Encoding good urban form

The use of Urban MorphoMetrics in the elaboration of Local Design Codes for Asian cities

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SUSTAINABILITY THROUGH UNIQUENESS

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Encoding Good Urban Form: The use of Urban MorphoMetrics in the elaboration of Local Design Codes for Asian Cities.

English
2022

ISBN: 978-1-914241-17-8 University of Strathclyde Publishing

Encoding good urban form is the result of the collaborative work between UNICITI, a think tank focusing on sustainability and urban issues, and the Urban Design Studies Unit (UDSU), at the University of Strathclyde. It proposes an alternative way of designing Asian cities via the use of a systematic and replicable method of urban form investigation.

Suggested citation: Romice, Ombretta, Alessandro Venerandi, Kavya Kalyan, Nitin Bhardwaj, Vija Viese, and Sergio Porta. 2022. *Encoding Good Urban Form. The Use of Urban MorphoMetrics in the Elaboration of Local Design Codes for Asian cities.* Edited by Olga Chepelianskaia. *UNICITI. A Third Way of Building Asian Cities.* Glasgow, UK: University of Strathclyde Publishing. doi: https://doi.org/10.17868/79571

An electronic version of this report is available for download from http://urbanmorphometrics.com.

Cover: Kochi urban pattern

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March 2022

Acknowledgements

The authors are grateful to Olga Chepelianskaia, the founder of UNICITI, for creating the "Third Way of Building Asian Cities" programme that made this collaboration possible as well as for her continuous support and feedback. In addition, the authors would like to thank the UNICITI team for the organisational and technical support.

The research presented in this report would have not been possible without the contribution of the students of the Welsh School of Architecture, "Liveable Urbanism" Design Studio led by Dr. Shibu Raman who provided the necessary datasets.

The authors equally appreciate the input of other team members who worked on the project in the past: Alessandra Feliciotti, Sebastian Ugas, Ayushi Khare and Harshita Mishra.

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01

Introduction

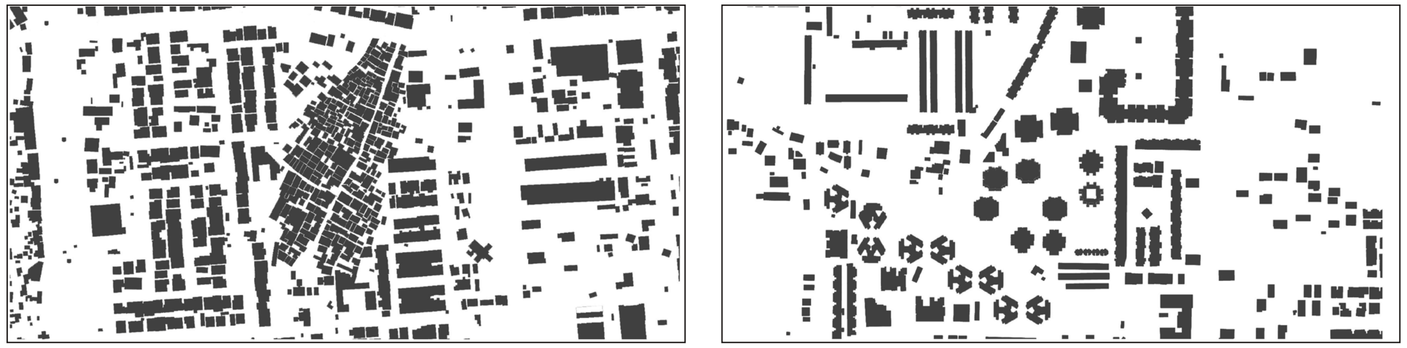
1.1. Call to action

In September 2019 UNICITI launched the initiative A Third Way of Building Asian Cities at the 55th ISOCARP World Planning Congress in Jakarta, Indonesia. UNICITI is an international consultancy and think tank, with the mission of 'helping Asian cities become sustainable, climate resilient, economically competitive, socially inclusive and culturally vibrant by reactivating their unique cultural and natural assets[1]. The "Third way" aims to overcome the a-contextual mass-produced practices of the "Business as Usual" (BAU) model as well as to provide an up-scalable and impactful alternative to the niche sustainable and local context tailored urban development which, despite often successful, only represents a tiny share of a city's urban fabric and risks having limited impact overall. In between these two ways, UNICITI's Third Way to urbanisation has called to action a network of international experts to build on break-through practices and assemble new knowledge and methods to **combine large scale urban development and design quality.**

It is in fact UNICITI's intention that a **Third Way** should be replicable and **scalable, as well as locally sensitive**, able to gain local support (and retain buy-in through development) and engaging (to enable delivery, share responsibility and capacity building): in other words, it **should work at XL and S scales**. Furthermore, it should be versatile enough to work in any urban settlement, city, up to nations and the whole of Asia. As a matter of fact, it should work anywhere. On this assumption though, we should remember that BAU tried to extensively apply conceptual and normative frameworks before, with often questionable results in several contexts (Remali et al., 2015). This is because BAU missed the capacity to link such general frameworks to specific places, local practices, economies and communities. The Second way on the other hand, albeit innovative and sensitive to place, doesn't scale up enough to achieve the now needed impact.

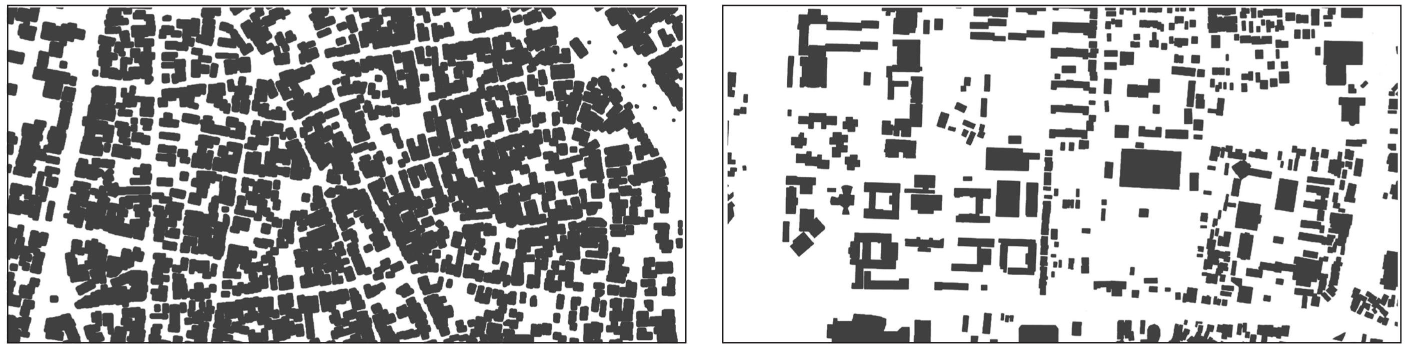
This report summarises the contribution of a group of experts from the Design Studies Unit (UDSU) at the University of Strathclyde led by Sergio Porta, an International Expert supporting the Third Way Program, and a team of 'Volunteers of Change' (professional urban Designers) engaged by UNICITI to this very ambitious program. Together, we have developed a proposal to UNICITI's 2nd Key Direction "Alternative urban development models". This consists of the vision for a **"New Planning Framework for Asian Cities"**

[1]https://www.uniciti.org



[1] (Left) Daulatabad Village in Faridabad, India. vs (Right) recently developed Sector 88, Faridabad, India

[2] (Left) Shanghexin Village, Shenzhen, China, vs (Right) residentail and commercial development in Shanghecun, Shenzhen China



[3] (Left) The Old Quarter - historical civic urban core of Hanoi, Vietnam, vs (Right) Cãau Giấay - Urban District of Hanoi, Vietnam

[4] (Left) Historical urban core of Amsterdam, Netherlands, vs (Right) Bijlmermeer neighbourhood, Amsterdam, Netherlands

Figure 1. Traditional vs Business as usual built form. *Source: Google Maps base, modified by authors.*

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(NPFAC), revolving around a next-generation evidence-based design coding system, the **"Third-Way Model Design Code" (TWMDC)**. The key-innovation in the latter is made possible by a cutting-edge research product of University of Strathclyde, an urban form analysis tool named **Urban MorphoMetrics (UMM)**. UMM is designed to allow bridging XL-scale of application with richness of information at S-scale, hence enabling a regional, national and potentially continental extent of locally sensitive design and community engagement initiatives.

1.2. Rationale

As part of this work led by the University of Strathclyde in Glasgow, we have decided to **invest in design codes** as key to our response to UNICITI's call, for both **practical and cultural reasons**. In urban development, Design Codes (DCs) are increasingly adopted to:

- improve the ability of planning systems to deliver good quality habitats, maintaining a degree of control on them long term;
- allow feedback and finetuning past the construction stage;
- calibrate design principles to context;
- When inclusively drafted, design codes also facilitate the buy-in of local stakeholders.

The UK, the first home of industrialisation, formalised town planning and public health as disciplines, with a long-established tradition in both planning practice and design codes, has recently embarked in a radical reformation of their planning system around a new **National Model Design Code** (2021). The Strathclyde Team has been researching how to link its work on UMM and resilient design (Romice et al 2020) within the DCs area of practice:
1) first, to fully exploit new capabilities of high-speed computing and big-data analytics to extend the geographic coverage of urban form analysis without losing detail of information along the way, and
2) second, to use this new detailed analysis as a rigorous base of evidence to inform current design practices.
As a Team, we therefore proposed to UNICITI to lead a pilot application, effectively a proof of concept, to demonstrate how the analytical innovation allowed by UMM can trigger a whole set of new opportunities in the planning practices of Asian cities, by way of a UMM-enabled new DC system: the **"Third-Way Model Design Code" (TWMDC)**.

Box 1. The UK National Model Design Code – An important reference

Urban design codes (UDCs), the regulatory statements attached to masterplans, have been and are widely used to help shape the future evolution of urban form and make our cities more viable, efficient, sustainable and satisfactory. Still, their full potential iremainlimited for a number of reasons, including who defines and sets them; which elements of urban form should be coded and which should not and consequently what they should regulate, and on what ground of evidence. Yet, they are generally understood to be beneficial across the management, design, delivery and community engagement elements of local urban development processes.

Because of these benefits, in 2021 the National Planning Policy Framework (NPPF) has established that all local planning authorities in England should prepare design guides – or codes – consistent with the principles set out in the National Design Guide and National Model Design Code, to reflect local character and sustainable design principles. Like all UDCs, the NMDC (Department for Levelling up, 2021) is based on the assumption that cities are made of areas that are consistently identifiable by way of their distinctive visible form, which is linked to the way they are used. In the NMDC language, these are named "area-types". The success of the NMDC lies then in being able to: a) set a description of the physical form of cities such that area-types can be in fact reliably identified on the ground; b) relate area-types to how places actually work locally, and c) set a system of prescriptions (codes) accordingly.

Figure 2. The UK National Model Design Code (NMDC). *Source: NMDC.*

The capacity of design codes to steer development towards quality that urban communities can relate to, relies on their ability to distinguish and tailor geographic coverage, detail of information and degree of prescription to the circumstances and scale of change in each place, and allow a suitable degree of variety. This means, the quality of the design code is deeply tied to the quality of its input information: the analysis of urban form.

02

New Planning Framework for Asian Cities (NPFAC)

2.1. Introduction

We propose a **New Planning Framework for Asian Cities (NPFAC)** that is based on two distinct and sequentially related decision-making processes. The first is named **Third Way Model Design Code (TWMDC)**, and works at the XL-scale of entire metropolitan areas, urban regions, the national space and beyond. The second is named **Local Area Plan (LAP)**, and works at the S-scale of the urban district, municipal ward, neighbourhood and individual development.

