safety needs of women living in marginalised communities. Sur (2014) focused on Kolkata and analyses through qualitative in-depth interviews how women navigate public spaces while considering their personal safety. The author reports that the main factors affecting women's fear of crime are street harassment, inadequate lighting, and lack of public transportation and highlights the importance of community support and collective action in creating safer urban places for women. Mahadevia and Lathia (2019) assessed the perceived safety of the Sabarmati Riverfront, Ahmedabad city's largest public space, for women through time-mapping and qualitative interviews. Results show that more than half of the interviewees were visually or verbally harassed at least 3-4 times during the survey. The interviewees expressed preference for places that are well-lit, well-maintained, and have more footfall and tend to abide by the social norm of having male peers when walking along the riverfront to avoid harassment. These studies are in line with a rich collection of established work on perception of safety, fear of crime and victimisation which started in the 1960s with Jacobs and Newman but expanded and diversified significantly over the past 50 decades. One important finding from this work is that fear of crime can be as important as real crime, with different but negative consequences i.e. resulting in the retreat from specific places or the public realm as a whole by vulnerable groups (Carmona et al., 2021). This point plays a particularly important role in South Asia and India, where women are already particularly vulnerable. Voluntary self-exclusion and the real risk of violence are not acceptable alternatives; instead, better understanding of the locations and features most associated with fear of crime can guide prompt, targeted and effective intervention.

Other studies investigated the matter through more quantitative, space related approaches. For example, Bahrainy and Khosravi (2013) analysed the relationship between urban design features, walking behaviours and health both from a men and women perspective, in environments under-construction, which were particularly diffuse in the case study under examination (i.e. Hashtgerd New Town, Iran). The study found that the most important factor associated with women's weekly amount of physical activity was safety, intended as the presence of other people on the street or inhabited buildings. However, this work did not directly test correlations between women's perceived safety and features of the urban environment as the former was one of the independent variables used in the model to explain levels of physical activity. More recently, Navarrete-Hernandez et al. (2021) investigated the gender difference in the perception of safety in public spaces by considering different urban interventions (i.e. presence and absence of public toilets, graffiti and blind walls). The researchers asked 104 participants to rank photo simulations of pre- and post-scenarios according to perceived safety and reported that removing blind walls from the streets had a significant impact on the perceptions of safety for women, removing graffiti only had a weak impact, while the presence of public toilets had no impact. While these studies provide useful insights on women's safety in cities through qualitative and quantitative approaches, urban design features of the case studies under examination were hardly investigated in a comprehensive and systematic manner. Furthermore, the few features considered usually have to do with street management issues (e.g. inadequate street lighting) rather than morphological characteristics of the built environment.

In this paper, we take a morphological stance on the matter and investigate the relationship between women's perception of safety in Kochi (India) and a comprehensive description of its urban form

through a quantitative methodology based on spatial mapping and correlation analysis. To do so, we i.) obtain point data on four scores of women's safety (i.e. presence of people in streets, feeling safe, visibility, gender diversity) from an openly accessible dataset provided by Saftipin, a social organisation investigating safety issues of women in the urban space; ii.) gather data from previous work on the different UTs, i.e. distinctive patterns of urban form, of Kochi (Venerandi et al., 2021); iii.) perform correlation analysis between safety scores and presence or absence of specific UTs. Results show that 4 UTs out of 24 are consistently, although weakly, correlated with the four tested safety scores. More specifically, UTs characterised by sparse, both fine- and coarse-grained urban fabrics, with very small or very large buildings are negatively associated with the safety scores. Conversely, one UT characterised by a compact and dense urban fabric with averagely sized buildings is positively associated with the tested scores highlighting, as previous studies already did, the importance of urban density and compact grain in relation to the perceived safety of women in the urban space.

THE CITY OF KOCHI

Formerly known as Cochin, Kochi is a coastal city and an important port of the Arabian Sea, located in the Indian state of Kerala. The city is composed of the mainland Ernakulam, the Mattancherry and Fort Kochi peninsula, as well as a cluster of islands, notably Willingdon Island, Vypin Island, and Gundu Island.

Kochi was a fishing village of little importance until the 14th century, when the Kerala flood of 1341 is attributed to having changed the landscape significantly, including the formation of the current Vypin Island (originally Puthuvippu). This new landmass turned the previously landlocked harbour into one of the safest ports on India's southwestern coast, thus putting Kochi on the map as a strategic commercial hub. Following its strategic growth, in 1405 Kochi was named the capital of the then-kingdom and has kept its significance until today, still being the capital of the present-day state of Kerala.

Due to its importance in the Arab, Chinese and European trade, the city earned its sobriquet as the "Queen of the Arabian Sea." Nevertheless, this prominence brought with it subsequent rounds of colonisation by the Portuguese (1503-1663), the Dutch (1663-1814), and finally the British (1814-1947) until India's independence in 1947. These successive dominations have left significant influence on the city and are still present in its culture, practised religions, used languages, architecture and urban form. These cultural differences are most clearly present on the Fort Kochi peninsula, where various ethnic and religious communities have historically occupied specific areas, leaving their mark on the built environment. This is reflected not only by the architectural form (temples, mosques, synagogues, and basilicas stand side by side here), but the public spaces differ as well. The spatial configurations are influenced by the way the spaces are used, which is directly related to the cultural identity and tradition. To preserve this singularity many symbolic gateways and walls between communities still exist, creating spatial boundaries.

Kerala consistently ranks high on national indicators for literacy rates, access to healthcare, and low infant mortality, which has been attributed to the decentralisation, empowerment of vulnerable communities and active civic participation (Parayil, 2000). These measures are part of a progressive system of governance adopted through the state to further human development, also known as the Kerala Model, which is regarded as a success story for the whole of India.

Comparing different indexes of women's empowerment in India, Kerala routinely ranks high in numerous metrics, including high education, cell phone use, personal income and finance and low spousal violence (Bansal, 2017). The state has been on a steady path of improvement over the last decades. Nevertheless, women's safety and perceived safety in public space within big cities of the

size of Kochi remains problematic. Police inefficacy and lack of response, lack of urban infrastructure and of public amenities are often cited as main reasons, in addition to the general culture of low acceptance of women's ownership of the public realm (Simon, 2023).

DATASETS

Safetipin Nite data

The Safetipin Nite dataset of Kochi consists of 1,003 data points representing each a streetview image scored according to the Saftipin parameters (i.e. walk path conditions, presence of transport, visibility, presence of people, quality of lighting, gender diversity, presence of police, levels of openness) by a team of data analysts, from 0 to 3 (where 3 represents the best performance). The overall score (i.e feeling safe) is calculated using an algorithm specifically developed for the Safetipin Nite app. Since the

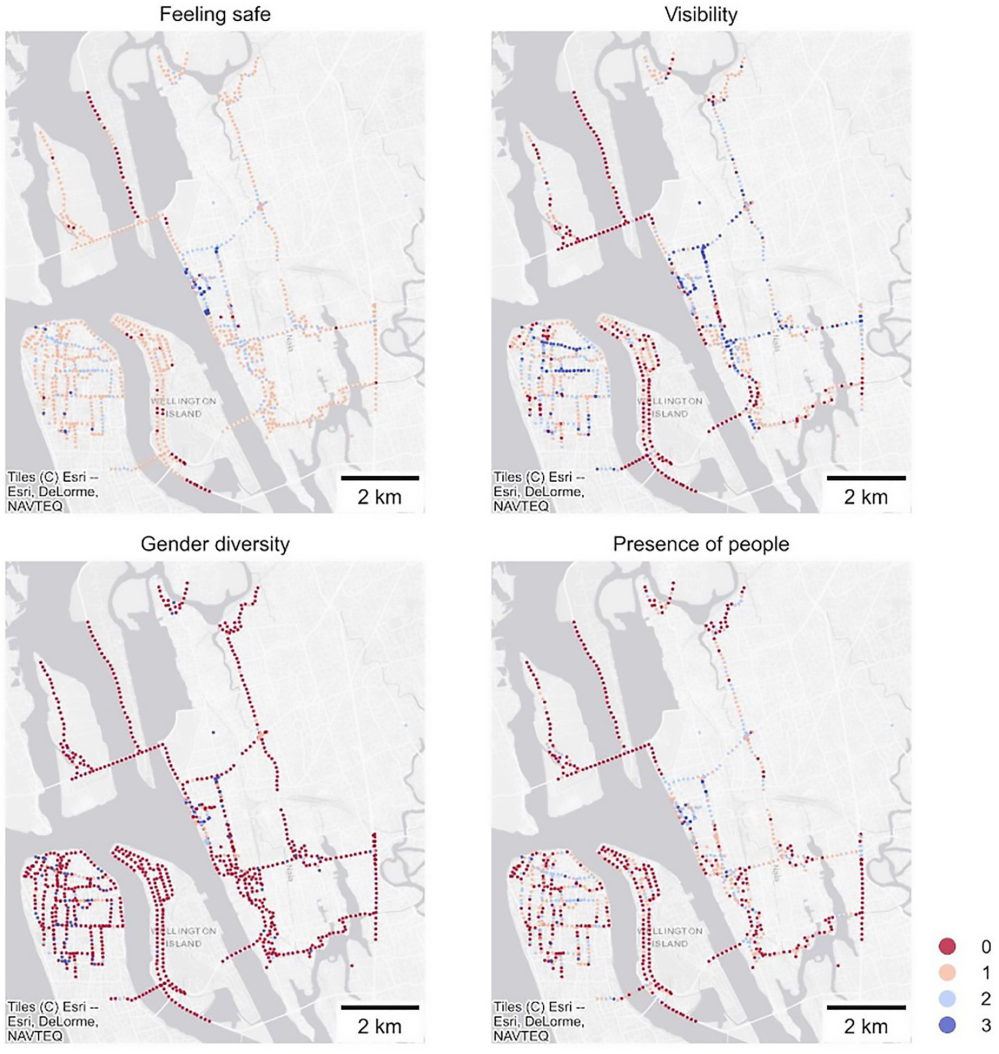

Figure 1. *The Safetipin scores used in this study: feeling safe, visibility, gender diversity, presence of people.*

focus of this paper is on safety aspects directly related with the configuration of the built environment, we filtered out those scores that measure other features, that is street management issues (i.e. walk path conditions, quality of lighting), offering of public transport (i.e., presence of transport) and street policing (i.e., presence of police). In Figure 1, we present the four Safetipin scores (i.e. feeling safe, visibility, gender diversity, presence of people) retained in this study.

Urban types

UTs are city parts characterised by distinctive patterns of urban form. They generally present similar, recurring configurations of buildings and streets. However, they may also be characterised by more heterogeneous patterns, consisting in a mix of different configurations of buildings and streets in the local context. Operationally, UTs are extracted through an unsupervised method called Urban MorphoMetrics (UMM) (Porta et al., 2022), that first computes hundreds of metrics of urban form (e.g.

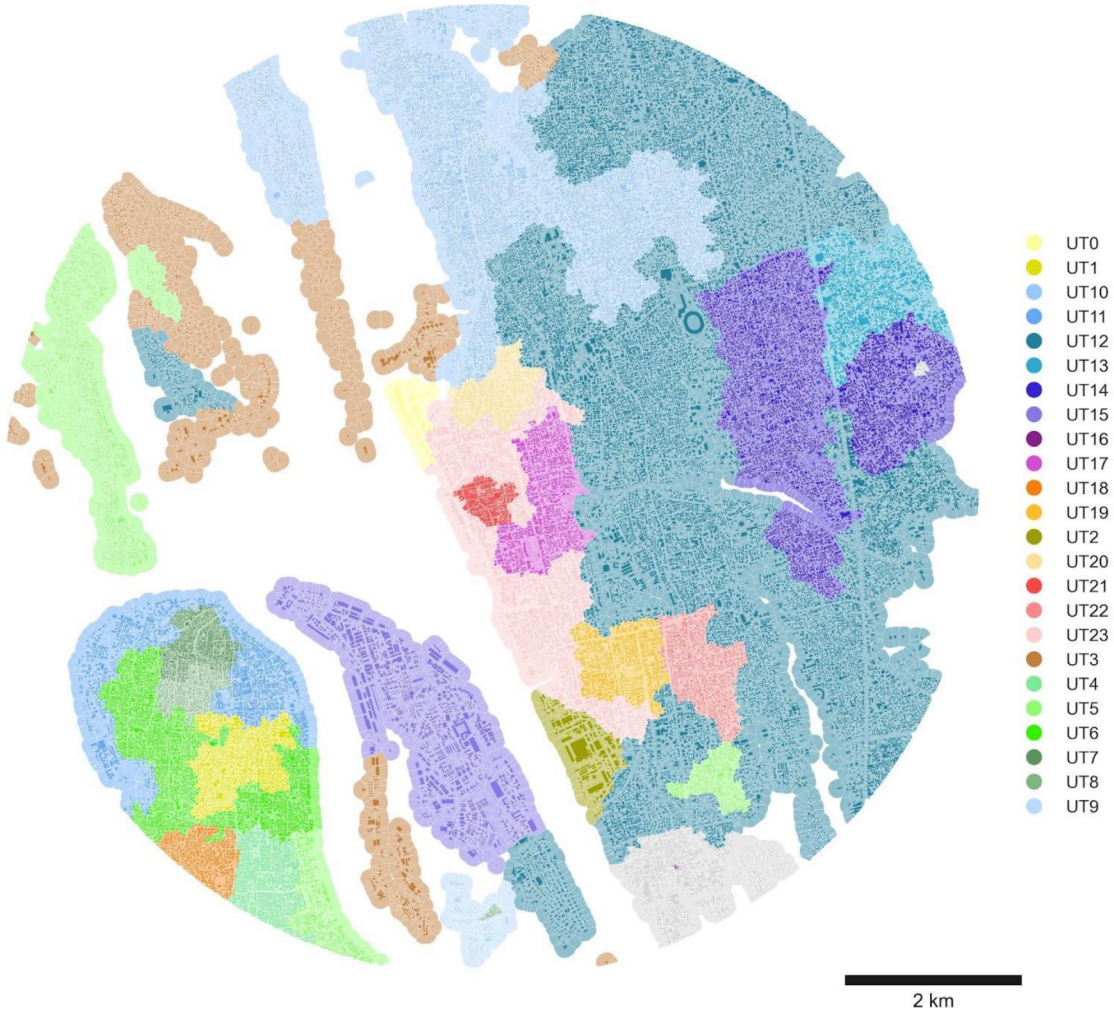

Figure 2. *The 24 UTs of Kochi. Buildings are colour-coded according to their respective UTs and level of morphometric similarity.*

building footprint, floor area ratio, local closeness centrality), at the scale of single buildings, from two input layers (i.e. building footprints and streets), and then uses agglomerative hierarchical clustering (AHC) on such metrics to identify recurrent patterns of urban form (UTs) in cities. The advantage of using clustering is that the morphometric similarity between clusters (or UTs, in the context of this study) can be evaluated through a tree graph called dendrogram and directly mapped on the UTs themselves by using similar colours for UTs belonging to the same branch of the dendrogram. The UTs used in this study are obtained from previous work focusing on the city of Kochi (Venerandi et al., 2022).

The application of UMM to Kochi identified 24 UTs (Figure 2). Buildings in each UT are coloured according to the degree of morphometric similarity across UTs, that is the more similar the colour, the higher morphometric resemblance between two (or more) UTs. Development phases of the city and functional distribution seem to align well with the location and extension of the identified UTs. For example, the historical part of Kochi located in the west peninsula (bottom left in Figure 2) characterised by a dense, informal urban fabric of small buildings is well captured by UTs with green shades (UT6, UT7, UT8). Similarly, the old port area of Fort Kochi and Mattancherry in the west peninsula, characterised by a compact urban fabric with a mix of large and small buildings (historical warehouses, public buildings, smaller residential units), is well captured by UT11. We refer the reader to Venerandi et al. (2022) for more information on UMM and detailed discussion of the results.

METHODOLOGY

The methodology used in this paper mainly consists of two main steps: aggregation of data on UTs for the Safetipin points and correlation analysis to ascertain the relationship between UTs and the four Safetipin scores considered in this work. In terms of spatial aggregation, since UTs and Safetipin points have different spatial units (buildings and survey points, respectively), to make the analysis possible, the latter are aggregated at the level of the former by assigning to each building the safety scores of the closest survey point. By doing so, we obtained a dataset of 1,003 data points with information on both safety scores and UT labels. Since the latter is a categorical variable and correlation assumes that both tested variables are continuous, a dummy variable with value 0 (absence of a specific UT) and 1 (presence of a specific UT) is created for each of the UTs in the dataset. Given the skew distributions of both safety scores and absence/presence of UTs, Spearman correlation (Corder and Foreman, 2014) is preferred to the more widely diffused Pearson correlation as the former, by assessing a monotonic relationship based on ranks rather than continuous values, is more robust in case of skewed distributions. The Spearman correlation test outputs two values: a coefficient (r_s) between −1 (i.e. perfect negative relationship) and 1 (i.e. perfect positive relationship) and a p-value providing information on the statistical validity of the test.

RESULTS

Spearman correlations between absence/presence of an UT and safety scores are presented in Figure 3. 33 statistically valid, although weak (ranging between 0.07 and 0.40), correlations were observed. Generally, correlations are scattered, that is an UT tends to be associated with no more than one or two safety scores (see, for example, UT11 and UT21). Only 4 UTs (i.e. UT10, UT15, UT23, UT3) are

consistently associated with all 4 safety scores. UT10, UT15 and UT3 are inversely correlated, with rs coefficients varying between -0.07 and -0.30. Such inverse relationships are stronger for visibility and presence of people. Conversely, UT23 is positively associated with all safety scores, with rs coefficients varying between 0.20 and 0.40, with the strongest correlations being for feeling safe and presence of people. Next, we present the morphometric profiles of these 4 UTs (Figure 4) and suggest explanations for the correlations found.

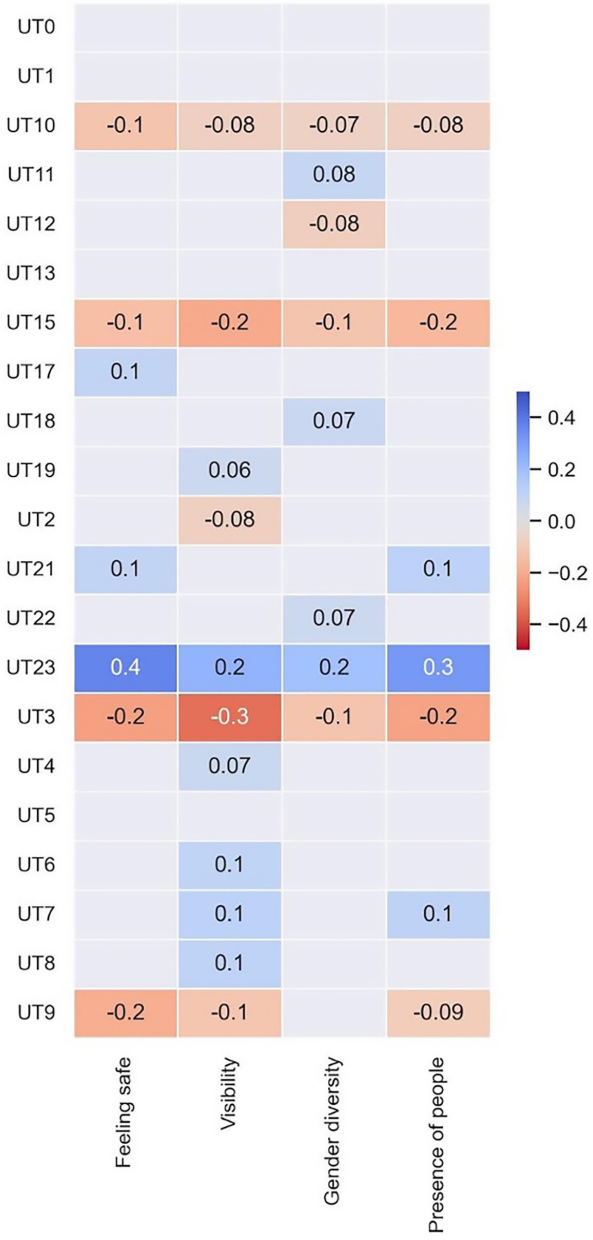

Figure 3. *Spearman correlations between absence/presence of UT and the four safety scores considered in this study. Darker the blue, greater the correlation coefficient. Darker the red, smaller the correlation coefficient. Grey represents non-statistically valid correlations (p-value>0.05).*

UT10

The morphometric profile of UT10 suggests a granular urban fabric, with about 35% of the plots measuring between 105.1 to 313.5m2 and 39% between 313.5 and 470.9m2. Building footprints follow a similar pattern, with about 80% measuring 32.3 to 130.6m2. Roughly 73% of the plots of UT10 have coverage percentages between 25% and 42%, suggesting low plot coverage. Buildings tend to be close to each other with around 70% being less than 9.8m away from their respective neighbours. The buildings tend to be aligned with each other with 86% diverging by 5 degrees or less. Finally, building footprints tend to be more square-shaped, with about 81% having an elongation between 0.69 and 0.8 (where 1 corresponds to a square). The inverse relationship with all safety scores is likely due to the low built density and mainly residential vocation of this UT. Both features may, in fact, not provide a sufficient level of informal control on the streets for making them safe or being perceived safe.

UT15

The morphometric profile of UT15 suggests a coarse urban grain, with about 80% of plots measuring between 1663.8 and 4364.4m2. Roughly 80% of the building footprints measure between 287.8 and 750m2. The plot coverage is less than that of UT10, with roughly 84% of the plots showing coverage percentages between 8% and 25%. Buildings tend to be sparse with about 91% being 18.7 to 40.4m away from each other. Buildings tend to be fairly aligned with each other with 71% diverging by 5 degrees or less. UT15 has more elongated rather than square-shaped building footprints with about 83% having an elongation between 0.29 and 0.61. The inverse relationships with all safety scores are generally stronger than the ones observed for UT10. This is likely due to an even sparser urban fabric characterised by low density and much larger plots and buildings, which, in turn, may negatively affect real and perceived safety levels.

UT23

The morphometric profile of UT23 indicates a granular urban fabric, with 81.5% of the plots measuring between 313.54 and 641.86m2. Around 75% of the building footprints measure between 151.86 and 287.81m2. The plot coverage is more than those of UT10 and UT15, with roughly 67% of the plots showing coverage percentages between 31% and 45%. Buildings tend to be closely knit with around 89% being less than 13.4m away from each other. Buildings also tend to be aligned with each other with 91% diverging by 5 degrees or less. UT23 has mildly elongated building footprints, with about 72% showing an elongation between 0.61 and 0.72. The positive relationships found between this UT and all four safety scores is likely due to a denser urban fabric compared to UT10 and UT15, with buildings and plots larger than those of UT10 (but not as large as those in UT15) and able to better accommodate more than just the residential function. The higher density and functional mix may, in turn, positively impact the perceived safety of this UT as more informal control may be present throughout the day.

UT3

The morphometric profile of UT3 suggests a very coarse urban grain, with 69% of the plots measuring between 470.92 and 3216.55m2. However, 75% of the building footprints measure only between 12.02 and 110.82m2. Indeed, plot coverage is minimal, with roughly 90% of the plots showing percentages between 1% and 14%. Buildings tend to be sparse with around 75% being 18.71 or more (up until 93.20m) away from each other. Buildings tend to be less aligned with each other as com-

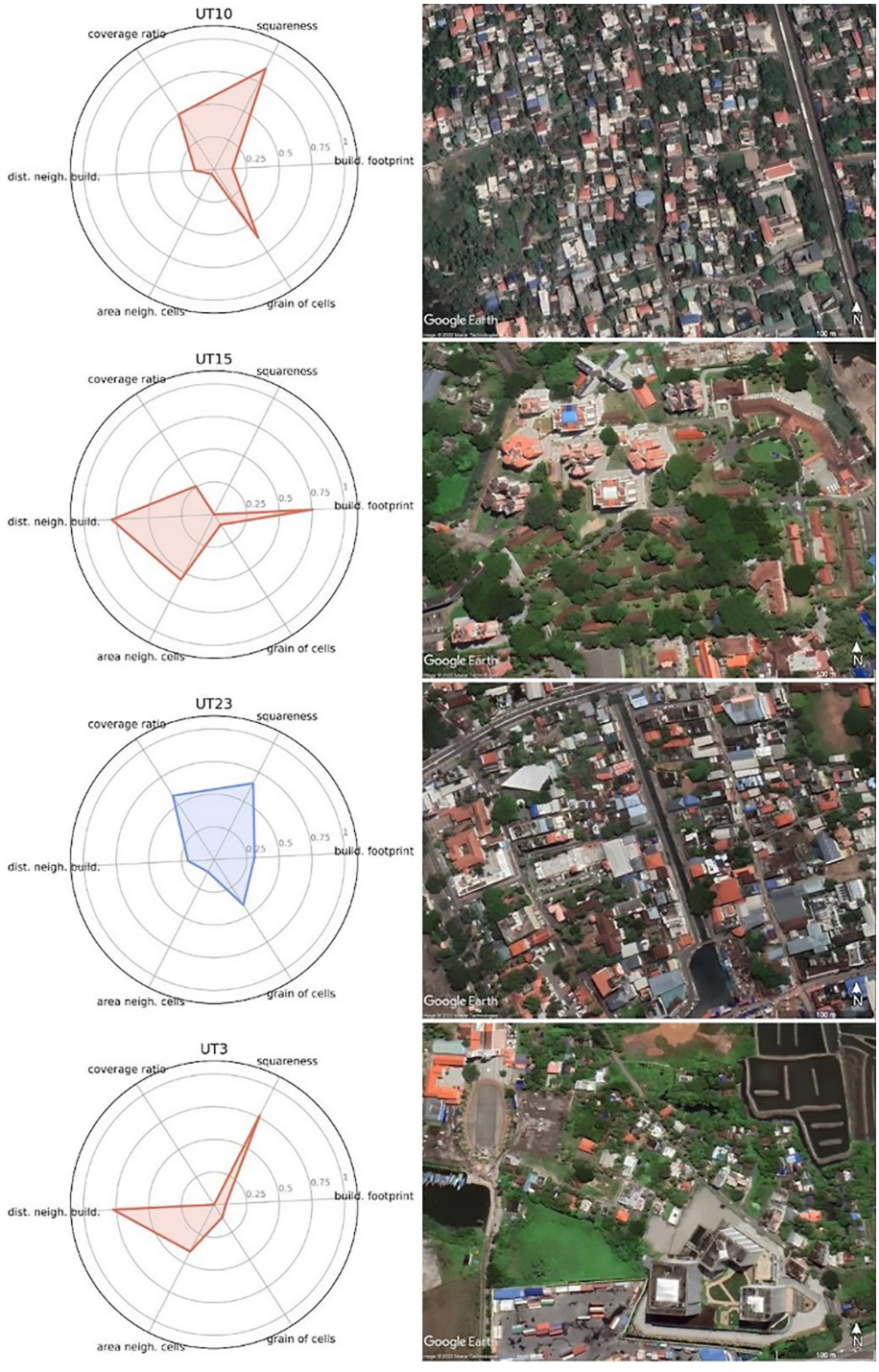

Figure 4. *Map extracts of the 4 UTs most consistently correlated with all safety scores. Red represents inverse correlation. Blue corresponds to positive correlation. Values in the spider graphs are standardised to make comparison possible across the selected metrics of urban form. Source of map extracts: Google Earth.*

pared to the other UTs with 77% diverging by 4.1 to 10 degrees. UT3 has mildly elongated building footprints, similar to UT23, with about 71% of them having an elongation between 0.64 and 0.77. UT3 shows the strongest inverse relationships with all safety scores considered suggesting that a very low density (indeed the lowest of the 4 UTs presented in this section) and scattered urban fabric is related to less (perceived) safety and this is likely due to low levels of informal control on the streets.

DISCUSSION

The findings of this study suggest that more chaotic urban fabrics (where buildings are less aligned to each other) with low built densities, sparse to very sparse large and small buildings (UT15 and UT3) but also small, tightly knit ones organised in an overly fine grained/dendritic, mainly residential urban fabric (UT10) are associated with less perceived safety at the street level. Conversely, denser urban environments (UT23) featuring structured and compact urban fabrics with buildings of average dimensions, better aligned to each other, hosting a mix of functions are positively associated with perceived safety. We suggest that this is because denser, functionally mixed and more compact urban fabrics, with buildings aligned to create continuous street fronts can provide a higher level of informal control on the public space due to the direct intervisibility that this morphological configuration offers. This, in turn, might ensure higher levels of (perceived) safety. Such findings seem to align with previous theories and works by Jacobs (1961), Newman (1972) and Martinez et al. (2019). Indeed, they all support the idea that compact/dense urban fabrics with buildings directly abutting on streets provide the necessary “eyes on the street” (Jacobs, 1961), “natural surveillance” (Newman, 1972), which can deter criminal activity, ultimately rendering streets safer places, whilst the opposite is triggered by lack of territorial demarcation and defined boundaries along streets and public spaces (Martinez et al., 2019).

This study has several limitations. Firstly, although data on perceived safety is available for different street types (from major roads to residential ones), it covers only part of the study area thus results might not provide a full picture of the tested relationship. The correlations found do not imply causation: designing according to the results of this study might not concretise in a place perceived safer than others. Finally, urban form is only one aspect of a much more complex puzzle. Future work will look into adding further variables (e.g. social norms, visibility levels) in the statistical analysis to better understand the relative impacts that the configuration of urban form and other factors have on perceived safety levels.

CONCLUSIONS

Women’s safety in the public space is a very current and urgent topic, especially in South Asia, where cases of violence and harassment are particularly widespread. While there exist several studies focusing on the social and infrastructural causes of this negative phenomenon, there are only a few investigating in a systematic manner to what degree the morphology of cities plays a role in this. We thus proposed and applied a methodology to study the relationship between four scores of perceived women’s safety in Kochi and the UTs characterising the city, through correlation analysis. Results revealed that four UTs were consistently associated with all safety scores, with three of them being inversely correlated and one being positively correlated. Their characteristics suggest that sparser and more chaotic urban fabrics with relatively large buildings or small ones organised in an overly fragmented plot system show negative associations with perceived safety. Conversely, denser and more structured urban fabrics featuring averagely sized buildings and functional mix are positively

associated with perceived safety. These findings are aligned with previous theories suggesting that denser urban fabrics characterised by buildings aligned to each other creating continuous street fronts promote safer urban spaces. While the results of this study are not generalisable, the methodology proposed in this paper allows the replication of this very same analysis in other contexts to understand whether the patterns found in Kochi are shared across different cities and ultimately increase our knowledge on how to design cities that are safer for women and the larger population.

ACKNOWLEDGEMENTS

This work was supported by the Axel and Margaret Ax:son Johnson Foundation as part of "The Urban Form Resilience Project" at the University of Strathclyde.

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Conservation-transformation dichotomy in the historical evolution of city walls: Reflections on urban morphology

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ABSTRACT

City walls with their physical, social, symbolic, political meanings have influenced spatial formation and progress of urban morphology as they have been affected by different morphological approaches and practices as well. Since their first formation, city walls have had a role of demarcation of boundaries limiting the urban growth and controlling the expansion, and separation of the cities into districts. However, this deterministic feature of city walls has evolved through different approaches mainly focusing on transformation and conservation in time. In order to understand how those approaches come into existence in the urban fabric and how urban morphology responds the compelling situations emerged, this study aims to explore the historical evolution of city walls, drawing on examples of different morphological cases with key sites including Amersfoort, Carcassonne, Dubrovnik, Istanbul, Paris, Vienna and Xi'an. As main results of this comparative assessment pointing out the challenges and potentials, transformation approaches accelerating the expansion of the city is emerged through creation of different uses at the exact location of the former walls in Paris, Amersfoort and Vienna while conservation approaches in Istanbul address the walls solely as architectural structures, and cause fragmented urban fabric in the surrounding today. Based on the findings, it is considered that the disconnection between approaches and their ways of practice regarding the city walls and urban form should be solved through integration with the relevant disciplines to the urban morphology and multi-dimensional perspective.

Keywords: city walls, conservation, transformation, urban form, morphology

INTRODUCTION: CITIES, WALLS, AND WALLED CITIES

The city serves as a nexus where the power and culture of a community converge, as described by Mumford (1961). This concentration of influence is visually manifested through the city's districts, which are demarcated by edges, both physical and symbolic. These districts encompass elements that are integral to the urban layout as well as those that are not. However, it's not solely physical boundaries that define a city's landscape; there exists a symbolic periphery, delineated by rules and regulations, which holds significance. Creighton and Higham (2005) emphasize the pivotal role of establishing a clear demarcation between the military and symbolic aspects of city walls. These walls, serving as the bedrock of identity and meaning, necessitate the identification of their physical and social connotations.

The city's connection with its walls extends beyond the realm of physicality; it permeates linguistic constructs as well. Kostof (1992) provides examples to underscore this connection, such as the Chinese term "ch'eng" signifying both city and wall, the Old Dutch word "tuin" an early variation of "town" denoting fence, and the English term "town" derived from an ancient Teutonic word meaning enclosure. In terms of their physical aspects, cities are sustained by an array of essential services and safeguarded by the natural landscape surrounding them, as symbolized by the periphery lines. This intimate relationship between the city and its protective walls is echoed in linguistic patterns. Just as the etymology of words like "ch'eng", "tuin" and "town" underscores the intertwining of city and wall, the physical and metaphorical interplay within a city's boundaries and periphery showcases the multifaceted nature of urban existence.

The reasons and historical events which are determinant on the development of city walls has affected the relationship between cities and their walls, and so the morphology of the entire cities. The accretive change occurred during this development process make the wall itself and its surrounding to be needed to examine in conjunction with the different approaches adopted in time. In this regard, this study seeks to investigate the historical evolution of city walls over different morphological cases, Amersfoort (The Netherlands), Carcassonne (France), Dubrovnik (Croatia), Istanbul (Türkiye), Paris (France), Vienna (Austria) and Xi'an (China) with a special focus to comprehend the origins of the transformation and conservation approaches and how urban structure reacts to arising critical circumstances.

INVESTIGATION ON THE EVOLUTION STAGES OF CITY WALLS

The significance and connotations of the boundaries present in every city have undergone transformations over time, whether in physical structure, functionality, or symbolism. These changes have been observed across various urban layouts, including organic and grid-based designs (Mrázová, 2021). Kostof (1992) traces the origins of cities back to Mesopotamia in the 4th millennium BC, with subsequent expansion into regions like the Indus Valley, China, and Greece. Throughout history, city walls have held substantial roles in shaping and progressing urban centers, serving both practical and visual roles from ancient eras to the contemporary world.

Kostof (1992) also notes that even the earliest settlements, such as Çatalhüyük, Jericho, and Ain Ghazal, dating back to 8000 BC, were enclosed by defensive walls. Notably, the formation of exterior border walls in Çatalhüyük, built alongside attached houses to facilitate human movement and security, stands as the earliest example of city wall construction. Situated in the Konya Plain, this arrangement aimed to serve the collective urban interest and is recognized as history's first defensive wall system. This innovative approach involved using outermost houses as a means to safeguard the city, diverging from traditional visible physical boundaries. This strategy, spanning from simple to intricate methods of city confinement, aimed to curtail unchecked urban expansion by confining settlements to specific areas. The only outlets connecting the city to the outside world were the access points integrated into the defensive walls (Smith, 2007).

Mumford (1961) highlights that the Hittite Civilization, around 2000 BC, strategically chose settlement sites based on natural defensive advantages, considering the topographical characteristics of sites crucial. Preferring hilltop locations as a proactive measure against security challenges of that era, they harnessed the landscape for protection. Although the ancient Greeks selected the rugged terrain of the Aegean Basin for establishing their city-states known as "polis" in a similar way during the 8th century, they also chose to construct city walls as a constraining factor. According to Wycherley (1991), these walls merely enclosed the city and did not serve as a structural framework integrat-

ed with the rest of the city's layout. This was particularly applicable to the initial Greek cities where walls were initially deemed a practical necessity, but as time progressed, the construction of city walls became an immediate security measure, implemented in the initial stages of city development.

Kostof (1992) explains that walled cities in the Middle Ages stood out due to their notable features such as castles, churches, and monasteries. In the 14th century, early medieval cities predominantly featured masonry walls consisting of either single or double curtains. The presence of a second wall in the double curtain design offered additional space for gatherings and potential defensive sorties, serving as a protective barrier.

Similarly motivated by defensive considerations, Medieval walled cities adopted an irregular and organic layout to complicate matters for their adversaries. These cities were also encompassed by moats, which served as supplementary protective elements alongside the masonry walls. The incorporation of moats and tall bastions as defensive structures became more prominent following advancements in materials like gunpowder, cannons, and catapults (Kostof, 1991).