We demonstrate the innovation potential of the TWMDC through its application to the Indian city of Kochi. In the following sections, we briefly introduce the proposed NPFAC as a whole, and subsequently its XL-scale component, the TWMDC, along with its analytical "engine", the UMM. In Section 3 we illustrate the "Kochi Demonstration Project". **In this demonstration, the evidence-based design coding system is put at work in the city of Kochi, the capital of the state of Kerala in the south-west of the Indian subcontinent.**

The TWMDC is essentially a supra-local system to support decision processes that occur locally. Such local processes, here referred to as Local Area Plans (LAPs), are positioned in the NPFAC context and described in the next Section 2.1. However, they are not part of this demonstration exercise undertaken for UNICITI, hence are not detailed nor demonstrated in this report (they might become subject of a further collaboration between experts and UNICITI in the future, pending travel capacity and funding). "Masterplanning for Change" (Romice, Porta, Feliciotti, 2020) illustrates the approach that LAP could adopt, where theoretical principles on how to navigate the seemingly unresolvable opposition between design and change are also presented.

NEW PLANNING FRAMEWORK FOR ASIAN CITIES (NPFAC)

The Third Way Model Design Code (TWMDC)

XL

1. Urban Morphometrics (UMM)
- Data Preparation, morphological tessellation and primary metrics computation
- Classification of Urban Types
- Profiling
- Design Coding

L-M

2. Validation
- Socio Economic analysis
- Correlation analysis
- Interpretation

The Local Area Plan (LAP)

M

3. Local Engagement
- Local urban Workshop
- Generative Design

S

4. Local Urban Code (LUC)
- Surveying the local preferences
- Surveying locally validated urban characters

5. Masterplan
- Masterplan Design
- Place design
- Regulatory framework and plot passport

Figure 3: New Planning Framework for Asian Cities (NPFAC). Highlighted: parts tested in the Kochi Demonstration Project, illustrated in Section 3. *Source: Authors.*

2.2. The New Planning Framework for Asian Cities (NPFAC): The Third Way Model Design Code (TWMDC) and the Local Area Plan (LAP)

In this section, we offer a synthetic illustration of the NPFAC. The workflow consists of two main steps:

1) The **Third Way Model Design Code (TWMDC)**, at **XL-scale** of the metropolitan, regional, national and supranational space; this is based on the **UMM**, a quantitative approach developed at the University of Strathclyde for the detection and measurement of patterns of urban form across scales. It is done remotely; our team is currently working on a portfolio of analyses at the national scale, as well as establishing a protocol for its application by other researchers to generate a comprehensive World Atlas. At this stage of development, it requires technical expertise and would therefore be provided in advance to local teams.

2) The **Local Area Plan (LAP)**, at the S-scale of local urban places and communities, is based on the outcomes of UMM and can be used for the collaborative co-production of development strategies and design solutions. Local planning authorities can use LAP to develop or commission masterplans for selected areas, as well as design codes for their implementation. LAP can also be used by planning professionals and authorities to efficiently engage with local communities and groups to discuss local character, assets and alternative scenarios for development. By combining reliable place analysis via UMM with contextually sensitive development and coding, the general planning process can become more efficient and faster, without losing quality or overlooking local dynamics. This is crucial for sustainable development, capacity building and for instilling a sense of place identity, important for its positive and inclusive use and management.

The Third Way Model Design Code (TWMDC)

1. Urban Morphometrics

- **Data preparation, morphological tessellation and primary metrics computation:** we first mine, check and clean the UMM required input information layers in Python and GIS environments. These are limited to building footprints (and the street network when available). From this input, we first, automatically generate morphological cells (Voronoi-based proxies for plots or cadastral parcels); then, we derive a comprehensive set of metrics of urban form for each cell, in a number that depends on the quality of the available input information.
- **Classification of urban types.** We use clustering to summarise the information of this large set of metrics in distinct homogeneous patterns of urban form, or "Urban Types" (UTs). These UTs are then presented in a numerical taxonomy map and similarity graph (dendrogram).
- **Profiling.** We extract from each UT its unique morphometric profile, i.e. the UT-specific set of values extracted from the original metrics that characterise it. Since each UT's profile is numerical, UTs can then be statistically compared, revealing patterns of similarity (or diversity) beyond what is visible to the naked eye.
- **Design coding.** A design-oriented subset of metrics (i.e. only those considered useful to guide design, as illustrated in Section 3 is then compiled for each UT to reflect its local character, in collaboration with stakeholders and designers. Each UT is then illustrated via a set of examples (UTs are not geographically identical, rather they vary slightly across, giving a 'lived-in' character to the areas they occupy), to provide a range of possible interpretations and applications of it useful for future design. This constitutes, in effect, a design code, which is made available at XL-scale for each UT of interest, to inform further design and community engagement of Local Area Plans (LAP).

2. Validation

To strengthen the validity of the UTs as design codes, it is useful to test them against how they perform on the ground. We do so by observing how they correlate with socioeconomic and environmental patterns. The correlations will depend on resources and skills available, ranging from statistical to anecdotal or a combination of both.

- **Socioeconomic and environmental analysis.** A set of social, environmental and economic aspects for the territory under scrutiny should be obtained from open data repositories or in collaboration with local agencies.
- **Correlation and modeling analysis.** Their relationship with the UTs is then investigated through correlation and spatial regression models.
- **Interpretation.** The outcomes of these analyses are then discussed with local stakeholders, to ascertain the role of urban form in relation to socioeconomic and environmental performance. This process is iterative and aims at selecting as codes those urban forms that perform the best against the aspects under examination.

Core parts of the TWMDC described above were tested in a proof-of-concept exercise conducted in the city of Kochi, India. In particular, the whole UMM analysis was experimented. The results are reported in Section 3 of this report. Some informal validation was also carried out, however it could not be meaningfully completed in the timeframe of the UNICITI initiative due to Covid-19 travel restrictions.

The Local Area Plan (LAP)

The LAP phases uses the knowledge gathered with UMM and works on it through local engagement, goal setting and design.

3. Local Engagement

- **Local urban workshop.** On the ground of the TWMDC, local authorities organise local workshops around specific communities, development opportunities and urban themes. Development agendas are generated with local stakeholders and development areas identified.
- **Generative design.** As part of the Local Urban Workshop, sessions of generative design can be performed according to the design codes generated via UMM at TWMDC level. This involves stakeholders and communities in quick design-based exercises aimed at focusing attention, generating momentum and building social capital into the local process.

4. Local Urban Code (LUC)

- **Surveying local preference.** Community-led sessions are performed to ascertain what are the desirable urban form characters and, accordingly, the "model" UTs of preference for the local community. This can be extended up to the national scale to include best practices, or desirable UTs to use as guidance and reference for design.

- **Surveying locally validated urban characters.** Surveys are conducted on samples of the selected model UTs, to complement the TWMDC characterisation with locally validated information. These model UTs constitute the Local Urban Code, a collection of reference/desirable urban forms, described in detail in all their typical physical features (e.g. location in relation to the street network, typical density bands etc). Each model UT is described by integrating information from the TWMDC with the one locally extracted from selected samples. UTs are then locally re-profiled according to this integrated base of information.

5. Masterplan

- **Masterplan Design.** Following the guidance set in the LUC, and the outcomes of local engagement, design exercises at the masterplan level are conducted and validated locally. Needless to say, these must fit into the local/regional/national planning process. For this, we also recommend guidance, in the form of resilient design, as described in Romice et al. (2020).
- **Place Design.** Special places are further detailed in terms of their expected environmental and architectural characteristics (ibid.).
- **Regulatory Framework and Plot Passport.** Spatial rights and obligations are defined for the overall intervention and individual plots (ibid.).

As part of the Kochi Demonstration Project, a proof of concept of generative design was tested to simulate Stages 4 and 5 (see Section 3.3 of this report).

2.3. Urban MorphoMetrics (UMM)

In this section, we "zoom" into the UMM analysis, which is part of the TWMDC. This is, in fact, an essential part of the process in that it carries its main technical and operational innovation. The application of UMM to the city of Kochi, in India, is illustrated in detail in Section 3 of this report; here, we offer some information about its main motivation and the science behind it. This introduction to UMM is necessarily very synthetic. The interested reader is welcome to scrutinise it further in the available scientific literature in the Bibliography Section (Fleischmann M 2019; Fleischmann M, Feliciotti A, Romice O, et al. 2020; Fleischmann M, Romice O and Porta S 2021a; Fleischmann M, Feliciotti A, Romice O, et al. 2021b; Porta S, Venerandi A, Feliciotti A, et al. 2022; Venerandi A, Romice O, Chepelianskaia O, et al. 2021).

UMM is a research innovation produced at the Urban Design Studies Unit of the University of Strathclyde in 2019. The method allows the numerical classification of urban form in a systematic, comprehensive, rich and scalable way. From extremely parsimonious input data (i.e. buildings and street network), UMM generates a detailed numerical description of urban form via unsupervised and replicable data processing techniques (Box 2). Agglomerative hierarchical clustering is applied to a large set of morphometric characters to identify areas that are consistently characterised by similar morphological patterns (UTs). UMM therefore helps to understand the local character that makes places distinctive, at the small and large scales, as well as those that they share.

Box 2. UMM – Description, Identification and Profiling

The UMM workflow has three steps:
First, we describe urban form. We start with parsimonious input information: building footprints and street network. From these two, we generate a rich set of 300+ urban form numerical descriptors of three morphometric elements, buildings, streets and geometrically defined cells (Fleischmann et al., 2021a), working as proxies of plots (cadastral parcels). These descriptors are organised in six distinct categories (dimension, shape, spatial distribution, intensity, connectivity and diversity), over three scales of observation (small, medium, and large) (Fleischmann et al., 2021b). All descriptors are attributed to cells.

Second, we use clustering to summarise the rich set of descriptors in distinct UTs. These are then organised in a map where cells (and buildings) are colour-coded according to their respective UT. The hierarchical structure generated via clustering allows the investigation of similarities across UTs, such that lower-level types are entirely contained in higher-level ones.

Third, we profile UTs by computing summary statistics based on the descriptors and visualising their urban form at different levels of detail. We may "zoom out" to the entire UK and classify three types only, for example "urban compact", "suburban sprawl" and "dispersed rural". Or, we can "zoom in" and distinguish—say— four or eight distinct subtypes of the same "urban compact" higher type. We can keep "zooming in" or "out", every time revealing different geographies at different scales. Importantly, we can access a UT profile, where the physical patterns are reported in numerical form, at each level.

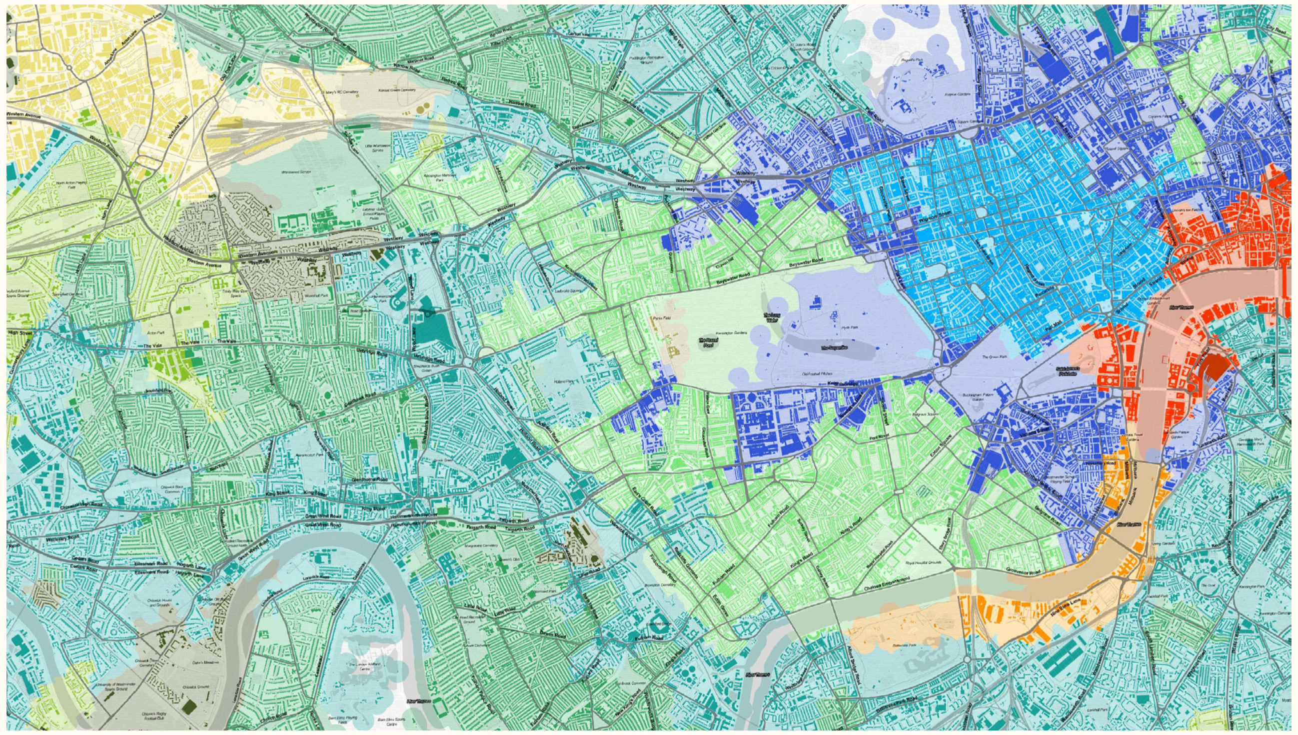


Figure 4. Taxonomy map showing the Urban Types (UTs) of London. *Source: Authors.*

03

Applying UMM to Kochi

3.1. Introduction

We have tested parts of the New Planning Framework for Asian Cities (NPFAC) sketched in Figure 1 in a "proof of concept" case study in the city of Kochi (India). In particular, the steps of workflow tested in Kochi (highlighted in Figure 3), were: 1) the whole UMM analysis workflow, and 2) a generative design session. The work was conducted entirely from distance: while that did not affect the UMM element, which is designed to be applicable from distance at XL-scale, the generative design test clearly could only be implemented in a simulation mode, without any local interaction. What is represented in this section is therefore only a technical experimentation of the design potential of the coding system generated in UMM: its results should not be confused with those of a complete Local Urban Code, for which the local engagement is fundamental.

All details of this test work in Kochi have been recently published (Venerandi et al 2022). In the following we present an overview of its main rationale and outputs, with some further materials produced after the publication.

The Kochi experiment has proven particularly useful for the following reasons:

- The city is **large in size and extremely diverse.** Through the test, we have been able to show that UMM can identify several distinctive UTs of historic and functional significance.
- The test has been carried out with **largely sub-optimal data input**. The only information available at sufficient level of quality in Kochi was the building footprint layer. Therefore, no building height nor street network information were used. Nevertheless, out of an informal process of validation conducted with colleagues holding first-hand experience of the city, the resulting classification seems to match some relevant historic, economic and social patterns;
- Despite the limited number of metrics that we were able to generate from the sole information available, that of building footprints, the coding system resulting from the UMM workflow proved surprisingly sufficient to support a meaningful generative design session. The aim of this design exercise was to check to what extent the UMM coding would have proved capable to guide different designers to create design proposals which: 1) despite stemming from the same UT, would be always different from each other, and nevertheless 2) would have all shared the essential intangible quality of place of the UT of reference.

Below is a summary of the process we conducted in the test.

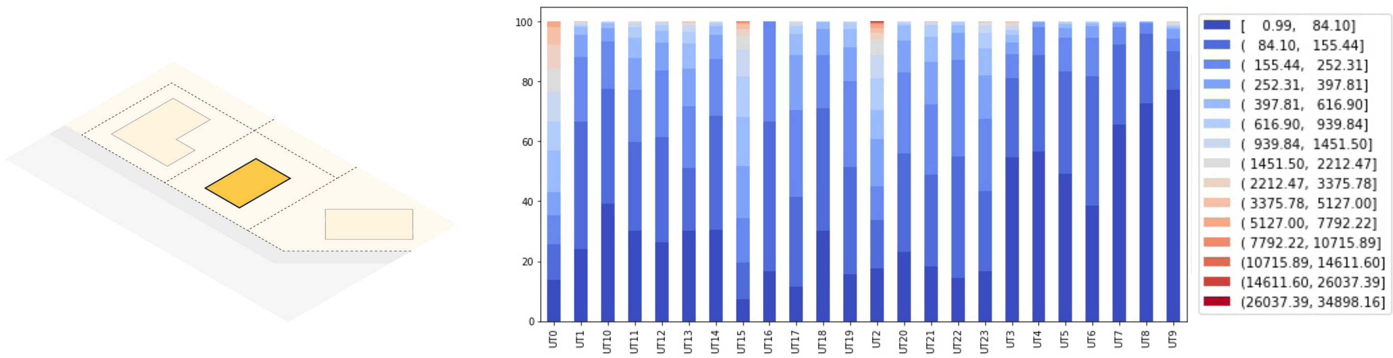
Figure 5, 5a: Kochi in India, 5b: Kochi as figure-ground. *Source: Authors.*

3.2. The Taxonomy of Kochi's Urban Form

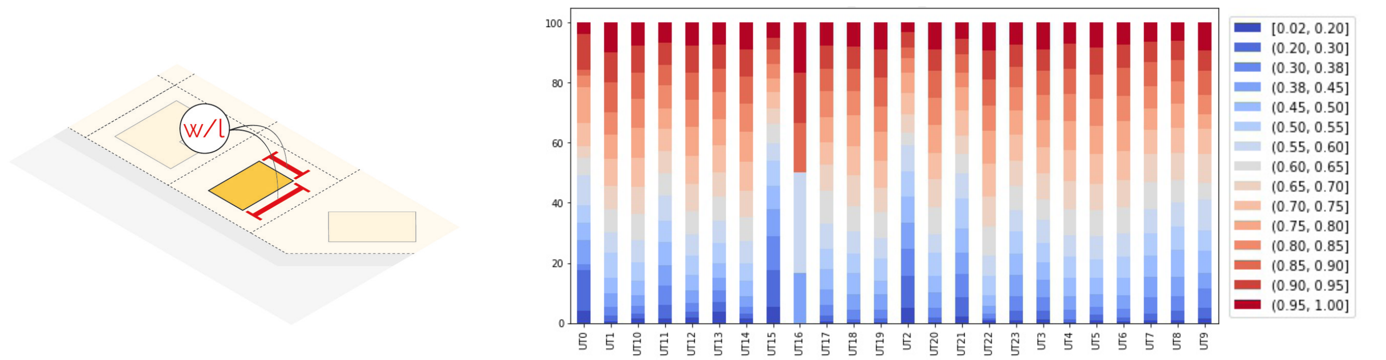
Preparing for design: mapping and profiling the city with UMM

Kochi, an overview. Started as a port city and key node in the spice and silk trade route, the city is today a cluster of islands connected to mainland Ernakulam (Liveable Urbanism, 2021). It contains both traditional informal areas, where trade originated (i.e. the Mattancherry area, with small warehouses along the waterfront and small compact residential buildings inland) as well as formally planned areas developed after 1498, where colonial influence is evident (i.e. Forth Kochi). It developed further in the post-independence period (i.e. Ernakulam, with dense purpose-built market areas surrounded by new residential neighbourhoods), and more recently saw large scale infrastructural development which followed economic liberalisation. At this time, Kochi expanded further inland and to neighbouring islands and villages with commercial and retail developments of high rises with large footprints on large blocks and the infill of all areas in between. Its large water-based economy, and water dependent management have also contributed to a distinctive pattern of development especially along coast line.

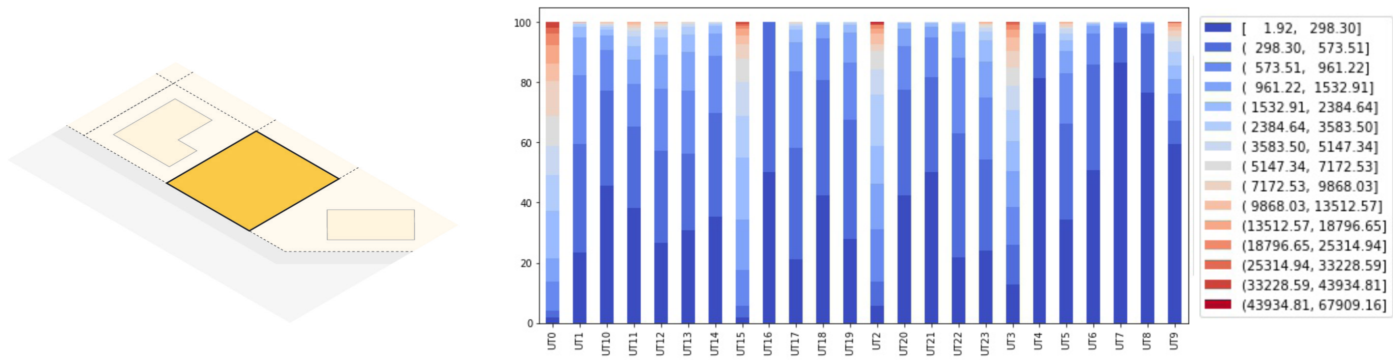
UMM of Kochi. Due to the data constraints already highlighted above, only 26 of the 74 primary characters normally generated were computed, leading to a total of 104 contextual characters. By applying agglomerative clustering to the latter, 24 urban types (UTs) were identified for the case study. Two specific UTs, characterised by high internal heterogeneity, were clustered further to better distinguish sub-patterns. The possibility of 'drilling down' with increasing precision specific UTs, and then "insert" results within the broader classification demonstrates that the process is suitable for complex environments, and can be used iteratively to refine interpretations. After engaging with some colleagues with direct experience of the place, UTs were checked against the city's historical development and land uses. This initial feedback confirmed UMM's ability to identify and measure, even from very sub-optimal input data, subtle variations in urban form effectively and with precision.