During the Renaissance Period, walled cities adopted engineering innovations driven by advancements in firearm technology, as previously mentioned. As noted by Kostof (1992), the configuration of city walls shifted from simple masonry structures, whether single-curtain or double-curtain, to more intricate bastioned designs often referred to as star-shaped walls. This evolution aimed to provide larger defensive areas. Between the 15th and 16th centuries, the form and elements of cities were influenced by functional and visual aesthetic considerations.

As highlighted by Kostof (1992), certain urban regulations emerged to ensure that the interior space within the walls remained free of construction for aesthetic reasons. This was because the area immediately beyond the city wall, known as the intramural zone, was farthest from the city center and consequently less desirable due to diminishing property values with increasing distance from the center. Furthermore, particularly by the late 17th century, the open spaces within the fortifications began to be repurposed as pleasure gardens. Some cities had already started landscaping and gardening the areas around their city walls for recreational purposes by the end of the 16th century. At the close of the 17th century, it became evident that certain recently constructed yet outdated defensive walls were transformed into promenades. This underscores how city walls and gates influenced the emergence of new street patterns and public spaces. Even if these walls were completely removed, their former locations still served as references for new circulation routes and played a role in shaping these routes.

During the Industrial Revolution, cities underwent more significant transformations compared to their initial foundations. The advancements in technology and inventions brought about changes in their defensive systems as well. According to Mumford (1961), advancements in transportation allowed for the movement of both people and goods beyond the city walls, leading to the expansion of urban activities beyond those confines. Lozano (2003) observes that the Industrial Revolution led to functional obsolescence and partial demolitions of city walls, causing a shift in their purpose from primarily defensive and exclusive to more inclusive elements. Thus, the evolution of city walls was influenced by their surrounding conditions, as explained by the representation of Ashworth (1991) (Figure 1). The figure illustrates two scenarios that city walls underwent as they fell out of use due to changing daily needs, expectations and different approaches over time. One scenario involves demolition followed by reconstruction, aimed at either defensive or non-defensive reuse of the space. The other scenario is preservation, which occurred either unintentionally or intentionally. Through reconstruction and conservation, the city walls transitioned to being regarded as part of the defense heritage due to changes in their significance.

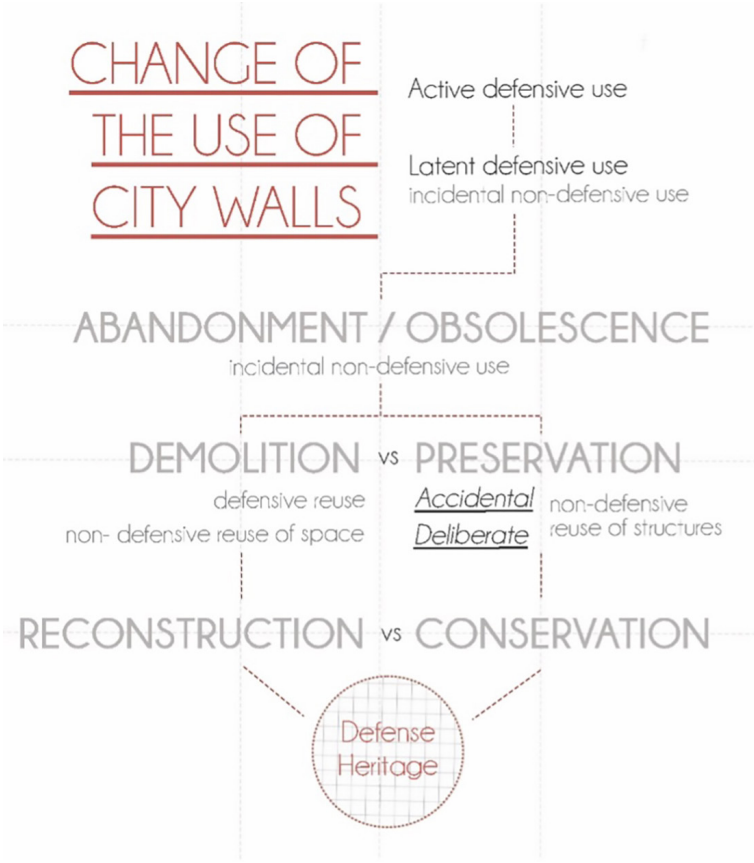

Figure 1. *Stages of changes in city walls (Re-edited by reference to Ashworth, 1991*

Expanding on these processes, it is notable that city walls encountered interventions advocating large-scale physical demolitions right after World War II. As Lozano (2003) points out, the trend of post-war city wall reconstruction accompanied the urban renewal movements that aimed to accommodate new structures and functions within city centers. This period marked a crucial juncture in the conservation-transformation dichotomy that has defined the historical evolution of city walls. The decision to either preserve and integrate existing walls into the changing urban fabric or to demolish them in favor of large-scale urban development projects had profound implications for urban morphology. Therefore, discussions on changes in use patterns of the city walls and the surrounding areas is considered important in terms of understanding how this dichotomy come into existence in the urban fabric and how urban morphology responds the compelling situations emerged, and it constitutes the backbone of this study.

DISCUSSIONS: REFLECTION OF "CONSERVATION VS TRANSFORMATION DICHOTOMY" ON URBAN MORPHOLOGY

City walls stand as enduring testaments to the evolution of urban fabric, reflecting the dynamic interplay between societal needs, geopolitical challenges, architectural innovation, and planning approaches. For this reason, it is significant to explore the reflection of these changes in city walls mostly caused by the dilemma between conservation and transformation approaches on urban morphology of the cities.

Evolution of city walls in selected cities

This study, which discusses the conservation-transformation dichotomy in the evolution of city walls, draws on examples of various morphological cases, including Amersfoort, Carcassonne, Dubrovnik, Istanbul, Paris, Vienna, and Xi'an. It holds the potential to clarify critical insights into the dynamic interplay between preserving historical heritage and accommodating modern urban needs. In each of these cases, the evolution of the city walls has played a prominent role in today's patterns of use around the remnants or former sites of the city walls, reflecting a range of conservation and transformation strategies. In this regard, an initial diachronic comparative analysis method for each selected city is used to explore the variations in conservation and transformation strategies related to city walls. This analysis involves assessing the evolution of city walls between Google Maps Street Views, which demonstrate the contemporary situations of representative samples from these cities, in conjunction old aerial photographs/illustrations. Therefore, it is considered important that these cases set the stage for various morphological discussions, revealing the unique conditions that contribute to the conservation and/or transformation of city walls today.

Amersfoort

Amersfoort's city walls underwent transformation-conservation processes across distinct periods. Military attacks on the first city walls, constructed between 1259 and 1379 prompted the construc-

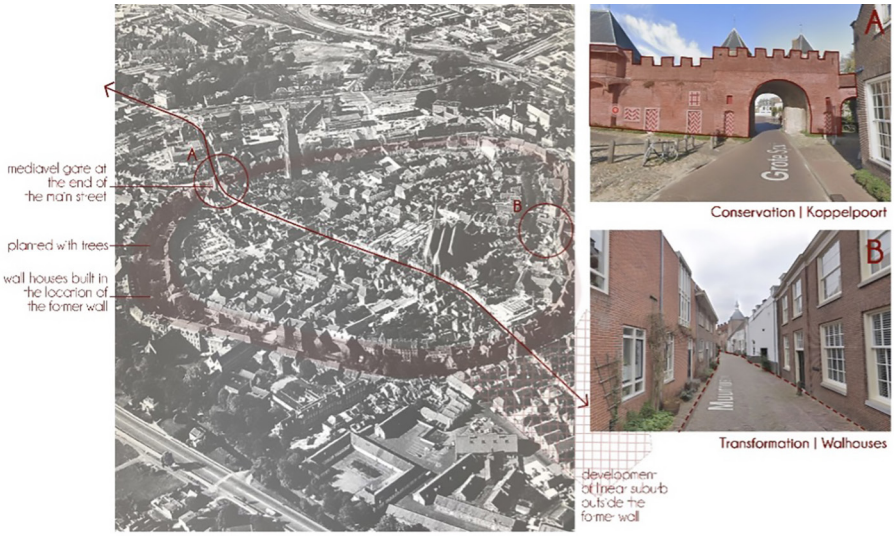

Figure 2. *Evolution of old city walls in Amersfoort, source: illustrated by reference to Kostof (1992) (left), Google Maps Street Views (right)*

tion of a second wall. and this signified expansion of the city while straining the resources (Van de Pol, 2021). However, the old city center was still surrounded by the traces of the first walls, demolished in the 15th century and replaced by wall houses. The remaining gates provided an access to the suburban settlements in the linear form, located outside of the old center (Kostof, 1992) (Figure 2). As the last step in the gradual deterioration process of the walls, they had lost their defensive purposes completely, and plans to transform the outer line into a green pathway emerged by 1829. Yet, by the end of the 19th century, a national ban on demolishing walls and some resistance from heritage organizations conserved the remnants of the walls (Van de Pol, 2021). It is still possible to observe a few examples of the conserved parts while monitoring many transformed areas consisting of the houses that follow the old course of the former wall line today (Figure 2).

Carcassonne

The evolution of Carcassonne city walls, dated back to the pre-Roman period, went through a shift in perception of conservation approaches throughout history. The conservation process of Carcassonne city walls began in 1853, following a government decision to demolish the fortifications in 1849, which had sparked strong opposition from the local population (Url-1). After years of effort to preserve the walls, UNESCO adopted a special perspective that emphasizes that authenticity of Carcassonne's historic fabric should be evaluated within the cultural context of the city. This change in the conservation approach reflected the evolving view of heritage conservation, where the restoration itself became part of the heritage (Creighton, 2007). Even today, due to the unusual structure and positioning of the walls, they cannot be separated from the city, neither physically nor symbolically, and they are considered as monumental elements in the contemporary city. With the enclosed walled city character, thanks to the well-implemented conservation approaches, the city serves as an implicitly experienced historic-touristic city offering different public uses. Transformation of the walls, on the other hand, can only be seen in the Ville Basse, which has served as the city's economic center for many centuries in the form of wall houses (Figure 3).

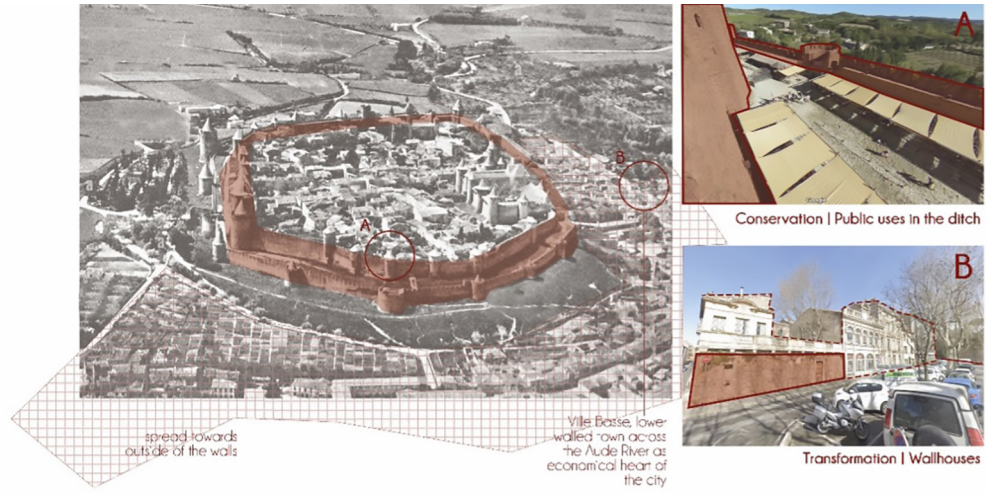

Figure 3. Evolution of city walls in Carcassonne, 1925 and today, source: illustrated by reference to URL-2 (left), Google Maps Street Views (right)

Dubrovnik

Dubrovnik city walls, which surrounded the entire city on both land and the seaside, were formed between the 8th and 16th centuries for defensive purposes. They underwent significant processes over time, adapting to new military technologies and urban needs. They were reinforced with the towers and bastions in the 15th and 16th centuries (Prelog, 1972). In 1667, a powerful earthquake caused extensive damage to the city, yet the massive city walls and fortifications mostly remained standing. Today, the conservation of the compact core of Dubrovnik, designated as a UNESCO World Heritage site, can be attributed to restoration efforts following the earthquake in 1667 and attacks during the civil conflict of the early 1990s. Currently, all reconstructed areas in the inner parts of the walls, including the buildings around the main street, Stradun, are strictly controlled (Radnić *et al*., 2020) (Figure 4). Despite of these changes, the walls continue to serve as monumental elements in the city due to their well-preserved physical structure, providing a basis for the city form today. Dubrovnik represents a well-defined historic-touristic city by bringing its characteristic enclosed walled city status to the present day. In addition to its historic-touristic aspect, some place-making approaches have emerged as a result of the reciprocal relationship between today's mostly conserved wall structure and the recreation of everyday spaces (Mosler, 2019). Thus, the ditches are used as urban gardens and sports grounds, while the natural stairs located next to the wall and elevated walkways on the wall structure are experienced as public/semi-public areas (Figure 4).

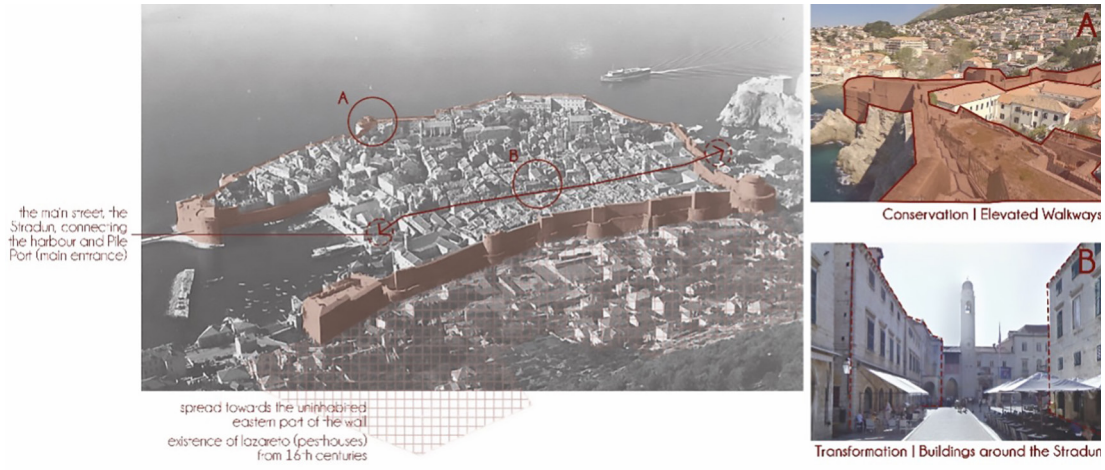

Figure 4. *Evolution of city walls in Dubrovnik, 1900s and today, source: illustrated by reference to URL-3 (left), Google Maps Street Views (right)*

Istanbul

The Theodosian walls were originally constructed during the reign of Septimus Severus between 193-211 BC in response to the rising threat of barbarian incursions in the western region. They encompass both land and sea walls along the Golden Horn and the Sea of Marmara (Van Millingen, 1899).

Over time, the spatial attributes and symbolic significance of the Theodosian walls have evolved, reflecting the changing political and social dynamics of various historical periods. During the Ottoman period, the city walls were revitalized and transformed to meet the needs of the new rulers. The walls were taken as a reference for forming the circulation system, and it was aimed to connect the inner and outer parts of the walls with the help of the perpendicular axes towards the walls (Kubat, 2019). They were also subject to damage from earthquakes, fires, and planning practices in the 19th century (Çelik, 1998). Yet, the land walls of Istanbul did not experience any intervention related to devastation, considering its characteristic feature in contrast to the partial devastation of Golden Horn Sea Walls and Galata Land Walls (Bütüner, 2019) (Figure 5). In the modern era, the conservation of the walls has become a significant issue. These shifts from transformation to conservation have left behind tangible traces of the walls' physical existence and utilization, and it is resulted in the survival of only the land wall portion of the city walls, which divides the surrounding area into two zones to the present day. This results a fragmented fabric around the lands walls due to the negative impacts of the large-scale implementations and interruptions today.

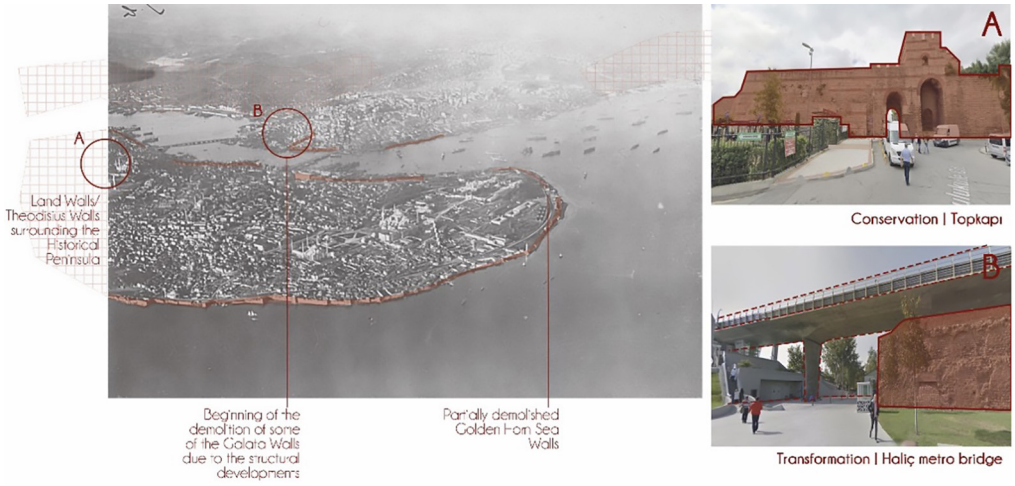

Figure 5. *Evolution of city walls in Istanbul, 1918 and today, source: illustrated by reference to URL-4 (left), Google Maps Street Views (right)*

Paris

Paris can be characterized as an early example of the practice of transformation of city walls. During the 17th century, Paris began the process of demolishing its defensive walls and, instead, constructed elevated walkways adorned with trees along the city's periphery. Due to their distance from city center, they prompted the creation of boulevards later. In Figure 6, straight streets which can be seen in the aerial photo from 1739 indicate the location of the city wall from the 14th century. To the north, there is a diagonal line of trees marking the path of the 1640s wall, which encompasses a larger area (Kostof, 1992). Despite the mostly transformed walls in Paris, their traces can be followed in the lay-

out, direction, and function of the city blocks in the central district of the city today. Like in the past, the gates including Porte Saint-Denis, which are almost the only remaining parts of the wall structure, continue to serve not just as links between significant locations but also as focal points for pedestrian activity today.

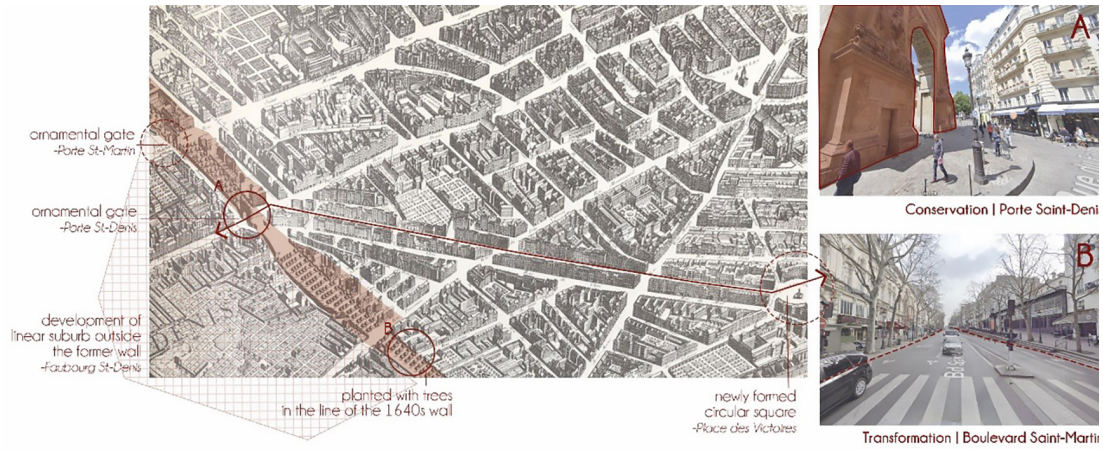

Figure 6. *Evolution of city walls in Paris, 1739 and today, source: illustrated by reference to Kostof (1992) (left), Google Maps Street Views (right)*

Vienna

Vienna began expanding beyond its old fortifications in the 18th century as a beginning of the planned transformation processes of its fortified boundaries. To connect the old city with the emerging suburbs, a competition was held in 1858 to redesign the city's edges after the removal of its walls, a key part of the city's restructuring. The winning proposal foucsed on creating a ring road (Ring Strasse) and designing socio-cultural functions, residential and green areas in place of the former city walls (Kostof, 1991). This concept of transforming city walls into ring roads set a unique example for other global cities. In the contemporary city, it is possible to understand the former line of transformed walls of Vienna by following the Ring Strasse, which encircles the old city center as a small portion of it is shown as Karntner Street in Figure 7. The remnants of the city walls, which have survived to the present day in an unplanned manner, are few in number and are located in different parts of the city, embedded in various cultural structures such as St. Rupert's Church (Figure 7).

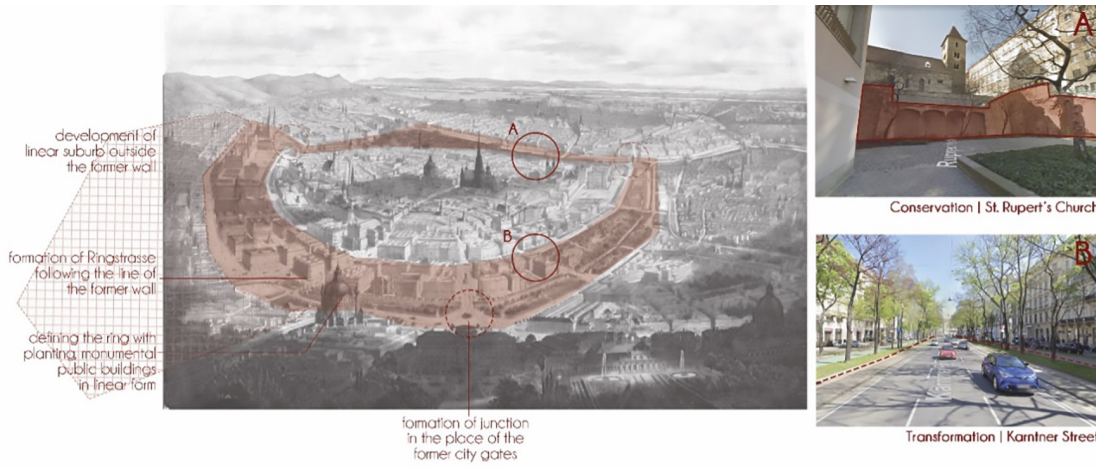

Figure 7. *Evolution of city walls in Vienna, 1873 and today, source: illustrated by reference to Url-5 (left), Google Maps Street Views (right)*

Xi'an

Xi'an city walls, built for defensive purposes during the Ming Dynasty, faced growing pressure to demolish substantial sections. The rapid urban development of the city necessitated a solution to address the controlling traffic congestion while conserving the walls in the early 20th century.

The approach of constructing more gates instead of demolishing the original city walls was adopted by urban planners to mark the first instance of aligning historical conservation with urban development Since then, the urban built-up area of Xi'an has expanded even more rapidly, leading to a period of functional evacuation and cultural revival in the inner-city wall (Wang et al., 2019). Following the planning of the city wall, which focused on the conservation and only the functional transformation, it now serves as a vibrant public hub with elevated walkways, hosted events, squares and green space today (Figure 8).

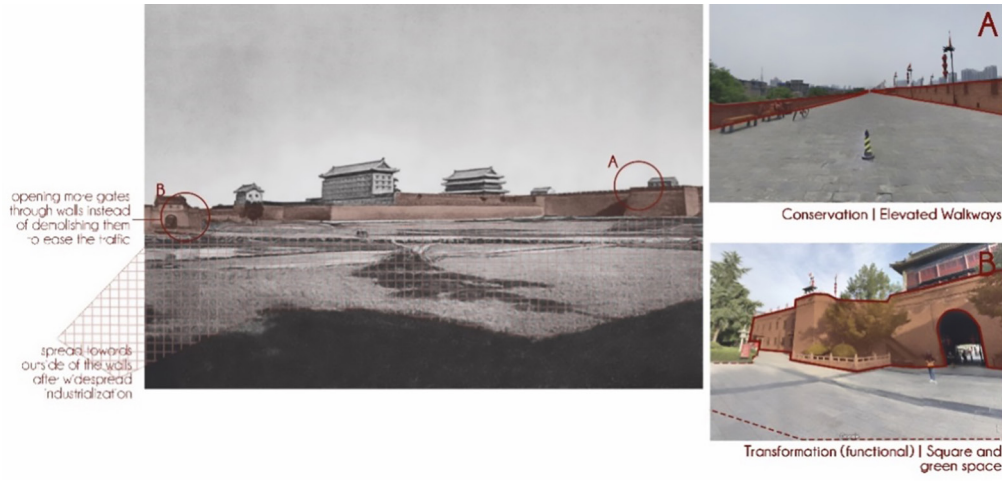

Figure 8. Evolution of city walls in Xi'an, early 1900s and today, source: illustrated by reference to Pingao (2001) (left), Google Maps Street Views (right)

COMPARATIVE DISCUSSION

Over the years, old city walls and associated structures have undergone numerous transformation and conservation approaches that have significantly influenced the layout of urban areas, as well as their physical and social characteristics. In an effort to categorize the evolution stages of city walls, the forms of conservation, their contemporary functions, and the impact of these approaches on the overall urban macroform are interpreted, as summarized in the Table 1.

Table 1. *Comparative discussion on the selected city walls, source: created by the authors.*

City	Evolution Stage of the Wall	Form of Conservation	Contemporary Function	Effect on Urban Macroform
Amersfoort	Mostly transformed	Accidental	Monumental element	✓
Carcassonne	Mostly conserved	Deliberate	Monumental element & Public use	Partially
Dubrovnik	Mostly conserved	Deliberate	Monumental element & Public use	Partially
Istanbul	Conserved & Transformed	Accidental & Deliberate	Residual Space	Partially
Paris	Mostly transformed	Accidental	Urban Space	✓
Vienna	Mostly transformed	Accidental	Urban Space	✓
Xi'an	Mostly conserved	Deliberate	Monumental element & Public use	✓

Among the cities and samples highlighted, walls of Amersfoort, Paris, and Vienna have undergone significant transformation with relatively slight existed remnants which can be characterized as accidentally conserved fragments with reference to the representation of Ashworth (1991) on the evolutionary stages of city walls. The traces of the former wall lines are followed as wall houses in Amersfoort, boulevards in Paris, and ring roads in Vienna today. Thus, the walls have a significant influence on the urban macroforms of these cities with the symbolically conserved wall line despite of their physically transformed structures.

On the other hand, deliberate conservation approaches and efforts in Carcassonne, Dubrovnik, and Xi'an have preserved their walls as both monumental elements and public spaces. Because of their unique structure and location in the city, these walls cannot be physically or symbolically disconnected from the city, and they continue to be regarded as significant features within the modern urban landscape. Besides the well-conserved structures, they are also integrated into the urban daily life, providing different activities and functions. In terms of their effects on urban macroform, Carcassonne and Dubrovnik with their characteristic of being enclosed walled city today have a partial effect compared to the Xi'an. With its complex formation and evolution process occurred through the superimpositions of different practices, walls of Istanbul stand as a unique case where conservation and

transformation coexist, resulting in fragmented urban fabric with residual spaces today. In a broader perspective, the diversity in conservation and transformation strategies and resulting urban dynamics is considered as important insights for the ongoing evolution processes of city walls.

CONCLUSIONS

City walls, once symbols of protection and identity, were often transformed into artifacts of historical significance by reflecting changing attitudes towards heritage and urban aesthetics. Investigating the conservation-transformation dichotomy clarifies the complex interplay between cultural heritage conservation, socioeconomic forces, and urban planning.

Furthermore, the impact of these decisions reflected through urban morphology, influencing the layout, density, and character of urban spaces. Conservation of city walls while adapting them to contemporary needs could lead to the emergence of unique hybrid environments, where historical remnants merge with modern functions. Yet, unless the multi-dimensional perspectives are adopted, they could also cause fragmented urban environment, where obsolete remnants merge with residual spaces. In other respect, the physical transformation of city walls could pave the way for expansive urban expansion, altering the spatial structure and potentially erasing historical layers. It is believed that the investigation of these reflections on urban morphology uncovers patterns of urban development and factors that shape the physical and cultural landscapes of cities.

In conclusion, the conservation-transformation dichotomy in the historical evolution of city walls highlights the possibilities which can guide the application of appropriate urban strategies for the city walls and the surrounding areas. In this context, it can be suggested that approaches and praxis related to city walls and the overall urban form should be rethought within the scope of integrating different disciplines and adopting a holistic perspective.

ACKNOWLEDGEMENTS

The research presented in this paper is part of an unpublished MSc thesis titled “Discovering the public use potentials of city walls and their surroundings: The case of Theodosian Walls” (2023), written by the first author under the supervision of the second author at Graduate School of Istanbul Technical University, Department of Urban Design.

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Rural linear settlement structures as a typological response to distinct settlement factors: climate, topography, landform, social structure and demography. A discussion based on the analysis of the Pannonian Basin

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ABSTRACT

Linear settlements are present in many rural regions in Europe: from England in the North to Italy in the South, from France in the West to Ukraine in the East. Although the villages vary widely in form and age, as well as in circumstances of their development - from historically grown to planned settlements - the distribution of linear settlements in their general area of distribution area suggests that there are specific conditions that favour their occurrence.

While there are linear settlements alongside canals or streams, as well as villages arranged along features such as village greens (Dorfanger), the most basic form of linear settlement is the street village (Straßendorf). It has a uniform urban parterre structure that serves all essential settlement tasks, such as dwelling, working, supply, recreation, worship, and traffic.

To date, there is a lack of comprehensive research regarding the preconditions for the development and spread of those linear settlements. Through a morphological analysis of relevant urban design factors our research will fill this knowledge gap. To start with, this paper offers first results and insights into analyses of linear settlements in areas of Austria, Slovakia and Hungary. The study is embedded in a recently initiated larger research project concerning the transformative potentials of linear settlement structures in the European area. Besides results, that are to be understood as first approximations, a short historical overview on the most important milestones of local settlement development in the study area is given. Furthermore, morphological analysis of relevant factors, local typologies and patterns of buildings and settlement structures as well as specific spatial qualities of villages are addressed with regard to the genesis of the investigated linear settlements.

Keywords: Linear Settlements, Pannonian Basin, Morphology, Regional Planning

INTRODUCTION

The paper is intended as a starting point for a cross-border systematic consideration of linear settlement patterns in the Austria-Slovakia-Hungary border area. Initial research results and discussions on the topic are presented here, as well as fields of interests and ongoing research activities. After the overall study is completed, final evaluations and the expected in-depth research findings will be published.

For this initial approach, a research area was first defined within the field spanned by the location of the cities of Vienna, Bratislava, Gyor, Sopron and Wiener Neustadt. The majority of the research region is located in Austria and Hungary, which have so far been the main focus of the evaluation. Currently the topic of linear settlement structures is often considered from a local building heritage perspective, with the aim of presenting regional and historical architectural and settlement aspects; while the focus of our approach clearly lies in a morphological development analysis.

To our knowledge there is little recent literature to this specific topic of linear settlement structures from an urban planning perspective. In the course of this, it must also be mentioned that the following work is primarily influenced by German-language literature. The inclusion of Hungarian und Slovak-literature is formulated as a following milestone in the upcoming steps of the research project.

The German-speaking respectively Austrian perspective on the topic of linear settlements is shaped among others, by the work of the architect Adalbert Klaar. For the creation of his maps–the "Siedlungsformenkarten" - he formulated very detailed and specific definitions of the single types of settlements, including the linear settlement types (Klaar, 1942). Due to further definitions, different subtypes, regional differences in interpretation in individual countries and the fact that the settlements studied have meanwhile been expanded and individual buildings partially converted, the present study–in order to create clarity and to focus on the morpho-analysis attempted here–henceforth uses a highly simplified categorization of the different linear settlement types:

- Corridor: a main street with rows of houses on both sides (no distinction between open or closed street front), no classifying width of the central main street an no central public space (Anger). Multi-row linear settlements are also categorized as Corridor.
- Anger: in contrast to the Corridor type, the Anger type has an additional public open or green space in the street space; this zone can also be partially built on.
- Hybrid: when both types–Corridor and Anger–occur side by side in a village/city, or when one of the two mentioned is combined with another special type within the settlement structure.

Background

The selected research area circumscribes a settlement area historically strongly influenced by the Austrian Habsburg monarchy and the Hungarian Aristocracy.

Prior to this, in the early Middle Ages from the end of 8th till the 10th century, the area was shaped among other things, by a colonizing German settlement process under Carolingian Influence as well as by the sedentary settlement of the Magyars in the Basin (Ernst, 1987: 22ff). With regard to linear settlement components in this area, the 11th century probably marks a decisive phase. In this period, further planned colonization with German settlers took place in areas of present-day province of Burgenland (Schickhofer, Schoberwalter and Kaufmann, 1987: 7) and Hungary (Ernst, 1987: 27). Parallel

to this, in the 11th and 12th centuries, a spreading of linear settlements in the province of Lower Austria (neighboring Burgenland and Hungary) is described, whereby these were all laid out in a concerted planned manner as part of colonisation (Miller, 1950: 46, 47). Also for the Burgenland, the use of linear settlement structures in the course of colonization is noted (Schickhofer, Schoberwalter and Kaufmann, 1987: 8). In the 12th and 13th centuries the emergence and development of the "Angerdorf" in Burgenland is depicted (Schickhofer, Schoberwalter and Kaufmann, 1987: 11). For military reasons of defence, the buildings in the villages, for example in northern Burgenland, were built close together and the Corridor and Anger Type prevailed (Schmeller, 1974: 43). Both types were built with clear planning principles. After the regions studied here were affected by heavy destructions during the Turkish Wars in the 16th and 17th century, the villages and linear settlements were rebuilt. In this phase a specific type of linear settlement emerged, the so-called engineer-village, "Ingenieurdorf" (Schmeller, 1974: 44).

From the end of the 18th to the middle of the 19th century a general colonization- and settlement policy took place in the central Danube valley, "Donautal", by the Habsburgs, which particularly affected certain areas of the Pannonian Basin. Villages were founded by the state and private businesses; both favored the linear settlement structure, which then subsequently formed the basis for multi-line settlements or other more complex types. The planning guidelines determined the size of settlement and population, as well as the distribution of fields and the type of cultivation (Miller, 1950: 63, 64). In the Habsburg Empire, a kind of genesis of settlement planning developed during this period, with different design guidelines and parameters (Miller, 1950: 66, 67). There were a variety of regulations, for instance the Hungarian State Chancellery in Vienna, which was also responsible for the already mentioned Burgenland, prescribed the planting of trees to prevent fire flashovers. (Bauer, 2023: 162). Since the second half of the 19th century, as the non-farming population increased, small buildings and settlement structures were built compactly next to the existing farm houses in the same but smaller scheme (Kleemaier-Weltl, 2023: 156); thus representing the first settlement extensions that did not reflect the main agricultural sense.

It can be argued that the chronology of the village structures, which is very abbreviated and not fully outlined here, ultimately led in the end to very homogeneous settlement patterns in large parts of the empire, with the associated linear settlements being rather defining and formative for the landscape. The widespread typological components for the linear settlement structures in the study area and beyond were, on the one hand, long lots combined with open-field and three field farming and, on the other hand, narrow but deep plots along the main road/"Anger" with the typical rural buildings on them: "Streckhof", "Zwerchhof" or "Dreiseithof" respectively „Doppelhakenhof".

With regard to the research area, two very different settlement developments can be observed in Austria and Hungary in the phase after the second World War:

Austria was marked by a phase of reconstruction and economic upswing, which ultimately led to major transformations in the linear settlements. Triggered by significant changes in agriculture, such as the extensive decline in livestock farming, meadows that were no longer needed near settlements were often redesignated as building land and filled in with settlement extensions, mostly in a grid structure. This is associated with the development of single-family-houses and the beginning of the urban sprawl, that continues to this day. A further significant transformation occured in the settlement core, where the old farmhouses were frequently expanded by an additional storey (Kleemaier-Weltl, 2023: 158, 159).