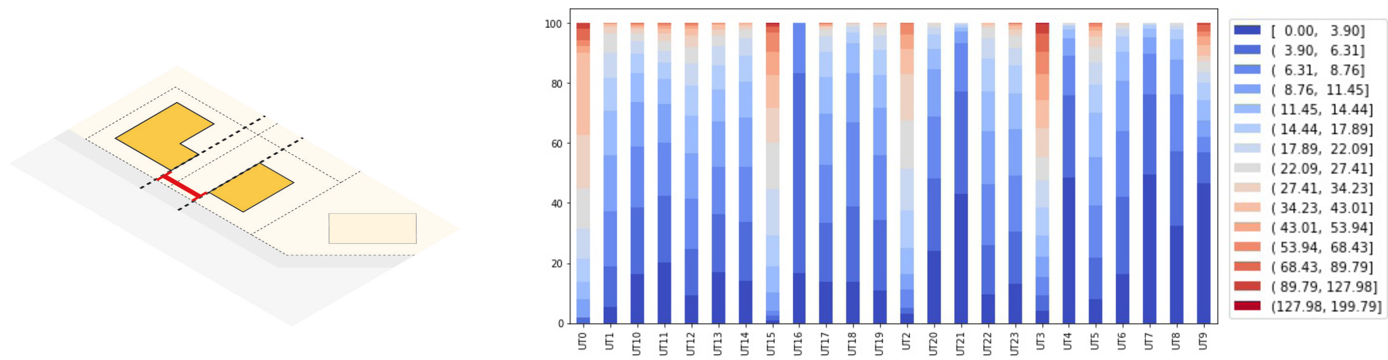
Building footprint



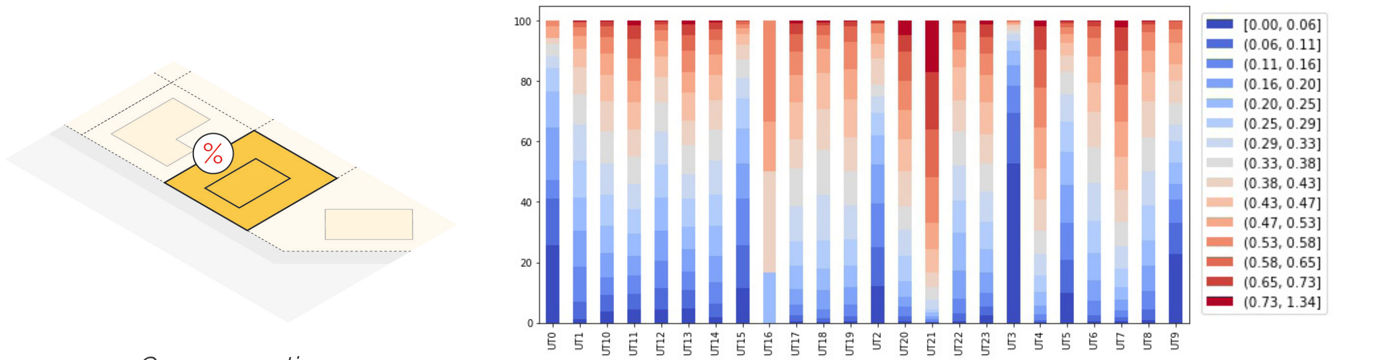
Building elongation



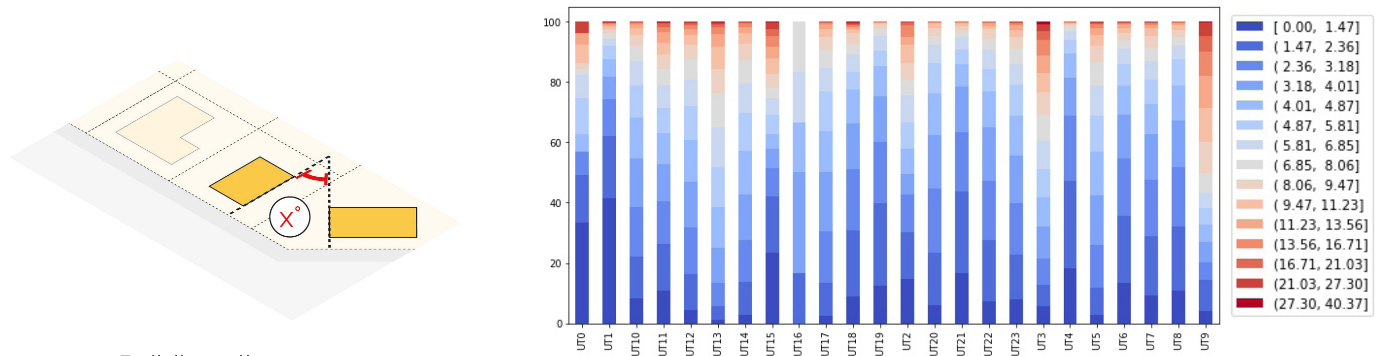
Plot size



Mean distance between buildings



Coverage ratio



Building alignment

Figure 6. Key primary metrics used in the Kochi case and their profiling charts. *Source: Authors.*

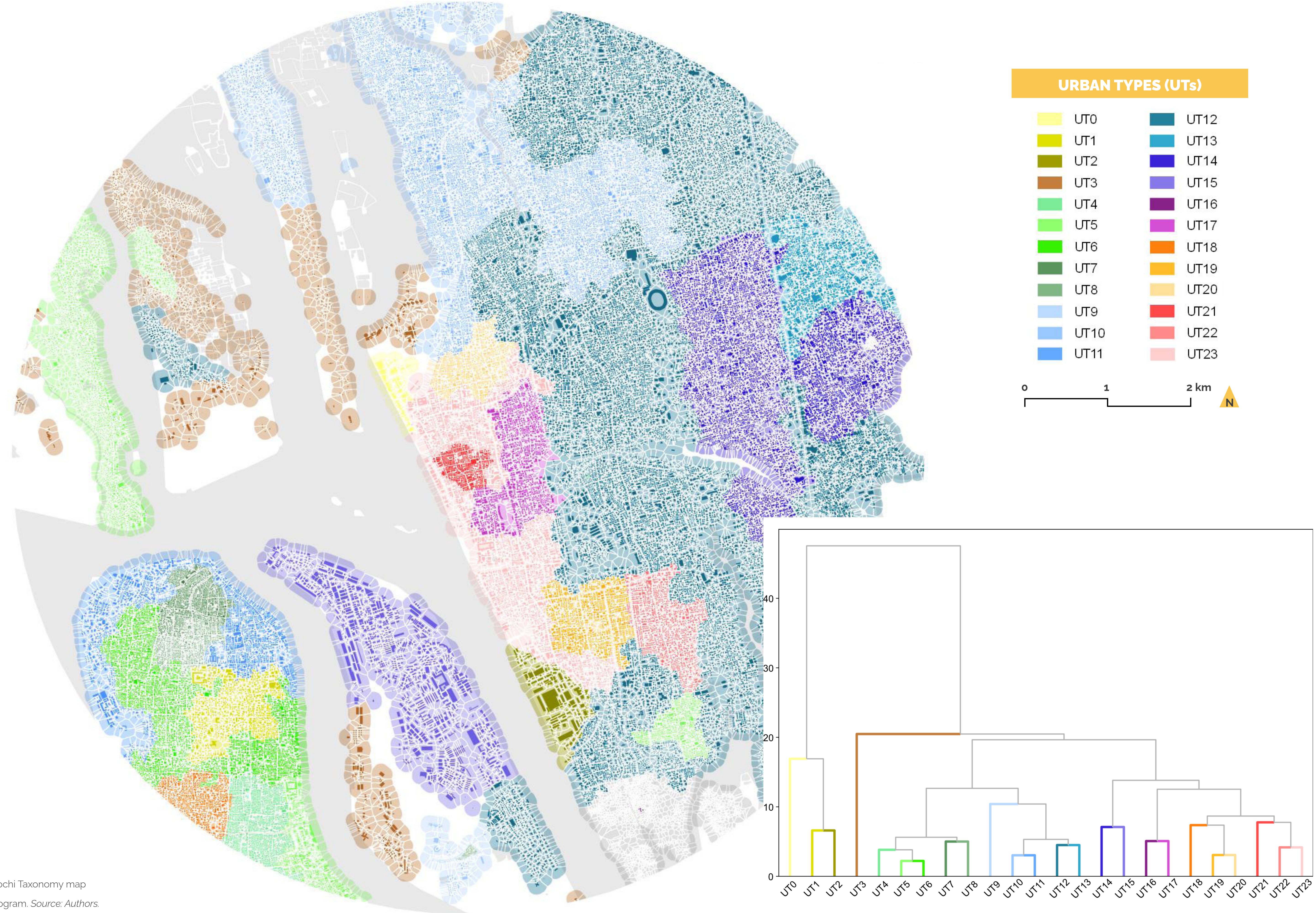


Figure 7: Kochi Taxonomy map and Dendrogram. *Source: Authors.*

Being able to recognize and locate different UTs is important, but for operative and design purposes, it is also crucial to describe them through specific, distinctive traits. Therefore, we **extracted for each UT its own unique morphometric profile,** a sort of "ID" of its most discriminatory (salient) physical properties. The UTs characters utilised in this UMM test to instruct the coding and the design exercises, were selected out of the whole set for their ability inform and guide design: we selected six physical properties in particular based on expert opinion and literature review of the most common indicators used in Design Codes and, in particular, in the UK Model Design Code (2021). These metrics - plot area, coverage ratio, building footprint, building elongation, alignment to surrounding buildings, and mean distance between buildings are in fact generally comprehensible and meaningful to urban designers.

CA intervals	% cells	CR intervals	% cells	BF intervals	% buildings	BE intervals	% buildings	ASB intervals	% buildings	MDBB intervals	% buildings
[24.60, 336.09]	29.70	[0.01, 0.06]	1.26	[12.02, 78.95]	20.15	[0.07, 0.20]	0.59	[0.00, 1.43]	40.59	[0.82, 3.67]	4.30
(336.09, 650.88]	36.59	(0.06, 0.11]	5.63	(78.95, 145.13]	42.00	(0.20, 0.31]	1.93	(1.43, 2.31]	20.59	(3.67, 5.95]	12.81
(650.88, 1,080.39]	20.22	(0.11, 0.16]	11.63	(145.13, 234.55]	24.07	(0.31, 0.39]	3.78	(2.31, 3.12]	12.07	(5.95, 8.33]	17.04
(1,080.39, 1,677.60]	9.33	(0.16, 0.20]	12.30	(234.55, 371.63]	8.30	(0.39, 0.46]	5.33	(3.12, 3.95]	8.15	(8.33, 10.96]	17.85
(1,677.60, 2,515.36]	2.89	(0.20, 0.25]	10.89	(371.63, 585.08]	3.56	(0.46, 0.52]	5.33	(3.95, 4.83]	5.70	(10.96, 13.91]	17.11
(2,515.36, 3,689.55]	0.59	(0.25, 0.29]	12.37	(585.08, 910.02]	0.59	(0.52, 0.57]	8.52	(4.83, 5.78]	4.74	(13.91, 17.34]	10.96
(3,689.55, 5,266.39]	0.37	(0.29, 0.33]	11.70	(910.02, 1,430.61]	0.81	(0.57, 0.62]	6.59	(5.78, 6.84]	2.44	(17.34, 21.52]	9.56
(5,266.39, 7,385.03]	0.07	(0.33, 0.38]	9.56	(1,430.61, 2,212.47]	0.30	(0.62, 0.66]	6.81	(6.84, 8.06]	1.93	(21.52, 26.72]	6.59
(7,385.03, 10,282.65]	0.07	(0.38, 0.42]	8.74	(2,212.47, 3,423.68]	0.07	(0.66, 0.71]	7.11	(8.06, 9.53]	1.41	(26.72, 33.26]	2.30
(10,282.65, 14,106.60]	0.00	(0.42, 0.47]	5.85	(3,423.68, 5,308.78]	0.07	(0.71, 0.75]	8.37	(9.53, 11.39]	0.89	(33.26, 41.53]	1.04
(14,106.60, 19,523.60]	0.15	(0.47, 0.51]	4.00	(5,308.78, 7,792.22]	0.07	(0.75, 0.80]	7.63	(11.39, 13.81]	0.59	(41.53, 52.31]	0.30
(19,523.60, 26,922.44]	0.00	(0.51, 0.56]	3.48	(7,792.22, 10,715.89]	0.00	(0.80, 0.85]	7.56	(13.81, 17.03]	0.37	(52.31, 67.13]	0.07
(26,922.44, 35,608.03]	0.00	(0.56, 0.63]	1.56	(10,715.89, 14,611.60]	0.00	(0.85, 0.90]	9.85	(17.03, 21.37]	0.22	(67.13, 87.98]	0.07
(35,608.03, 48,659.49]	0.00	(0.63, 0.71]	0.89	(14,611.60, 26,037.39]	0.00	(0.90, 0.95]	10.07	(21.37, 27.66]	0.15	(87.98, 118.10]	0.00
(48,659.49, 67,909.16]	0.00	(0.71, 1.34]	0.15	(26,037.39, 34,898.16]	0.00	(0.95, 1.00]	10.52	(27.66, 40.37]	0.15	(118.10, 199.79]	0.00

Table 1: Morphometric profile of UT 1 (refer fig 7) *Source: Authors.*

GENERATIVE DESIGN WORKFLOW

This is the procedure we followed to **demonstrate** that it is possible, using only a handful (6) of UMM metrics, to replicate the typical grain of any UT. Most importantly, that our workflow generates a range of possibilities, each with its own merit and rationale. Therefore, generative design is not deterministic but allows **interpretation** and adjustment. It is, at all effects, a starting point for discussion for locally significant design.

A. Selecting the sample site.

- Starting from a chosen UT which we want to 'replicate' as a test, we identify an area within it of at least 100 existing buildings, large enough to reveal diversity of its urban form.
- We 'clear it' of existing buildings. This is our site to design.
- We draw the site boundary (from the middle of streets or open spaces).
- We calculate its area in m2

B. Calculating built density.

- From UMM, we use the UT's distribution of plot sizes to calculate its median plot size
- Then, we use this measure to calculate the total number of buildings to use to populate the sample site.

C. Producing the buildings as grain.

- We use the distribution of building footprints and their elongation ratios to generate the set of building envelopes that will populate the sample site
- The necessary number of each character is generated and they are paired - either randomly or by replicating the existing forms (eg. small buildings are more compact).

D. Observing the urban type.

- A more traditional visual observation of key urban features provides a sense of how that specific UT works - i.e. how are land uses distributed, how streets align to streets, how are green and open spaces placed and how are they defined by buildings.

E. Generating new design.

- Finally, we populate the test site with the set of building envelopes from Step C, following any typical pattern identified in Step D (i.e. continuing the existing street patterns of major roads; maintaining any typical alignment and distances between buildings based on their size, abutting on streets of a certain value etc).

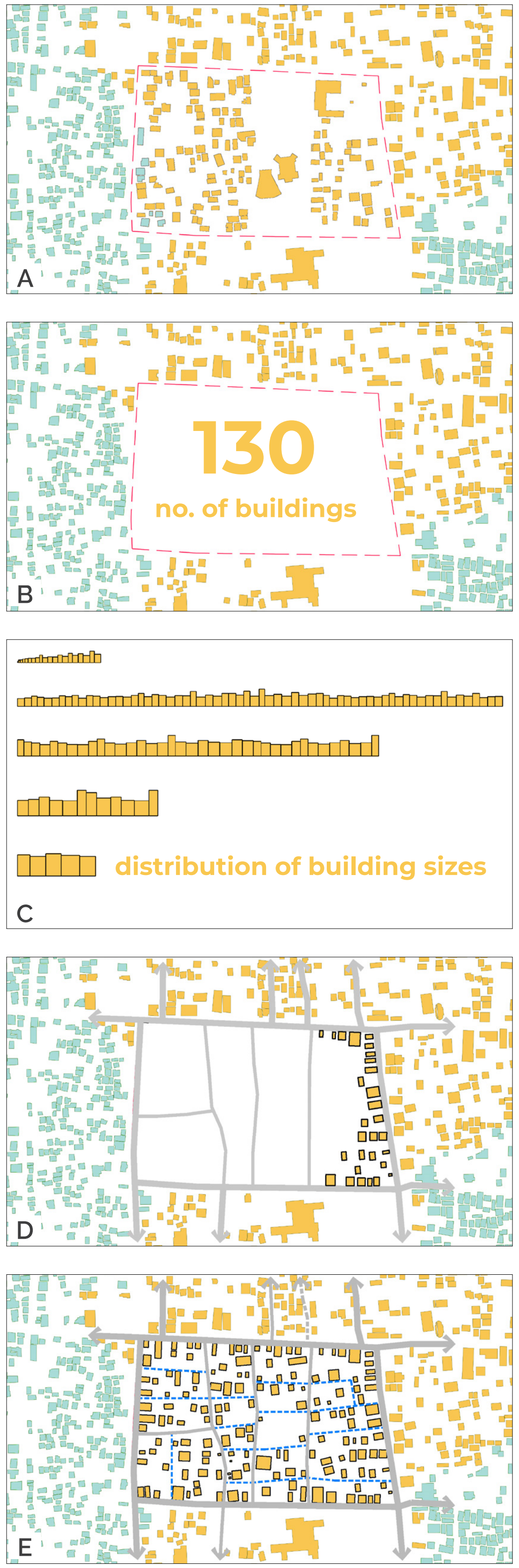


Figure 8: Generative design workflow. *Source: Authors.*

3.3. Testing UMM's potential for (abstract) generative design

We tested the generative design potential of the UMM classification of the urban form of Kochi with UNICITI's team of Volunteers of Change.

After having been briefed on the UMM taxonomy, the four UNICITI Volunteers of Change were asked **to design**, using only the UMM morphometric profiles and a minimal place assessment conducted only visually from remote, a set of **design alternatives for a number of selected UTs**. Our intent was to demonstrate that **it is possible to regenerate urban areas that inherit, from UTs of reference, those intangible and unique qualities that make them distinctively recognisable, whilst never replicating them identically.** We argue that, whilst these should never be considered final design solutions, they constitute solid ground on which to build discussion and collaboration with local stakeholders.

Working on a shared trial and error **design workflow (Fig 8)**, the team produced a list of **independent design alternatives, all different but all coherent with the selected UT** (Venerandi et al., 2021). The starting scenario developed was abstract (an 'empty sample site'), with the aim of regenerating its UT of reference without replicating it, independently from its use and urban significance, obviously abstract premises.

After a first successful attempt on one UT and some finetuning of the workflow, this design generation exercise was then applied to a range of different UTs (Venerandi et al., 2021), to test and establish its versatility. The results suggest that **UMM supports the design of markedly diverse urban forms**.

3.4. Testing UMM's potential for (commissioned) design: steps towards the Third Way

Design is never abstract, as were the generative tests above, which were done with no brief, if not as an attempt to recreate and insert an urban type in its context.

Therefore, our next step consisted in applying the same workflow to resolve real design scenarios i.e. using active briefs for portions of the city. In particular we run 3 experiments.

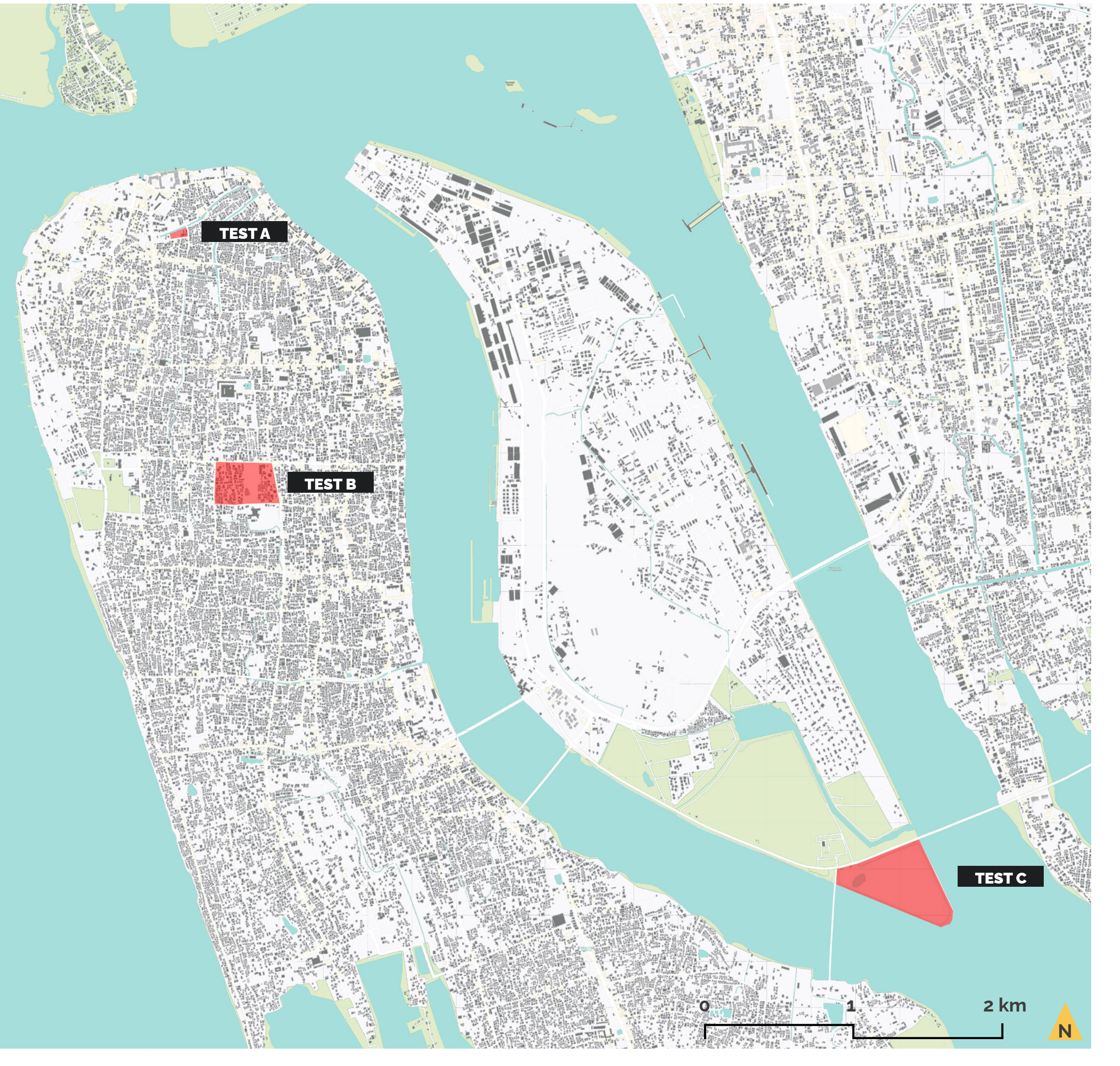
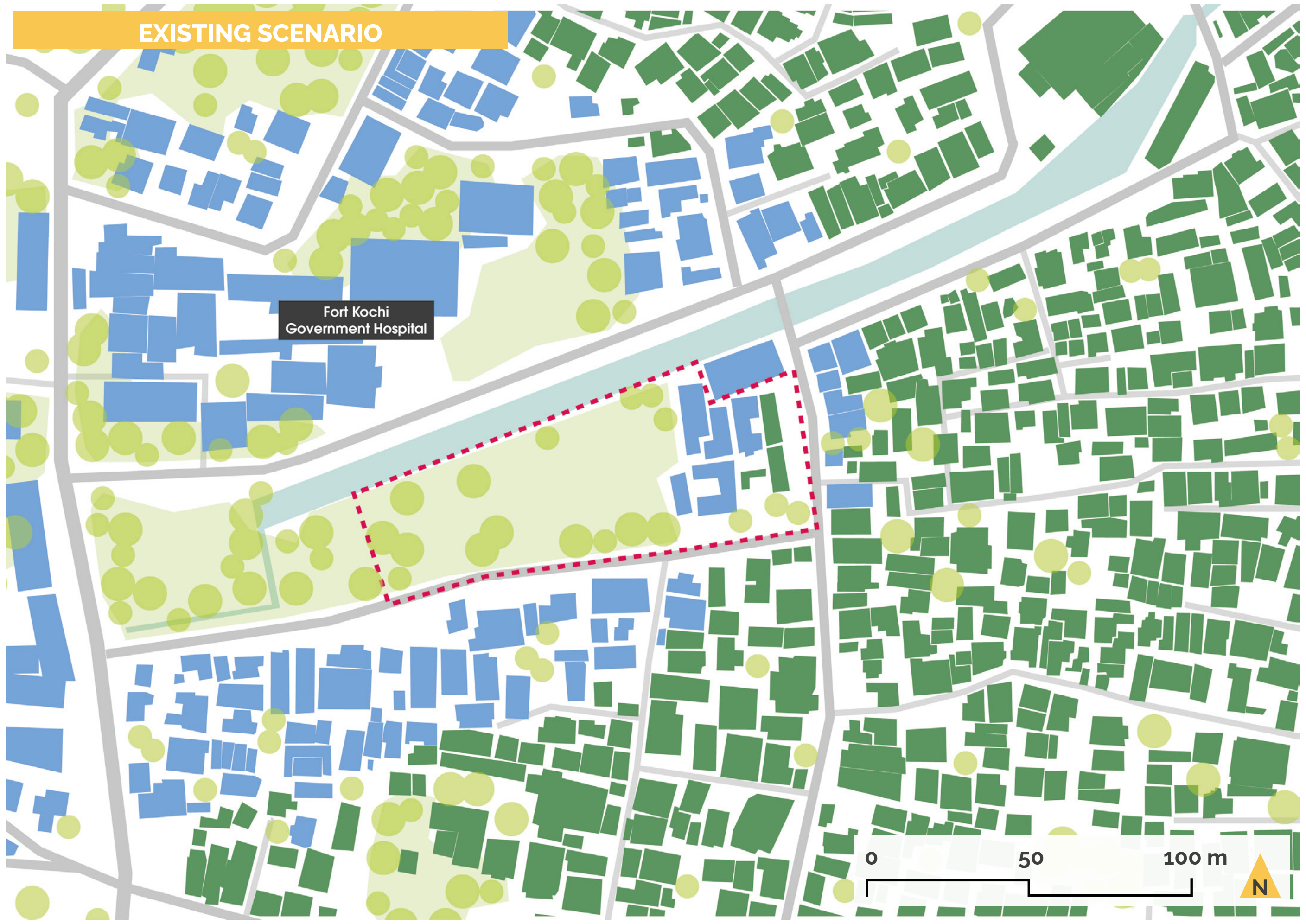