In the same time was a completely different development in Hungary, where agriculture was collectivized: farmhouses no longer needed their own farm buildings or barns, so that these increasingly disappeared from the village landscape. At the same time, with the cube house "Kádár Kubus" a uniform house type was created for settlement expansion and transformation. These new houses were integrated into the existing long parcel system; a new linear settlement type was realised by connecting these buildings with new access roads (Kleemaier-Weltl, 2023: 159). This pattern characterises the rural areas of Hungary even beyond the research area.

METHODOLOGY

Frame

The area spanned by the cities of Vienna, Bratislava, Gyor, Sopron and Wiener Neustadt forms the research area and includes settlements from 13 counties and 4 federal provinces: Niederösterreich (AUT), Burgenland (AUT), Bratislava (SVK) und Gyor-Moson-Sopron (HUN).

With focus on the rural aspect, all villages and towns are considered and only the district capitals are excluded. In order to analyse the individual aspects and qualities, three Phases with different scale levels were defined. On a large-scale level phase 1 describes a first approximation and recording of all settlements that still exhibit a historically linear settlement structure. In phase 2, a selection of surveyed villages is analysed for single spatial parameters and urban patterns are presented. In phase 3, selected settlements are examined in more detail and urban qualities are addressed.

Phase 1

Based on the approach of Klaar's "Siedlungsformenkarte", the linking of categorization and mapping of settlement-types, a new settlement-based mapping is developed, which focuses on the geographical orientation of the historical linear settlement centre.

In order to achieve the most efficient management of the land, historical linear settlement layouts paid particular attention to geographical features. Thus, landscape and topographic components such as hills, forests, canals or streams as well as soil conditions were decisive. In addition, wind and other climatic influences also played a role in the alignment (Miller, 1950: 64, 65).

In phase 1 over 270 settlements were considered, and in around 65% of them historical and actual qualities of linear settlements structures could be identified according to the three types: Corridor, Anger or Hybrid. Both, Klaar's "Siedlungsformenkarte" and the Arcanum web portal (Arcanum: Franziszeische Landesaufnahme) are used as data basis for this historical consideration.

The Classification of orientation is north/south, west/east, northwest/southeast, southwest/northeast as well as north/south–west/east. The last category can arise if, for example, two settlement cores are found within a village or town.

Phase 2

Based on the 176 linear settlements surveyed in phase 1, a representative cross section of 20 villages is identified, whereby at least one settlement per district (within the study area) must be represented in

each case. Further selection criteria are the proper representation of the three types (Corridor, Anger and Hybrid) and the geographical orientation as well as the urban structure of the settlement itself.

The aim is to identify urban development patterns, and subsequently to derive different parameters and qualities of individual types and possible cultural and regional imprints. Various parameters are examined here: quantitative aspects such as distances to water bodies or higher-level road networks, number of inhabitants, the dimensions of the local centre as well as further points of interest–those points of interest are seen as indicators of the frequency of activity (residents and tourists) by capturing the number of shops, restaurants, banks, hotels, etc.

An attempt is also made to determine the type and scale of the settlement expansion in comparison to the settlement centre. Furthermore, the relationship between the linear settlement and the road system is examined, as well as whether the ancient major road still holds the highest significance within the neighbourhood street system. Additionally, it is examined to see if distinctive topographies can be found nearby or if unique structures like industries or castles had an impact on the growth of the settlement.

Table 1. *Profile recorded for each linear settlement*

Collected Data: Metropolitan Region Wien - Bratislava - Györ - Sopron - Wiener Neustadt

Geography	Geographical Orientation of the historic linear settlement	North/South	West/East	North-South/ West-East	Northwest/ Southeast	Southwest/ Northeast
	Distance to water	0 - 2km	2km - 4km	4km - 6km	6km - 8km	> 8km
	Characteristic topography	Yes	No			
Spatial Structures	Length of the local center of the linear settlement	0- 400m	400m- 600m	600m- 800m	800m- 1.000m	> 1.000m
	Extensions of the linear settlement	Linear structures	Grid structures	Both		
	Number of Points of Interest (Gastronomy, Shops,…)	0- 5	6- 10	11- 20	21- 30	> 30
	Characteristic special objects (Castles, Factories, Others)	Yes	No			
Mobility	Distance to current superordinate road network	0- 2km	2km- 4km	4km- 6km	6km- 8km	> 8km
	Connection of the settlement (local center) to the road network	Central	Parallel	Across	Other	
Society	Population	0- 1.000	1.000- 2.000	2.000- 4.000	4.000- 6.000	> 6.000

Phase 3

With one village from Hungary and one from Austria, the objective is to demonstrate morphological distinctions and various qualities in phase 3, which will focus on two settlements chosen out of phase 2. In addition, a third linear settlement is included as a comparison object, a special form of Anger settlement - the geometrically precisely laid out "engineer village". The aim is to convey an understanding of how the settlement layout works and what spatial qualities are associated with it.

In this phase, the morpho-analytical UPM-method (Urban Parterre Modelling) developed by Angelika Psenner, is applied in an adapted and highly simplified way. The idea of the UPM-method is to represent the functioning of the urban parterre system, consisting of the street space, the ground floor zone and the courtyards. A holistic application of the method, with the collection of historic data on streets and buildings in archives, the representation and comparison of historical and current uses in the ground floor zone, the three-dimensional modelling of the buildings and the street space, etc. is also considered as an outstanding milestone. For the current time a mapping of the present uses, affecting the ground floor zone, was carried out (the online mapping services Google Maps and Openstreetmap were used as data basis). Furthermore, schematic street sections were created, to illustrate local urban qualities and relations between street space, buildings and courtyards.

RESULTS AND DISCUSSIONS

Phase 1: The results of phase 1 with 176 evaluated structures show that there is no generally applicable preference with regard to the geographical orientation of the linear settlements: 29% northwest/ southeast, 23% southwest/northeast, 23% north/south, 17% east/west und 8% north/south–west/ east. Geographical connections as well as important road systems were probably decisive for the lo-

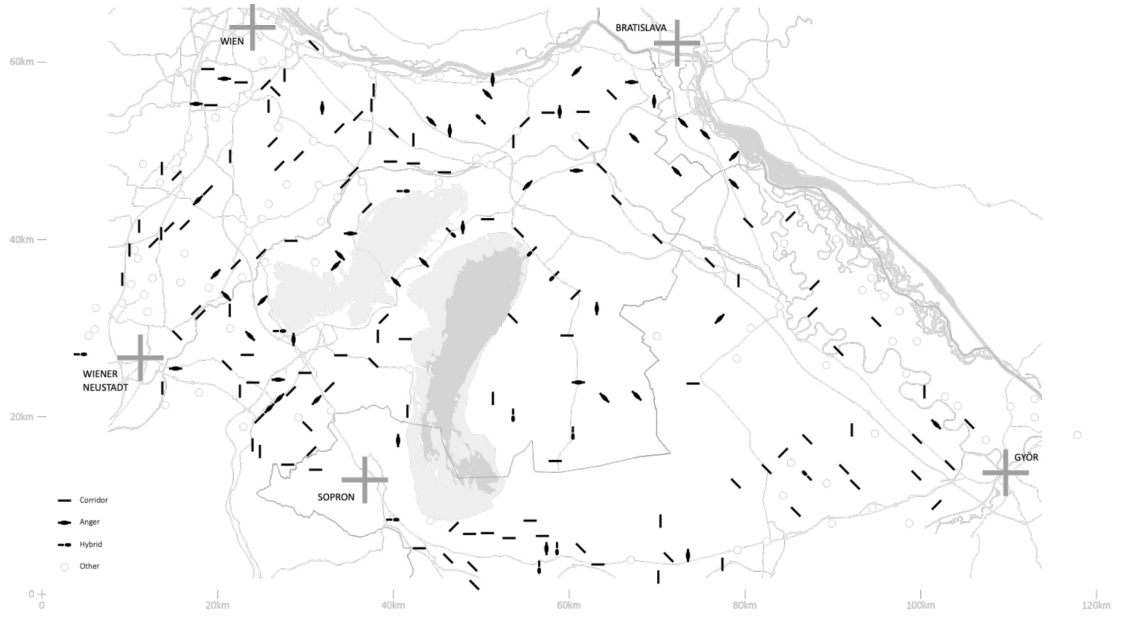

Figure 1. *A settlement-based map, with focus on the geographical orientation of the historical linear settlement centre, © Loeschenbrand/ Tobisch/ Psenner (Datasource for map basis: OpenStreetMap, ODbL)*

cation and orientation. A corresponding spatial pattern can be seen along the river "Leitha", where almost all linear settlements run parallel to the river. If the superordinate parameters did not clearly determine the layout of the linear settlement, factors such as wind could be determinant. In this sense the northwest/southeast orientation, i.e. the category with the largest proportion, corresponds to one of the main wind directions in parts of the research area.

A fundamental finding of this phase 1 is the fact that, from a morphological point of view, geographical und climatic design principles were often decisive for the functioning of linear settlements.

Phase 2: From the current state of analysis and the evaluation of the collected data so far from the 20 selected linear settlements, it was possible to define an archetypical linear settlement of the research area: a Corridor type with northwest/southeast orientation and a population between 2.000 and 4.000. The distance to a water body is less than 2km, a characteristic topography is not given. The centre of the linear settlement is between 600m and 800m, the most important and busiest road is still the central main street of the settlement and the distance to a superordinate road network is under 2km. The settlement expansion consists of linear and grid structures development. Special objects are not identifiable and the number of points of interests is between 6 and 10.

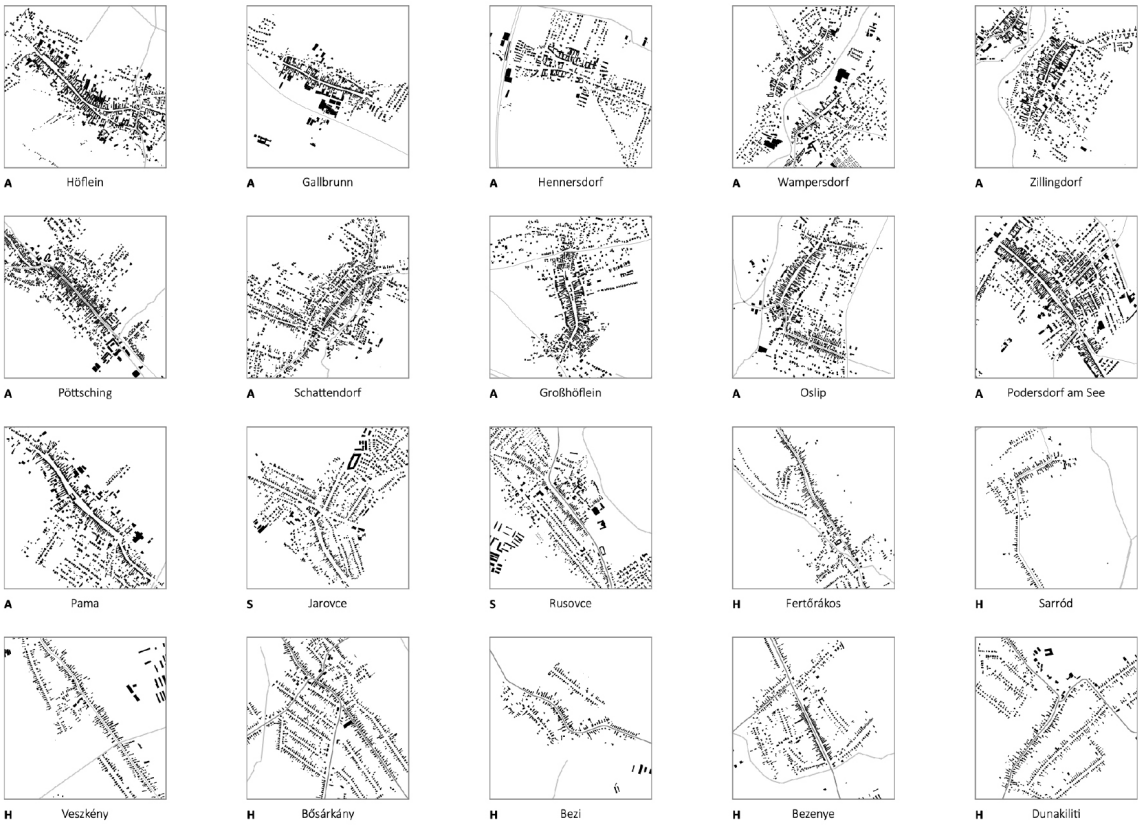

Figure 2. *Structural plans of the selected linear settlements (Phase 2), © Loeschenbrand/ Tobisch/ Psenner (Datasource: OpenStreetMap, ODbL)*

The distinction between the linear settlements from Hungary and Austria in terms of settlement expansions and density levels is clear when looking at the existing structural designs of the chosen communities (Figure 2).

The various developments in the second half of the 20th century, which have already been discussed under the heading “Background” may have played a key role. The villages studied in Slovakia, all of which correspond to the Anger type, show similarities to Hungarian settlements in terms of density and are more comparable to line settlements from Austria in terms of settlement extent.

The study on the parameters of the selected linear settlements represents a first approximation and an preliminary status. The anticipated more in-depth investigation and evaluation should yield more intriguing results that will help us understand how villages work and the typological characteristics of linear settlements both historically and geographically.

Phase 3: With regard to spatial qualities, it is planned to apply further principles of the UPM method to the selected settlements of phase 3, such as the comparison of historical and current use or the three-dimensional modelling of the main street and the buildings.

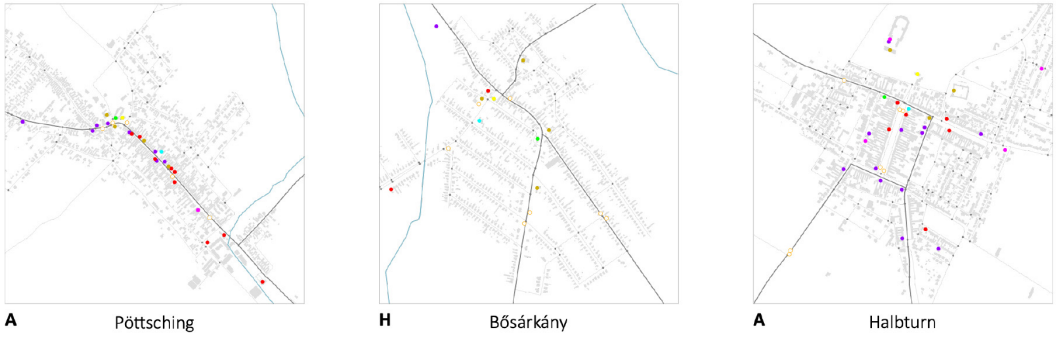

Figure 3. *Mapping process of ground floor uses (Phase 3), © Loeschenbrand/ Tobisch/ Psenner (Datasource for map basis: OpenStreetMap, ODbL)*

However, the applied method of mapping and the representation of qualities in the sections, already allow for making first statements on various qualities:

It can be seen, that linear settlements with a more compact and denser settlement core, as can also be found in isolated cases in Hungary, the points of attraction tend to be located on the main street and thus strengthen its linear core and show more urbanity. Moreover, in the dense agglomerations with connected street fronts, the permeability of the facades – i.e. how entrance doors and gates influence the Stadtparterre experience (Psenner, 2023) – is clearly different from settlements with a looser density, where driveway gates are characteristic. This also results in a different approach to parking in public space. Another interesting field is the transformation of the old farmhouses and original building typologies, some of which have changed considerably in the second half of the 20th century.

All these theses, themes and topics are to be addressed in ongoing research process.

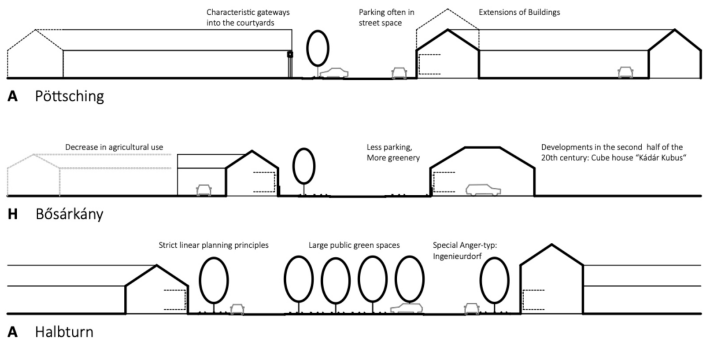

Figure 4. *Sections of the selected linear settlements (Phase 3), © Loeschenbrand/ Tobisch/ Psenner*

CONCLUSIONS

The consideration of the linear settlements in this selected research area already reveals the importance and diversity of potentials for further research in this typology. This is not only about understanding an urban historical heritage, but much more about questions of whether and how we can possibly counter the urban sprawl in rural areas with appropriately infrastructurally equipped and compact village structures. This requires in particular a morphological and systematic knowledge of the existing components and structures.

The network of the linear settlement structures in the selected research area also shows the aspect of distances and connections to higher-level structures. Connected to this is an important facet of the topic that has not yet found space in the research project, but is elementarily important for the structure and design of linear settlements, namely mobility and traffic.

ACKNOWLEDGEMENTS

The Authors want to thank Friedrich Hauer (TU Wien) for his input in the writing of this paper. Furthermore, he is part of the research project with his expertise.

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Identification of Deficient Urban Form in Informal Settlements

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ABSTRACT

Informal urban development can lead to undesirable living conditions, including restricted accessibility, limited public space, and haphazard densification. The present study analyses the urban morphology of the centrally located informal settlement Mafalala in Maputo, Mozambique to identify such conditions. The study used a drone to survey the neighbourhood and photogrammetry software to generate a high-resolution orthomosaic. The orthomosaic was manually delineated to label key features of the urban environment and compute six quantitative indicators of urban form. These were used to identify blocks with restricted vehicular accessibility, constrained pedestrian permeability, inefficient building configuration, low proportions of public space, and limited open private space. In addition, the analysis was informed by field observations documented with photographs. The study found that the aforementioned deficient urban form characteristics were prevalent in the settlement, largely in groups of blocks located away from main streets, and more widespread in the economically disadvantaged northern part of the settlement. On the basis of the findings, the study discusses potential appropriate modes of intervention, such as structural readjustment, investments in infrastructure, and capacity building of local level authorities. Finally, the study discusses the potential of urban morphology analysis in combination with other research fields to identify factors associated with compromised livelihood and guide targeted interventions in informal settlements.

Keywords: informal settlements, sub-Saharan Africa, urban morphology, urban diagnostics, Mafalala

INTRODUCTION

At present, sub-Saharan Africa is undergoing rapid demographic transformations, involving both extensive migration from rural to urban areas along with high population growth rates (Ahimah-Agyakwah et al., 2022). The development occurs without adequate institutional capacity for urban management, resulting in large-scale proliferation of informal settlements (Wekesa et al., 2011). These are extra-legal residential areas typified by housing constructed without formal permits on land to which the occupants have no legal claim (Satterthwaite et al., 2020). The limited institutional capacity and lack of state recognition of the informal housing sector is associated with insecure tenure and inadequate provision of basic infrastructure, including water, sanitation, and mobility systems. These conditions compromise the livelihood of the residents of the informal housing sector and informal settlement comprises a key challenge for sustainable development globally (Mottelson, 2023). The capacity gaps in urban management hinder effective policy formulation, implementation, and enforcement, leaving informal housing as the only attainable means of meeting the demand of affordable housing for the majority of the population in sub-Saharan Africa. The lack of enforcement of building and planning regulations emblematic of informal settlements can lead to deficiencies manifested in the physical environment, such as inadequate access conditions and inefficient utilization of space (Mottelson & Venerandi, 2020). However, important knowledge gaps remain on the relation between emerging settlement patterns and sub-standard living conditions in informal settlements.

As the spatial attributes of inhabited areas are linked to human behaviour and livelihood, the study of the physical form of human settlements has emerged as an important research domain for understanding the interrelation between settlement patterns and carbon emissions, livelihood, and sustainable development (Chen et al., 2023; Glaeser & Kahn, 2010; Kim & Hipp, 2019; Marshall et al., 2014). Early studies of urban morphology used cartographic methods to trace the evolution of cities and highlight how cities transform in parallel with the development of technology and social institutions (Conzen, 1960). Later studies used statistical methods to document links between the physical configuration of cities and carbon emissions, health conditions, and crime (Chen et al., 2023; Glaeser & Kahn, 2010; Kim & Hipp, 2019; Marshall et al., 2014). In recent years, the study of the physical form of informal settlements have enhanced the knowledge on their formative processes, highlighting how previous land use and social structures are linked to the emerging settlement patterns (Dovey et al., 2020). Other works have suggested that inherent spatial qualities are found in informal settlements, produced through bottom-up processes similar to those of historical medieval city centres (Venerandi et al., 2021). Comparative analysis of the urban morphology of informal settlements in the context of sub-Saharan Africa have highlighted considerable interregional differences, suggesting that contextual cultural and social factors are crucial for the formation and development of the urban form (Mottelson & Venerandi, 2020). Although these works have highlighted important aspects on the spatial conditions of informal settlements and their formative processes, urban form analysis has not been instrumentalized to identify particular deficiencies manifested in the physical environment of informal settlements and thereby inform potential urban planning interventions to improve the living conditions.

The present study analyses the urban morphology of Mafalala, a historical and centrally-located informal settlement in Maputo, capital of Mozambique to identify deficient urban form features in the neighbourhood, such as constrained accessibility, inefficient building configuration, and limited access to spaces that can accommodate social life. On this basis, the study discusses the use of urban morphology techniques to guide interventions and thereby improve living conditions in informal settlements. The study relies on qualitative and quantitative analysis of the urban fabric of the neighbourhood, based on high resolution geospatial surveys, field observations, and geographic data available via open platforms (OpenStreetMap). The indicators of deficient urban morphology characteristics were computed at block level, and a cross indicator composite ranking was produced to identify blocks characterized by multiple undesirable urban form features.

CONTEXT: MAFALALA, MAPUTO, MOZAMBIQUE

Mozambique is a low-income country located in south-eastern Africa along the coastline of the Indian Ocean, covering more than 800.000 km². The region was inhabited by Bantu-speaking people for centuries before the Portuguese arrived in the late 15th century and established trading settlements along the coast which emanated the colonization of Portuguese East Africa (África *Oriental Portuguesa*) (O'rourke & Williamson, 2009; Semo et al., 2020). The Portuguese colonization intensified in the late 19th century when the city centres of most of the current largest cities were planned and large areas extending from the coastline were occupied. The colonial oppression culminated in armed resistance under FRELIMO leadership against the Portuguese colonial authorities until Portugal ceded its colonies in 1975 (Machava, 2011). After Independence, Mozambique was inflicted by a 16-year long civil war during which urbanization increased rapidly as cities became destinations for fleeing internally displaced people and previous restrictions on the free movement of people were abolished (Jenkins, 2000). Many centrally located informal settlements in Maputo formed during this time, often without coherent urban planning (Jenkins, 2000).

Mafalala is located in proximity of the formal city centre of Maputo (Figure 1) and was established prior to Independence. At this time, racial segregation policies prohibited the indigenous population from residing in the centre of the city and Mafalala emerged as the primary settlement for the black population in the city (Ribeiro & Rossa, 2016). In the 20th century, Mafalala accommodated a diverse range of middle and low-income migrants from different origins that arrived to work in the city. These included largely Muslim ethnic groups from northern Mozambique and further up the Swahili coast, as well as workers from India and the British and French island colonies in the Indian Ocean. Mafalala became a hub of cultural and political activity that played an important role in the Mozambican liberation struggle against the Portuguese colonial rule. During this period, notable Pan-African artists, poets, and political leaders resided in the neighbourhood and influenced in the formation of the country and the national identity (Mottelson & Chilaule, 2018).

Figure 1.*Overview of Maputo. Credit: the authors.*

During the colonial period, use of 'permanent' construction materials were restricted for the black population. Reed (*canic*o), timber and corrugated iron sheets became the main materials for housing construction, along with hedges for demarcating plot boundaries (Andersen et al., 2015b, 2015a). Many notable corrugated iron sheet timber houses (*casas de madeira e zinco*) dating back to the early 20th century remain in the neighbourhood (Ribeiro & Rossa, 2016). After Independence, the urban development occurred without planning and haphazard occupation of common space and low-lying flood-prone areas ensued, along with prevalent street encroachment. In 1994, by the end of the civil war, the neighbourhood was characterized by narrow streets, unsafe water provision, decentralized untreated sanitation solutions, and no consistent solid waste scheme, leading to public health hazards. In the early 2000s the World Bank funded a "slum upgrading program" to address challenges linked to unregulated urban development, such as inadequate access conditions and limited infrastructure provision

(Jorge & Melo, 2014). Approximately 3.5 km of main streets were paved and 11.8 km drainage where implemented. Some houses had to be partially or completely demolished, but the project succeeded in improving accessibility, sanitary conditions, and storm water management. Nevertheless, critical challenges remain regarding accessibility, infrastructure provision, and haphazard urban development.

Today, Mafalala has approximately 18.000 inhabitants (Instituto Nacional de Estatística, 2019). The administrative area of the neighbourhood covers an area of approximately 0.84 km². However, local community perception of the neighbourhood boundaries and major roads demarcating the continuous urban fabric spatially includes an additional approximately 5000 inhabitants and 0.18 km², although this northern part of the settlement is a part of the adjacent Urbanização neighbourhood administratively. This study includes Mafalala and the adjacent part of Urbanização as the analysis emphasises the settlement structure rather than the administrative structure. During the civil war, a landfill in the northern part of the neighbourhood became populated and eventually transformed into the most economically disadvantaged area of the settlement. The urban fabric of Mafalala has limited rigid geometry of street and plot layouts and have thus largely emerged without urban planning. The urban form has a notable hierarchical structure of mobility systems, comprised of paved main streets with universal vehicular access and secondary unpaved alleys with moderate vehicular access. The built environment is characterized by largely single-storey single-family dwellings constructed with limited enforcement of planning and building regulations, although some larger apartment blocks have been constructed along the periphery of the neighbourhood, largely through formal processes. An overview of the neighbourhood and typical spatial characteristics are presented in Figure 2.

Figure 2. Left: Aerial view from Mafalala towards city centre. Right: Typical social life in street space of Mafalala. Credit: the authors.

METHODOLOGY

The present study seeks to identify urban deficiencies manifested in the physical environment of informal settlements using urban morphology techniques. The study utilizes high-resolution geospatial data to compute urban form metrics at block level and thereby pin-point areas with substandard conditions. The analysis relies on (1) high resolution geospatial surveys utilizing drones and photogrammetry software for automatic generation of a high-resolution orthomosaic; (2) manual delineation and integration of open data to label the orthomosaic and produce vectorized geospatial data of the main features of the neighbourhood using open source GIS software; (3) on-site qualitative field observations; (4) computation of urban form metrics using open source software, which provided the basis for identification of deficient urban form characteristics.

Field surveys and geospatial data

The geospatial survey was conducted using a DJI Mavic Pro 2 drone to systematically capture over 1000 vertical georeferenced images across the entire neighbourhood. These images were processed using cloud-based photogrammetry software (OpenDroneMap) to generate a high resolution orthomosaic (3.7 cm/pixel, later reduced to 5cm/pixel for data management purposes). The survey was authorized by the local neighbourhood administration and conducted in January 2019. The orthomosaic covers approximately 1 km^2 and provided the basis for manual tracing of key features of the urban environment. The orthomosaic was uploaded to OpenAerialMap (OAM) and made publicly available in the raster GeoTIFF format. The orthomosaic was exported to Java OpenStreetMap (JOSM) in which buildings, street network, and trees were traced. These features were uploaded to OpenStreetMap (OSM) and also made publicly available in vector formats in 2019-2020. In 2023, additional features were traced with open source GIS software (QGIS) on the basis of the same orthophoto for the purpose of this paper. This included public space and open drainage systems, which were integrated with the former features from OSM to produce the final dataset, including more than 9500 buildings, 38 km of street network, and 237 blocks. The orthomosaic and corresponding vectorized map are presented in in Figure 3 and 4. The study included on-site field surveys to integrate localized qualitative observations of the neighbourhood in the analysis of remotely sensed data. This included verification of the street network mapping and photographic documentation of key characteristics of the physical environment.

Measuring deficient urban form

Insufficient provision of basic infrastructure such as water, sewage, and drainage systems is an important challenge linked to informal urban development in sub-Saharan Africa (Satterthwaite et al., 2020). Such infrastructure is usually integrated into the layout of streets. Hence, limited public space and constrained access conditions challenge the provision of such infrastructure. Furthermore, constrained accessibility of garbage trucks, ambulances and fire trucks increase vulnerability of informal settlements due to restricted related service delivery. However, these services are limited in Maputo and local concerns regarding constrained accessibility relate to cars, hearses and trucks for transportation of construction materials. Dead-end streets are associated with reduced pedestrian permeability. On this background, the study includes metrics to measure accessibility and public space proportion to highlight compromised conditions for mobility, service delivery, and infrastructure provision. On this background, metrics such as restricted vehicular accessibility (RVA), number of dead-end-streets (NDS), and public space ratio (PSR) were included in the study. Open private space plays a crucial role for the social life of informal settlements in Maputo, as dwellings are often small, overcrowded, and of sub-standard quality. However, high level of building coverage and haphazard configuration of buildings can compromise the space use efficiency and thereby have negative consequences for the social life (Mottelson & Venerandi, 2020). On this basis, the study investigates the access to adequate private outdoor open space, and quantifies the proportion appropriate for social life using indicators such as, open private space ratio (OPR), social space ratio (SSR), and social space to private open space to ratio (SOS). A composite ranking across the six indicators was computed for each block to facilitate an overall comparison beyond individual indicators. This involved assigning a score of 0-10 for each indicator, with 10 indicating the least deficient urban form characteristics and 0 indicating the most deficient urban form characteristics in the settlement. The composite ranking for each block was computed by calculating the average rank of all six indicators per block.

Summary of the indicators and their methods of computation

- *Restricted Vehicular Accessibility* (RVA) was computed by applying a 1.75m interior offset fromcthe street space polygon, to highlight areas with streets narrower than 3.5m and identify blocks with limited and no vehicular accessibility.

- *Number of Dead-end Streets* (NDS) was computed by automatically placing a node on all street centrelines that ended in dangles, and summing the number of dead-end-streets entering each block, to highlight restricted pedestrian permeability.
- *Public Space Ratio* (PSR) was computed by tessellating the neighbourhood using the centrelines of the public space and measuring the area of the public space associated with each block. The public space ratio was computed by dividing public space area associated with each block by the area of each block, to highlight the proportion of public space associated with each block
- *Open private space ratio* (OPR) was computed by summing the non-built-up private space divided by the total block area, to highlight the proportion of open private space at block level.
- *Social Space Ratio* (SSR) was calculated by applying a 2.5m exterior offset from the building clayer, and then applying another 2.5m exterior offset to the resulting interior polygons. These were then clipped with the block layer to identify areas larger than 5 m wide and 25m² area, that can accommodate social life.
- *Social space to private open space ratio* (SOS) was computed by dividing the social space area with the private open space area, to highlight the proportion of open space that can accommodate social life.

RESULTS

A detailed section of the survey results is presented in Figure 3, highlighting manual delineation of the high resolution orthophoto, including labelling of buildings, streets, and blocks. The georeferenced orthomosaic generated using the drone survey aerial photos along with the corresponding vectorized map is presented in Figure 4. The urban form indicators computed at block level are presented in Figure 5. The results of the composite ranking are presented in Figure 6.

Figure 3. *Detailed section of geospatial survey outputs. Credit: the authors.*

Figure 4. *High-resolution orthophoto and vectorized map of Mafalala. Credit: the authors.*

Although much of the neighbourhood has vehicular access via the main streets that were expanded during the interventions in the early 2000s, many of the lanes in the remaining neighbourhood have restricted access for cars. Blocks with completely restricted vehicular access are generally located away from the main streets. Similarly, the blocks with lowest public space ratio are located away from the main streets. The public space ratio is generally low across the settlement and particularly in the northern part. Blocks with many dead-end streets entering the block are larger and often located in the settlement periphery. Blocks with limited open private space and private social space are generally smaller and located inside the settlement. Similarly, blocks with low private social space to private open space, indicative of inefficient building configuration, are mostly smaller and located inside the settlement. Concerning this metric, some blocks scored less than 0.5, indicating that more than half the open space is of limited value for social life. The composite ranking highlights a number of cluster of blocks that are largely characterized by restricted accessibility, inadequate public space,

limited open space, and inefficient building configuration. These are generally located away from main streets in clusters of smaller blocks. Notably, the largest of these clusters is located in the northern part of the settlement, which is incidentally also the most impoverished part of the neighbourhood where multiple other forms of sub-standard living conditions are present.

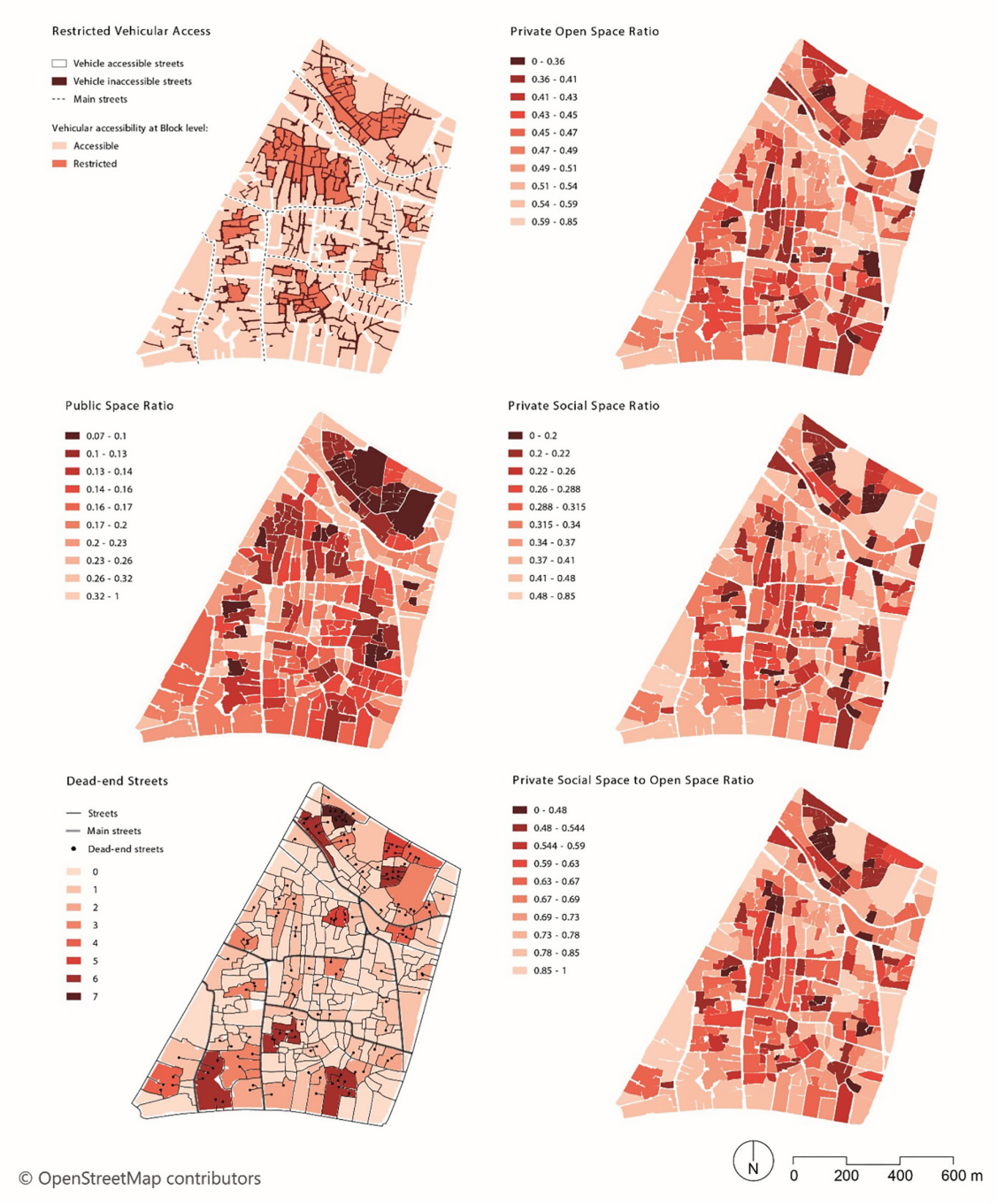

Figure 5. *Overview of outputs of computation of urban morphology indicators at block level. Credit: the authors.*

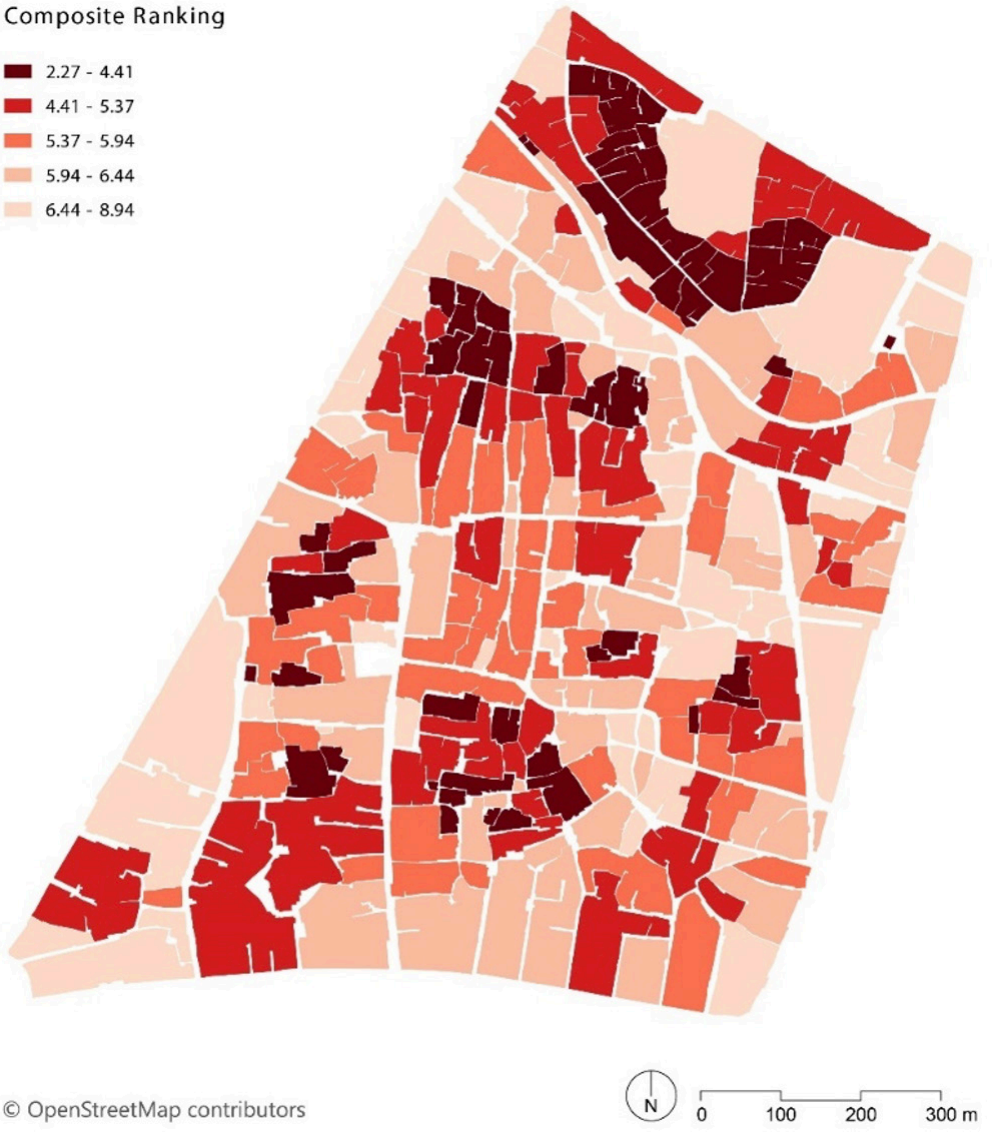

Figure 6. *Output of composite ranking of urban deficiencies. Credit: the authors.*

DISCUSSION

The results of the study provide detailed insights into the prevalence of undesirable spatial characteristics in Mafalala at block level, such as restricted vehicular accessibility, limited proportion of public space, lack of open private space, and inefficient building configuration. These findings provide a basis for wider discussions on use of urban morphology techniques for 'urban diagnostics', its application for guiding policy and urban planning interventions, and potentials for future related research.