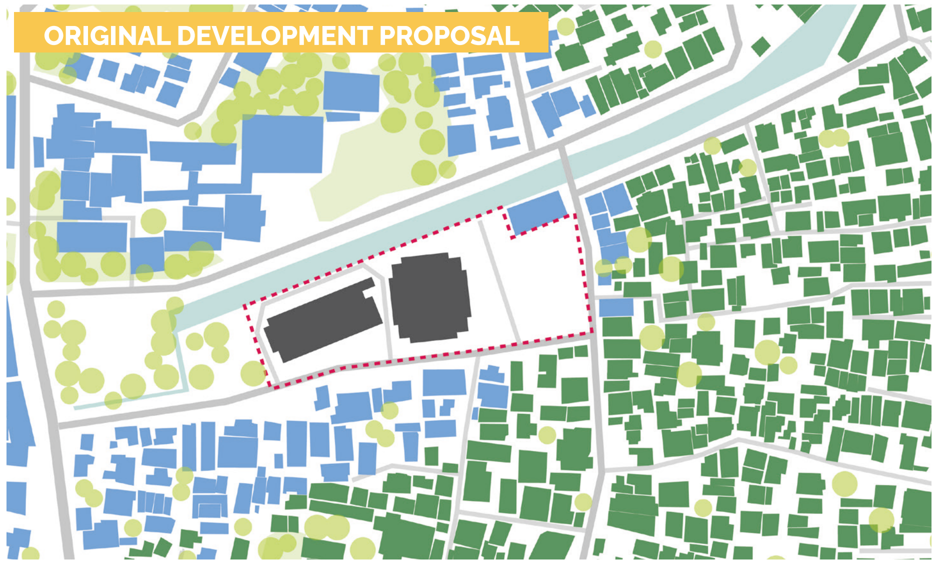
Figure 9: Kochi Design experiment areas. *Source: Authors.*

Test A: In-Situ Slum Rehabilitation/Housing



Test A focuses on slum rehabilitation. Slum rehabilitation in Indian cities has followed different policies in the past such as slum clearance, slum redevelopment, slum improvement and the Basic Services to the Urban Poor (BSUP) scheme. So far, these approaches have failed to provide a holistic satisfactory solution for the improvement of living conditions in the slums and informal settlements. Yet the current proposed plan (figure above) for the Cochin Smart Mission (CSML) slum rehabilitation in UT7, has followed the same path of THE BAU model of high density towers with no space for incremental development, adaptation or change in general.

Therefore, we tested our workflow with three alternative designs to compare with the controversial CSML residential development which proposes the demolition of a number of informal blocks to house two high-density, high-rise towers, remarkably alien to the heritage zone of fort Kochi. The first UMM based design alternative adopts the character of the heritage zone UT7 to produce a place sensitive low-density and low-rise masterplan. The second alternative uses the same UT for medium-density & medium-rise development to accommodate built-up area in the same quantity as the CSML proposal.
The third alternative uses a combination of UT7 and UT19 to achieve medium-density and medium-rise. These tests demonstrate that it is possible to achieve similar or comparable efficiency of covering as CSML with more contextually and culturally sympathetic layouts.

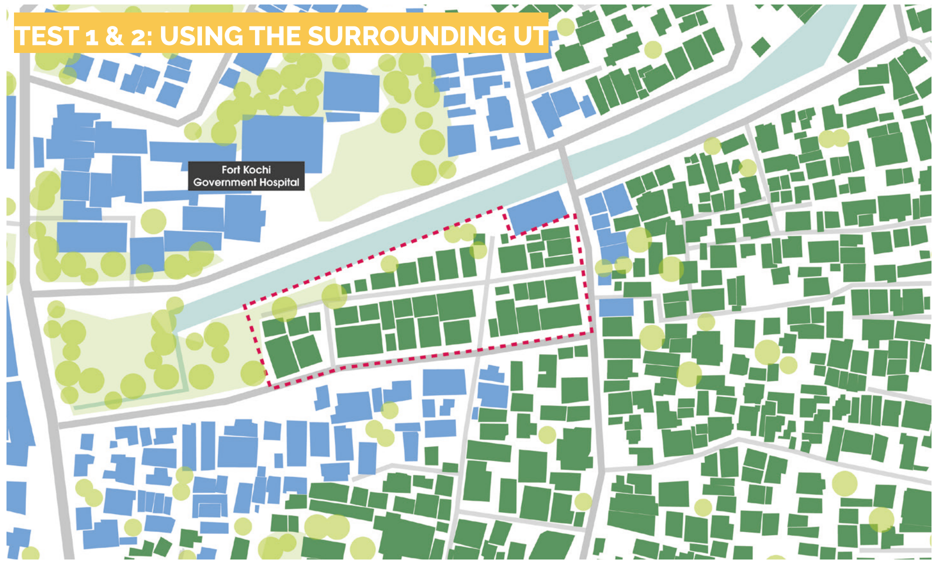


Original Development Proposal
Tower 1 & Tower 2 plinth area = 1393 Sq M
Tower 1 (G+11) + Tower 2 (G+13) = 16711 Sq M
No of Dwelling Units = 394 (32 Sq M carpet area each)

Test 1 (Using surrounding UT7)
40 building footprints plinth area = 3284 Sq M
Total Builtup area (G & G+1) = 5000 Sq M
No of Dwelling Units achieved = 166

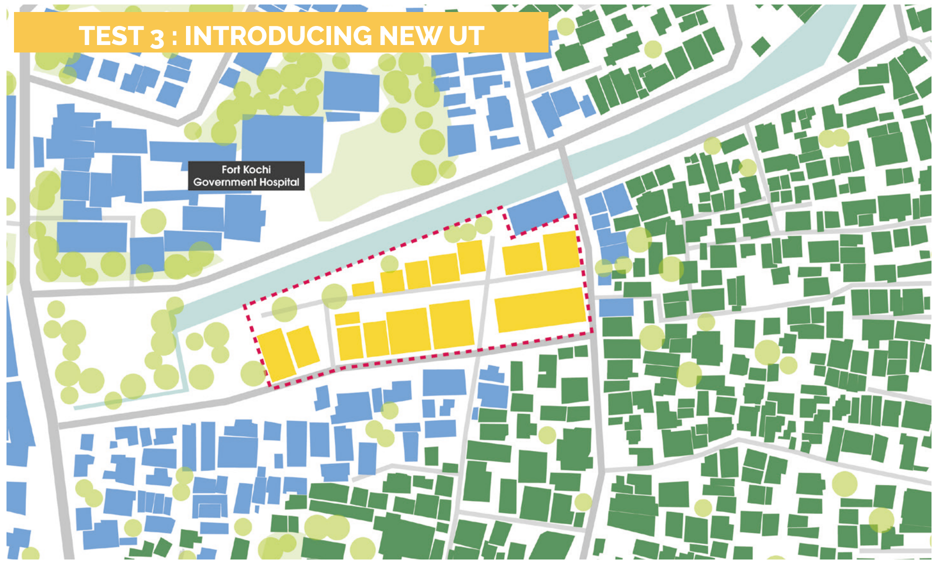
Test 2 (Using surrounding UT7)
40 building footprints plinth area = 3284 Sq M
Total Builtup area (G+4) = 16420 Sq M
No of Dwelling Units achieved = 387

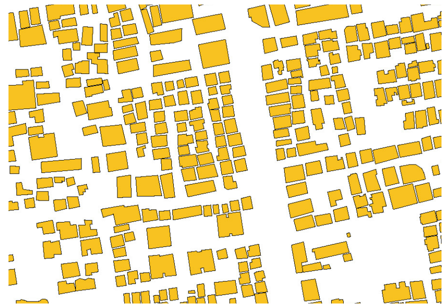
Test 3 (Introducing UT17)
15 building footprints plinth area = 2846 Sq M
Total Builtup area (G+5) = 17076 Sq M
No of Dwelling Units achieved = 402



RESIDENTIAL AND MIXED USE URBAN TYPE (UT7)

Uniform, rather informal development, with permeable street networks and blocks of regular size, traversed by pedestrian paths. Very small plots and building footprints, host a range of commercial activities. Fronts are continuous and defined, limited setbacks.

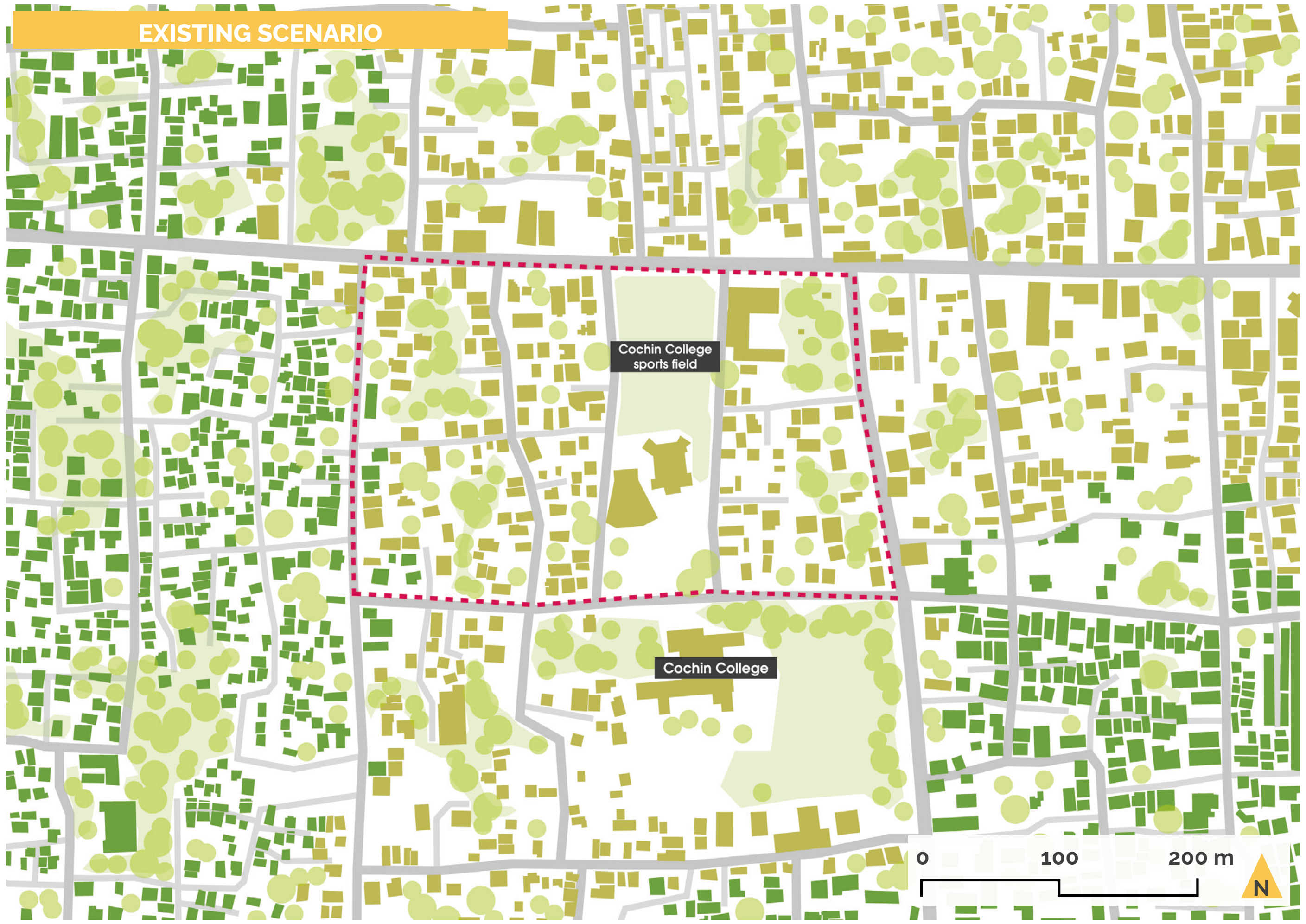




RESIDENTIAL AND MIXED USE URBAN TYPE (UT19)

Fairly homogeneous, granular, dense urban type merging historical and recent form. Independent, compact, medium density buildings, with medium-low plot coverage and in close proximity to each other. High permeability due to frequent capillary roads.

Test B: Urban Regeneration/Campus Extension

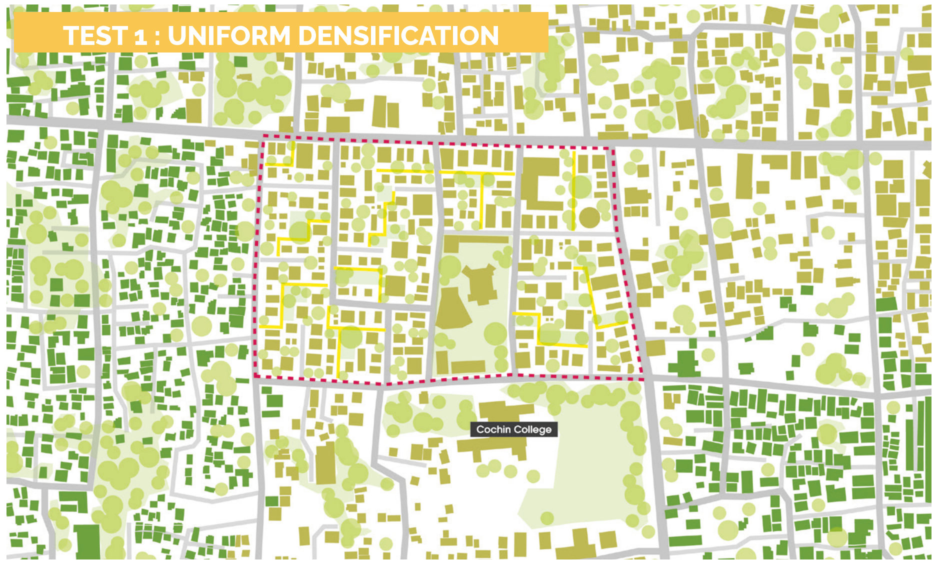


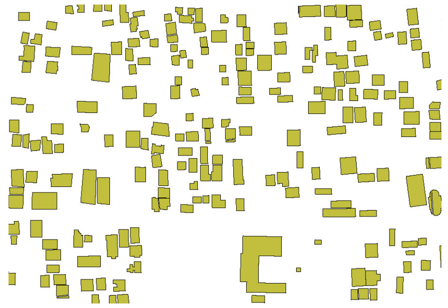
Test B focuses on mixed urban types and the problem of integration between such types. We use an area in UT1 as case study. It contains a mix of specialist (two university buildings and the campus ground, a food processing unit, and a water tank) and ordinary typologies (mostly residential). The specialist buildings are embedded in a largely residential fabric but with little integration and legibility. The proposed designs scenarios explore urban renewal and densification possibilities within the blocks while aiming to improve the integration of the two types of functions.

Scenario 1 (which we called 'uniform densification') retains the specialist buildings and converts the rest of the open college ground into mixed fabric using UT1, designating a few larger building envelopes as a part of the University. This improves the transition between specialist and residential functions, defining edges.

Scenario 2 (partial densification) retains part of the ground as it is, designates a few buildings as a part of the university and converts the edges along the primary road into residential fabric. In both these scenarios, the buildings along the two primary roads are larger, with regular alignments, helping legibility, orientation and character.

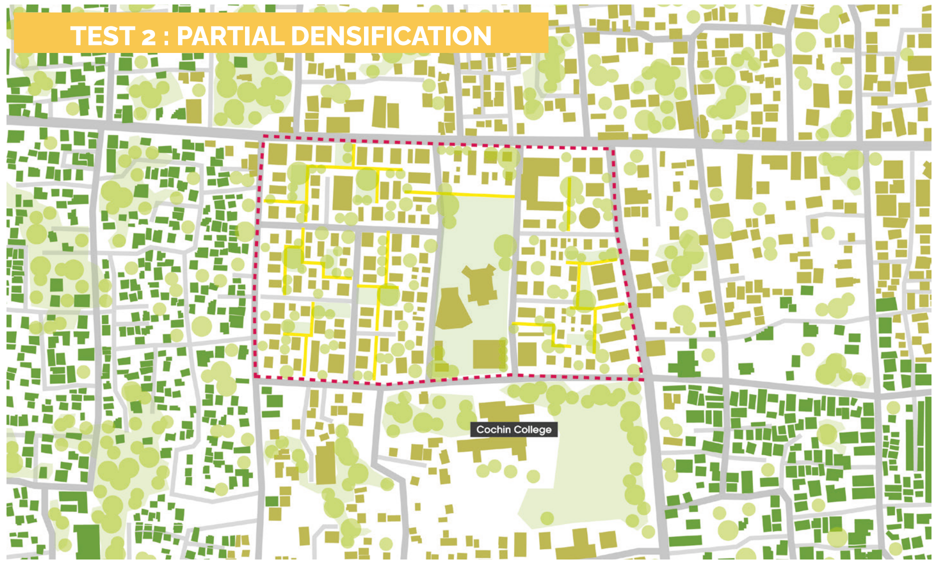
Scenario 3 (Mixed Typology Renewal) retains the university ground as it is, but combines two UTs – UT6 along the primary roads, in continuity with the adjacent fabric, with more mixed use functions, and UT1 for the rest of the block, mostly residential in nature.

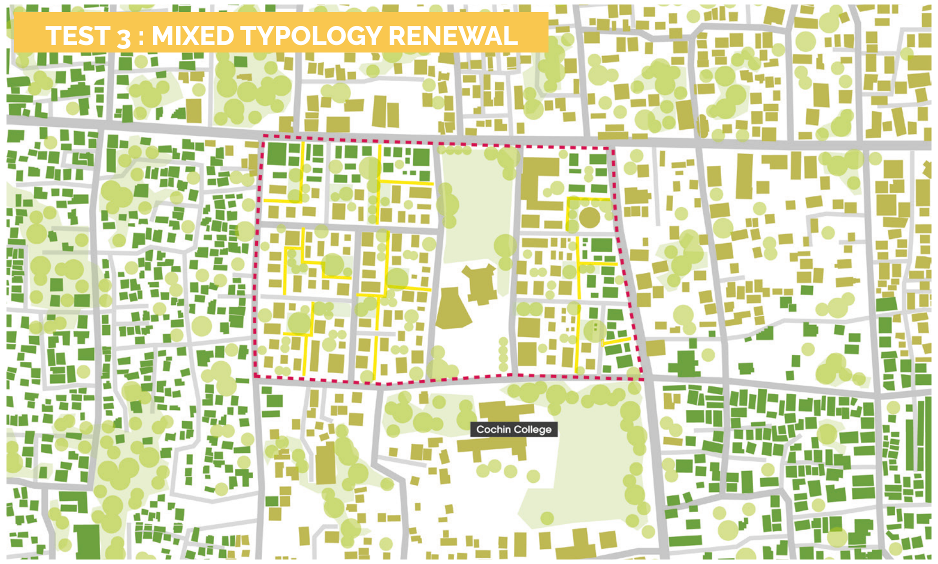


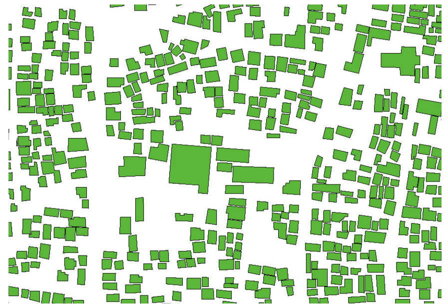


RESIDENTIAL AND MIXED USE URBAN TYPE (UT1)

Quite regular well connected street network, low-medium density with a high proportion of larger plots, and the smaller plots tending to cluster together. Along main streets, especially those point towards important landmarks, plot and building alignment is more regular.







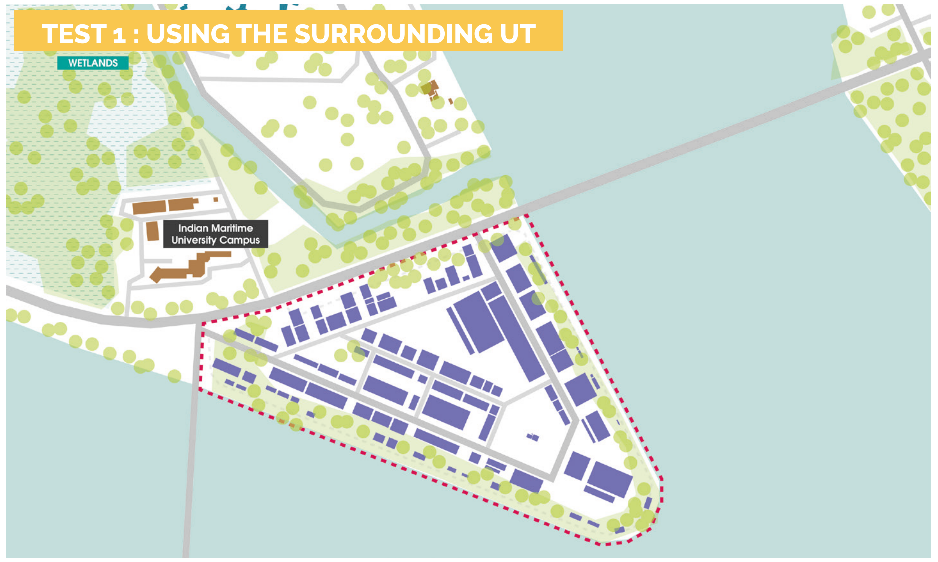
RESIDENTIAL AND MIXED USE URBAN TYPE (UT6)

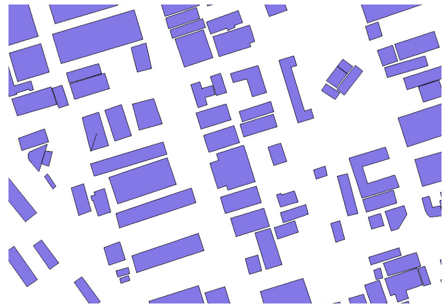
Regular street structure, plots generally aligned to streets, across all street types, getting closer to the waterfront, they have larger building footprint. Main streets aligned with commercial and industrial activities or large apt blocks getting closer to the water.

Test C: Business District

Test C is a masterplan for a strategically important site on the Willingdon island, following a design brief issued by the local government. The brief focuses on the development of a business district and a hospitality node in areas beyond the bridges connecting the mainland to the island. The area would house hotels, convention centres, commercial complexes, open shopping areas and public spaces.

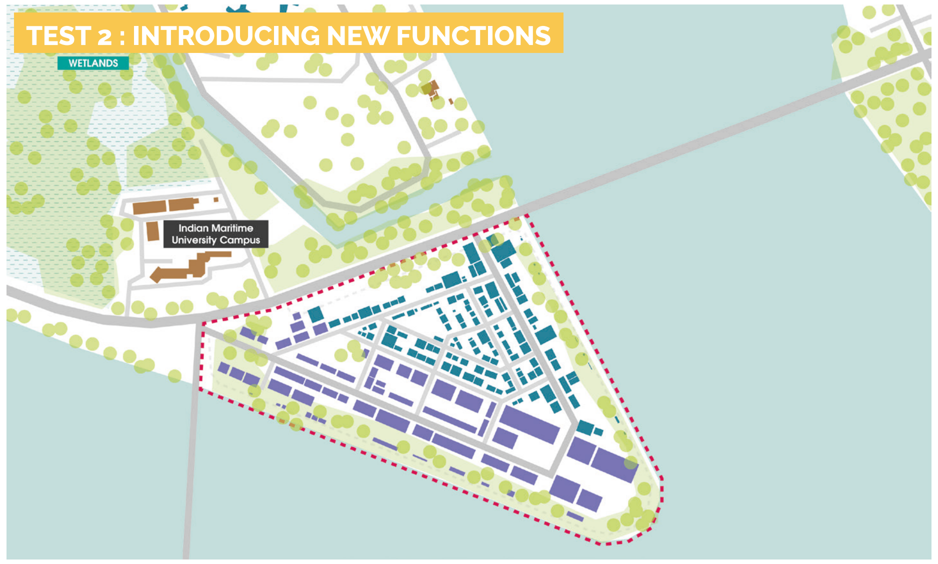
Two proposals were produced during the test. The first focuses on replicating the existing urban fabric of the island by using the most common UT15 of the area (industrial and mixed use planned development). This produced a somewhat monotonous urban form despite the rather rich range of activities housed in the area. A second master plan was produced using a combination of two UTs - UT15 and UT12 (adding a residential and mixed use typology) to provide the liveable, more human-scale spaces from a small grain typology that would be important for the character and livability of the site.