The analysis highlights two main aspects of the settlement morphology, including the layout and distribution of streets and public space as well as the proportion and configuration of private open space. The composite ranking thus generally highlights areas that are characterized by both constrained accessibility and limited public space as well as low proportion of open private space and inefficient building configuration. Blocks with restricted accessibility and low proportion of public space are generally located away from the main streets. Blocks with inefficient building configuration and lack of open space are generally smaller and non-peripheral blocks. The composite ranking highlights that these conditions are clustered in groups of non-peripheral blocks located away from main streets. The relatively widespread dead-end streets and small blocks in the settlement indicate that the mobility system is inefficiently configured. In addition, the limited public space and widespread constrained accessibility further underscore a potential for structural readjustment, to increase accessibility, access to common spaces, and establish adequate street space to provide basic infrastructure. This may be achieved by conjoining smaller blocks, connecting dead-end streets of larger blocks, in situ expansion of narrow alleys, and establishment of public spaces. The low-density peripheral blocks with abundant open space currently used as parking lots may be used for construction of low-rise high-density housing for relocation of residents and retain their integration in the social fabric of the neighbourhood. In general, such structural adjustment interventions should arguably be carried out via a case-by-case assessment of the access system and built environment in dialogue with the residents and preserve the predominantly pedestrian character of the neighbourhood. The inefficient space use at block level and restricted accessibility are furthermore indicative of a need for capacity building of the local level administration to guide the 'auto-construction' in the neighbourhood and thereby mitigate inefficient settlement patterns, optimize the use of open space, and restrict street encroachment. Addressing issues concerning restricted accessibility, inadequate public space, and inefficient building configuration will typically require demolition and reconstruction of buildings. Such interventions are costly and may not be feasible, particularly concerning inefficient building configuration at block level. Consequently, identification of these conditions emphasizes the need for resource allocation towards capacity building, to gradually rectify these issues when old buildings are demolished as a part of the gradual urban development instead of guiding direct interventions.

The study highlights a number of limitations and potentials of using urban morphology techniques to identify physical characteristics of urban areas associated with sub-standard living conditions. While these techniques provide insights into the physical aspects of informal settlements, they do not highlight the full spectrum of challenges faced by residents. Many aspects of substandard living conditions, such as access to healthcare, education, and economic opportunities, are not directly related to the urban morphology. However, adequate street space is critical for basic infrastructure provision and urban morphology analysis can thus be used as a component of informal settlement interventions to improve livelihood. Accordingly, it is essential to complement related analyses with a broader assessment of social, economic, and environmental factors impacting the community.

The individual indicators, such as restricted vehicular accessibility and the presence of small blocks or dead-end streets are straightforward for municipal urban planners to identify. Accordingly, although the analysis of each indicator may appear banal, similar approaches can be adopted widely. The value of such approaches may lie in highlighting the presence of multiple interrelated factors and thereby identify particularly vulnerable specific areas. Interestingly, the area observed during field work as characterized by the most compromised living conditions qualitatively was also highlighted as the largest cluster of lowest performing blocks in the composite ranking, underscoring a potential of the model in terms of 'urban diagnostics'. However, critical questions remain regarding the application of such techniques for guiding interventions beyond merely documenting the need for street expansions and capacity building of local level authorities.

To advance this field of research and make it more relevant for policy and urban planning interventions, future studies may benefit from including household data, additional urban form metrics, and application of more robust statistical analysis. Future studies could broaden their scope by incorporating household data, encompassing socioeconomic status and factors that compromise livelihoods. Such research holds potential to enhance the knowledge of the interrelation between urban morphology and compromised livelihoods and thereby advance the relevance of related work. For example, substandard housing conditions are likely detectable based on remotely sensed data, which may be utilized to identify vulnerable households, particularly in the context of sub-Saharan Africa where data is scarce. Inclusion of additional urban form metrics indicative of compromised livelihood in related work, such as substandard housing conditions may thereby further advance the relevance of such research while application of statistical analysis may strengthen the validity of the findings.

While the focus of the present study has primarily centred on urban planning implications, the broader potential of this research may extend beyond the realm of urban design. By integrating urban morphology data with factors such as household socioeconomic status and substandard living conditions, related research may uncover valuable insights into the vulnerabilities of individual households. As substandard housing conditions are associated with compromised health outcomes (Tusting et al., 2020), identification of such conditions may support health interventions. Related research could thus advance identification of substandard housing conditions using remotely sensed data to assess health associated risks and subsequently inform targeted health interventions. Such approaches could be used to develop and implement health interventions that address the specific needs of individual households to mitigate health risks factors prevalent in informal settlements.

CONCLUSIONS

This study employed urban morphology techniques to identify undesirable spatial characteristics within the informal settlement of Mafalala in Maputo, Mozambique. Six key urban form indicators were computed at block level to identify areas with restricted vehicular accessibility, constrained pedestrian permeability, low proportions of public space, limited open private space, and inefficient building configuration. The findings reveal that such deficiencies are clustered, particularly in the impoverished northern part of the settlement. While this research underscores the potential of urban morphology for diagnosing urban deficiencies and informing urban planning, it also highlights

limitations in addressing broader livelihood issues. Future research discussed in the paper include integrating household data, exploring additional urban form metrics, and considering their application in public health interventions, thus contributing to more holistic and targeted policy development for informal settlements.

ACKNOWLEDGEMENTS

This study was made possible by contributions of the mapping community #MapeandoMeuBairro, the Mafalala based NGO's IVERCA and DAMBO, as well as a large group of Mafalala residents and university students attending Faculdade de Arquitectura e Planeamento Físico, Universidade Eduardo Mondlane (FAPF-UEM). The data collection was supported by HumanitarianOpenStreetMap Team (HOT). In particular, we thank Dirceu Matusse, Ivan Laranjeira, Gulamo Mose, Rebecca Firth, and Gustavo Ribeiro. The local authorities in KaMaxakeni deserve recognition for supporting and facilitating the fieldwork. The study used open map data copyrighted OpenStreetMap contributors from https://www.openstreetmap.org.

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Guidelines for sustainable land use of New Belgrade from perspective of urban morphology

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ABSTRACT

Given the fact that the morphological patterns of land use within super-blocks of New Belgrade were created during the period of non-market economy in Socialism, now it is possible to review the effect that the sociopolitical transition into Capitalism (which started in the 1990s) has had on its land use. Findings of this paper are based on the previously done research within the urban morphology scope, specifically on „3-steps Methodology" which was created as the combination of the typomorphology approach and the morphogenetic analysis in relation to land use of New Belgrade's residential super-blocks. Since the preliminary findings of the morphogenetic analysis of the area have revealed that dominant professional trend is no longer essential in shaping it but the impact of land policy driven by the transition of socioeconomic process in the country, and that nowadays there are negative trends of using the land in super-blocks in New Belgrade (almost 100% of the unbuilt soil in the newly developed super-blocks is covered /paved), focus will be on presentation of the final results of the research – specific „guidelines for the sustainable urban land use of importance for the morphological aspect of New Belgrade", which could be of help for management of its space nowadays.

Keywords: sustainable urban land use, urban morphology, typomorphology, morphogenesis, land policy, professional trend, modern residential communities, recommendations

INTRODUCTION

Research of New Belgrade's residential super-blocks within the urban morphology scope based on „3- steps Methodology" is already published (Gajić 2012; Gajić, 2015; Gajić, 2019) and in this paper the final results of the research are presented.

The example of New Belgrade is particularly interesting given the fact that the morphological patterns of land use within its super-blocks were created during the Socialism that ceased to exist in the 1990s, and now it is possible to review the effect that the socio-political transition into a capitalist society, had on its urban land use.

The conceptual path in making the New Belgrade was paved with the ideas of *Moderna*, in time-period between the World War I and the II (Blagojević, 2014). Construction has begun after the World War II in the communist/socialist system of Yugoslavia within the non-market-oriented economy, on an area between the historically independent cities of Zemun and Belgrade. New Belgrade spans on approx. 4074ha flood-prone and marchlands undeveloped land at the confluence of rivers Sava and Danube (Fig.1). Today, New Belgrade is a largest municipality of Belgrade, the Serbian Capital and it has 72 super-blocks with 39 of them predominantly residential and with the population of about 236 thousand.

Figure 1. Position of New Belgrade in the city of Belgrade (http://www.isocarp.net/data/case_studies/748.pdf)

After the introductory part with the explanation on basic terms and location description, theoretical framework and the methodology of the research will be presented followed by the short explanation on already published results (step one and two of the three steps methodology). Evaluation process and the final results - guidelines for sustainable urban land use of New Belgrade from perspective of urban morphology will be presented next. Lists of guidelines conclude the paper.

Sustainable urban land use – notion – definition

The use of urban land with the aim of sustainable development should form the basis of contemporary urban planning and urban design practice. Considering that land use in the city represents the projection of the complex urban socio-economic activities and land system of plots, based on opinions and definitions given in documents promoting sustainable development, the definition of the sustainable urban land use has been proposed:

*"Sustainable urban land use includes both urban and certain non-urban land uses and comprises a system organization within the developing and regulatory control forms from the viewpoint of ecological, economic, social and morphology aspects, by means of integrated approach, in a balanced manner to the greatest degree possible, so that the production capacities are not decreased, provide preservation of the natural environment quality, social equality, increased accessibility and achieve related parameters for maintaining quality life of people." (*Gajić, 2009: 155*)*

Urban morphology as the tool for urban land use study

In urban morphology analysis, land is included as a constitutive element – and become a link between individual elements (parcels and houses) and a wider urban context (Whitehand and Larkham, 1992; Đokić, 2007; Lloyd-Jones and Erickson, 2007). Almost every urbo-morphological study addressed the use of land in the studied area, be it through the method of occupation, travel patterns and/or through ownership status/patterns (Rofe, 1995; Cataldi *et al*., 2002; Hillier and Stuty, 2005; Hillier and Vaughan, 2007; Whitehand *et al*., 2009)

Djokic points out to the three principles of urban morphology studies: the principle of classification (based on the selected number of criteria), the principle of identity (with adjustment to each individual case, with a focus on socio-historical moment and intricate processes which caused the emergence of the pattern) and the principle of morphogenesis (with a focus on the series of space transformations through time). (Đokić, 2007).

These three principles are by means of diverse approaches/methods translated into practice, and for this research the significant were the typo-morphology and the morphogenesis (Lloyd-Jones and Erickson, 2007). (Whitehand and Larkham, 1992; Whitehand *et al*., 2009)

The methodology applied in the study leans on contemporary urbo-morphology approach: the synthesis of morphogenetic and typomorphological approaches, as suggested by Whitehand (Whitehand, 2001). The support in the creation of the methodology are also considerations that promote the importance of linking urban morphology and urban design with the goal "*to produce a better places, with the understanding of the form and functioning of the existing urban fabrics*." (Çalişkan and Marshall, 2011: 381)

THEORETICAL FRAMEWORK AND METHODOLOGY

Framework for sustainable urban land use analysis from the standpoint of urban morphology

By connecting criterion fields important for morphological aspect of land use and topics/issues of significance for sustainable development (within frame of morphological aspect of land use), analytical frame for sustainable urban land use from the viewpoint of urban morphology is created: 1/ surface within the context of the typology; 2/uses-activities within the context of accessibility; 3/changes that occur in distribution of uses through time; 4/elements of form built on the land through the aspect of sustainable buildings, and finally 5/interaction in urban space (those that have been caused by specific way of land occupancy) through public and private relation. (Gajić, 2009; Gajić, 2012). Result of the analysis relying on above framework represent an extensive database - a tool for planning urban land use with the sustainability as a goal in respect to the urban morphology point of view for (any of) the researched area. It represents the widest frame of criteria fields and topics for research.

"3-steps Methodology" – explanation

Table 1. METHODOLOGY – schematic overview
STEP 1 /sustainable development+urban land use/ from the best practice examples
/ the reference guidelines
_determin of general/reference guidelines for the sustainable use of urban land from the perspective of urban morphology for the specific case of residential community of European cities (which are built within idea of sustainability /"EU guidelines")
STEP 2 /urban morphology+urban land use
/ urbo-morphology study of typical case - defining the spatial units for further work
_determin of morphological typology of residential superblocks of the typical case (through typomorphology and morphogenesis approaches)
STEP 3 /evaluation + final guidelines
/ guidelines for typical case
_analysis of the present condition, evaluating the degree of compliance of the established types of residential superblock of the typical case with "EU guidelines" and determining "guidelines for the sustainable use of urban land from the perspective of urban morphology for residential superblock of the typical case."

Methodology for determin guidelines for the sustainable use of urban land from the perspective of urban morphology for the specific case of residential community includes three stages/steps (Tbl. 1.): 1/determin of general guidelines for the sustainable use of urban land from the perspective of urban morphology for the specific case of residential community of European cities (which are built within idea of sustainability /"EU guidelines"); 2/ determin of urbo-morphological typology and morphogenesis context of residential superblocks of New Belgrade (through typomorphology and morphogenetic approaches) and 3/analysis of the present condition, evaluating the degree of compliance of the established types of residential superblock of New Belgrade with "EU guidelines" and determining "guidelines for the sustainable use of urban land from the perspective of urban morphology for residential superblocks of New Belgrade."

Step 1 of the "3-steps Methodology", brief explanation (Gajić, 2012)

First step of the methodology aims to determine the existed "reference guidelines for the sustainable use of urban land from the perspective of urban morphology" for the specific case of residential community of European cities (which are built within idea of sustainability /"EU guidelines"). EU countries are selected as a reference since Serbia naturally belongs within that geographical and cultural realm and is in the process of joining the EU.

Following the „analytical frame for sustainable urban land use from the viewpoint of urban morphology", the guidelines are established by systematization of characteristics related to the use of land within three levels/scales: macro (residential community as a whole), meso (block/superblock) and micro (urban design). Each level is analysed from three viewpoints of space-time: surface/2D, buildings in space/3D and flows on the terrain/4D. (See Graphic overview, Fig. 2.)

Figure 2. *Graphic overview of the STEP 1 within "3-step Methodology"*

These guidelines can be used as reliable data when planning new housing units within the European cultural space and in Serbia can be especially important for understanding former and for planning future sustainable growth and development of residential superblocks of New Belgrade.

Step 2 of the "3-steps Methodology", brief explanation (Gajić, 2015)

Next step of the methodology is definition of the morphological typology of residential superblocks of the typical case (through typomorphology and morphogenesis approaches). In its essence it is the urbo-morphology study of typical case, aiming to define the spatial units and their characteristics, for further work.

Typomorphology analysis of the second step encompasses identification of the morphological types of land use (follow the classification against direct - visible effects of spatial use, concerning relations between land/2D, buildings/3D and flows on the terrain/4D). The matrix used for identification of the typology of land-use in the residential superblocks of New Belgrade is on Fig.3.

Morphogenetic analysis of the second step means: identification of common characteristics of, in the previous stage identified morphological types of land use, through a prism of genesis of space – through the analysis of the morphological consequences of land policy 'dictate' and the 'dictate' of, in the time actual, urban trend.

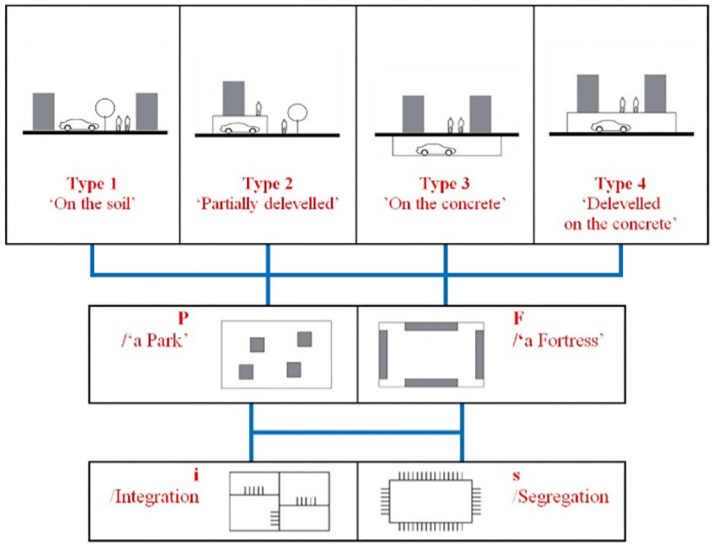


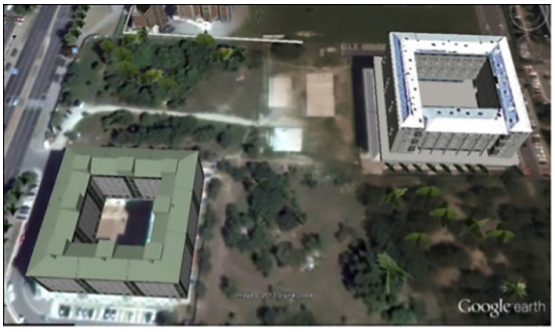
Figure 3: *The matrix for identification of the typology of land use in New Belgrade (Gajić, 2015)*

Overview of TYPOMORPHOLOGICAL ANALYSIS within STEP 2 – digest (Gajić, 2015)

Considering the morphology of the position of the buildings on the terrain, and traffic (cars-pedestrian) flows, data base with the typology of residential superblocks of New Belgrade was created: there are four main morphological types with subtypes relative to the positioning of objects on the ground, "fortress" and "park" and compared to the car/pedestrian flows," segregation" and "integration." (Fig.3).

1Fs_FORTRESS_ segregation (Google Earth)
TYPE 1 'On the ground' example

2Fs_ FORTRESS_ segregation (Google-Earth)
TYPE 2 'Partial delevelling' example



3Fs_FORTRESS_segregation (Google-Earth)
TYPE 3 'On the concrete' example

4Fs_FORTRESS_segregation (http://ilicd.tripod.com)
TYPE 4 'Delevelling on the concrete' example

Figure 4. *Four types of superblocks in New Belgrade NOTE: Only one example of every type (in the form of FORTRESS_segregation) is given; for detailed explanation and presentation of each type, see (Gajić, 2015)*

TYPE 1_'On the ground'

Main characteristics: Open structure superblocks, with the lamellas and skyscrapers in the open parks, approachable directly from the ground and from any side of the superblocks. Rich in greenery and great percentage of water-permeable soil. Presence: around two thirds (62%) of all super-blocks in New Belgrade

TYPE 2_'Partial delevelling'

Main characteristics: Considerable segregation between vehicular and pedestrian traffic in parts of superblocks, with wide areas of water-permeable soil in other parts of superblocks. Rich in greenery. Presence: about 20% out of the total.

TYPE 3_*'On the concrete'*

Main characteristics: With underground garages covering almost 100% of the superblock's land; pedestrian paths and space for leisure and children's playgrounds are on the roof of the garage, at the ground floor level. Almost without water-permeable soil. There is insignificant presence of greenery, exclusively in the containers on the garage roof. Presence: 10% out of the total.

TYPE 4 'Delevelling on the concrete'

Main characteristics: With the garages on the ground floor level and all pedestrian communication and space for leisure and children's playgrounds on the first-floor level - on the roof of the garage. Without water-permeable soil. There is insignificant presence of greenery, exclusively in the containers on the garage roof. Presence: 8% out of the total

/Overview of MORPHOGENETIC SYNTHESIS within STEP 2 - digest **(Gajić, 2019)**

The subject of the last phase of the second step is morphogenetic analysis/genesis of the area considering influence of land policy and prevailing urban trends, which were standard of the period when the certain urban fabric of New Belgrade's was built.

Synthesis map (Fig. 5) shows the spatial distribution of the superblock types and includes all other data as well (building heights, density of use, occupancy percentage, water permeability of the site surface, uses). The map is the basis for the identification of connections (by analyzing the morphological consequences of the land policy 'dictate' and the 'dictate', at the time actual trend in urban planning), with an attempt to identify the specific characteristics, development phases, and the 'spatial logic'.

Results of the morphogenetic synthesis are the identification of: 1/common characteristics of specific types; 2/development phases (with a chronological differentiation of what type belongs to what phase) and the 3/perspective of how they are connected in the space (in this specific research – it was interesting to find the prevalence of the urban trend influence over the land use policy influence).

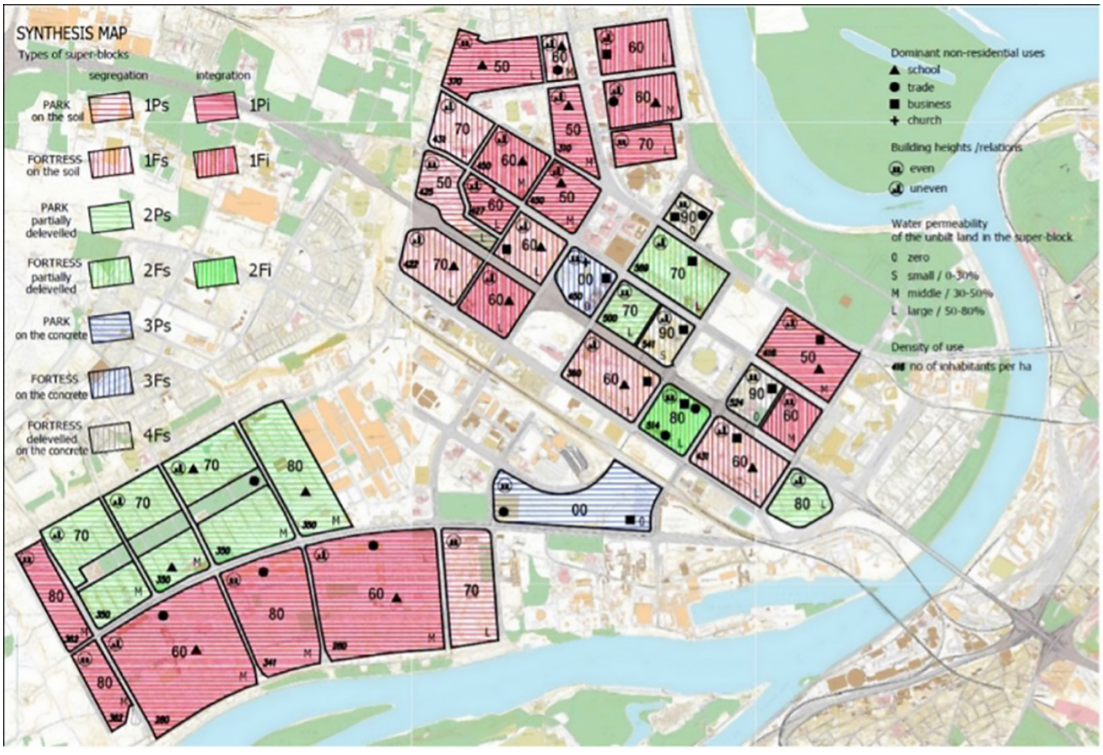


Figure 5. *Synthesis map with the time of construction (number in every super-block represents decade of the 20th century and "00"is the first decade of the 21st century)*

Findings on morphogenesis revealed that there are superblocks built with the dictate of dominant professional trend in the time:

//**Influence of Moderna – in the 1950s, and 1960s** with the predominantly superblocks 'Type 1" (Blagojević, 2004; 2014)

//**Influence of Symbolism and Progressivism – in the 1970s** with the predominantly superblocks "Type" 2. A need for innovation and desire to symbolically express the ideas, through the spatial image in line with global trends prevailing at the time (Venturi, Scott-Brown, Eisenhower 1977).

//Influence of the Postmodernism – in the 1980s presented also by superblocks type 2, but with more compact land use concept, more similar to the traditional core. The morphological approach to buildings and land-use structure clearly reveals the influence of *Post-modern*, through the positioning of 'streets' and 'squares' inside the block, bigger construction density, and smaller distance between buildings of same height. (Stojkov 1977).

//Influence of the partial/private interest – since the 1990s until today, with the superblocks type 3 and 4. The trend in spatial shaping of the superblocks has the out-of-date characteristics of postmodern or even back to symbolism ("a street, a square, creation of pseudo-traditional city block" /Ellin, 1999).

Since 1990s for the first time in the history of New Belgrade construction, the topics such as title issues and private investors are present. It could be concluded that dominant professional trend is no longer essential in shaping the residential construction (and related land use) in New Belgrade, but the impact of land policy driven by the transition process that affected all spheres of life.

STEP 3 OF THE "3-STEP METHODOLOGY" – part: evaluation

Evaluation – presentation of the procedure

The final, third step of the methodology encompasses:
//analysis of the present condition of the typical case (New Belgrade's superblocks, in this research) by evaluation of the degree of compliance with the "EU guidelines" and
//determining "guidelines for the sustainable use of urban land from the perspective of urban morphology for residential superblock of the typical case", as the final guidelines.
The present condition within several criteria for a typical case (New Belgrade' superblocks, in MACRO, MESO and MICRO scale) was assessed by categorization through a coefficient from 0 to 10 (analogous to the percentage of adaptability of the present condition for the application of a certain "EU guideline", divided by 100), on the following scale (Tbl. 2):

Table 2. *Grades for assessment of compliance of the present condition of a typical case to the „EU guidelines"*

10	(100% adaptability)	condition in accordance with the EU guidelines
8	(80% adaptability)	condition mostly in accordance with the EU guidelines
6	(60% adaptability)	condition partly in accordance with the EU guidelines
4	(40% adaptability)	condition partly not in accordance with the EU guidelines
2	(20% adaptability)	condition mostly not in accordance with the EU guidelines
0	(adjusment is impossible)	condition does not comply with the EU guidelines

Evaluation for any specific scale (MACRO, MESO, MICRO) was done by evaluation system adjusted for each concrete case/scale (depending on the number of criteria for assessment), while FINAL values for the whole, were determined in accordance with the following levels (Tbl. 3.):

Table 3. *Final values – evaluation of levels of the adjustment of a typical case to „EU guidelines"*

FIVE LEVELS FOR EVALUATION of any scale (MACRO, MESO, MICRO)	
condition is not in accordance with the EU guidelines	(0%)
condition is poorly aligned with EU guidelines	(adjusted up to 32%)
condition is moderately aligned with the EU guidelines	(adjusted up to 33-65%)
condition is of high quality compared to the EU guidelines	(adjusted up to 66-99%)
condition adjusted to EU guidelines	(100%)

Within the tables for analysis, when describing the present condition for each individual criteria it should be indicated the degree of adaptability for the implementation of EU guidelines of the observed situation. In the cases where exists opportunities for improvement, those opportunities should be described in the form of activities. These activities (potentials) serve to create guidelines, in this case, for New Belgrade, since by activating the potential, development is directed in the desired direction (of sustainable use of land).

Evaluation – process, results

Analysis of the degree/percentage of adaptation of MACRO, MESO and MICRO scale of New Belgrade's urban structure with "EU guidelines", followed with the comments on the potentials/activities for improvement, provided the basis for the evaluation and establishment of specific guidelines for New Belgrade.

MACRO level

By evaluation for the level of MACRO scale, compliance of urban fabric of the New Belgrade as a whole were assessed through a total of eight criteria: global matrix of the structure, dimensions of superblocks, orientires/sights, uses, accessibility, public domain, infrastructure and brownfield locations.

Results for MACRO level of urban structure of New Belgrade show intermediate level of compliance with "the EU guidelines" (65%) and that is on the upper limit to the quality assessment (which starts from 66%), which indicates that the activation of the potentials can rapidly lead to improvement.

MESO level

(NOTE: for explanation on superblock types see above, section „Overview of results of typomorphological analysis within STEP 2 – digest", Fig. 3 and Fig. 4.)

By evaluation for the level of MESO scale, compliance of four morphological types of land use of superblocks in New Belgrade were assessed through a total of seventeen criteria: different ways of

occupying the land, the matrix of the built structure, dimensional relations, buildings storeys, types of construction, underground construction, flows, accessibility of uses, relation between pedestrians and motorized traffic and the infrastructure for the superblock level.

Results for MESO level analysis shows that condition of land use from the viewpoint of urban morphology in superblocks TYPE 1 and TYPE 2 are of high quality compared to "EU guidelines" (specifically, 78% for TYPE 2 and 75% for TYPE 1), while the compliance with the "EU guidelines" within TYPE 3 and TYPE 4 is in moderation (39% for TYPE 4 and 42% for TYPE 3).

For superblocks TYPE 1 and TYPE 2, since their compliance is closer to the middle of the status of high quality adjustment to EU guidelines (which is 66-99%), it can be expected that they will maintain it, especially with the activation of their potential.

The results of compliance of TYPE 3 and TYPE 4 superblocks with EU guidelines are at a lower level of moderate status (which is 33-65%) and this indicates a tendency for poor adaptation in the future without proper maintenance, especially concerning the fact that these superblocks are newly constructed (after the 1990s), and it is not expected that they will be renewed or reconstructed soon.

MICRO level

By evaluation for the level of MICRO scale – urban design, compliance of four morphological types of land use of superblocks in New Belgrade were assessed through a total of eight criteria: heritage preservation, the quality of the space surrounding buildings, the presence of flora and fauna, the quality of urban furniture, ecological efficiency, safety, infrastructure and the topic of the introduction of urban farms.

With regard to the quality of urban design and the requirements set within the "European guidelines", it turns out that all four types of superblocks are poorly aligned.

Superblock TYPE 2 has the highest total score, at the upper limit, towards medium compliance (32%), so it is expected that this type will improve the fastest by applying suggested activities. With a small difference in the total, the estimate is slightly worse for TYPE 1 (about 30%), but even in this case, activating the potential can quickly lead to improvement.

For TYPE 3, however, although it seems that it could undergo a transformation in the same way as previous superblock types (percentage of compliance to the EU guidelines is 27%), by reviewing the table with the specific analysis of each individual criteria, it is clear that there are no real potentials since it would presuppose the reconstruction of the infrastructure and buildings with the aim of achieving environmental and energy efficiency; since TYPE 3 are a newly constructed superblocks (in the first decade of the twenty-first century), this is not likely.

TYPE 4 is on the verge of full non-compliance with EU guidelines for the MICRO level - urban design (percentage of compliance is only 5%); there also almost no potential for improvement, so, conclusion for this type of superblocks in New Belgrade (built during the 1990s), in relation to the criteria of urban design, is to avoid it.

STEP 3 OF THE "3-STEP METHODOLOGY" – part: final guidelines, explanation

To create final conclusions regarding the evaluation of the degree of adaptability to the "European guidelines" of the superblocks of New Belgrade, one must look at the sum of the coefficients/ per-

centages that were achieved for the MEZO scale - superblock's structure and the MICRO scale - urban design, for each of the four morphological types.

The poor condition of the urban design of the superblocks of New Belgrade in relation to the "EU guidelines" affects the overall, now worse result, of the previously well-positioned superblock types (1 and 2), which in total now are "moderately adjusted" (TYPE 1 about 60%; TYPE 2 around 63%), as well as TYPE 3, which is on the lower border towards bad (around 37%), while TYPE 4 is poorly aligned with the "EU guidelines" (around 28%).

The final results show that the superblocks that were built during the 70s and 80s with the concept of partial deleveling (TYPE 2, "partially delleveled" with significant segregation between pedestrian and car traffic, with underground garages in smaller parts of the superblocks and with water-permeable soil in larger parts), are closest to "EU guidelines" (around 63%). With about 60% compliance with "EU guidelines" are the TYPE 1 superblocks, "on the soil", that were built from the beginning of construction in New Belgrade, during the 50s and 60s and sporadically during the 70s and 80s, (with buildings, pedestrian and motorized traffics paths and spaces for leisure activities in open parks accessible directly from the ground, with considerable percentage of water-permeable soil). For both types (1. and 2.) there is significant potential for improvement towards sustainable development.

Residential superblocks built in the first decade of the twenty-first century on the territory of New Belgrade with underground garages and pedestrian paths on the ground floor, almost without water-permeable soil (TYPE 3, "on the concrete") has the result on the verge of poor compliance with "EU guidelines" (37%) and in relation to most of the criteria, there is no much potential for changes, and that's the same for superblocks built since the 1990s, with pedestrian platforms on the roofs of underground garages (TYPE 4, "delleveled, on the concrete"), which practically do not meet the recommendations for sustainable use of urban land from the viewpoint of urban morphology - only 28% is percentage of compliance with "EU guidelines".

GUIDELINES FOR SUSTAINABLE LAND USE OF NEW BELGRADE FROM PERSPECTIVE OF URBAN MORPHOLOGY

(NOTE: for explanation on superblock types see above, section „Overview of results of typomorphological analysis within STEP 2 – digest", Fig. 3 and Fig. 4.)

There is not much space left for new construction in the territory of New Belgrade, but what is certain is the renewal of the areas built there 60-70 years ago, so it is suggested that these ventures, especially reconstructions, be conducted bearing in mind the guidelines that are the result of this research.