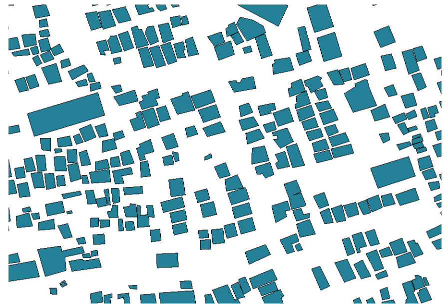




INDUSTRIAL AND MIXED USE URBAN TYPE (UT15)

Industrial and military layout with high diversity of plot and building sizes. Generally greater in grain than across all other typical urban fabric. Access from main arteries and many plots with direct access to water. Unconventional form, ad-hoc to function.





RESIDENTIAL AND MIXED USED URBAN TYPE (UT12)

Fairly homogeneous, granular, dense urban type, covering large districts and often containing some large urban infrastructure. Edges of districts along main urban roads generally occupied by specialized buildings. Independent, compact, medium density buildings, with medium plot coverage and in close proximity to each other, with access from a network of local streets.

04

Conclusions

Designing the Third Way, from Kochi up

The recent rate and pace of global urbanisation are concerning; the figures generally used to illustrate this overwhelmingly. If we then account for the implications these will have on climate change, health and inequality, which are undoubtedly affected by current forms of development, then it is clear that concern must quickly turn into action, evidence-based action, and swiftly used to curb and even revert these trends.

The focus on evidence is crucial, and the wider the pool from which we can draw this evidence is, the better, so we can both discern between and learn from diversity, and adapt it to specific contexts, geographical, social, economic. Our proposal, to **inform design, development and management of urban change with the most detailed and scalable evidence on urban form to date**, is one step in this direction. Two caveats, however, are worth mentioning. The first has to do with validation, the second with application.

In terms of validation, the risk would be to overwhelm those tasked with development with data. Data, per se, can be meaningless, unless it is interrogated properly. We need to **learn to read the spatial dimension of our urban settlements in relation to a range of performances** . And for this, we need to learn how to ask the relevant questions, which must depend on place and context but at the same time help contribute to some of the issues that join us globally.

In terms of application, the risk would be to propose a Third Way that simply substitutes the BAU model, a replicable process made more palatable by dressing it up with some of the Second Way attention to detail. To avoid this, our proposal is not to replace professional and local expertise, but rather to **serve it with better information on how and why certain urban forms seem to work consistently "better" than others**, so that abstraction, ideology and budgets don't overlook local practices. Local stakeholders would find in the proposed workflow a central voice, through which informed evidence and capacity building becomes an integral part of the development process.

We are at an early stage of the Third Way. The objective is hugely ambitious: to set up a framework that harmonises and composes two of its most antithetic realities, large scale production of the built environment, and its quality, defined primarily by unicity, humanity and sense of place. Our generative design exercise aims to prove that **the unique character of places can be captured, coded and made available to the built environment production system at XL-scale, without being detrimental to the endless variety of its local and even personal expressions.** UMM, at its present stage of development, is a radical innovation to one of the most established practices of place-making in the business, that of design codes. It is not a magic wand and should never be used as such.

The next step will entail **expanding the UTs profiling across a much wider set of urban areas**, across entire regions, nations and possibly beyond, to capture their own character, their similarities and differences. One of the beauties of UMM, is that it can only grow and get better and sharper as evidence is added and keeps improving in quality. It is a self-developing tool. We aim, effectively, to build nothing short of an **Atlas of Asian Urban Form** and to continue to validate it, so as to generate a repertoire of well functioning practices that can be used as a point of reference for the development of Local Urban Codes for Asian cities. These codes become better when they are locally imagined, discussed and generated via local co-design processes involving stakeholders in a responsible way.

It is important to state that this process is designed to be **ongoing**. There is no limit as to how much is contained in the Atlas. It can grow to include much more information, potentially as many cases and settlements exist. The TWMDC will be tailored to what is available. This is the fundamental character of our proposed Third Way: that it is evolutionary in nature, as urban form is, and adjustments in knowledge and practice are part of the process of development itself.

This is perhaps the most fundamental message of the Third Way: that it is always possible to improve our ways.

05

References

Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2021). National Model Design Code: Part 1 - The Coding Process, n.d. 51.

Fleischmann M. (2019) momepy: Urban Morphology Measuring Toolkit. *The Journal of Open Source Software* 4(43): 4.

Fleischmann M, Feliciotti A, Romice O, et al. (2020) Morphological tessellation as a way of partitioning space: improving consistency in urban morphology at the plot scale. *Computers, Environment and Urban Systems* 80: 101441.

Fleischmann M, Romice O and Porta S. (2021a) Measuring Urban Form: Overcoming Terminological Inconsistencies for a Quantitative and Comprehensive Morphologic Analysis of Cities. *Environment and Planning B: Urban Analytics and City Science* 48(8).

Fleischmann M, Feliciotti A, Romice O, et al. (2021b) Methodological Foundation of a Numerical Taxonomy of Urban Form. *Environment and Planning B: Urban Analytics and City Science.*

Liveable Urbanism Survey Website (2021). Last visited 15 Jan 202: https://liveableurbanism.wixsite.com/liveableurbanism].

Porta S, Venerandi A, Feliciotti A, et al. (2022, in print) Urban MorphoMetrics + Earth Observation: an Integrated Approach to Rich/Extra-Large Scale Taxonomies of Urban Form. *Projections: Journal of the MIT Department of Urban Studies and Planning* 16(Spring 2022).

Remali A, Porta S, Romice O, et al. (2015) Street Quality, Street Life, Street Centrality. In: Vaughan L (ed) *Suburban Urbanities: Suburbs and the Life of the High Street.* London: UCL Press.

Remali AM and Porta S. (2017) Street networks and street-blocks in the city centre of Tripoli. *Urban Morphology* 21(2): 161-179.

Romice O, Porta S and Feliciotti A. (2020) *Masterplanning for Change: Designing the Resilient City*, London, UK: Royal Institute of British Architects - RIBA.

Venerandi A, Romice O, Chepelianskaia O, et al. (2021) Urban Morphometrics and the Intangible Uniqueness of Tangible Heritage. An Evidence-Based Generative Design Experiment in Historical Kochi (IN). *Heritage* 4: 4399-4420.

06

Appendix

Primary morphometric characters

index	element	context	category
area	building	building	dimension
height	building	building	dimension
volume	building	building	dimension
perimeter	building	building	dimension
courtyard area	building	building	dimension
form factor	building	building	shape
volume to façade ratio	building	building	shape
circular compactness	building	building	shape
corners	building	building	shape
squareness	building	building	shape
equivalent rectangular index	building	building	shape
elongation	building	building	shape
centroid - corner distance deviation	building	building	shape
centroid - corner mean distance	building	building	shape
solar orientation	building	building	distribution
street alignment	building	building	distribution
cell alignment	building	building	distribution
longest axis length	tessellation cell	tessellation cell	distribution
area	tessellation cell	tessellation cell	distribution
circular compactness	tessellation cell	tessellation cell	shape
zequivalent rectangular index	tessellation cell	tessellation cell	shape
solar orientation	tessellation cell	tessellation cell	distribution
street alignment	tessellation cell	tessellation cell	distribution
coverage area ratio	tessellation cell	tessellation cell	intensity
floor area ratio	tessellation cell	tessellation cell	intensity
length	street segment	street segment	dimension
width	street profile	street segment	dimension
height	street profile	street segment	dimension
height to width ratio	street profile	street segment	shape
openness	street profile	street segment	distribution
width deviation	street profile	street segment	diversity
height deviation	street profile	street segment	diversity
linearity	street segment	street segment	shape
area covered	street segment	street segment	dimension
buildings per meter	street segment	street segment	intensity
area covered	street node	street node	dimension
shared walls ratio	adjacent buildings	adjacent buildings	distribution
alignment	neighbouring buildings	neighbouring cells (queen)	distribution
mean distance	neighbouring buildings	neighbouring cells (queen)	distribution
weighted neighbours	tessellation cell	neighbouring cells (queen)	distribution
area covered	neighbouring cells	neighbouring cells (queen)	dimension
reached cells	neighbouring segments	neighbouring segments	intensity
reached area	neighbouring segments	neighbouring segments	dimension
degree	street node	neighbouring nodes	distribution
mean distance to neighbouring nodes	street node	neighbouring nodes	dimension
reached cells	neighbouring nodes	neighbouring nodes	intensity
reached area	neighbouring nodes	neighbouring nodes	dimension
number of courtyards	adjacent buildings	joined buildings	intensity
perimeter wall length	adjacent buildings	joined buildings	dimension
mean inter-building distance	neighbouring buildings	cell queen neighbours 3	distribution
building adjacency	neighbouring buildings	cell queen neighbours 4	distribution
gross floor area ratio	neighbouring tessellation cells	cell queen neighbours 5	intensity
weighted reached blocks	neighbouring tessellation cells	cell queen neighbours 6	intensity
area	block	block	dimension
perimeter	block	block	dimension
circular compactness	block	block	shape
equivalent rectangular index	block	block	shape
compactness-weighted axis	block	block	shape
solar orientation	block	block	distribution
weighted neighbours	block	block	distribution
weighted cells	block	block	intensity
local meshedness	street network	nodes 5 steps	connectivity
mean segment length	street network	segment 3 steps	dimension
cul-de-sac length	street network	nodes 3 steps	dimension
reached cells	street network	segment 3 steps	dimension
node density	street network	nodes 5 steps	intensity
reached cells	street network	nodes 3 steps	dimension
reached area	street network	nodes 3 steps	dimension
proportion of cul-de-sacs	street network	nodes 5 steps	connectivity
proportion of 3-way intersections	street network	nodes 5 steps	connectivity
proportion of 4-way intersections	street network	nodes 5 steps	connectivity
weighted node density	street network	nodes 5 steps	intensity
local closeness centrality	street network	nodes 5 steps	connectivity
square clustering	street network	nodes within network	connectivity

About the institutions and authors

Urban Design Studies Unit, University of Strathclyde

The Urban Design Studies Unit at the University of Strathclyde has been studying and designing urban environments for over 30 years. It specialises in evidence-based, sustainable and resilient design, urban analytics, user participation in design and the impact of space on life. The Unit is now also part of the Centre for Policy, Planning and Technology, a recent ambitious and interdisciplinary initiative of the University.

Dr. Sergio Porta is Professor of Urban Design, Director of the Urban Design Studies Unit and co-director of the Strathclyde Centre of Urban Policy, Planning and Technology at the University of Strathclyde, Glasgow, UK. He is founder and international director of BuildingBeauty.org

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Dr Alessandro Venerandi is a Research Fellow at the Department of Architecture, University of Strathclyde

UNICITI

UNICITI is an international consultancy and knowledge development institution. It shapes future oriented approaches to help Asian cities of tomorrow become sustainable, climate resilient, economically competitive, socially inclusive and culturally vibrant by reactivating the potential of their unique cultural and natural assets. Its tools are climate vulnerability and carbon footprint analysis, climate resilient and local context tailored urban planning and design, project preparation, clean technologies, policy formulation and climate finance. Its strength lies in combining a vast international development experience with local context grounded approaches and a continuous in-depth research on innovative and feasible ways to tackle climate change and the business-as-usual urban development. UNICITI's international program A Third Way of Building Asian Cities gathers over 15 international experts and 80 professionals across over 30 countries.

Olga Chepelianskaia is an International Climate Change, Disaster Risk Management and Sustainable Urban Development Specialist. She is the Founding Director of UNICITI and leads the international program A Third Way of Building Asian Cities. Over 15 years of her professional engagement, she managed 7 major international programs, covered over 30 cities and 40 countries, and worked with leading international institutions such as ADB, CDIA, ISOCARP, Rockefeller Foundation, UNDP, UNECE, UNEP, UNESCAP and UNIDO.

Volunteers of Change, UNICITI

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ISBN: 978-1-914241-17-8 University of Strathclyde Publishing