For TYPE 1, guidelines are:

- to increase occupancy % in the "Fortress" subtype,
- to preserve water-permeable terrain in superblocks where their percentage is high and to change land cover in those where it is low, to meet the good standard of water-permeability,
- to rearrange "pedestrian – motor vehicles" traffic in order to meet the primary goals of segregation between cars and people within the superblocks,
- to reconstruct buildings in order to comply with ecological and energy efficiency standards,
- planning and setting up bicycle parking,
- to innovate the infrastructure,

- to raise the level of overall security within the blocks
- to introduce educational urban farms
- to introduce contemporary (humane) standards in the field of stray animal control (**this is a measure that applies to the whole city, but the problem is especially present in superblocks TYPE 1, since they are accessible, with a lot of free green spaces and this enable stray animals to make their habitats most often in them*).

For Type 2, guidelines are:

- to increase occupancy % in the subtype "Fortress" and "Park" segregation,
- to preserve water-permeable terrain in superblocks where their percentage is high and to change land cover in those where it is low, to meet the good standard of water-permeability,
- to reconstruct buildings in order to comply with ecological and energy efficiency standards,
- to construct ramps for bicycle access to pedestrian plateaus,
- to innovate the infrastructure,
- to raise the level of overall security within the blocks
- to introduce educational urban farms.

For Type 3, guidelines are:

- significantly reconstruct buildings and infrastructure with the aim to achieve environmental and energy efficiency

For type 4, guidelines are:

- there are no potential for change (recommendation is that this type of superblocks should never be represented in a significant percentage in any area)

CONCLUSION

Through a comparative analysis of the degree of flexibility of the structure of morphological types of New Belgrade's superblocks for application of normatively defined "EU guidelines" for sustainable urban land use of importance for urbo-morphological aspect, and by synthesis with conclusions of the morphogenetic approach, has been proven that the morphological matrix of land use within the superblock of New Belgrade from the period when it was the dominant influence of world global professional trend (chronologically before nineties of twentieth century) have more potential for sustainable development – they are adaptable for implementation of the guidelines of sustainable urban land use from the perspective of urban morphology in relation to the morphological matrix of land use that have built influenced by land policy of the transition period (partial interest, since the nineties of the twentieth century to the present).

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Preservation and Transformation of Modern Socialist Residential Building Heritage of China: Exemplified by Beijing Baiwanzhuang Neighborhood and Shanghai Caoyang No.1 Estate for Workers

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ABSTRACT

The contradiction between preservation and transformation has always been a critical theme in the field of heritage conservation, particularly evident in modern residential heritage, especially within the context of China. On one hand, due to economic constraints in the past few decades, the construction standards of such heritage buildings were relatively low. The living conditions no longer meet the needs of current local residents. The residents' desire for improved living conditions clashes with the imperative to preserve the material remnants, placing them in a dilemma between preservation and transformation. On the other hand, as a result of economic development and urban expansion, the economic location of residential heritage has undergone significant changes. The low-density development pattern is in contradiction with the economic location of the high land price, leading to strong pressures for renovation and renewal. Residential heritages are not easily categorized as landmark heritage projects imbued with specific political or cultural significance. In the contemporary development of urbanization in China, their survival is in an extremely delicate position.

This study selects Baiwanzhuang Neighbourhood in Beijing and Caoyang No.1 Estate in Shanghai to conduct a comparative study. Baiwanzhuang Neighbourhood and Caoyang No.1 Estate are emblematic examples of modern residential heritage in New China, representing crucial material legacies under the great historical process of China's socialist practice. The study will first briefly trace the morphological process of Baiwanzhuang Neighbourhood and Caoyang No.1 Estate, identifying their heritage preservation value. Then, the study will pay particular attention to the comparative analysis of preservation and transformation measures taken by the two modern residential heritages, engaging in a deep reflection on the relationship between preservation and transformation from a morphological perspective.

Keywords: Modern Residential Heritage; Preservation; Transformation; Urban Morphology; Chinese Socialist Practice

INTRODUCTION

The contradiction between preservation and transformation has always been a critical issue in the field of heritage. In different periods, regions, and for different types of heritage, there are varying choices that reflect people's understanding of heritage value and subjective judgments. This reflects the differences in planning concepts and value orientations under different historical, social, econom-

ic, and cultural backgrounds. The contradiction between preservation and transformation is even more prominent in modern residential heritage. Modern residential heritage not only reflects the human construction experience, cultural customs, and socio-economic characteristics of historical periods, but also records the lives of urban residents during the process of social change. It is an important type of urban heritage, containing profound historical, economic, cultural, and social connotations. However, the characteristics of modern residential heritage in terms of function, historical significance, and material remnants present planners with more profound dilemmas of preservation and transformation in practice. The specific reasons are as follows:

(1) Particularity of function: Modern residential heritage continues to bear a significant practical function in real life – that of habitation. Consequently, a conflict arises between the preservation of heritage authenticity and integrity, and the ongoing enhancement and development of the residential environment. Protection of modern residential heritage cannot be pursued at the cost of sacrificing the quality of life for its inhabitants. Therefore, protecting this type of heritage cannot be approached in the same manner as other heritage types, using an all-encompassing static preservation approach. Instead, it necessitates a detailed analysis of the heritage site, leading to the removal and improvement of elements that do not align with modern living needs, and protection, restoration and reinforcement of the positive aspects and core manifestations of its heritage value. This enables modern residential heritage to be not only protected as historical heritage in a sustainable manner, but also to adapt to and support new living requirements comprehensively, thereby realizing its functional value in the city.

(2) Insufficient awareness, recognition, and consensus on heritage value: A scientific understanding of heritage value is a crucial prerequisite for its proper preservation. On the one hand, the longer the age and the sparser the material remains, the easier it is for people to recognize their value. However, for material remains from historical periods closer to us, their value is often not fully appreciated and can lead to less consensus on heritage value. On the other hand, heritage value is often more readily recognized for landmark public buildings with specific political and cultural significance. In contrast, "ordinary" residential buildings are frequently overlooked and face the threats of renewal and demolition. In the context of China, modern residential heritages are mainly consisted of residential areas constructed after the establishment of the People's Republic of China. These residential buildings are formed during the period of socialist exploration and practice in the 1950s and 1960s. The typical residential areas of the period represent China's exploration in housing construction, reflecting a brand-new political, economic, cultural, and social process. The heritage value of these areas deserves a deeper understanding and more attention.

(3) Poor material remains: Compared to other rare, politically and culturally significant landmark buildings, residential heritage has undergone multiple regeneration and replacements to meet the evolving needs of modern living. Most residential areas are changeable and fragile, with only a small amount of material remains. Therefore, identifying the heritage value solely based on the material remains will inevitably lead to inaccuracies and omissions in understanding their historical and societal significance.

Urban Morphology is the study of how urban form is originated and developed. In the dilemma of protection and transformation of modern residential heritage, urban morphology can contribute to the three aforementioned issues:

(1) First of all, urban morphology studies the transformation processes and patterns of urban form from an evolutionary and retrospective perspective. It involves an assessment of historical and geographical facts, serving as the foundation and basis for conducting significant value judgments on the remnants of history and geography—referred to as heritage. Tracing the formation and evolution of

residential areas in China after 1949 enables a better understanding of the spatial reflection and remnants of that historical period. As a result, a more scientific identification of the heritage value can be achieved. Additionally, urban morphology focuses not only on landmark buildings but also encompasses the overall urban spatial composition that includes “ordinary” areas. Therefore, it provides a methodological approach to studying the formation processes and heritage value identification of residential areas that are often overlooked.

(2) Urban morphology provides detailed methods for dissecting and analyzing heritage sites to formulate more precise practical strategies. Spatial resolution is a crucial concept in urban morphology, involving the hierarchical subdivision of material space at different resolutions. This allows the elements requiring preservation and transformation at heritage sites to be mapped onto specific levels within the morphological structure. As a result, broad and general preservation and transformation issues become decomposable, refined, and operationally feasible in practice.

(3) A scientific understanding of the heritage value of modern residential areas cannot be based merely on the remains in stages of decline and/or renewal, but on a comprehensive study of the entire evolution process. Urban morphology emphasizes an evolutionary perspective to trace the formation of urban landscapes. Urban morphology, as a methodological approach that identifies heritage and its value through morphological processes, provides systematic guidance for grasping the authenticity and integrity of heritage, offering a concrete methodology for analyzing the evolution of urban landscapes to assess heritage value.

In conclusion, regarding the issue of preserving and transforming of modern residential heritage, the study of urban morphology holds significant academic and practical value.

This research selects Baiwanzhuang Neighborhood in Beijing and Caoyang No.1 Estate in Shanghai, China as case studies. Although representing different types of residential areas in China, both of them are typical modern residential heritage sites of PRC. They are important remains of China’s great historical process of socialist practice. In the 1950s and 1960s, both were synonymous with superior housing and social status. However, these model residences have fallen into disrepair. After being designated as heritage sites, they lost the opportunity for housing improvement brought by urban renewal. Residents were left behind in this wave of social change. Despite highly similar historical backgrounds, these two cases have taken different approaches to preservation and transformation, leading to distinct fates. Therefore, studying these two cases can reveal the commonalities of such residential heritage sites and comparing them can uncover some breakthroughs in the challenges of preservation and transformation.

The second chapter is methodology. Conzenian morphological approach is used to analyze the morphological processes of Baiwanzhuang Neighborhood and Caoyang No.1 Estate. Also, by integrating he morphological hierarchical framework proposed by Conzen and Karl Kropf, the study analyzes the preservation and transformation of modern residential heritage from the perspective of spatial resolution. The third and fourth chapters respectively delve into case analyses of Baiwanzhuang Neighborhood and Caoyang No.1 Estate, including morphological processes, identification of heritage value, analysis of modern living needs, and preservation and renewal strategies. The fifth chapter is a comparative analysis that focuses on measures, results and reasons of the two under the dilemma of protection and transformation. Lastly, the sixth chapter presents the conclusion and discussion.

METHODOLOGY

Urban Morphology of Conzenian School

Conzenian School origins from landscape studies in German geography. Conzen adopted a historical and evolutionary perspective, believing urban landscapes as cumulative records of economic, social, and cultural histories, which emphasizes the interpretation of the processes and mechanisms of urban landscape formation and evolution, reflecting distinct characteristics of historical geography. In this study, the Conzenian school's theory of urban morphology is employed as the fundamental method for analysing and interpreting morphological processes.

In terms of the structure of urban landscapes, Conzen employed a tripartite division, categorizing urban landscapes into town plan, land use pattern, and building fabric. Town plan is further subdivided into street systems, plot patterns, and building patterns.

Morphological Hierarchy Levels of Karl Kropf

Karl Kropf established the system of morphological hierarchy based on his critique and integration of the morphological definitions and morphological hierarchies of Conzen and Caniggia. Kropf argues that both Conzen's and Caniggia's theories have the problem of mixing material space and function to varying degrees, whereas he seeks to analyse the material space objectively and purely, Therefore, Kropf proposed his morphological hierarchy system based on the strict "part-whole" grouping relationship between levels, which is divided into nine levels (Table 1).

Table 1. *Morphological hierarchy system of Karl Kropf*

Rank Number	Rank Name	Latin Name of Rank
1	Combinations of Objects of the Level Sedes	Complures
2	Combinations of Plan-units	Sedes
3	Tissues/Plan-units	Textus
4	Plot Series/Blocks/Streets	Sertum
5	Plots	Fines
6	Buildings	Aedes
7	Rooms	Tectum
8	Structural Elements	Statio
9	Building Materials	Materia

Morphological Hierarchy Levels Integrated from M.R.G. Conzen and Karl Kropf

Kropf aimed to provide a purer interpretation of material space by focusing solely on the physical aspects and disregarding analysis on functions. However, the functional dimension is indispensable for the description, explanation, and practical implementation of urban form. Therefore, this study integrates the research of both Conzen and Kropf, utilizing the morphological hierarchy levels depicted in the diagram below for conducting case analyses. It's important to note that the division of hierarchies is not intended to create a systematic and precise distinction, but simply an analytical method

to make things clearer. There exist close connections among the components. For instance, building pattern and building fabric offer two perspectives for analyzing buildings and their combinations in the city from the perspective of two-dimensional and three-dimensional, the whole and the internal structure, but the two are not completely separated. The change of the building's block-plan will affect the building fabric, and the change of the building fabric may also affect the building's block-plan.

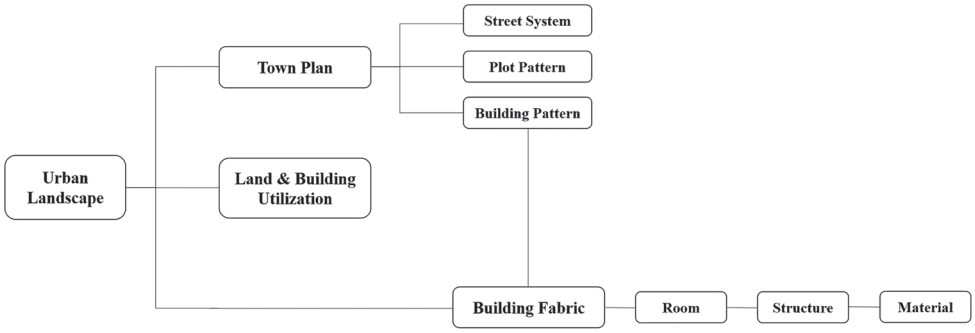

Figure 1. *Morphological Hierarchy Levels Integrated from M.R.G. Conzen and Karl Krop*

CASE STUDY: BAIWANZHUANG NEIGHBORHOOD

Overview

Baiwanzhuang Neighbourhood is located in the west of the old city of Beijing. In the early 1950s, the government initiated the construction of government departments and institutions, including the "Four Ministries and One Commission". Baiwanzhuang Neighbourhood began to be built in 1953 as the supporting housing for the government departments and institutions, and was fully completed in 1956. Baiwanzhuang Neighbourhood is the earliest independently designed residential area in the PRC, representing the exploration and practice of China's residential planning and design after the founding of PRC. Baiwanzhuang Neighbourhood is a milestone in China's residential design and planning, and therefore has the title of "the first residential area of the PRC", and was listed in the "Second Batch of China's 20th Century Residential Areas" in 2017, and in 2019, it was listed as one of Beijing's historical buildings.

Morphological Process Analysis and Heritage Value Identification

Baiwanzhuang Neighborhood has gone through three main morphological periods, namely the initial construction phase (early 1950s to late 1950s), the repletion phase (late 1950s to late 1980s) and the decline phase (after the early 1990s).

Figure 2. *Satellite map of Baiwanzhuang Neighbourhood in 2023 (Source of base image: Google Earth)*

Initial Construction Phase (early 1950s to late 1950s)

Baiwanzhuang Neighborhood was built in 1953, with the design concept of "Neighborhood Unit", divided into nine residential clusters of "Zi, Chou, Yin, Mao, Chen, Si, Wu, Wei, Shen", showing strong symmetry and sense of order. *Shen District* is located on the central axis of Baiwanzhuang Neighborhood, serving as the residential area for senior officials, with office buildings distributed along the street in the north. In terms of architectural style, residences in *Shen District* are two-story north-south oriented row houses with sloped roofs., while residences in remaining 8 clusters are three-storey buildings. In addition, the residential layout and architectural details adopt the pattern that looks like the Chinese character "回"(pronounced Hui), including the improvement of "single perimeter" to "double perimeter" in the organization of buildings, and decorating doors, windows and staircase handrails with "Hui-Character" pattern.

Repletion Phase (late 1950s to late 1980s)

In this stage, Baiwanzhuang Neighborhood continued to replete. On the one hand, the number of bungalows increased as the work shed area in the centre of the neighbourhood continued to develop. On the other hand, the Tangshan Earthquake in 1976 affected Beijing, and "earthquake-resistant sheds" appeared in the open space. In the latter stage of the Cultural Revolution, spontaneous additions in the open space of the residential area intensified, either by building bungalows or by directly using the earthquake-resistant sheds for reinforcement and renovation, resulting in disharmony in the residential landscape.

Decline Phase (after the early 1990s)

Spontaneous additions dominated repletion after the 1990s, with most extensions found in the backyards of the initial buildings, serving as utility rooms or additional living spaces. Many residences have also added fences at their fronts, and the stacking of items and the placement of ornaments have become common forms of this enclosure movement. Residents carried out a series of spontaneous redevelopment to improve the quality of living, including replacing windows, installing security grids, opening holes in walls, replacing wall bricks, etc., which greatly weakened the integrity Baiwanzhuang Neighborhood's landscape. The uncontrolled spontaneous extensions and depreciation

of the houses led to a sharp decline in the quality of both the physical landscape and the practical functions of Baiwanzhuang Neighborhood.

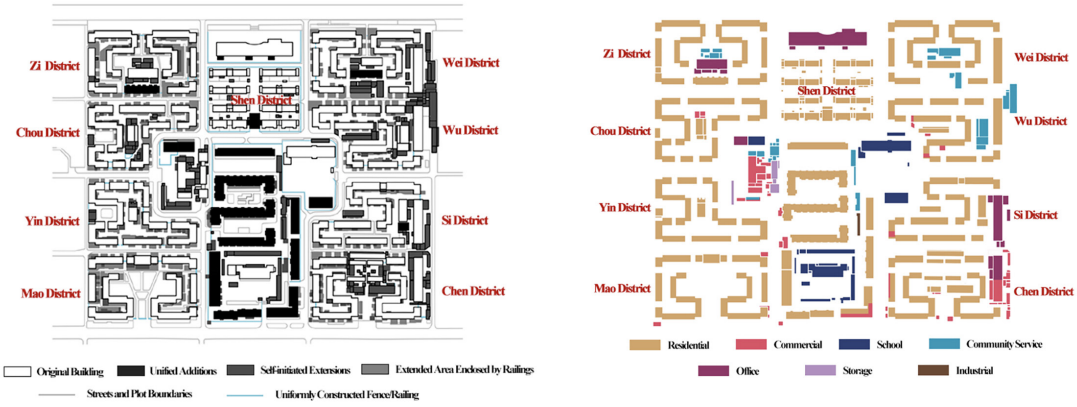

Figure 3. *Baiwanzhuang Neighbourhood Building Extensions Types and Functional Types (Source: Huang)*

Based on the above analyses, its heritage value can be summarized as follows:

(1) It is a typical example of the "*national form, socialist content*" of the residential construction ideology in the early exploration stage of Chinese socialism, and it is a unique material witness to the exploration of design of residential areas at the beginning of the founding of the PRC.

(2) The pioneer and important representative of the standardized design of housing in the early exploratory stage of Chinese socialism, providing an example of the economic and social policy of "production before living" and large-scale economic and rapid construction in the early stage of China's socialist construction.

Problems and Needs of Modern Living

Baiwanzhuang Neighborhood is no longer able to meet modern living needs due to low building standards and depreciation, which can be summarized into three points:

(1) A large number of buildings and infrastructures are aging, with great health and safety hazards: poorly insulated windows, thin walls, aging pipes, outdated plumbing, heating and electricity infrastructures, and damage to the roofs.
(2) Numerous mosquitoes and insects in all seasons: due to the random stacking of debris and the clogging of underground pipes, the sanitary environment is poor, resulting in the breeding of mosquitoes and insects in all seasons.
(3) Serious problems of "enclosure" and damage to public space: self-oriented construction and random stacking of debris, and arbitrary parking in the courtyard and along the roads.

Analysis of Protection and Transformation Measures

After being listed as a historic building in Beijing in 2019, Baiwanzhuang Neighborhood has been

plunged into a deeper dilemma of protection and transformation. Being listed as a historic building has completely destroyed the possibility of demolition and relocation of Baiwanzhuang Neighborhood. The authorities haven't made sufficient efforts in identifying the core heritage values of Baiwanzhuang Neighborhood, leaving inhabitants in a state of confusion. On the one hand, there is a lack of financial support for the systematic renewal of Baiwanzhuang Neighborhood, which makes it impossible to increase the value of Baiwanzhuang Neighborhood. On the other hand, due to the lack of clarity on the heritage values and conservation management measures, there is no clear constraint on the spontaneous renovation of Baiwanzhuang Neighborhood by the residents. The confusion caused a negative impact on the conservation of heritage and the improvement of living conditions in the neighbourhoods. This confusion is also clearly reflected in the material form of Baiwanzhuang Neighborhood: Figure 4 shows the two gates of the entrance to the unit, the red wooden door is a product of the 1950s and 1960s, which can no longer meet the needs of modern living, but is preserved due to the potential need for protection, while the blue iron door is a later extension, which plays a role in practical security. The co-existence of the two doors is a material reflection of the dilemma of conservation and transformation, heritage value and practical value.

Figure 4. Two Types of Entry Gates of Units in Baiwanzhuang Neighborhood
(The text on the door pictured on the left reads: "Strongly opposed to unauthorized removal of building gates, public property must be preserved! Destruction of public property must be held legally responsible!!" The text on the door on the right includes: "Please take care of public facilities ..... application for repairing this door is not easy".)

CASE STUDY: CAOYANG NO.1 ESTATE

Overview

Caoyang No.1 Estate is the earliest residential area constructed in Caoyang New Estates, which is located in Putuo District, Shanghai, and is the earliest and largest workers' estate in Shanghai. Caoyang New Estates consists of 9 separate clusters, of which Caoyang No.1 Estate actually constructed 1,002 workers' residences. Caoyang No.1 Estate is the most completely preserved remnant of a workers' new estate in terms of material remains, which was listed as a modern historical building in Shanghai in 2005. Caoyang New Estates, as a whole, are closely interconnected among its various sections. However, the majority of buildings from the No.2 Estate to No.9 Estate have undergone multiple rounds of renovation and transformation. In contrast, Caoyang No.1 Estate has preserved the rela-

tively complete material remains and has been listed as a modern historical building for protection. Hence, this paper primarily focuses on Caoyang No.1 Estate as the main research subject, while also analysing the entire Caoyang New Estates to provide supplementary contextual information.

Figure 5. *Satellite map of Caoyang New Estates in 2023 (Source of base image: Google Earth)*

Morphological Process Analysis and Heritage Value Identification

The morphological process of Caoyang New Estates is closely related to China's economic and social processes. The major morphological phases are as follow:

(1) Socialist exploration stage (1951-1962): the Putuo District, where Caoyang New Estates is located, is one of the important old industrial districts in Shanghai. In 1951, in order to cooperate with the development of industrial production, combined with the financial and economic situation of China at that time, the construction of industrial buildings was carried out. the construction of Caoyang No.1 Estate was started in 1951, and it was completed in 1952. The second phase of the project followed, with Caoyang No.1 Estate as the centre of expansion, and the second, third, fourth, fifth, sixth, seventh and eighth villages were completed between 1953 and 1958, adopting the idea of "neighbourhood units" and setting up various public buildings within the residential area.

(2) Cultural Revolution (1963-1978): During this period, the residential construction of Caoyang New Estates was basically at a standstill, with only a few new constructions (including Cao Yang Nine Villages, which was completed in 1977) and additions to the already constructed buildings.

(3) The period of reform and opening up (after 1978): after 1978, under the impetus of the housing

policy reform, welfare housing transitioned to commercial housing, and housing marketisation was fully implemented after 1998. During this period, in addition to the reconstruction and expansion of the new village housing, some of the housing was demolished and replaced by new commercialised residential areas, and new public and commercial buildings appeared accordingly. As a result, a "mosaic" urban fabric was formed throughout the area, with three differentiated types of neighbourhoods existing simultaneously: the first was the new workers' villages built in the 1950s, the second was the new public housing built after the 1980s, and the third was the new high-rise flats built after the 1990s.

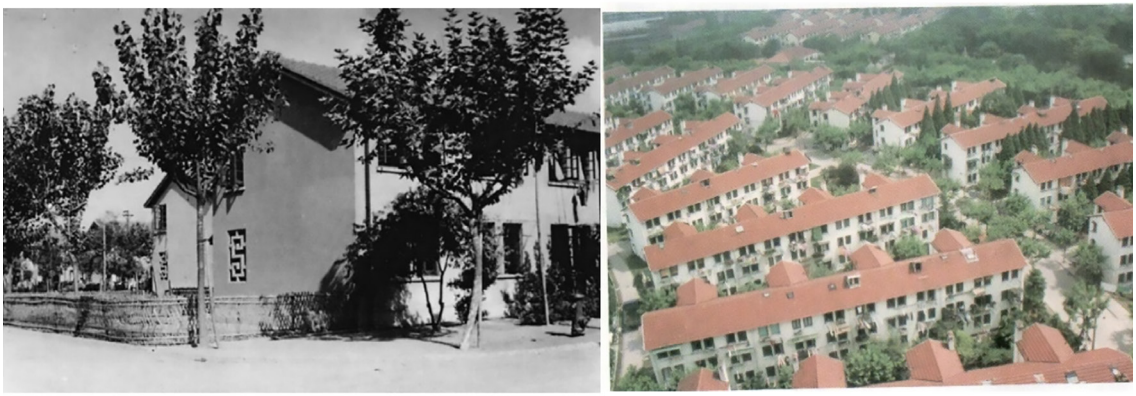

Figure 6. *Images of Caoyang No.1 Estate before renewal and reconstruction (Source: Internet)*

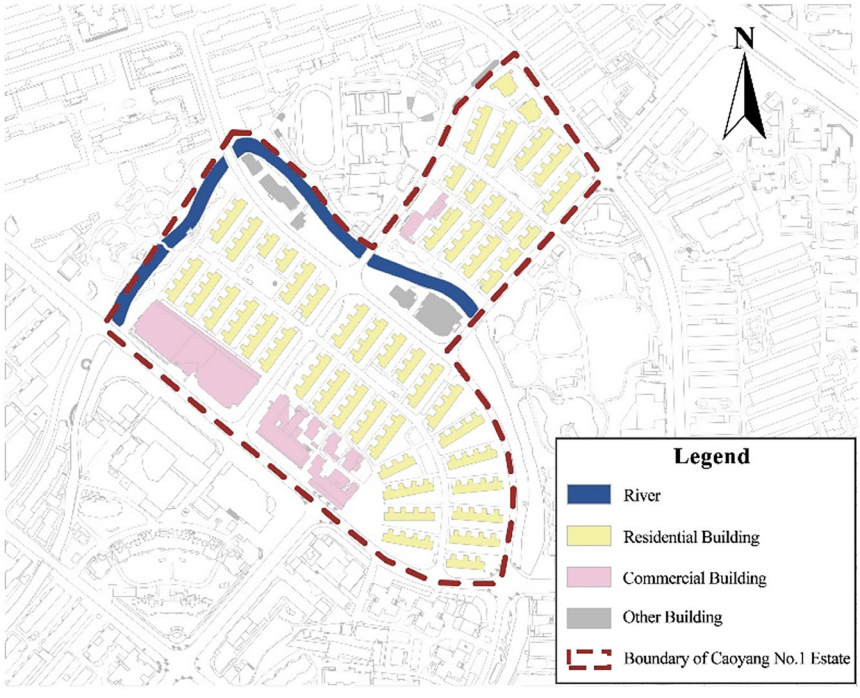

Figure 7. *Town plan of Caoyang No.1 Estate*

The morphological process of Caoyang No.1 Estate records the history of China's socialist exploration and economic and social changes, and retains relatively complete material remains. Its heritage value can be summarized as follows:

(1) Caoyang No.1 Estate is the earliest and best preserved workers' estate in Shanghai, and has become a model for the construction of workers' estates in Shanghai and even in China, and it is the only well-preserved material remnant of workers' estates in China in the 1950s and 1960s.

(2) Its town plan has remained relatively stable, which is a product of the socialist exploration and "production first, living later" in the early years of the establishment of PRC, and a material witness to the idea of welfare workers' housing planning under China's planned economy policy, and a model of housing standardisation.

(3) It is the material carrier of Shanghai's socialist workers' culture and collective cohesion in the early stages of socialist construction, carrying collective memory and the spirit of place, which is epochally, historically and culturally significant.

Problems and Needs of Modern Living

The problems and needs of modern living in Caoyang No.1 Estate can be summarized into three points:

(1) Small living space: As of 2010, the per capita living space in Caoyang No.1 Estate was less than 6 square metres, far below the average per capita living space in Putuo District (16 square metres) and Shanghai (17.5 square metres).

(2) Inconvenience caused by shared kitchens and toilets: the residential layout of Caoyang No.1 Estate is a three-family sharing kitchen and toilets, with no bathrooms, Until 2010, 86.7% of the residents in Caoyang No. 1 Estate still shared kitchens and bathrooms (compared to only 4.2% in Shanghai).

(3) Low construction standards and declining building quality: The design standards in the 1950s were generally low, and after more than 60 years of intensive use, the houses and equipment have experienced serious aging, including damages to wooden staircases, doors and windows, water seepage in bathrooms and toilets, roof leakage, and poor acoustic and thermal insulation properties of wall and floor materials.

Analysis of Protection and Transformation Measures

Compared to Baiwanzhuang Neighborhood, Caoyang No.1 Estate has adopted a more proactive strategy of "preservation-oriented regeneration" carrying out on-site reconstruction, which can be analysed in two parts.

Firstly, in terms of renovation, the focus is on addressing the residents' housing difficulties. The renewal strategy primarily involves modifications to the internal structure and building materials. Firstly, the outer wall of the northern interior courtyard is expanded by 2.65 meters. Secondly, changes are made to the staircase layout within the residential buildings. The original "straight-line" staircase is transformed into a "zigzag" pattern, incorporating resting platforms. While maintaining the original layout of one staircase serving three households, each household has gained an average of 4 square meters of additional area. Moreover, each household now features independent kitchen and

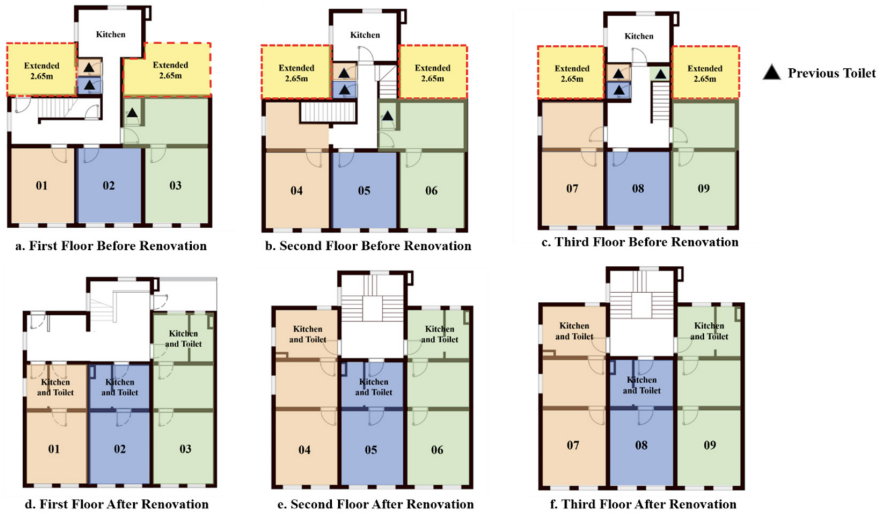

Figure 8. *Diagram of the preservation-oriented regeneration strategy in Caoyang No.1 Estate*

bathroom. The specific details of these renovations are depicted in Figure 8. Thirdly, there has been a replacement of building materials, with a focus on the replacement of wooden materials, as well as the reconstruction of building roofs.

The second aspect is focused on preservation, aiming to restore the original appearance of the buildings and retain collective memories. Firstly, the decorative elements with carved patterns in the original staircase area are preserved, and the same carved pattern design is applied to the air conditioning brackets. Secondly, the exterior facade is recreated using materials and colors that are identical in appearance. For instance, although the window materials have been changed from wood to glass-aluminum alloy, they are still made in the same style with a purplish-red imitation wood grain

Figure 9. *Caoyang No.1 Estate after renovation*

hollow pattern. Thirdly, illegal constructions and improvised windows have been removed to ensure uniformity and consistency of the facade. Lastly, in public spaces, collective memories are reshaped or even deliberately emphasized. The most prominent example is the restoration of the original red five-star gate.

COMPARATIVE ANALYSIS OF BAIWANZHUANG NEIGHBORHOOD AND CAOYANG NO.1 ESTATE

Based on the above analysis, Baiwanzhuang Neighborhood and Caoyang No.1 Estate share a high degree of similarity in terms of their morphological evolution and historical context, and were listed as heritage almost at the same time. However, Caoyang No.1 Estate has managed to explore a path that reconciles this conflict between preservation and transformation, basically solving the three living problems mentioned in the previous section on the premise of preserving. Baiwanzhuang Neighborhood, on the other hand, remains deeply entangled in the dilemma of preservation and transformation and lacks unified efforts, undermining both the preservation value and the utility value. Through comparative analysis, we can shed light on the challenges of preserving and transforming modern residential heritage.

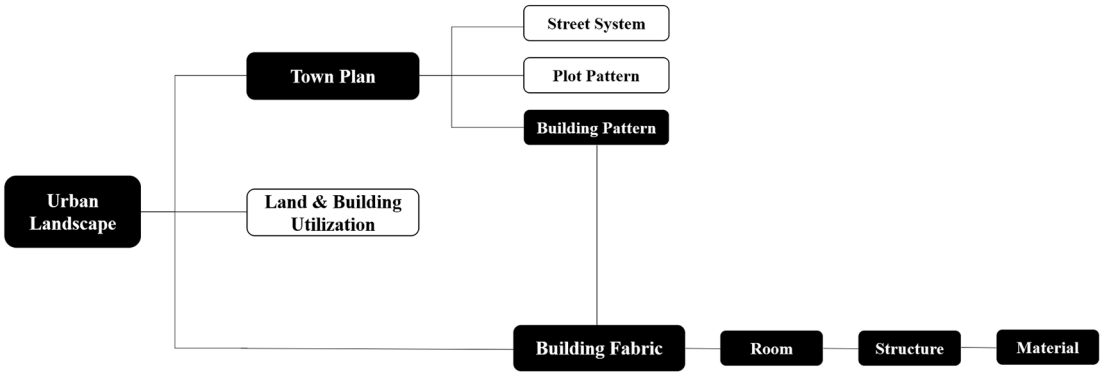

Figure 10. *Morphological analysis of restoration and protection strategy of Caoyang No.1 Estate*

Firstly, in terms of specific measures, Caoyang No.1 Estate corresponds conservation needs and utility needs to specific morphological hierarchies respectively, so as to identify the contents of preservation and restoration. Here the strategy is analyzed according to the morphological hierarchy levels.

According to the previous analysis, Caoyang No.1 Estate's living problems and needs are mainly concentrated in the *building fabric* and lower levels, specifically, the small living area and the sharing of kitchen and bathroom are mainly problems at the *room* level, the low building standard and the declining quality are mainly problems at the *structure* and *material* levels. Therefore, it endeavours to reconcile protection and transformation at these levels: (1) At the *material* level, materials that

better meet the needs of modern living were used, and the exterior was made to look like the original materials. (2) At the *structure* level, doors, windows, roofs, walls, etc. were repaired and modified, and efforts were made to maintain the original appearance. (3) At the *room* level, the division of the stairwells and rooms were changed, while minimising changes to the original room layout. (4) The above measures together constitute the changes at the *building fabric* level. (5) At the *building pattern* level, it was difficult to achieve a significant expansion in living area by simply changing the division rooms, so an extension of 2.65 metres to the north elevation was used, resulting in changes to the individual building's block-plan. (6) Streets, plots and land use patterns, as important carriers of heritage value, have had less impact on residential demand and have remained largely unchanged.

In contrast, Baiwanzhuang Neighborhood has only been classified as a historical building and protected in its entirety. Due to the lack of a systematic and precise strategy, most of the changes have been carried out spontaneously. On the one hand, the morphological changes happened mainly in the lower levels, with *material* and *structure* as the main focus. Such changes are uncontrolled and result in a variety of outcomes, thus destroying the consistency of the landscape. On the other hand, due to the limited ability of individuals to promote morphological changes at the upper levels, it is difficult to address their housing problems fundamentally. As a result, both the conservation and utility values of Baiwanzhuang Neighborhood are hurt.

However, the differences in specific measures are only superficial, regional and hierarchical differences are the fundamental causes of the differences, with the differences in property rights and interest relations being the essential cause. The property rights of Baiwanzhuang Neighborhood have two characteristics. Firstly, the property rights of Baiwanzhuang Neighborhood originally belonged to the central government, and after the housing reform, they still belonged to the central ministries and commissions, so even though the building was built on Beijing's land, the property rights do not belong to Beijing. Secondly, Baiwanzhuang Neighborhood was originally owned by eight central ministries. Due to the subsequent restructuring and merging of departments and numerous transfers of property rights, Baiwanzhuang Neighborhood now has unclear property rights and responsibilities, so there is a lack of powerful administrative and financial support to promote the unified renewal. In contrast, the property right of Caoyang No.1 Estate was simpler in comparison.

CONCLUSION AND DISCUSSION

The comparative analysis of Baiwanzhuang Neighborhood and Caoyang No.1 Estate carried out using morphological methods has profound insights into the issues of preservation and transformation of the modern residential heritage, which are summarised here as follows:

Firstly, urban morphology is of great significance for the identification of heritage value of modern residential heritage. The heritage value of townscape is formed and accumulated in its evolution process. Townscape is the material carrier of economic and social changes, containing historical information and collective memory. The methodology of the Conzenian School can describe and explain how townscape evolves, so as to understand the heritage value in a relatively complete and systematic way.

Secondly, as heritage values are relative, preservation will inevitably involve some trade-offs, which are more evident in modern residential heritage. People select and refine heritage values based on their own perceptions, and this choice will be reflected in the practical strategies. What is retained, what is removed and what is strengthened in practice is an objective reflection of subjective judgements on heritage values.

Thirdly, by analysing the morphological hierarchies of heritage sites, it is possible to target the conflicts between conservation and transformation over specific morphological levels, so that specific strategies can be chosen to reconcile the conflict at different resolutions. Of course, it should be pointed out that the division of the townscape into hierarchies is an idealised analytical perspective, not for a systematic and precise distinction, and this analysis is only a way to deconstruct the contradiction between conservation and transformation, making it more operational in practice.

Fourthly, while the identification and selection of heritage values are essential technical steps, socio-economic relations and agents' structure are the dominant forces. The subjective value judgements and choices of the agents, which are dominated by socio-economic relations, are decisive. Therefore, a more in-depth analysis of the agent and agency is needed, which is the direction of the follow-up efforts of this study.

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Bratislava ring road: new life for the 100 years old idea. Contribution of morphological research to contemporary urban planning of the Slovak capital

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ABSTRACT

The ring boulevard is a characteristic element of the urban structure that strongly determines the parameter of movements or flows. The growth in the intensity of movements formed in the 18th century the impulse to remove city fortifications and hence the first creation of a spatial framing of an outer boulevard of many European cities. However, despite many series of concepts, such a ring has never been realized in Bratislava. The question of a ring road was first discussed at the turn of the 19th century. Its spatial form was clearly defined in the regulation plan designed by architect Antal Palóczi (1917), but his proposal was never officially approved and forgotten after the disintegration of the Habsburg monarchy. After WWII, the idea of a boulevard was replaced by a concept of inner highway, which led to the demolition of many historical buildings. Therefore, the significant part of the criticism after 1989 was directed towards the impact of the transport and the original idea of the ring remained completely abandoned. The presented research is therefore focused on the identification of spatial, formal and operational features of the planned ring, as well as on the mechanism of the persistence of key ideas – the phenomenon of 'unintentional continuity'. These findings were recently also responded to by the city's management. In 2019, an international architectural-urban competition to redesign part of the ring was launched and the city representatives are currently working on the examination of specific urban solutions of its western and northern sections.

Keywords: ring road, boulevard, urban history, urban planning, Bratislava

INTRODUCTION

Bratislava's ring or inner city circle has an ambivalent character. Its course, spatial form as well as its functioning have varied from the end of the 18th century to the present day. These transformations have taken place in a fragmented manner, to such an extent that the idea of the ring has gradually disappeared from the memory of the city and from professional discussion. Only in recent years has the phenomenon of the Bratislava ring come to the fore. The results of our research into the history of Bratislava's planning and construction have contributed significantly to this. In the process

of research, we have identified a typology of urban situations that characterize the urban structure of Bratislava. One of the situations was the inner city circle. Its current form is not the result of the application of a single plan, but the result of the partial implementation of several plans, while even its current form cannot be considered final.

Staromestská Street is currently considered to be the biggest urban-spatial problem of the Bratislava ring. It was created in the 1970s in connection with the construction of a new bridge over the Danube, when one of the city's main transport corridors was excavated on the border between the historic core and Castle Hill. This change in the original morphology of the terrain has since then been attributed to the radicalism of post-war urbanism following a modernist paradigm of dealing with the city. Therefore, after 1989, Staromestská Street was perceived as a legacy of the authoritarian communist regime. In an attempt to deal with this legacy, proposals began to emerge for overlaying, embedding or otherwise modifying this road. The extremely sensitive public perception of this place and its one-sided stereotypical interpretation by experts was one of the motivations for a deeper architectural-historiographic reflection on this territory.

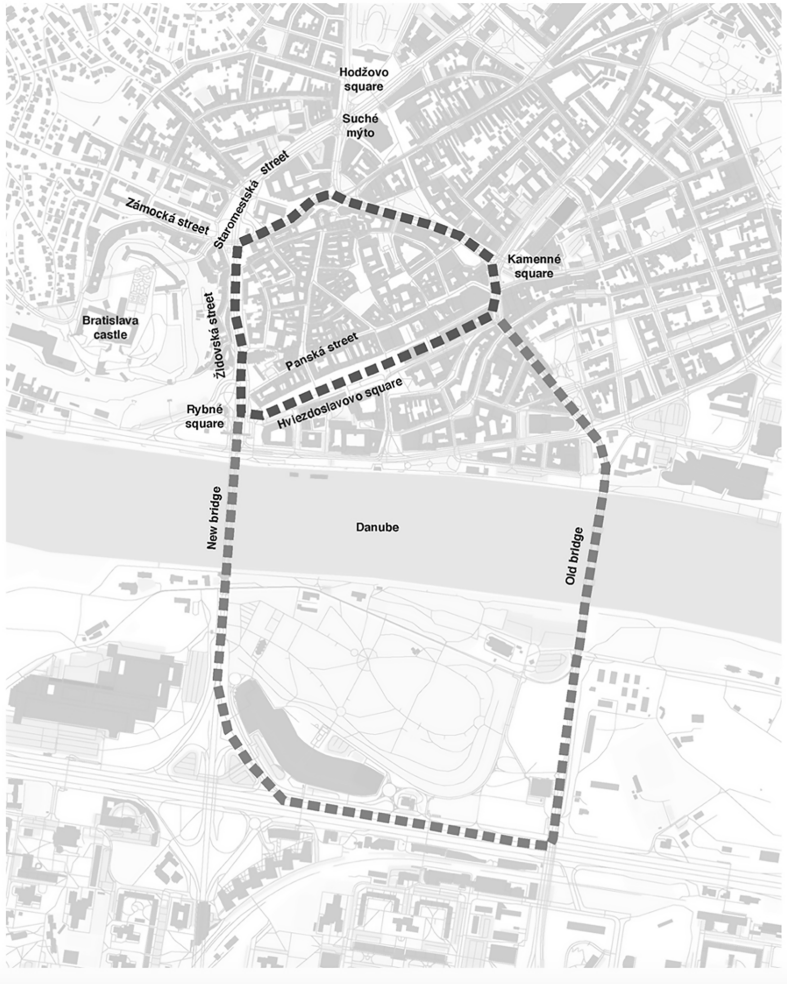

Figure 1. *Map of Bratislava with an indication of the original course of the city walls (inner ring road) and a later planned circle, connecting old town with Petržalka district. Credit: Department of Architecture IH SAS*

METHODOLOGY

The basic starting point for research into the history of modern planning and construction in Bratislava was provided by older works in the fields of general history, architectural history, geography and ethnology. This included not only scholarly publications, but mainly contributions from the contemporary daily press, source documents in the form of minutes from meetings of the city council, the city's regulatory commission and other contemporary texts. Equally important were period graphic materials, such as historical maps, regulatory drawings and urban plans, as well as period photographs depicting the appearance of the urban structure in different historical periods. In the process of interpreting the planned and actual development of the urban structure, we used not only traditional textual interpretation, but also contemporary 3D rendering and animation technologies, which make it possible to present the complex processes of the city's transformation in a more comprehensible and attractive way. In our research, we therefore applied a methodological approach that represented a hybrid combination of architectural, urban and architectural-historical qualitative research methods and current display tools of architecture and urbanism. In order to better understand the relationship between the planned and realized construction of the city and the mechanism of its transformation, we confronted the factual knowledge about the history of planning and construction with the visualization of planned and realized interventions in the urban fabric.

At the same time, this method allowed us to identify, name, abstract and then visualize the key features of the city's urban morphology and its transformations over the last hundred years. In addition to standard archival research, this meant digitizing dozens of historical drawings and constructing 2D and 3D models of both realized and unrealized interventions in the urban fabric. We used modelling in Autocad, Archicad and Sketchup, with axonometry or isometrics as the basic display tool. To identify the differences between the planned and realized development, we used 2D and 3D model layering, drawings in the historical cadastral map of the city and collage. In the case of unpreserved or only partially preserved regulatory plans from the period of the Austro-Hungarian monarchy, on the contrary, we managed to reconstruct and display the planned regulatory interventions in their graphic form on the basis of textual descriptions in the period press using the above-mentioned hybrid method. Periodisation, i.e. the depiction of selected places of the urban structure at the time of their most significant historical turning points, also played an important role in the construction of the visual narrative.

RESULTS AND DISCUSSIONS

The origin and shaping of the inner city circle

The first prerequisite for the creation of the inner city ring in Bratislava was the construction regulation on the territory of the city fortifications. In the second half of the 18th century, the Habsburg Empress Maria Theresa ordered the demolition of the inner walls and the filling in of the city moat. At the same time, she commissioned the architect Franz Anton Hillebrandt (1719-1797), head of the Vienna court building office, to draw up a plan for unifying the inner city with the suburbs and to lay out new streets in the resulting area. Hillebrandt proposed that most of the area of the original city moat should be subdivided and developed. At the beginning of the 19th century, Bratislava thus had the ideal spatial conditions for the creation of a representative circular city street.

However, the complete removal of the walls never took place. This caused construction on other areas of the ring to develop in an evolutionary manner, and building on almost the entire perimeter of the ring prevented the potential widening of roads. The unmanageable traffic situation in the historic core and the need to regulate new construction in the suburbs was one of the main reasons, which led the City Council in 1898 to commission a plan for the regulation and expansion of the city. The first regulation plan of the late 19th century, prepared by the city's engineering department, proposed mainly the widening of existing roads in the Ring area. Victor Bernárdt's proposal worked with the idea of an inner city ring more concretely. He proposed to run the inner ring in the form of a large, 37-metre wide avenue, which was to be connected by a bridge over the Danube at the exact location of today's Staromestská Street. The ring road was to be lined with green undeveloped areas. However, neither of these plans was accepted. Therefore, in 1907 the City Council commissioned the renowned Budapest architect and urban planner Antal Palóczi (1849-1927) to prepare a new regulatory plan for the city. Palóczi, however, no longer envisaged a circular street in the line of the city walls, but planned it as a looser circle leading from the main station for 13 km back to the main station. He proposed to connect the circular street with two new bridges to the right bank of the river. However, even his plan was not approved by the city council in the end. Nevertheless, Palóczi's idea of an inner ring influenced at least the regulation of new construction on the Danube embankment, where several important public investments were made in the early 20th century.

The first opportunity to implement the plan to extend the western part of the inner ring road came after the devastating fire of the lower settlement of the castle hill called Podhradie in 1913. At that time, a proposal for the regulation of Židovská Street was quickly made in accordance with Palóczi's plan. The town council approved the document in July 1914. However, the widening of the street and the fully opening of the inner ring road did not take place. This was mainly due to finances, which did not allow the city to buy the land needed for the street widening.

After the collapse of the Austro-Hungarian monarchy and the establishment of Czechoslovakia, the new representation of the city, the architects and the regulatory commission were critical of the spatial planning documents of the previous period. However, the question of the city ring road was still relevant. The first inter-war regulatory studies of Bratislava, prepared in 1920-1926 by the Czech architects Alois Balán and Jiří Grossmann, envisaged the preservation of the inner ring in the footprint of the fortifications. They also proposed a major extension of Židosvská Street on the western side of the ring. In 1929, the city announced an international competition for a regulatory plan of Bratislava. However, the competition proposals did not address the question of the inner ring and left the buildings in the historic city centre unchanged. There were, however, partial construction regulations in the northern part of the ring. This stabilised the northern, eastern and southern parts of the inner ring road.

However, the western part of the ring road in the line of Židovská Street still remained unsolved. There were tensions arising from the conflict between the protection of historical monuments and the increasing demands of traffic. In early 1931, the State Department for the Protection of Monuments initiated the preparation of a regulatory and development plan for the area around the Cathedral and Židovská Street. In this connection, the city's Regulatory Advisory Board commissioned the Regulatory and Roads Department to draw up the basic framework of future regulation in the form of the regulation lines and the road level of Židovská Street. The conditions imposed by the City were surprisingly radical. They envisaged widening the street to 16 metres in the stretch from Dlhá Street (now Panská Street) to Suché Mýto and its potential connection to today's Hodžovo Square. Even the narrowest parts of the street were not to be less than 10 metres wide. The proposal for the

regulation of Židovská Street, which was prepared by the city's regulatory department, was approved by the city council in June 1932. The regulation envisaged the construction of residential, tenement, commercial or office buildings or other public buildings in this area, which was to confirm the importance of the ring road as a multifunctional urban space. The dimensions of the new Židovská Street corresponded to this. The eastern edge of the street was to be widened in three sections at intervals of between 4 and 6.8 metres. The western edge of the street was to be widened just as radically. Here, the regulation line was shifted at intervals ranging from 4 to 16 metres. Interestingly, the proposal identified only three buildings as protected monuments, the St. Martin's Cathedral, the House of the Good Shepherd (Mikulášska 1) and the so-called Blue House (Beblavého 1). The height of the building on Židovská Street was set at 17 metres. The proposed street profile included a roadway rising from Rybné Square to Kapucínska Street, flanked on both sides by pedestrian walkways, while stair arms were integrated within the sidewalk on the western edge of the road, at the confluence of Mikulášská and Beblavého Streets, to overcome the height difference. In parallel with the regulation of Židovská Street in the section between the Cathedral and Kapucinska Street, the regulation department also worked on the design of its continuation towards Hodžovo Square. The new, 16-metre wide, street was to be created by widening the then Kölcseyho (now Pilárikova) and cutting its continuation crosswise through the block between Konventná, Veterná and Župné Square, and then joining it with the easternmost part of Konventná at the outlet to Hodžovo Square. This regulatory change was approved by the city council in August 1932. Although there was no major redevelopment of Židovská Street and its surroundings, a number of new buildings were implemented in accordance with the new regulations. However, the overall intention of completing the western part of the inner ring road could not be realised at that time. The reasons were again finance and lack of legislation. In the absence of an expropriation law, the municipality was unable to purchase the land needed to widen the street. This is probably why the city's transport experts gradually gave up on the idea of an inner city ring road.

The widening of Židovská Street and its extension to Hodžovo Square finally began to be realised after the Second World War, while the concept of the inner city ring road was increasingly reduced to a traffic corridor. Initially, it was again a question of using the area in the footprint of the original fortifications, as proposed in the regulatory plans at the beginning of the 20th century. In the first approved post-war directional plan from 1956, which was prepared under the guidance of the urban planner Milan Hladký, the inner ring road followed the footprint of the fortifications, connected to the New Bridge in the extension of Židovská Street and crossed the Petržalka side of the river to the Old Bridge. "The creation of a circular broad avenue around the central city area with the incorporation of radial arterials" was considered the most traffic-friendly solution at the end of the 1950s. (Alexy, 1958)

The individual parts of the circle were also specified in terms of their predominant function. SNP Square was to continue to be shaped by public services, Šafárikovo, Rybné or Mierovo Square, on the contrary, was to be determined by transport. This categorisation, together with the functional division of the town, was also key in the elaboration of more detailed development proposals. Extensive demolition of the existing buildings was also envisaged, especially in the western part of the area around Židovská Street and Rybné Square, but also in the north around Kamenné Square. This idea was also taken up in the following directional land-use plans of the city approved in 1966 and in 1976. Bratislava's inner ring road was thus programmatically fragmented into sections determined by different functional purposes and traffic characteristics. Prioritising the connection between the city centre and the new satellite centre on the right bank of the river also played an important role. This was reflected in the enlargement of the perimeter of the ring road, in the change of its course and form. The circle was to be evenly spread out over the river, with its northern part continuing to be

made up of the historic street network, while its southern part was to consist of a section of the new city avenue that started at the outlet of the Old Bridge on the right bank of the river, passed through the Centre Zone in the Petržalka area in the line of today's expressway, and ended at the connection to the new bridge, which was planned to be in the same position as it had been designed for it at the beginning of the 20th century.

The fact that the construction of the bridge was mainly influenced by the requirement to ensure a smooth traffic flow is also illustrated by the choice of its design. The winning competition design of a steel-concrete bridge (Milan Beňuška, Tomáš Braun, Ivan Hyža, Róbert Lamprecht) was not realised, but a steel bridge significantly raised above the terrain, which came fourth in the competition (Jozef Lacko, Ladislav Kušnír, Ivan Slameň, Arpád Tesár, 1967-1972). It enabled faster assembly and more generously met the needs of traffic flow. However, its connection to the city radials required a more radical intervention into the original terrain. In connection with its construction, the buildings on the eastern edge of Židovská Street were completely removed. The road was extended up to the city wall and into the immediate vicinity of the Cathedral. Massive removal of buildings also took place on the western side of the street. The level of the road was also fundamentally changed. The western part of the road was left in its original profile and is called Židovská Street. The eastern part was deepened and named Staromestská. Originally a ten-metre wide city street with three-metre wide sidewalks on each side, it has been transformed into a 25-metre wide traffic corridor running on two levels.

Rethinking movement preferences on the inner city ring road

At the same time, however, the idea of a representative social function of this part of the inner circle emerged. In the section between Staromestská, Suchý mýto and Župné Square, a series of representative public buildings were planned. The buildings of the Ministry of Culture, the Ministry of Justice and the Supreme Court, as well as a new international hotel were to be built here. The complex of buildings was to close the city block that had been disturbed by the construction of Staromestska Street. In the end, however, only the building of the Supreme Court and the Ministry of Justice (Vladimír Dedeček, 1977-1989) in the western part of the block was realised. The consolidation of the block structure occurred gradually in the following decades.

Parallel to this, pedestrian movement and the issue of pedestrian zones in the historic core of the city began to be addressed. The prominent Czechoslovak urban planner Emanuel Hruška (1906-1989) and his students tested the possibility of modifying the traffic in such a way as to exclude cars from the southern part of Hviezdoslav Square (in the place of the former city moat) and part of the embankment. This plan was only partially realised at the end of the 20th century by restricting traffic on several sections of the oldest line of the inner city ring road. These considerations also affected the western part of the inner city ring road. The interrupted natural pedestrian movement between the historic city and Podhradie was to be compensated by three off-street connections (a footbridge between the city walls and Židovská Street, a pedestrian walkway located on the overpass connecting Kapucínská Street and Zámocká Street and a pedestrian underpass implemented in the extension of Zochova Street) and one pedestrian walkway running at ground level in the part where Staromestská Street rises towards the bridge, connecting Rybné Square with one of Podhradie's original districts, Vydrica. With the same intention of preserving the pedestrian movement along the walls, a pedestrian route was implemented directly at the top of the city fortification wall. At the same time, this area was also used for cultural events. All these plans simultaneously made the idea of the original ring as a continuous circular urban space more ambiguous and reinforced its fragmentation into functionally and spatially isolated parts.

The currently valid city master plan describes this area as the inner traffic circle and, together with the adjacent nodal spaces of the main radial routes, characterises it as the most important area of the city. However, in the draft urban concept of the spatial layout of the city, no attention is paid to the course, the form of construction or the functional purpose of the inner ring road. Only the fundamental importance of the compositional axes that form the city's radial routes, or the nodes through which these radial routes connect to the ring road, is mentioned. The plan proposes to complete these 'nodal spaces' with public facilities and multifunctional city-forming structures. The 2015 city traffic master plan confirms the splitting of the inner city ring road into a "pedestrian" ring road passing through the line of the historic fortification, which is reserved for pedestrians, cyclists and, in some part, for the tram line, and a traffic circle passing through Staromestská, Štefánikova, Šancová, Legionárska, Karadžičova, Dostojevského rad, Vajanského nábrežie and Rázusovo nábrežie, which is reserved for car traffic.

The two mentioned planning documents agree in their perception and interpretation of almost the entire inner city circle. However, they think differently about the section of the ring that leads from the Danube embankment to Hodžovo Square and is today represented de facto by two parallel roads, Židovská Street and Staromestská Street. As we have shown in the analysis of the historical development, the ambivalence of views on this part of the inner ring comes from the very nature of this urban space, its ambiguous physical form, a pedestrian road with limited car traffic and a 4-lane expressway leading from the SNP Bridge to the underpass at Hodžovo Square. These two different types of movement in terms of intensity, character and speed also generate two basic approaches to the future design of this part of the ring road. Both approaches argue for the prioritisation of pedestrian movement over motor traffic and the need to connect two important historical entities - the Old Town and Podhradie.

Two ways of current thinking about the inner circle

After our research on the history of Bratislava planning focused on the Bratislava ring, this phenomenon also took its place in the professional discussion. The establishment of the Metropolitan Institute of Bratislava (MIB) in 2019 contributed in no small part to this. At this specialized institution, considerations on the conceptual regulation of the city's construction and public spaces have once again begun to develop. A certain counterpart to the MIB is the Faculty of Architecture and Design, where a new generation of urban planners is developing participatory and other soft approaches to city planning. Both of these institutions have recently begun to address the issue of the city ring. In 2020, MIB organised a competition for the architectural and spatial design of the northern part of the ring in the section of the SNP Square and Kamenné Square. Currently, both departments are working on the western part of the inner city ring.

The MIB conception considers the inner city ring road as a historically determined urban space that has been deformed over the last century by the modernist idea of inner city expressways. In this conception, Staromestská Street is a "scar" on the body of the city, which has been "traumatising" its inhabitants and visitors for a long time. In the light of such thinking, the aim is to reconnect the city with Podhradie and the castle and its grounds. The traffic corridor running in the lower level of this part of the ring road is not considered as an integral part of the ring road, but rather as an urban radial that only complements the ring road. In line with this idea, it is then necessary to keep this traffic corridor fully functional but eliminate the collision points of crossing pedestrian and vehicular traffic. Such an approach could be seen as a continuation of the modernist vision of the segregation of dif-

ferent types of movement, which has been applied in the area so far in the form of their out-of-level routing. According to the current conception, which was commissioned by the municipality and its analytical part prepared by MIB, a part of Staromestská should be covered with a plateau in the form of a large-scale bridge. The plateau should ensure a smooth pedestrian passage between Židovská Street and the pedestrian route leading within the city walls. This concept seeks to 'right' the wrongs of the past by changing the spatial conditions and morphology of the terrain.

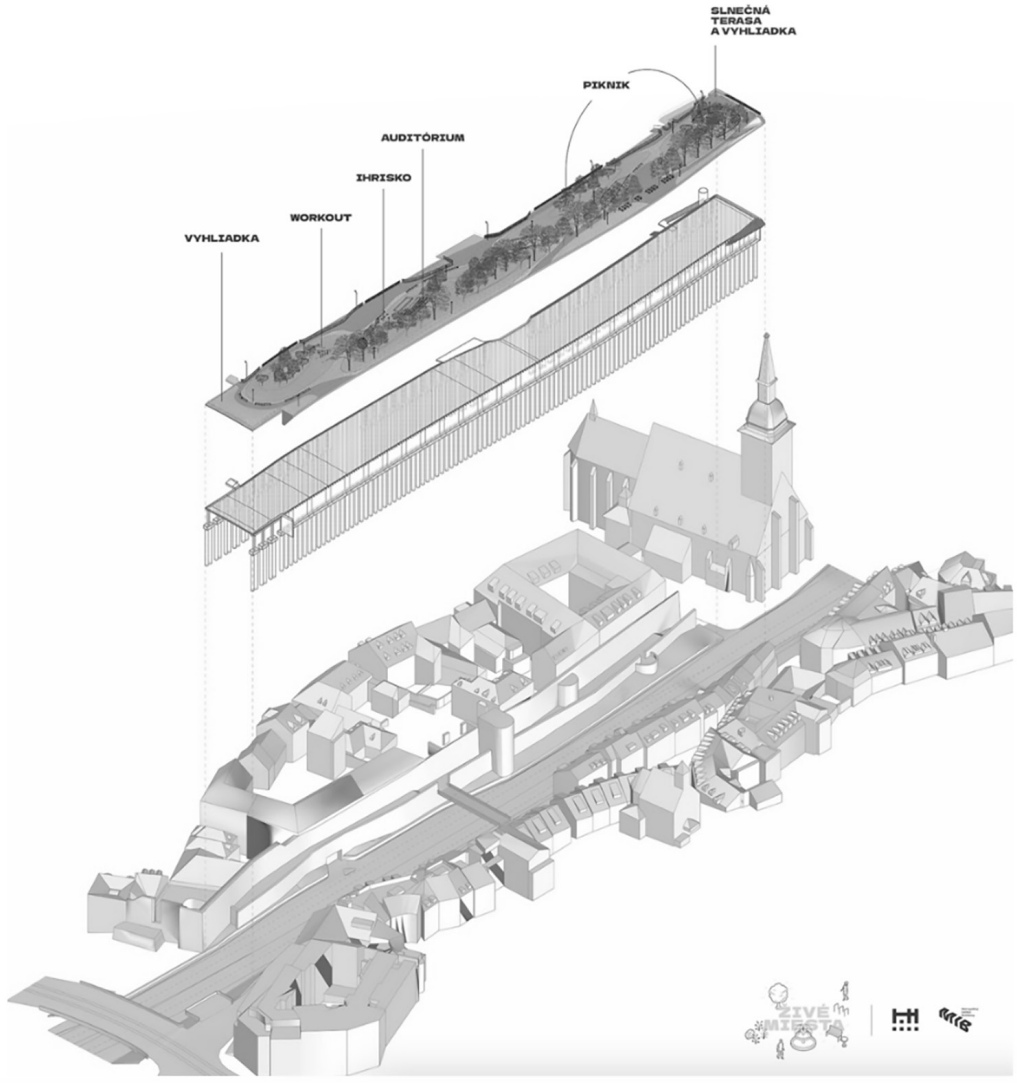

Figure 2. *Project Plató Staromestská. Proposal of the redesign of Staromestská street, based on the spatial segregation of different types of movement. Credits: Metropolitan Institute of Bratislava*

The concept, which was developed in an academic environment at the Faculty of Architecture and Design as part of the Art Nouveau II project, is based on respect for the current morphology of the terrain and for previous interventions. It approaches the space of the western part of the inner city ring in the sense of equalizing all types of movement, with the presumption of tolerance for its most sensitive components. Pedestrian and vehicular movement are thus brought into line, with vehicular traffic being significantly eliminated. However, the gap between the historic city fortifications and the castle hill is preserved. This concept does not seek to 'undo' the interventions of modernist urbanism by interfering with the physical essence of the environment. It intervenes in favour of the connection between the city and Podhradie through the reorganisation of the different modes of movement and their relations in space.

Both approaches are based on the same results of the research on the history of planning and functioning of the inner city ring road, which we carried out between 2017 and 2020. However, each interprets these results in a different way.

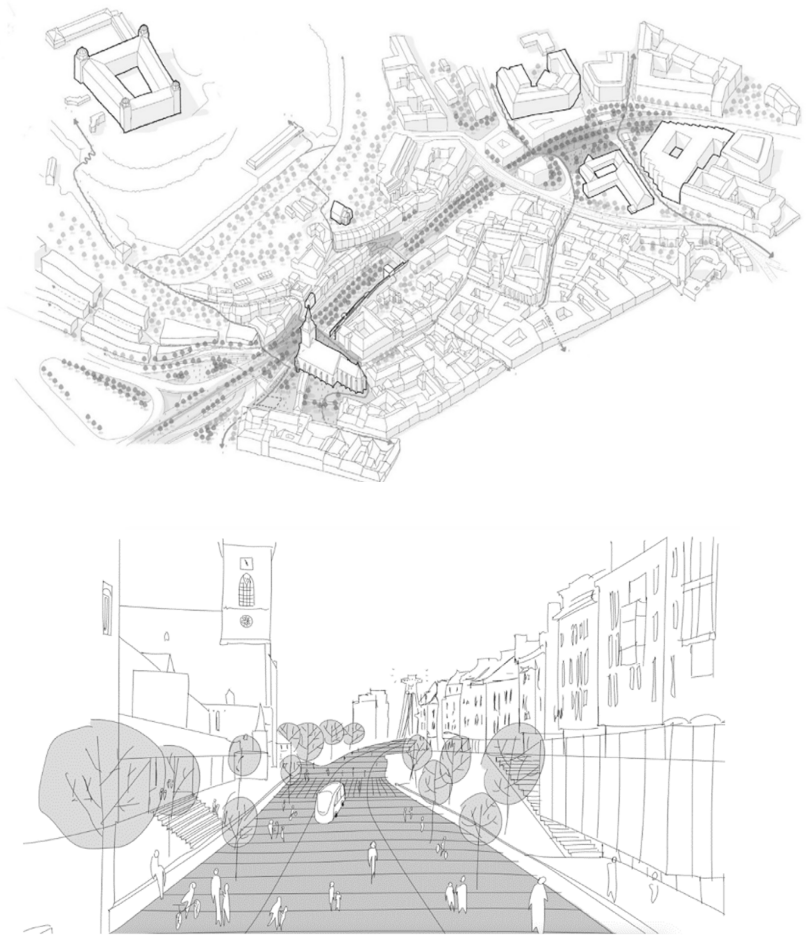

Figure 3 and 4. *Proposal of the redesign of Staromestská street, preserving the original morphology of the terrain and equalizing all types of movement. Credits: Katarína Fejo, Tomáš Hanáček, Institute of Urban Design and Planning FAD SUT*

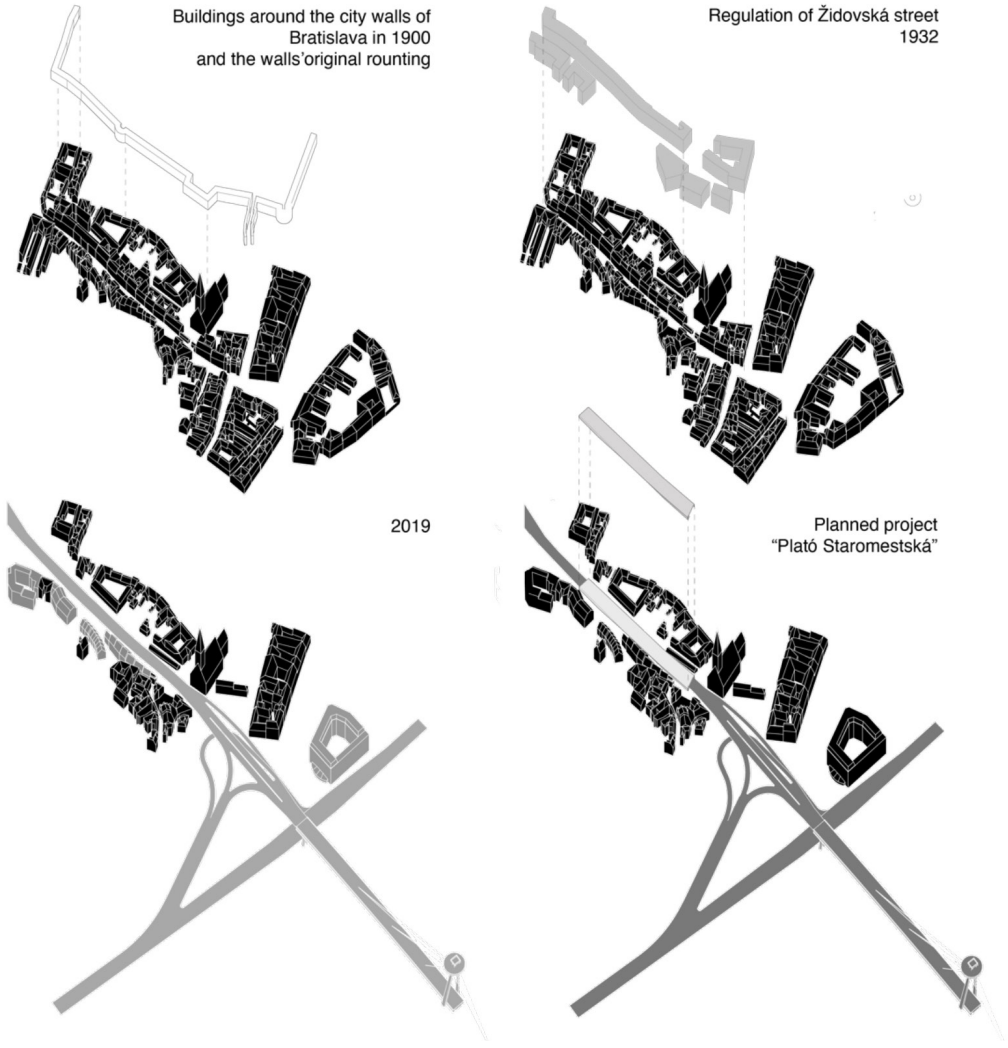

Figure 5. *Planned and real development of the urban structure around Židovská and Storometská street in 20th and 21st century. Credit: Department of Architecture IH SAS*

CONCLUSIONS

The digital medium allowed us to communicate the results of scientific research in an understandable and interactive form not only to professionals but also to the general public and to follow the trend of innovative presentation of cultural heritage. At the same time, our research has initiated a revival of the debate on urban planning, drawing attention to forgotten or deliberately marginalised urban planning conceptions.

In relation to the specific case of the Bratislava ring, it has been possible to compile a history of thinking about this type of urban structure and to place it in its historical context, to reveal all the regulatory intentions and to identify their fulfilment or non-fulfilment. In a fundamental way, we have succeeded in illuminating the historical roots of today's situation in the western part of the inner urban ring and thus challenging its decades-long interpretation as the essence of communist authoritarian planning. By identifying and naming the characteristic features of Bratislava's inner ring, which we have identified for the first time in almost a century as Ringstrasse or Ring, we have opened up new possibilities for its interpretation and use. An important result is also the clarification of its ambivalent ambiguous character. This characteristic, which could be perceived as a deficiency, is in fact one of the basic characteristics of Bratislava's urban fabric and an important element of its identity. By clarifying historical intentions and the motives that led to them, our research has simultaneously opened the way for a pluralistic thinking about individual urban situations. This is illustrated by a pair of conceptions currently being developed for the revitalization of the inner city circle - the Bratislava Ring.

A few weeks ago, in June 2023, the mayor of Bratislava presented the intention of financial security for the implementation of the plateau above Staromestská Street. The intention of a fundamental transformation of the western part of the ring thus took a more realistic form. It is worth mentioning that the representatives of the conservation authorities have reservations about such a solution, which problematizes the presentation of the historic city fortification and fundamentally changes the morphology of the site and the visual relationships between the individual historical monuments. It was the conservation community that was the main opponent of the construction of the expressway in this part of the ring road in the past. Today, it is once again defending the historic layers of the city, even those that have traditionally been perceived as insensitive to the historic environment. As a side note, we might also recall that the modernist design of Staromestská Street dates back to the period when the urban planner Milan Hladký was the mayor of the city, who sketched its line in 1956 in the city's zoning plan. Today's mayor, the architect Matúš Vallo, became famous in the past for his Urban Interventions initiative, the aim of which was to eliminate problematic spots in the city by means of subtle changes. At that time, today's mayor was already proposing a partial overlay of Staromestská Street. It is clear from the above that the implementation of the results of independent research in the field of architecture and urbanism is far from straightforward, and is largely influenced by the broader social and power contexts.

ACKNOWLEDGEMENTS

This text is based on the results of research carried out at the Department of Architecture at the Historical Institute of the Slovak Academy of Sciences (APVV 20–0526; VEGA 1/0286/21) and the Institute of History and Theory of Architecture at the Faculty of Architecture and Design of the Slovak Technical University (VEGA 1/0286/21).

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Evaluation on the morphological structure and facility layout of the mobility hub areas based on the strategy of public transport priority

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ABSTRACT

Car travel consumes finite fossil fuel resources and is a major cause of increased carbon emissions and accelerating climate change. However, the size and shape of modern cities have resulted in people being unable to commute to the towns without car-based transport. In the context of decarbonization strategies, applying public transport priority strategies has become a consensus in many cities in China and Europe. However, with completed urban road networks and the mass of family cars, the question of how to incentivize people to prioritize public transport as a mode of travel has become an issue for city management and designers to consider. To improve the accessibility (the so-called last mile) of the public transport network, many cities have deployed mobility hubs to provide more choices for people to travel. In addition, research has shown that the convenience, comfort, and functional diversity of walking processes can help people to abandon driving in favor of walking or cycling. This paper will look at the morphology of various types of mobility hubs, their design and location, analyze public transport facilities and possibilities to walk and cycle. This study will establish a suitable indicator system through evaluation and provide a basis for subsequent morphological design optimization. This study aims to inspire urban design interventions to increase mobility options, improve the quality of walking or cycling and thus achieve the goal of public transport as the preferred mode of travel.

Keywords: Mobility hubs area, Morphological structure, Facility layout, Path qualities

INTRODUCTION

Car travel consumes scarce fossil fuel resources and is a major contributor to the increased carbon emissions that are accelerating climate change (Climate Action 2022). However, the size (especially in China) and shape of the modern cities that have been created have made it impossible for people to

commute in cities without a car. As a result, reducing carbon emissions and decarbonising transport has become a common goal for many cities and municipalities, with public transport becoming the primary strategy for urban operations in China and Europe. (United Nations)

There are many reasons for the unsatisfactory implementation to date. Firstly, the ability of residents of these cities to own private cars and the level of development of urban transport infrastructure make it unlikely that residents will choose public transport for economic reasons or will have to drive a private car because of a lack of bus services. The willingness of residents to choose travel options becomes an important factor.

To improve the accessibility of the public transport network, many cities have introduced mobility hubs to give people more travel choices. The Mobility hub has been identified as a mechanism to aid the move toward a sustainable transport network. A mobility hub (MH) is a physical location where shared mobility options are offered at permanent, dedicated, and visible locations as well as where public or collective transport can be found within a walking distance (Geurs et al., 2021). It has the potential to create an attractive and competitive alternative to private motorized transportation by including and connecting different mobility opportunities in a hub area.

Given the importance of mobility hubs in the operation of urban public transport systems, our study focuses on an urban mobility hub and selects a one-kilometer square area (1 km2) as the mobility hub area for a comprehensive assessment of morphology. The assessment includes walking distance, metro entrances, bus stop layout, transfer distance and facility layout. Our study will select 10 samples from different morphological characteristic zones in different locations in Nanjing.

Firstly, the mobility hubs were divided into categories according to their location in the city and its surroundings, such as the city's public centres, large residential areas, business districts, suburban areas and external transport hubs. Second, the assessment of the morphological structure based on the ease of walking and cycling: such as the density and type of road network, the type and density of road intersections, the functional configuration of paths and the visual richness of streets. Thirdly, the configuration of static transport facilities in the areas will be assessed, such as the total number of public transport lines and the density of stations, the connections between different modes of transport, the connections between different lines of the same mode of transport (especially buses), the abundance of destinations reached by public transport lines, the accessibility of public transport stations in the areas. This study will establish, through comparison, analysis and evaluation, an efficiency index system for mobility hub zones and to lay the foundation for the development of optimization strategies.

RESEARCH BASES

Public transport priority strategy and its practice have a history of more than two decades. Research on the implementation methods, techniques, policies, and evaluation of the effects of it has also been accumulated for more than ten years. And a large number of papers have been published in the areas of transport facility technology, user satisfaction, etc., which form the basis of our study. A large number of studies have shown that people's willingness to choose, walking distance and walking environment, and ease of line transfers influence their choice of public transport for travel (Gupta and Pundir, 2015; Van Soest et al., 2020; Cheng and Tseng, 2016). Commuting is a major activity component of urban transport. In this study, commuters are considered as the main concern, including willingness, walking distance and walking environment. In addition, a number of scholars have already focused on the accessibility and multi-optionality of urban walking space from the perspective of urban form as a criterion for evaluating the urban walking environment.

Nanjing is the capital of Jiangsu Province, China, a sub-provincial city, one of the core cities in the southeast region of China, as well as the most important comprehensive transportation hub city in China. Nanjing's urbanization began in the mid-1980s and, after more than a decade of accumulation, began to develop rapidly in the early 21st century (Figure 1).

Nanjing's first metro was built in 2005, with a second to follow four years later. Since then, the pace of new metro construction has accelerated, with several lines being built simultaneously and existing lines

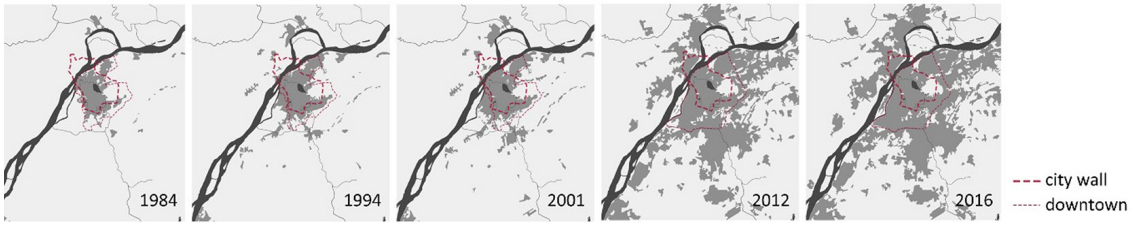


Figure 1. *Urban expansion of Nanjing, photo credit: drawn by the authors*

being extended to accommodate the city's expansion. To date, 12 metro lines have been opened and are in operation in Nanjing, including lines 1, 2, 3, 4, 7, 10, S1, S3, S6, S7, S8 and S9, with a total of 208 stations (double counting of interchanges), which constitute a subway network covering the whole city of Nanjing (Figure 2) and it is expected that there will be 27 subway lines in Nanjing by the year 2035.

Bus lines have been operating in Nanjing for more than 70 years since 1949, and as the city has grown, bus lines have not only increased in length but also in number. To date, there are about 700

Figure 2. *Subway lines operated by Nanjing Metro, photo credit: drawn by the authors*

bus lines in Nanjing, serving all areas. There are approximately 1,000 bus stops located within the city center, of which 50% serve more than 20 bus lines. In recent years, the bus stops have also been upgraded, adding roofs, seats, bus card recharge facilities and bus service information to make it easier for people waiting for the bus to keep track of the time (Figure 3).

Nanjing's buses have been upgraded to electric buses, with more than 700 lines and 12 metro lines combined to form public transportation system. Therefore, our study must include transfer system between bus and metro.

CASES AND METHODS

Public Our study is a comprehensive evaluation based on the convenience, comfort, and diversity of transit options for moving people. This goal determines how we choose what to evaluate and how we set the metrics for analysis. For commuters, saving time getting to and from work is the most im-

Figure 3. *Photographs of facilities for the hub, photo credit: drawn by the authors*

portant factor. In addition to time spent on public transit, the biggest difference between transit and self-driving trips is walking distance to different types of transit stops and walking distance to transfers on multiple routes. This is between the point of origin to the bus stop, the transfer point, and the bus stop to the workplace, and the same for the return trip. This means that the evaluation has to go down to the geospatial location of the points and the paths between them to really understand the problems and opportunities for optimization.

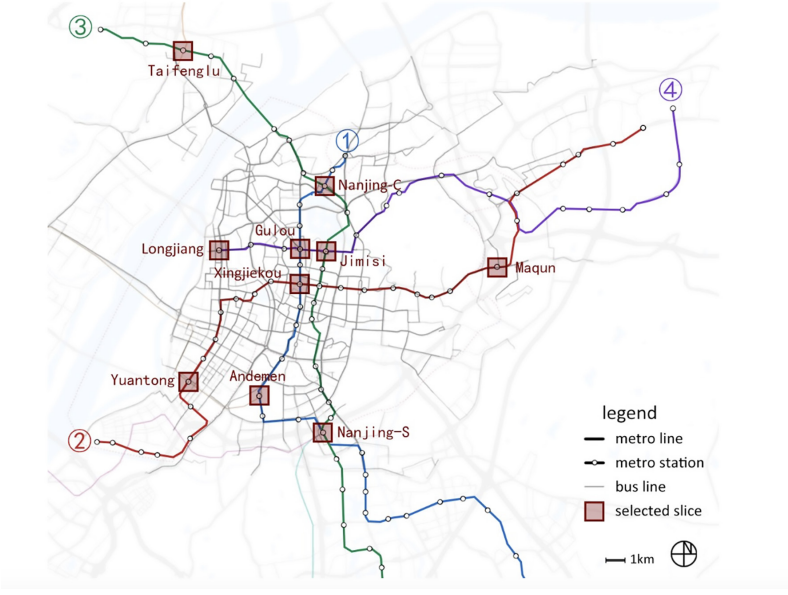
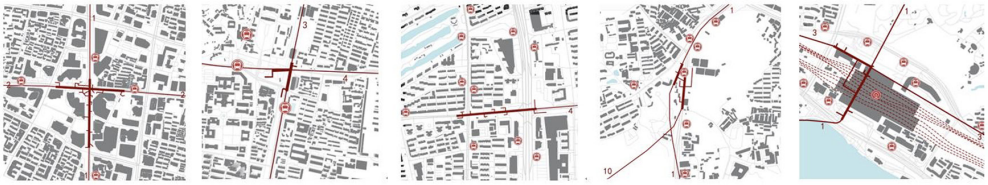


Figure 4. *Distribution of slices of selected metro stations in Nanjing, photo credit: drawn by the authors*

In our study, 1 km by 1 km slices of 10 subway stations were selected in four of the earliest opened and busiest subway lines in Nanjing (Lines 1, 2, 3, and 4) (Figure 4), which were divided into five categories, including central areas, business districts, residential areas, suburbs and transportation hubs. Each category contains 2 slices, providing the basis for subsequent comparative analysis (Table 1).

Table 1. *Ten selected slices*

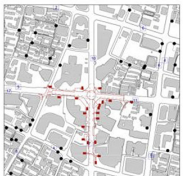
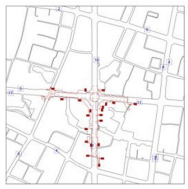
Category	**Central areas**	**Business districts**	**Residential areas**	**Suburbs**	**Transportation hubs**
Name	Xinjiekou	Jimisi	Longjiang	Andemen	Nanjing-C
Map					
Name	Gulou	Yuantong	Taifenglu	Maqun	Nanjing-S
Map					

In order to carry out the subsequent studies, the mapping methodology must first be defined. The map should contain the following information: road network, buildings, green areas and water, residential quarter entrances and building accesses, subway stations and their entrances and exits, bus stops and the number of bus lines owned by them, and so on. Among them, the centerline of the road network can be transformed into an axial expression; residential quarter entrances and building accesses, subway entrances and exits, bus stops can be transformed into a point expression. By combining the various pieces of information, ten types of maps can be drawn, including satellite map of the city, map of land use, map of the city, map of buildings, map of road network for motorized vehicles, map of the motorway network axis, map of pedestrian routes, map of the pedestrian network axis, maps of building and neighbourhood accesses, map of bus stops and metro entrances (Table 2). The different maps serve different purposes.

At the methodological level, our study uses Geographic Information System (GIS) to evaluate street network characteristics and quality, including road network structure, shortest paths, road space, and activities.

Firstly, considering that saving commuting time is the most important factor for commuters, they tend to take the shortest paths from their homes or offices to the hubs, as well as the shortest paths for subway and bus transfers. Therefore, based on the road network structure of the pedestrian network axis above (Table 2), the shortest paths between the points of the three categories (residential area entrances and building entrances, subway entrances and exits, bus stops) are calculated by GIS, and the shortest paths are overlaid to form a frequency map of the shortest paths.

Table 2. *Ten types of graphs of Xinjiekou area*

Types of graphs	Satellite map	Land use	The city	Buildings	Road network for motorized vehicles
Map					
Types of graphs	**Motorway network axis**	**Pedestrian routes**	**Pedestrian network axis**	**Building and neighbourhood accesses**	**Bus stops and metro entrances**
Map					

The following three steps are required to obtain the frequency map. Step 1, find the shortest distance between two points. Step 2, based on the calculation function of GIS, the frequency maps of different types of shortest paths is graphically displayed. Step 3, according to the frequency of each route being used, the frequency rankings map of the shortest distance from all entrances to all bus stops is obtained. The hierarchical display of the frequency of paths allows us to visually identify the structure of commuting routes in the region. To facilitate subsequent comparisons and analyses, frequency ratings are divided into six categories on a case-by-case basis and darker colours indicate higher frequency (Figure 5).

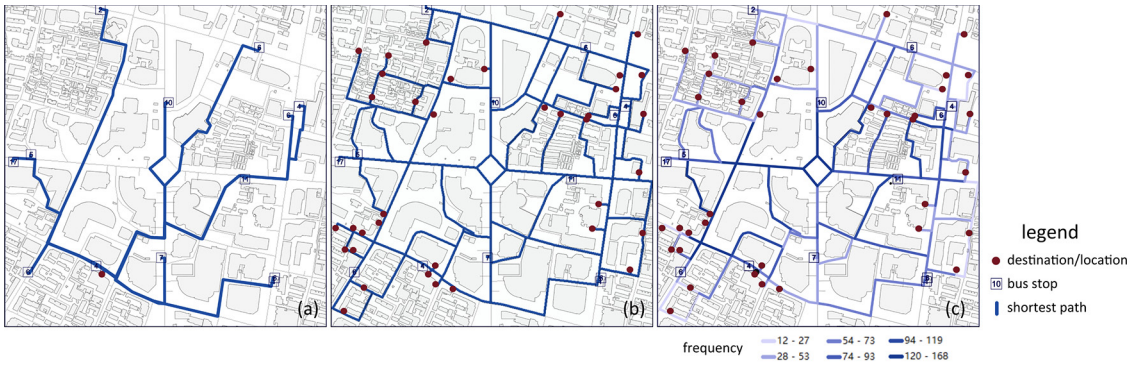


Figure 5. *Route map of the shortest distance from destinations/locations to bus stops of Xinjiekou area. (a) from an entrance to all bus stops, (b) from all entrances to all bus stops, (c) frequency rankings of the shortest distance from all entrances and exits to all bus stops, photo credit: drawn by the authors*

Secondly, in order to test whether or not the shortest distance given by the GIS was correct, the navigation function of our mobile phone was tested, and the navigation application was Golder Navigation. Taking the Longjiang area as an example, the test object is the map of the shortest route from the entrances and exits of buildings and settlements to all bus stops. We first locate all the entrances and bus stops on the Gaode map, then display and record the paths through the Gaode map one by one, and finally overlay all the shortest paths to draw all the shortest path maps. Finally, we can compare the shortest path map generated by GIS with the shortest path map based on the navigation map, which can show the accuracy of the GIS shortest path map. The experimental results show that the GIS-generated shortest path map and the shortest path map drawn based on the app navigation path overlay are basically the same, and the experiment confirms that our subsequent calculations and analyses can be based on the GIS-generated shortest path map. Interestingly, we found that the shortest path in the GIS map is one more than that in the Gao's map, which is due to the fact that the GIS walking route map is drawn based on the actual walkable paths, while in the Gao's map this walkable path does not exist. This phenomenon explains why strangers will find the shortest route by following the navigation of the Gao's map, while acquaintances will find the shortcuts (Figure 6).

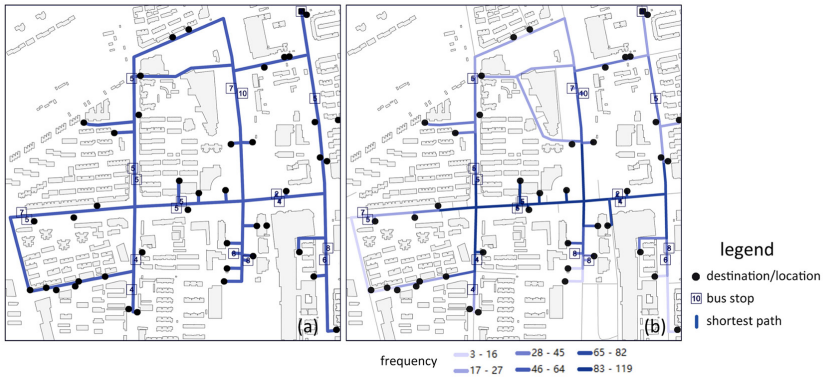


Figure 6. *Route map of the shortest distance from destinations/locations to bus stops of Long Jiang area. (a) based on Gaode Map, (b) based on GIS, photo credit: drawn by the authors*

Finally, the study identified three ways to access public transportation using pedestrian road network. Below are calculations and descriptions of these modes. Mode 1 is to find shortest distance from all the destinations/locations to all the bus stops since public bus lines go in different directions in the city, and people may go anywhere in the city from their home or office. Although this method has some unrealistic scenarios, it is still a simple and mostly accurate calculation. Mode 2 is to find the shortest distance from destinations/locations to the nearest one metro entrance/exit, the shortest distance is calculated as the same block according to pedestrian habits since commuters know empirically which subway entrances/exit are the most convenient for them. Mode 3 is to find the shortest distance from bus stops to the nearest one metro entrance, the shortest distance is calculated as the same block, since the entrance/exit targets are clearly marked inside the metro station (Figure 7).

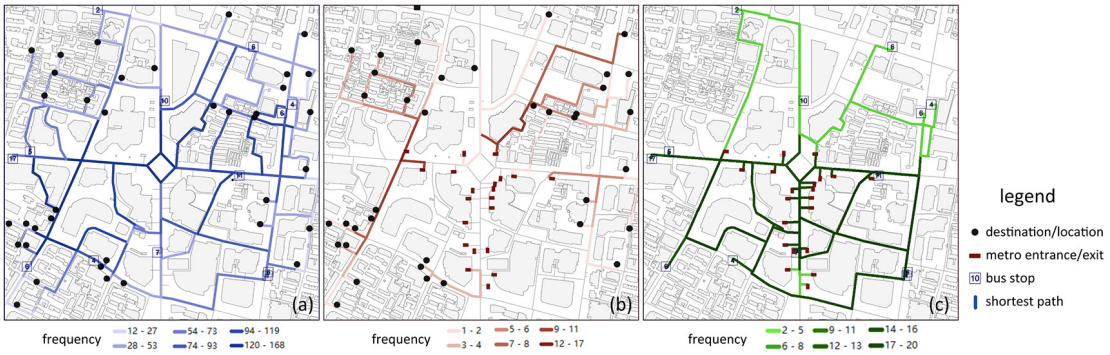


Figure 7. *Frequency rankings of the shortest distance. (a) from destinations/locations to all bus stops, (b) from destinations/locations to the nearest metro entrance/exit, (c) from bus stops to the nearest metro entrance/exit, photo credit: drawn by the authors*

MAPPING AND STATISTICS

In order to get the paths related to the public transportation priority strategy, this study overlaps the three mode graphs to produce the total shortest path frequency map. Any colour-covered road axes represent shortest paths. These road segments are not identical to the original road axes, and we refer to the presentation of all shortest paths overlaid in the three modes as pedestrian network to public transport (PNPT). The map contains different colours representing each mode, with blue for mode 1, red for mode 2, and green for mode 3. A particular road segment's colour represents which mode uses it exclusively. Mixing two of these three colours together results in purple, cyan, and yellow. If a road section appears purple on the map, it is only used by mode 1 and mode 2, not by mode 3. A similar situation applies to cyan and yellow road sections. If a road section appears black or gray, it indicates that all three modes use the road segment and that the road segment plays an important role in the PNPT map. Similarly, the darker the colour of the paths indicates higher frequency; road axes that are not covered by any colour mean that these roads are not being used by commuters going to public transportation in 1 km by 1 km slices (Figure 8).

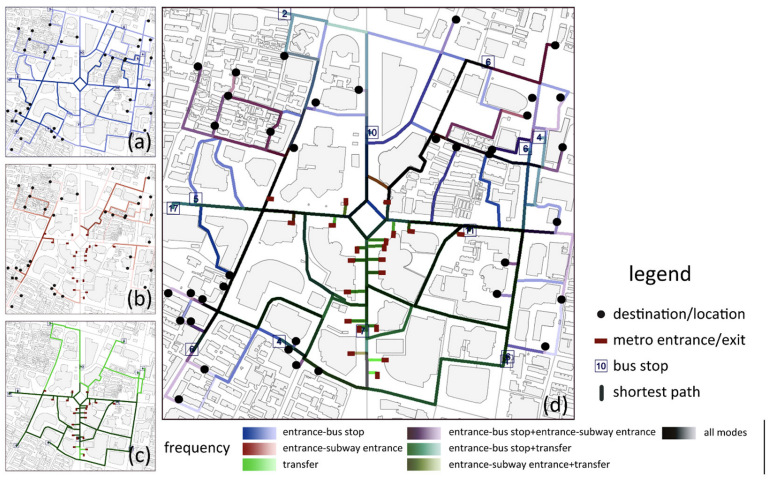
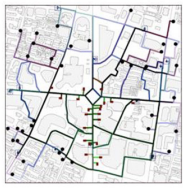
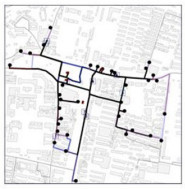
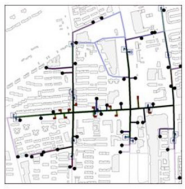
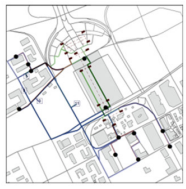


Figure 8. *Frequency rankings of the shortest distance. (a) from destinations/locations to all bus stops, (b) from destinations/locations to the nearest metro entrance/exit, (c) from bus stops to the nearest metro entrance/exit, (d) total shortest paths, photo credit: drawn by the authors*

Following the same mapping methodology, the study produced frequency rankings maps of total shortest path (PNPT maps) for 10 selected slices (Table 3).

Table 3. *Frequency rankings maps for 10 selected slices*

Name	**Xinjiekou**	**Jimisi**	**Longjiang**	**Andemen**	**Nanjing-C**
Frequency rankings map					
Name	**Gulou**	**Yuantong**	**Taifenglu**	**Maqun**	**Nanjing-S**
Frequency rankings map					

Based on the maps above (Table 3), we used the GIS function to collect the maximum (L distance), minimum (S distance), average (A distance), and median (M) values of the three types of shortest walking routes, and calculated the ratio of the median to the average of the quantities (M:A) (Table 4). The three types of shortest paths are calculated as follows:

1. Frequency of the shortest distance from the entrance/exit of the work/settlement to each bus stop in the study area.
2. Frequency of the shortest distance from work/residence entrances to metro entrances and exits in the study area.
3. Frequency of the shortest distance from the main metro entrance to a bus stop.

Table 4. *Relevant statistics of the three types of shortest paths*

Category		**Central areas**		**Business districts**		**Residential areas**		**Suburbs**		**Transportation hubs**	
Name		Xinjiekou	Gulou	Yuantong	Jimingsi	Longjiang	Taifenglu	Andemen	Maqun	Nanjing-C	Nanjing-S
entrance/exit to bus stop	L distance	1505	1041	1576	889	1585	1033	1383	906	1500	537
	S distance	50	33	31	27	26	13	75	60	148	65
	A distance	749	550	777	421	655	475	348	418	855	356
	M / M:A	739/ 0.99	519/ 0.94	750/ 0.97	431/ 1.02	648/ 0.99	414/ 0.87	580/ 1.67	430 /1.03	941/ 1.10	371/ 1.04

entrance/ exit to metro entrance	L distance	752	660	987	659	806	679	537	721	831	495
	S distance	154	92	247	54	78	88	73	195	338	68
	A distance	428	382	685	285	366	327	348	421	567	295
	M / M:A	405/ 0.94	379/ 0.99	777/ 1.13	332/ 1.16	369/ 1.01	195/ 0.60	396/ 1.14	415/ 0.99	526/ 0.93	347 / 1.18
metro entrance to bus stop	L distance	728	537	1134	286	811	819	812	427	454	829
	S distance	40	83	91	14	42	35	61	54	64	65
	A distance	469	155	378	147	311	354	404	309	284	504
	M / M:A	510/ 1.09	326/ 1.06	300/ 0.79	127/ 0.86	306/ 0.98	289/ 0.82	284/ 0.70	343/ 1.11	328/ 1.15	578/ 1.15

RESULTS AND CONPARISONS

The shortest path percentage (SPP) reflects the accessibility of bus, metro and transfer possibility. Through GIS mapping and statistical tables (Table 5), our study compares different districts based on their morphological structure and the SPP of bus, metro and transfer possibility. Xinjiekou area and Yuantong area both have well-developed underground pathways and malls for people to walk through, however they have different SPP in terms of metro and transfer (Figure 9). In yuantong district, metro and bus entrances are all concentrated in the centre thus it is convenient for people to transfer, but difficult to travel to the destinations. Xinjiekou area, on the other hand, has more than 20 metro entrances, all of which directly lead to destinations, making the SPP of metro nearly 6 times as Yuantong's (Table 5). But its bus stops are located in a cross way, making the transfer SPP lower than Yuantong.

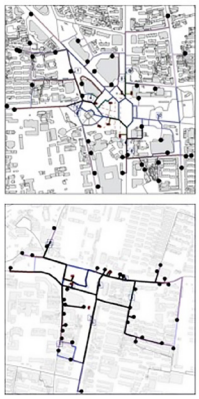
Table 5. *Relevant statistics of shortest path percentage of Xinjiekou and Yuantong area*

Name	Xinjiekou	Yuantong
Bus SPP	19.1%	17.8%
Metro SPP	45.9%	8.3%
Transfer SPP	29.9%	75.9%

Figure 9. *Comparison of Xinjiekou, Yuantong area: drawn by the authors*

There is a university campus in Gulou and Jimingsi district and they both have relatively high SPP of bus and metro. (Figure 10) However, the universities cover large areas with few entrances, making people in these two districts hard to walk across campus. And because bus and metro entrances are located throughout Gulou district randomly, it has low transfer SPP compared to Jimingsi's 100%. (Table 6)

Table 6. *Relevant statistics of shortest path percentage of Gulou and Jimingsi area*

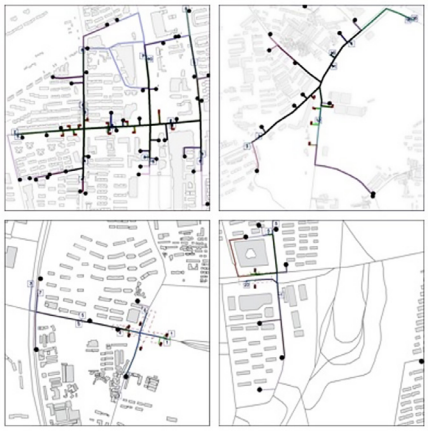


Name	Gulou	Jimingsi
Bus SPP	25.4%	46.6%
Metro SPP	51.3%	78.4%
Transfer SPP	15.8%	100%

Figure 10. *Comparison of Gulou and Jimingsi area: drawn by the authors*

By comparing the four residential and suburban districts, it is clear that the arrangement and size of the enclosed apartment blocks affect the bus, metro and transfer SPP greatly. In Longjiang area, there are many small residential communities with one main road that most of the bus and subway entrances are located on it. Shops and malls are also concentrated along the main road, making the SPP of metro and transfer relatively high. (Table 7) Taifenglu district has a typical large community with nearly 30 residential buildings but only three entrances. The bus and metro are located near the entrances, resulting in high SPP. However, people living in the community may still have difficulty accessing the public transportation. Andemen and Maqun districts are in suburb, and most of their roads are expressways. Buildings are located on one side of the area. Bus and metro are concentrated near communities, thus having high SPP of transfer. (Figure 11)

Table 7. *Relevant statistics of shortest path percentage of Longjiang, Taifenglu, Andemen and Maqun area*



Name	Longjiang	Taifenglu	Andemen	Maqun
Bus SPP	22.4%	45.0%	29.2%	46.4%
Metro SPP	59.5%	66.7%	50.0%	42.9%
Transfer SPP	86.8%	65%	54.5%	100%

Figure 11. *Comparison of Longjiang, Taifeng, Andemen and Maqun area: drawn by the authors*

CONCLUSIONS AND DISCUSSIONS

Our study confirms that transit priority strategies, urban design and their correlation, specifically the structural form of the city (potential transit routes) and neighbourhood form (potential walking routes), are key factors influencing short and medium distance transit trips. Our research found that the structure of PNPT and the general pathway network do not coincide. The PNPT represents the network connecting the destination point with bus stops or metro entrances. For commuters, selecting the shortest possible distance between two points is clear and vital, making PNPT an efficient network for public transportation. Consequently, the walking distance within the PNPT may serve as a crucial indicator for identifying Mobility Hub areas.

Given that the PNPT network is defined by the configuration of the road network between destination and various transportation stops, any relocation of these stops will alter the PNPT configuration. Hence, optimizing the location of the stops or adding more entrance and exit locations could potentially shorten the distance of the PNPT network. Furthermore, for the Mobility Hub areas, enhancing the connectivity between ground-level bus stops and metro entrances and exits can easily strengthen interchange convenience, thereby fostering a more vibrant and commercially viable MH area.

In China, urban residential areas, known as gated communities, consist of enclosed apartment blocks. These communities are typically large, with up to 30-40 buildings, and typically have only two entrances. To reduce management expenses, usually, only one of these entrances is open. This means that many residents living farther from the entrance must walk long distances to access streets and stations. Furthermore, it's important to consider the significant distances within extensive institutions like universities, where separate buildings are often located far from the main entrance. This inconsistency significantly impacts their willingness to use public transport for commuting. The PNPT map of the urban road network does not indicate any distance errors.

Using GIS, our study has visually represented the shortest pedestrian routes and their potential usage frequency within the Mobility Hub area. By mapping hotspots and conducting investigations, we have confirmed the presence of high-frequency pedestrian pathways. Upon comparing these shortest high-frequency routes with the functional layout of urban planning, it was revealed that certain districts within the Mobility Hub areas do not align with the high-frequency routes of the PNPT network. Consequently, some high-frequency routes for commuters are underutilized, resulting in

Figure 12. *Non-motor vehicle parking lots: photo by Mengjie Gu*

reduced commercial value for these pathways. Notably, some urban managers have responded to pedestrians' needs for purchasing everyday items along their routes by establishing makeshift stalls along the roadside, as observed in our research. Essentially, based on the PNPT map, retail businesses can be adjusted to enrich the commercial offerings along the high-frequency pathways, ultimately enhancing commuting convenience and efficiency.

Our study is the initial phase, and future work will involve re-evaluating the review scope based on urban form characteristics, defining appropriate assessment zones, and identifying methods that can be refined through additional case studies.

ACKNOWLEDGEMENTS

We sincerely thank Mengjie Gu, alumnus of Nanjing University for providing photos. We thank Yong Fan, also alumnus of Nanjing University for the help of GIS. The research is supported by program: Transit-Oriented Development 2 (TOD2) – Public spaces, mobility hubs and climate neutrality toolbox.

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Urban morphology on the Southern African periphery: Notes from practice, research, and teaching in Cape Town

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ABSTRACT

Urban form in African cities is dynamic, unpredictable, and in constant flux. Urban morphology remains mostly undocumented in Southern Africa as an emerging region. Local meanings and processes of peri-urban informal land occupation, changing suburbia and townships, and incremental settlement transformation patterns present fragile, yet interesting morphological characteristics that are worthy of interpretation. In the absence of any formalised network of ISUF in Southern Africa, there is the potential to make a meaningful contribution to urban form and its associated processes and agents of transformation. The paper describes a theoretical perspective framed within a peripheral context of Southern African cities. A brief overview of a methodological approach is provided. Findings from case studies through practice, research, and teaching are expressed to understand, interpret, and translate urban morphology in South Africa. The case studies explain, 1). Area-based development using an example of informal settlement upgrading in Khayelitsha, Cape Town; 2). Community-led data collection on urban form and social practice based on evidence from a local context, Lotus Park Informal Settlement in Gugulethu; and 3). Deliberate and engaged teaching and learning on urban transformation currently taking place in the urban design programme at the University of Cape Town, explained through a community project, iThemba Walkway. Urban morphological approaches in Southern Africa must be multi-scalar, relevant, valuable, and affordable. This requires stripping out of irrelevant principles and techniques and focusing on low-cost, low maintenance and sustainable labour-intensive ways of understanding the changing city. Concluding remarks summarise the paper, offering areas for further research.

Keywords: urban transformation, Southern Africa, emerging network, informality

INTRODUCTION

Urban form in Southern African cities is dynamic, unpredictable, deeply layered with historical underpinnings, and in constant flux. Urban morphology remains mostly undocumented in Southern Africa as an emerging ISUF region. Processes of informal occupation of peripheral land (Ewing, 2008; Meth et al., 2021), changing suburbia and townships (Buire, 2014; Ewing, 2022; Mabin et al., 2013) and incremental settlement development and spatial transformation patterns present fragile, yet

interesting morphological characteristics that are worthy of interpretation (Chirisa & Matamanda, 2019; Ewing, 2021). In addition, large portions of urban centres, and infrastructure are yet to be built, bringing expectations of immense and rapid growth that will require ongoing evaluation of the changing shape of Southern African cities (Watson, 2014). Still, how are we understanding, representing, perceiving, and anticipating changing southern urban form?

One may build on Vitor Oliveira's[1] question of what is the value-add of understanding urban morphology (Larkham, 2022) and the physical form of human settlements in the Southern Africa context. In the absence of any formalised network of ISUF in Southern Africa, there is the potential to make a meaningful contribution to urban form and its associated processes and agents of transformation.

With this starting point, I would like to present urban morphology on the Southern African periphery. I feel there is much to learn from informal urban transformation occurring on the 'periphery' of many African cities, bringing my interpretations from experiences in Cape Town, South Africa, Harare, Zimbabwe and Windhoek, Namibia.

Within the context of my paper, I briefly frame theoretical perspectives from the global South in a time of uncertainty. I then describe a methodological approach. Further, I provide findings from three case studies that I have been involved in through practice, research, and teaching to understand, interpret and translate urban morphology in Southern Africa. These case studies expand on, 1) area-based development and informal settlement upgrading practices in Khayelitsha, Cape Town; 2) community-led data collection on urban form and social practice based on evidence from a local context in Gugulethu; and 3) deliberate and engaged teaching and learning on urban transformation in the urban design programme at the University of Cape Town, South Africa. Concluding remarks summarise the paper and offer areas for future research.

PERIPHERAL CONTEXT OF SOUTHERN AFRICAN CITIES

Urban Africa presents us with many complex and often contradictory challenges from marginalisation, inequality, informality, environmental degradation, displacement and extreme poverty, and crime and violence. Yet, many African cities are developing at an incredibly fast pace without plans, infrastructure, or economic investment. Where there are spatial guides (often outdated in approach) they appear shrouded in the political quest for the glamour of the 'modernised', mega-projects and glass-fronted fantasy city of tomorrow (Watson, 2014) or inappropriate to context. Parnell and Pieterse (2014, p. 1) argue, *"Africa's dramatic demographic transition is a profoundly spatial story."*

Amidst the wicked challenges, Griffiths (2018) states, *"…Africa may give birth to new forms of city-making and find bold ways of responding to rapid growth, environmental sustainability, and reconfiguring cities to be spatially more inclusive in a context of urbanisation without industrialisation."* One needs to question the interpretation of urban morphology and spatial transformation, where there is an urgency to implement multi-dimensional solutions to Africa's multicultural problems (Griffiths, 2018, p. 4), yesterday.

[1] Email conversation with Vitor Oliviera in early 2020 around developing a Southern African ISUF network. Further conversations and correspondence with Vitor Oliviera and Michelle le Roux in early 2023.

The debate on spatial (in)justice (Dewar, 2019; Soja, 2010) and urban designers' increasing awareness to review, design, interpret and evaluate urban form and spatial transformation practice in the Southern context has opened the opportunity to dive into the southern urbanism theory and review spatial practice, research and teaching.

Urban morphology is not a new area of study (Oliveira, 2022; Whitehand, 1992). However, I claim that to analyse human settlements in Southern Africa we need to be flexible to emergent concepts and ways of understanding urban form that may differ from more conventional approaches. Du Plessis *et al* (2015) write of their concern about the interdependence of morphological systems to understand the future of researching urban form in Southern Africa. Chirisa and Matamanda (2019) note spatial transformation and changing urban form in Southern African cities post-independence require further attention.

Consequently, the paper scaffolds on the term 'periphery', both in terms of physical form, relationships, and perceptions of space-making practices. Caldeira (2017) explores the concept of 'peripheral urbanism' to examine how self-constructed neighbourhoods and urban space are produced in cities of the Global South.

According to Caldeira (2017, pp. 3-4), peripheral urbanisation consists of a set of interrelated processes, challenging traditional urban theories and presenting new ways of understanding how space is created. Her argument intentionally de-centres northern concepts. Roy further argues the study of twenty-first-century Southern cities demands "new geographies of theory" (Roy, 2009). Hereby, applying a similar concept to urban morphology on the southern periphery.

Peripheral urbanism foregrounds the creative socio-cultural practices shaping spaces and subjects in Southern cities (Lindell, 2019). This includes questioning terms and values of informal space-making (Roy, 2011; Roy & AlSayyad, 2004), and debating what happens in between or "grey space" (Yiftachel, 2009). Public engagement (political claiming of space) or contestation (land evictions and removal) in *and* with space in the past 20 years in Southern African cities has led to further reconfigurations and a reshaping of the urban landscape (Ewing, 2008). In many instances, dwellings, neighbourhoods and infrastructure have been *"self-constructed"* by their residents (Caldeira, 2017).

Self-constructed neighbourhoods, streets and dwellings are often in conflict with the state and its authoritarian systems, and construction (across scales) is generally outside of planning regulation, nor on any database for urban form. Where the state is part of the process, operations and spatial production of physical form may happen in what Caldeira (2017, p. 3) calls *"transversal ways"*. In addition, powerful actors (such as local governors or political agents, gang leaders, and influential business owners) have the potential to reclaim spaces and (re)configure (or destroy) urban form at an alarmingly fast rate. Evictions and relocations are common in peripheral spaces. Removal of physical form is not something that is often discussed in urban morphology.

SOUTHERN AFRICAN CITIES IN A TIME OF UNCERTAINTY AND CHANGE

Spatially, Southern African cities present examples of vast spatial inequality with fragmented and racially segregated urban neighbourhoods, and mono-functional land use as relics of colonial modernist and apartheid spatial planning (Dewar, 2016, 2019). The resultant character consists of an odd mix of dispersed growth patterns and inadequate urban performance.

Infill urban areas, developer-led office nodes and shopping malls, 'fringe belt' (Oliveira, 2018)[2] townships and rapidly expanding new informal growth. Township settlements contain low-density sprawl of informal and individual state-subsidised housing, poorly designed urban spaces with minimal or collapsing infrastructure and inaccessible and low-quality public spaces and facilities. Reinforcing a legacy of poverty and inequality from the smallest to the largest scale through all the elements of the urban form including the region, settlement, block, plot, street, and building.

Positive change demands that urban design professionals review and recognise their social role. Good urban design provides space and place for the public to prosper and imagine, improving their quality of life. To reach this level of 'good' urban design in many African cities, we need to consciously grapple with the spatial implications of the past (and current) dominant and oppressive forces influencing urban form.

At a city scale, there is the need to design appropriate and sustainable blue-green infrastructure (movement, water, electricity, waste) that deals with resource flows and volumes of the urban, whilst addressing risk and resilience. At the neighbourhood and street scale, communities make space and hold valuable local knowledge, everyday culture, and diverse rhythms of the city that must be utilised in any future design process. At the household scale, there is a need to understand the territorial base of the family. The key to this process of understanding urban form is to unpack the politics and power of space to actively address values of spatial justice and equity.

The paper highlights three areas of focus in terms of the radically changing urban form in Southern Africa,

- First, urgent *informal land occupation* and mass growth *of peri-urban land* with porous imaginary boundaries, avoiding the risk of eviction, land use implications or urban 'tax' (Ewing, 2008; Meth et al., 2021).
- Second, rapid *incremental transformation* occurring in informal settlements, post-apartheid, including institutional, community spaces, streets, and dwellings (Ewing, 2021).
- Third, *informal, urban infill and change* within the neighbourhood, 'suburbia' (Buire, 2014) or established township locations. This includes the mode of everyday socio-economic and cultural practice of the (re)production of space and remaking of place, emphasising a more fluid relationship between formal and informal habitats (Ewing, 2022; Mabin et al., 2013).

METHODOLOGY

Southern African cities, by their diverse and complex nature, form a platform for creativity and innovation. We should be learning from local urban meanings of space-making. Methodological and analytical approaches to interpret urban morphology in the Global South must be multi-disciplinary, multi-scalar, contextual, valuable in the co-production of knowledge, and importantly, affordable to conduct research and teaching in precarious neighbourhoods and cities (Larkham, 2022). This requires stripping out of irrelevant principles and techniques and focusing on low-cost, low-maintenance, sustainable artificial intelligence, and labour-intensive and community ways of understanding the changing city.

[2] Oliviera (2018) refers to the several dimensions and concepts of the fringe belt. In this case, I refer to fringe belt townships in Southern African cities of South Africa, Zimbabwe and Namibia.

The paper presents work based on participatory urban design approaches, empirical action research and engaged spatial practice. Lessons build from the Violence Prevention through Urban Upgrading (VPUU)[3] Programme (Ewing, 2021, 2022; Ewing & Krause, 2021), and my teaching and research work in South Africa, Zimbabwe, and Namibia.

Participant (and community) observation and engaged dialogue is the research method used to understand urban change. The work is action-orientated, making use of basic technology and community-led data collection using smartphones and geolocated spaces. Data, information, and neighbourhood transformation are interpreted through local meanings. There is a growing public interest and acknowledgement in community *"…localities, their pasts and potential futures"* (Larkham, 2022, p. 4), particularly within informal, self-constructed settings. A range of methods are used, such as collecting urban stories (urban talks), basic GPS data collection and GIS interpretations (urban walks), and continual time-lapse photography (by community, researchers, and students).

Urban design teaching of urban form in a peripheral Southern African context applies a participatory approach including the application of co-design workshops, role-play, detailed and emotive site analysis (emotional and social mappings), and resilience strategies through scenario testing (what if…) to grapple with some of the 'wicked' urban challenges urban Africa is facing today and in the future.

In addition, personally, as an architect and urban designer co-designing, building, monitoring, and evaluating physical form through intervention projects with diverse stakeholders assist in understanding and representing unique and changing human settlements. Scales are considered from,

- Household (territorial base of the family, home-based enterprise),
- Street and public space (space as public for everyday local activities to function),
- Sections (determined, named, and occupied by the community),
- Neighbourhood or township (bounded by community markings or local municipalities or environmental barriers, social connections within, between and beyond), and
- City territory (within the peri-urban and extending to rural villages).

FINDINGS ON URBAN FORM FROM SPATIAL PRACTICE, RESEARCH AND TEACHING

The following 3 case studies reveal some of my findings.

Area-based development and transforming neighbourhood of Monwabisi Park, Khayelitsha

An area-based development and partnership approach encourages people-centred design with environmental responsibility, social justice, and economic strength at the local neighbourhood scale. The approach looks at understanding and designing strategically located, impact-orientated public projects based on phased intervention possibilities. This is an unfolding and reinforcement of a 'commons'[4] as opposed to a 'plot burgage', within which peripheral space holds new ways of understanding emerging commons, networks, and hybridity in urban form.

VPUU works on an area-based approach to upgrading informal settlements (Ewing & Krause, 2021).

[3] Violence Prevention through Urban Upgrading (VPUU) Non-profit Company (NPC) has conducted research in peripheral urban settlements in South Africa.

[4] Iain Low in Palmer, Henrietta. The Language of the Becoming City. Making spatial justice from conflicts, commons, networks and hybridity. 2021, refers to the Violence Prevention through Urban Upgrading projects as 'commons'.

Monwabisi Park (MP) informal settlement is seen within the territory of the southern periphery of Khayelitsha and connected neighbourhoods of Harare and Kuyasa. It is a large informal settlement in the Southeast Metro District of Cape Town, commonly known as the Cape Flats.

VPUU has been active in MP since 2010 through partnerships between communities, interested stakeholders, intermediary organisations, and the local municipality, the City of Cape Town (CoCT). Monitoring and evaluating urban transformation in MP are considered a priority for continuous and open engagement between all parties. The approach supports inclusive participation including the capacity to deliver sustainable development goals (SDGs) aligned to Africa's Agenda 2063.

The idea in MP was to initially understand the context through a detailed analysis of the physical form, but at the same time a detailed baseline survey, including a social and safety lens, was conducted (and is reviewed annually). All existing movement networks and infrastructure were mapped using hand-held GPS systems with local community members. Through a co-design process and building on the baseline survey and spatial data, a community action plan, and a spatial reconfiguration plan (SRP) or public investment framework (PIF) were developed to direct public investment in the public realm. The focus has always been on future upgrading without relocation.

The framework guides future legal land recognition and incremental tenure (at block and neighbourhood scale), service delivery and housing scenarios. Urban blocks (often unusual in urban shape) define an alternative infrastructure and collective tenure systems. Streets are mostly walkways, interspersed with a network of small public spaces, known as 'emthomjeni' (Ewing & Krause, 2021) and safe access routes. Buildings are expressed as household dwellings, with often a rental option or potential for small-scale business (spaza, shabeen emerging creche or early childhood development centre).

Community-led 'off-grid' data collection on urban form in Lotus Park, Gugulethu

VPUU research in Cape Town highlights multi-layered, **open-source** mapping software and simple low-cost, digital monitoring techniques that can be used as design tools to define spaces for public intervention and monitor the activation of public spaces and buildings. This is often a field that is under-resourced and under-capacitated in peripheral settings (policy and practice) but holds immense value to urban morphology. Community-led 'off-grid' data collection and an evidence-based approach **demonstrates the reality of existing urban form and measures the impact of wicked problems in local environments. This includes ongoing enumerations, household surveys and social mappings, particularly at the building and street scale.**

In a neighbourhood called Lotus Park Informal Settlement in Gugulethu, resident-based information, social networks and local knowledge have been used to understand spatial informants but also to identify vulnerabilities and risks, assets, and capabilities to guide the co-design of a safe neighbourhood. **Digital mappings show the historical and changing building footprint at the neighbourhood and territory scale** of Lotus Park in the broader Gugulethu. Importantly, tracing and interpreting the growth of an incrementally growing precinct, including a community neighbourhood centre, and associated public space interventions have been a focus area in Lotus Park over the past 13 years. Critical to understanding the neighbourhood transformation is the reaction of the community to the implementation of community facilities and how the residents respond both in physical form and social practices (Ewing, 2021).

At the street scale, data has been collected over the years by community members, VPUU staff and design students to understand the small-scale micro economy of Lotus Park and the resultant urban

form, mainly interface conditions to the street. Intriguing to this process, however, is the constant change of the streetscape due to flux in the economy and the changing nature of access to finance and opportunity. Additional mapping of early childhood development (ECD) centres in both Lotus Park and the surrounding Section 3 neighbourhood of Gugulethu assisted in developing an approach to ECD intervention programmes and the building of an ECD centre in the neighbourhood precinct.

Education and the co-production of knowledge on urban form

A deliberate and engaged teaching and learning approach enables the co-production of knowledge between students, partners, and communities around the changing nature of the production of space and the current emerging urban form situated within the southern periphery. Local agency and an everyday culture (as explained by a local agent from Gugulethu) in occupied space reveal a dynamic urban change taking shape in township areas in Cape Town. It is here that self-built infrastructure overlays the rigours of engineered service delivery patterns and brings into question the role of the urbanist. Not only does this add a sociological dimension to urban morphology but it encourages debating the need for change in the study of urban form beyond the academy in the context of the southern periphery.

As part of a studio project, called Gugulethu Hope, in the Master of Urban Design (MUD) programme in the post-graduate programme in the School of Architecture, Planning and Geomatics (APG) at the University of Cape Town (UCT), researchers and students have been involved in the mapping of 'off-grid' data to understand and interpret the neighbourhood transformation and social infrastructure. As part of this process, a small public space, iThemba Walkway, has emerged as a changing and dynamic urban form (Ewing, 2022).

CONCLUSION

In summary, I argue that urban morphological approaches in the global south must be multi-scalar, relevant, valuable, and affordable. Larkham (2022, p. 3) argues, "Urban morphological approaches and analyses must be seen to be relevant, practicable, valuable, but also affordable. Past approaches have often been seen to be time-consuming, expensive, and perhaps not well communicated in forms of words that related well to these problems". This requires a critical reflection on not just change but flux, including stripping out of irrelevant principles and techniques and focusing on low-cost, low maintenance, sustainable artificial intelligence and labour-intensive ways of understanding the changing city.

Areas for future research include defining 'what is urban morphology on the southern periphery' as a potentially different approach to the conventional. This requires more in-depth understanding, data collection and review of the complexity of neighbourhood transformation in southern African cities. There are three areas of focus, first the rapidly expanding 'new' neighbourhoods (such as Peter Nanyemba in Windhoek, Namibia and others); second, understanding and mapping the internal incremental change within established informal settlements post-independence / post-apartheid (such as further detail on Monwabisi Park in Khayelitsha, South Africa and Epworth in Harare, Zimbabwe), including understanding modes of intervention and changing social practice and infrastructure investment; and lastly, unpacking and interpreting the changing physical form or 'infill' and space-mak-

ing practices of the everyday culture in the township fringe belt areas (such as Gugulethu township). I refer to this as mapping physical form and socio-cultural practice as 'off-grid'.

The future development of African cities needs to take a significant stand on the interdependence of morphological systems including socio-economic realities and the role of political action, local agency, and their relationships with urban from.

ACKNOWLEDGEMENTS

The paper scaffolds from a viewpoint published in SAJ, 2023. I would like to take this opportunity to thank Michelle le Roux for encouraging me to both write about urban form and attend the conference in Belgrade. Further acknowledgements extend to VPUU colleagues for their ongoing commitment to improving the quality of life in precarious neighbourhoods in South Africa. A word of thanks is given to my iThemba Walkway colleagues for their community commitment to change, particularly Xolile Ndzoyi.

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Planning x praxis: the evolution of three Brazilian urban regions

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ABSTRACT

The British idea of satellite cities associated with the proposal for urban decentralization was globally disseminated in the middle of the last century. It was also adopted and specifically adapted in the planning of three Brazilian regions - the northern region of the state of Paraná (1940s), the Federal District (1960s) and the northern region of the state of Mato Grosso (1970s). The three regions examined showed different levels of the activity of urban planning and control. This article explores what this means for current urban forms and for their future planning. What is evident today in these regions is a transformation from the original planning proposal, with a sprawling configuration differing from the one initially built. Therefore, it appears that the evolution of Brazilian satellite cities transformed the originally applied concept. The configuration of the city-region is related to the process of decentralization of the population, services, employment and the urban growth of the periphery, in its most generic sense. The tentacular urban form, opposed by the creators of the satellite town, reappeared in the urban sprawl of the cases studied here. However, this sprawl could favour the establishment of green areas in coexistence with urban occupation, indicating a possible path to a more sustainable future.

Keywords: urban form; regional planning; new towns; urban sprawl

INTRODUCTION

The British scheme for population decentralization and occupation of the territory through the creation of satellite cities was applied to the private colonization of northern Paraná from the mid-1940s. This colonization initiative had been initiated two decades earlier, by a British company that adopted the scheme of social cities for the joint planning of urban and rural areas. Thus, by 1944, nine cities were implemented for approximately 30,000 inhabitants, equivalent in form and in urban infrastructure, independent and equidistant, separated by a green belt and connected by the railway. After the nationalization of the railway in the mid-1940s, the Brazilian management of the enterprise implemented numerous smaller, interconnected and dependent cities. In this way, a less costly and

faster regional occupation resulted from the satellite cities scheme and urban hierarchization. This ensured the close relationship between city and countryside that had been envisioned since the beginning of the project (Rego and Meneguetti, 2010; Macedo, 2011).

Four main cities and several intermediate urban centres were planned. The main cities functioned as regional centres, arranged every 100 km along the railroad. The nine existing cities in conjunction with smaller cities and urban centres for 1,000 or 5,000 people were established between them at a distance of 10 to 15km. Together, regional centres, cities and small urban centres created an urban region, with interdependence and sharing of services.

These cities were implanted along the main ridge lines, where the roads were settled passed. They are located at prominent points of the relief and their original green belt coincided with nearby springs. The grid was the recurring pattern in the design of these cities. But the grid was always adapted to the site and customized with characteristic formal motifs, in order to generate unique urban forms. The rural subdivision that was implemented revealed a strong connection with the natural elements. Again, the grid was adapted to the geographical conditions, resulting in a more or less organic layout of 'almost' rectangular lots drawn from the ridges and watercourse lines.

The urban references mobilized for the organization of the territory of the Federal District in the late 1950s also included the notion of decentralization, low density and satellite cities. Thus, a polynucleated metropolis was delineated, dominated by a center, with dependent peripheral settlements (Derntl, 2016). The distribution of satellite cities in the territory partially followed the occupation and organization of rural space in the Federal District. Rural plots to supply the federal capital had been created on land beyond the Sanitary Belt of Brasília and a system of rural villages for agricultural production had been planned, offering a hospital, primary school, cinema and church. None of them was implemented, but their location served for the implementation of some of the satellite cities that came to be planned later.

The distribution of the satellite cities also prioritized the main access roads to Plano Piloto de Brasília [Brasilia's Pilot Plan]. Thus, the distances between these cities and the central area of the pilot plan vary from 15 to 40 km and their location around the federal capital is not regular. Although a certain logic can be found in the distribution of satellite cities in the territory, they do not appear to have been articulated or systematized in a coordinated territorial planning scheme (Derntl, 2016). Just as these cities did not comply with a system of general occupation as in the north of Paraná, nor did the definition of their areas and populations seem to have served any logic.

Brasilia's satellite cities share similar principles in their formal organization. Their layouts were shaped from certain pre-existing conditions, with an invariably regular and orthogonal design, modernist and, at times, symmetrical. In these urban designs, low density, functional sectorization and large blocks predominated. The notion of neighborhood unity appeared in some of them. In all of them, however, residential lots for single-family homes prevailed. In this sense, the satellite cities of Brasilia provided a kind of urban life intermediate between the rigidity of the radically innovative urbanization of the pilot plan and the conventional occupation of Brazilian cities.

These two experiences of urban and regional planning were references for the occupation scheme of the northern state of Mato Grosso in the 1970s. There, a principal city was planned, Sinop, and two small cities positioned 75km and 30km, respectively, away from the main city. The main city was defined as an urban center of convergence and a leading city, initially prepared to accommodate 20,000 inhabitants - and a few years later reconfigured for 100,000, while the others were originally planned to house approximately 5,000 residents each. Between these small towns, 'rural neighborhoods'

should have been built every six kilometers to serve religious and social life, primary education and agricultural production. If this scheme had been effectively implemented, an urban region would have materialized (Rego, 2015). The division of rural lots, also proposed there, guaranteed direct road and water access for all agricultural units, as in the north of Paraná. However, rural plots in the north of Mato Grosso were larger, reaching 120ha, and the plots around Sinop had areas of up to 290ha. Therefore, population density was lower and agricultural production was more extensive than those observed in northern Paraná.

Sinop is located along the Cuiabá-Santarém highway, while its two satellites are in a remote position, each connected to this highway by a secondary route. The town of Vera presents a linear configuration, with rectangular and square blocks arranged along a central avenue positioned in the interfluve. The Santa Carmem municipality has a similar shape, with a hexagonal perimeter. All of these cities have conventional residential plots arranged in regular blocks, with no distinction between neighborhoods or urban areas. The layouts of these cities differ from those presented in the colonization plan and support a population twice as large as that initially envisioned. In any case, they corresponded to the same type of settlement in the urban hierarchy. There is, therefore, a more extreme polarization than that seen in the hierarchical urban network of northern Paraná. Moreover, as in the satellite cities of Brasilia, these small nuclei did not interact with each other, but rather only in isolation with the leading city.

METHODOLOGY

Based on recent studies and on-site surveys, the evolution of these urban forms from the time of their implementation until the 2020s has been mapped. The drawings that represent the urban forms of the north of Paraná, the north of Mato Grosso and the surroundings of Brasília were composed of: (1) land parcels and road layouts; (2) occupation of the land with urban characteristics, country houses or condominiums outside urban perimeters; and (3) specific urban land use, namely, large industries or large institutional and commercial areas. In this mapping, special attention was given to the remaining natural green areas. The components that give rise to the corridors and green patches considered are: (1) remaining or reforested forest areas; (2) areas of parks or environmental reserves; (3) reconstituted riparian forest. These maps were constructed using, predominantly, the historical images tool of the Google Earth PRO software.

RESULTS AND DISCUSSIONS

In the north of Paraná (the two left images on Figure 1), the expansion of the two main cities was most evident between the years 1960-1990. With a high rate of urbanization (97%), the area between Londrina and Maringá houses an estimated urban population of 1,688,636 inhabitants (IBGE, 2020). This population increase has led to significant changes in the shape of this group of cities. State plans, based on the notion of development corridors, prompted the sprawl of cities along the logistical axes (Coimbra and Beloto, 2020; Ribeiro and Beloto, 2020). Suburbanization has become evident since the 2000s. Urban fragments not only sprawled along the main transport routes, but were also scattered over an increasingly larger area from the main cities. The effect of the cultural movements of ‘condominialization’ and ‘neo-ruralism’ is evident. The creation of a linear urban continuum can also be seen throughout the region, albeit to a lesser extent.

The urban area of the Federal District that was studied corresponds to almost 4,000,000 inhabitants (the two middle images on Figure 1). While Brasília grew 18% in the last decade, the urban population in the surrounding area increased by 26%. The polynuclear metropolitan structure gave way to an urban continuum guided by road transport lines. In the 1970s, occupation of an urban and peripheral character became predominant. More recently, some country house added to urban area are being converted into residential gated condominiums. The peculiarity of this urban tissue is the rate of permeability of the land that tends to zero. Recent verticalization, which is not seen in the Pilot Plan, has signaled that the landscape, which is still eminently rural, will soon change.

In the north of Mato Grosso (the two right images on Figure 1), in the first two decades after the Sinop implementation, the low quality of the infrastructure combined with the national economic difficulties of the 1980s meant that only agricultural activity could prosper. Deforestation for farming automatically spurred the extraction of wood and the establishment of the timber sector. Initially, primary economic activities and the low price of soil incentivized population of the region, intensifying livestock cattle production and extensive agricultural land use since 1985 (Chioveto et al, 2012). Sinop registered its highest population growth rate in the 1990s, with a 95% increase in the number of inhabitants in the municipality. As a result, the city expanded beyond the original project, even though it was not fully occupied.

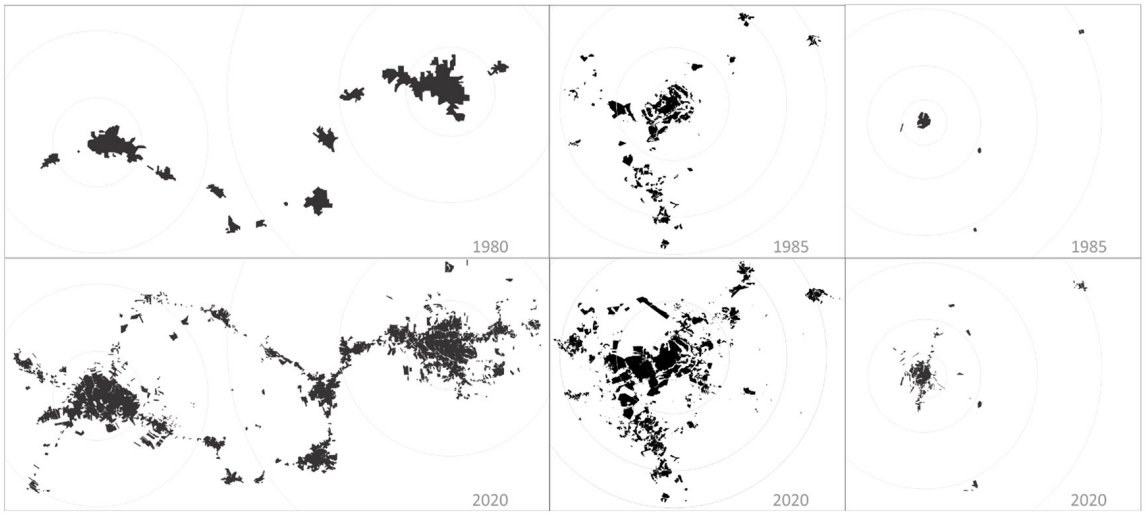

Figure 1. *North of Paraná, Brasília and north of Mato Grosso urban area. Source: Google Earth PRO*

Fragmentation at the Sinop border was formed from parcelling made after 1995. The region in which Sinop is located is one of the main grain producers in Brazil. Along with the specialization that occurred in agriculture, the city saw its GDP grow with the increase and improvement of the service sector, especially those related to education. The low level of articulation between the leading city and the satellite cities due to physical distance reinforces the primacy of Sinop in the regional context. The fact that there was no establishment of an "urban region" as proposed in the original project, in part, explains the territorial disarticulation between Sinop and the satellite cities.

The expansion of the cities in the three regions studied reveals the absence of an environmental planning model, which is evident in the economic ventures being done despite the particularities of the natural basis in the three biomes – Mata Atlântica, Cerrado and Amazonian Forest (respectively, left, middle and right images on Figure 2).

In the case of northern Paraná, the green corridor system is the ecological structure that sustains the region environmentally. The landscape reveals a mosaic composed of cultivation areas, urban areas and forests: while the urban ring highlights the ridges, the valleys shelter the forest reserves, in a condition similar to the model that Forman (1995:309) calls "Interdigitated". Nevertheless, the rural matrix facilitates the territorial expansion of the urban area.

Northern Mato Grosso exhibits a territorial matrix that oscillates between rural plots and large forested areas. The urban area, in itself, does not have a great impact on the constitution of this matrix, in which the deforested areas destined to agropastoral activities prevail, imposing a mosaic in the form of a "checkerboard" (Forman, 1995:309) with landscapes varying between predominantly rural and intact forest areas. Despite the decrease in the amount of deforested areas over the last fifteen years, compared to the 1980s and 1990s, this "checkerboard" is what enables the natural flow of the ecosystem, including connecting the urban area to the forested areas.

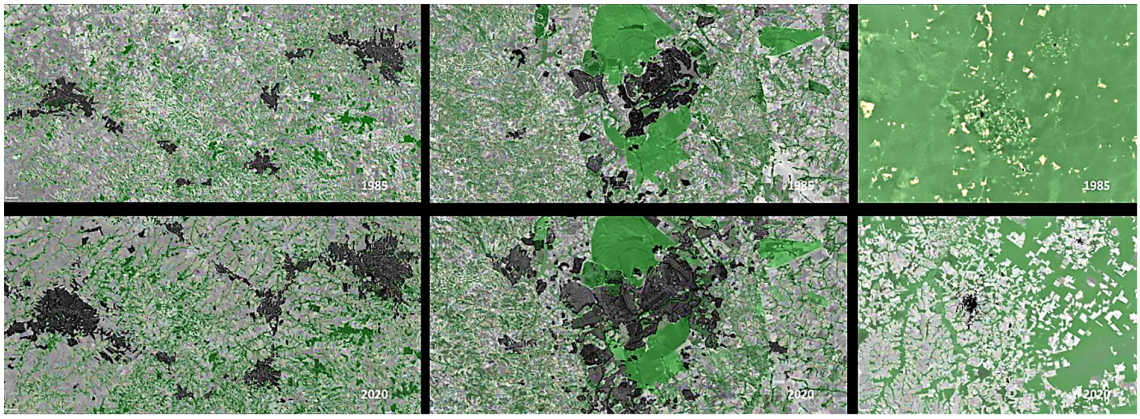

Figure 2. *North of Paraná, Brasília and north of Mato Grosso urban expansion x fragmentation. Source: Google Earth PRO*

Brasília and surroundings require a different perspective than the other cases presented because they belong to the Brazilian Cerrado biome, whose characteristics diverge from the dense forests of the Mata Atlântica and Amazon rainforest biomes. Large natural areas limit the urban area, at the same time that the road transport lines are vectors of growth and directly participate in its territorial configuration.

Road transport lines are, of course, the main drivers of the sprawl of urban areas. The advance of anthropic actions meant the retreat of natural areas. Suburbanization, in the way it presented itself, approximates the notion of city-region. The configuration of the city-region is related to the process of decentralization of the population, services, employment and the urban growth of the periphery, in its most generic sense. The tentacular urban form, opposed by the creators of the satellite town, reappeared in the urban sprawl of the cases studied here.

CONCLUSIONS

The original British idea, initially applied to these three Brazilian cases, consisted of a low-density urban form limited by the containment of a green belt. Roughly speaking, the green belt became green wedges. Springs were preserved with riparian forests, but urbanization enveloped them. In itself, this is not a bad thing, but the low density remained as long as the urban form extended over vast territory, forming conurbation areas.

Contemporary urbanism views urban sprawl in a negative light, however, here, it is also seen as an imminent risk to the natural environment and not only to human populations. The low densities that are sprawled over increasingly wider areas from the metropolises are the villains of CO^2 emissions due to extensive daily commuting between home and work. In addition, horizontal growth consumes arable land and makes urban infrastructure more expensive. However, this sprawl can favour establishment of green areas in coexistence with urban occupation. Current urban forms reveal as false the notion that nature is beyond the city. Cities have advanced and surrounded watercourses and forest reserves. Maintaining the possibility of coexistence with natural elements in order to allow natural processes to exercise their cycles in conjunction with human occupation, or even for the benefit of it, becomes imperative for the planning of cities and urban regions.

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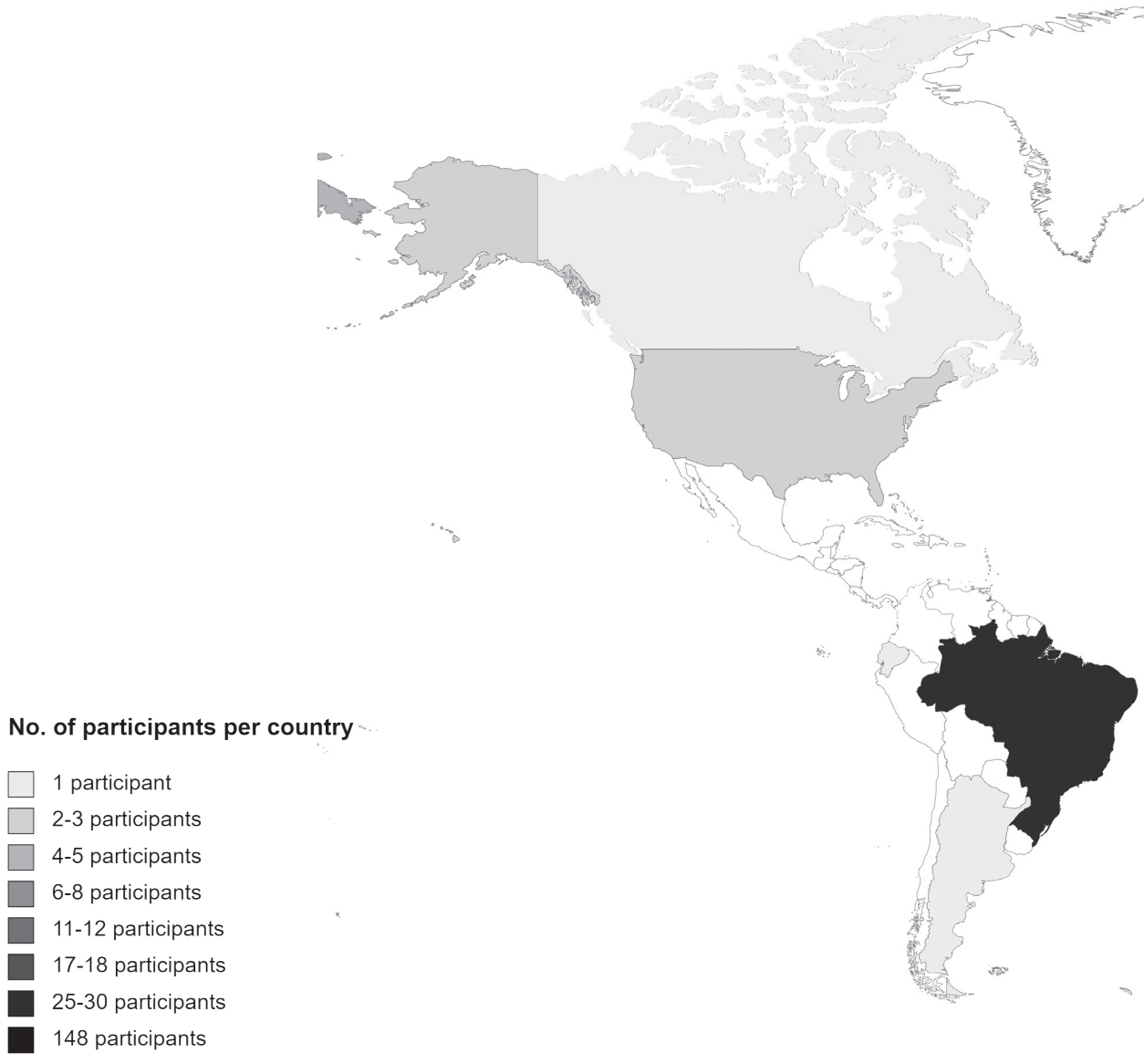
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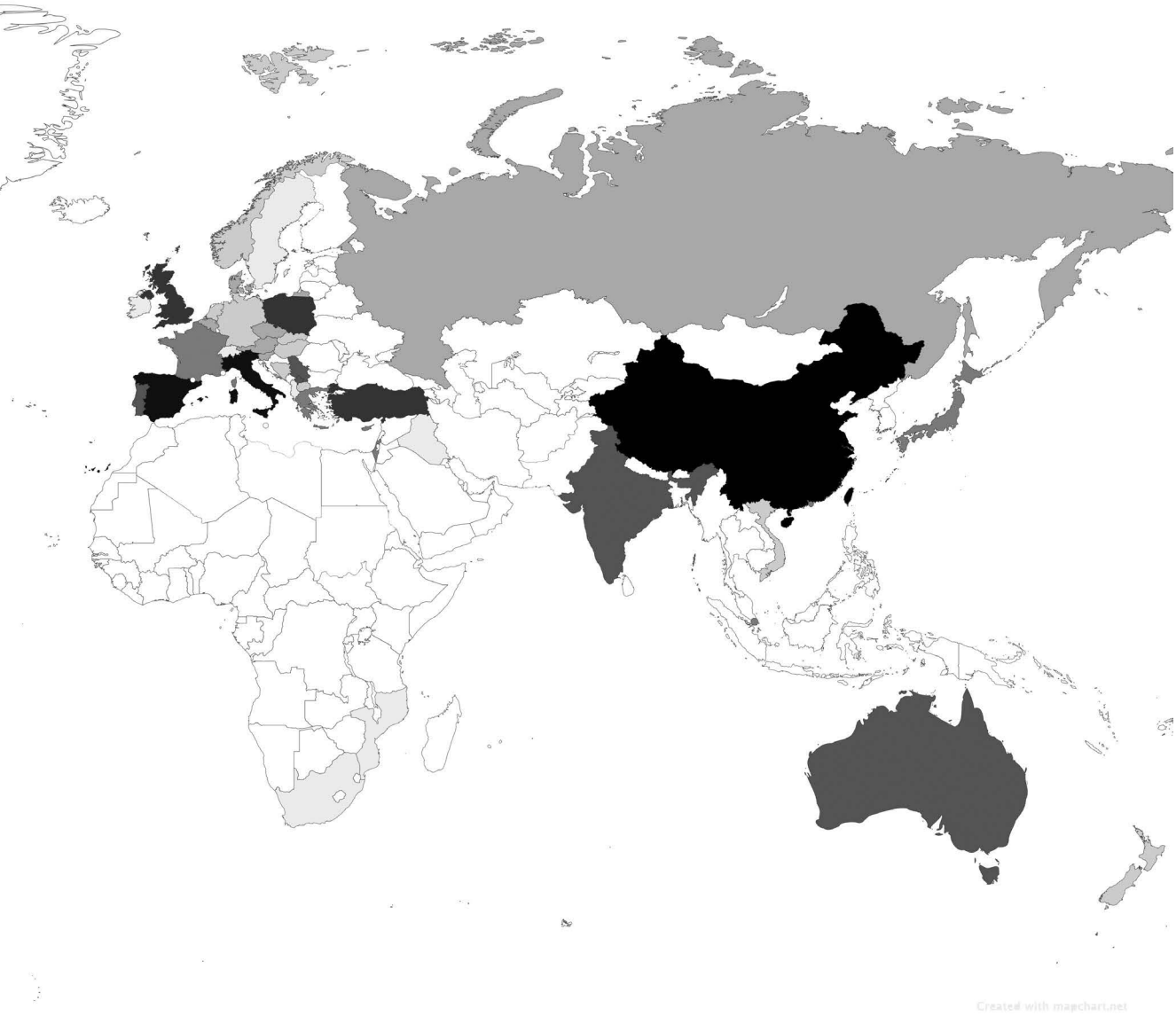
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CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

711.4.01(082)
711.4:005.591.6(082)

INTERNATIONAL seminar on urban form. Conference
(30 ; 2023 ; Beograd)
Praxis of urban morphology : conference proceedings. Part 1
/ XXX conference of the International seminar on urban form
(ISUF2023) ; [editors Vladan Djokić ... [et al.]]. - Belgrade
: University of Belgrade, Faculty of Architecture, 2023 (Beograd
: Birograf comp). - 175 str. : ilustr. ; 27 cm

Tiraž 100. - Napomene i bibliografske reference uz tekst.
- Bibliografija uz svaki rad.

ISBN 978-86-7924-341-6

a) Урбанистичко планирање - Зборници b) Градови
- Мултидисциплинарни приступ - Зборници

COBISS.SR-ID 129788169

Belgrade 2023