Doctoral Dissertation Summary

Academic Year 2024

Generative Urbanism in Morocco: Simulating Adaptive Processes from Traditional Models

モロッコにおける「ジェネレイティブ・アーバニズム」 ～伝統的空間形成に基づく適応的プロセスのシミュレーション～

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Abstract of Doctoral Thesis

Academic Year 2024

Generative Urbanism in Morocco: Simulating Adaptive Processes from Traditional Models

This research explores Moroccan historical cities' adaptive and generative urbanism. It highlights their peculiarities within the Arab-Islamic cultural context and investigates how traditional urban development processes could inform contemporary design and planning through bottom-up and emerging computational processes. The traditional city is characterized by a complex adaptive form that has evolved to meet environmental, social, and cultural changes. Similar to the processes forming traditional cities, generative urbanism is an approach to urban design and planning that applies adaptive and interactive rule-based processes to generate flexible and sustainable built environments.

The study critically examines the transition from community-based, bottom-up urbanism to centralized, top-down urban planning systems introduced during Morocco's colonization (1912–1956). Specifically, this study approaches the generative principles of traditional urbanism and their underlying socio-cultural and religious rules for developing adaptive generative codes for contemporary developments.

This research adopts a mixed-method approach combining historical-comparative analysis, case studies, and computational simulations. The historical-comparative analysis investigates the inherent adaptability of traditional Moroccan urban forms compared to the rigidity of (post)colonial planning models. Case studies focus on the persistence of generative principles in urban environments in Morocco, including informal settlements and post-disaster reconstruction contexts. Qualitative data is gathered from interviews, surveys, and observations. Based on this, computational simulations explore the feasibility of generative codes by producing urban configurations and assessing their performance using multi-agent simulations and Genetic algorithms on Rhinoceros 3D and Grasshopper.

Results show that Moroccan traditional cities have adaptive and self-organizing features from day-to-day **citizen-driven, iterative growth processes** and flexible rules for compact urbanism. This research codifies rules for generating urban forms, translates them into algorithmic models, and tests them with simulations as proof-of-concept (POC). The phased simulations conducted in this research—one addressing slum rehousing and another geared towards post-disaster regeneration scenarios—demonstrated the practical potential of generative urbanism in accommodating contextual complexities and changing needs. Simulations demonstrate how generative urbanism principles result in adaptive and contextual forms. The POCs show their applicability in contemporary design and how to create adaptive urban space that evolves with changing needs.

The study demonstrates the transformative potential of generative urbanism as a paradigm shift for creating resilient urban spaces that evolve with societal needs, leveraging computational simulations to actualize traditional urban principles. Re-encoding these rules in simulations offers a practical framework for sustainable, bottom-up urban development and advancing urban studies and architecture.

Keywords: Islamic city, Slums, Architecture, Design, Simulation.

博士論文要旨

2024 年度

モロッコにおける「ジェネレイティブ・アーバニズム」
～伝統的空間形成に基づく適応的プロセスのシミュレーション～

本研究は、モロッコの歴史的な都市における適応的かつ生成的な都市形成を探究し、アラブ・イスラム文化圏における特性を強調するとともに、伝統的な都市開発プロセスがどのように現代のデザインおよび計画に情報を提供できるかを、ボトムアップ型の計算手法を通じて検討するものである。伝統的な都市は、環境的、社会的、文化的変化に対応して進化した複雑で適応的な形態を持つことが特徴である。「ジェネレイティブ・アーバニズム（都市生成）」は、柔軟で持続可能な環境を生み出すために、適応的かつ対話的なルール型プロセスを利用する都市デザインおよび計画のアプローチである。

本研究では、コミュニティのボトムアップ型都市形成から、モロッコの植民地化（1912～1956 年）以降に導入された中央集権型のトップダウン都市計画への転換を批判的に検討している。特に、伝統的な都市形成の生成ルールとその基礎となる社会文化的および宗教的規則を、現代の開発に適応可能なジェネレイティブ・コードの開発に結び付けて考察する。

本論文は歴史比較分析、ケーススタディ、および計算シミュレーションを組み合わせた混合法を採用している。歴史比較分析では、伝統的なモロッコの都市形成の柔軟性を、コロニアル・ポストコロニアル都市計画モデルの硬直性と比較して調査する。ケーススタディでは、モロッコの都市環境における生成ルールの継続性を検討し、インフォーマル居住地や災害後の再建事例に焦点を当てる。質的データはインタビュー、調査、観察から収集される。シミュレーションでは、Rhinoceros 3D および Grasshopper を使用した ABM（マルチエージェント）シミュレーションや遺伝的（Genetic）アルゴリズムを通じて都市配置の生成可能性を探り、その性能を評価する。

研究結果として、モロッコの伝統的な都市・空間形態は、日常的で市民主導の反復的成長プロセスとコンパクトな都市形成の柔軟な規則に基づき、適応的かつ自己組織化的な特徴を持つことが明らかになった。本論文では、都市形成のルールを成文化し、それをアルゴリズムモデルに変換して概念実証（POC）として検証した。研究の段階的シミュレーションでは、スラム再住居化と災害後の再建を対象とし、ジェネレイティブ・アーバニズムが文脈の複雑性と変化するニーズに対応する実用的可能性を示した。シミュレーションの結果、ジェネレイティブ・アーバニズムの原則が適応的で文脈に応じた形態を生み出すことが確認された。

本研究では、ジェネレイティブ・アーバニズムが、社会のニーズとともに進化するレジリエントな都市空間の創造に向けたパラダイムシフトを示していることを立証するものである。伝統的な都市規則を解読し、それを計算シミュレーションに再符号化することで、持続可能なボトムアップ型の都市開発に向けた実践的な枠組みを提供し、都市研究と建築学の進展に貢献している。

キーワード：イスラム都市、スラム、建築、デザイン、シミュレーショ

Chapter I: Introduction

Background

The catastrophic earthquake in Morocco on September 8, 2023, served as a stark reminder of the urgent need to conserve our architectural heritage, particularly under the threat of natural disasters. This magnitude 6.8 Richter earthquake, with its epicenter in the Atlas Mountains near Marrakech, left a trail of destruction in several regions, including Al Haouz, Chichaoua, Taroudant, and Ouarzazate (Alsaafin 2023). The earthquake resulted in significant loss of human life and terrible damage to nearly every modern and traditional building in this area [Figure 1].

This disaster made us confront the fragility of our built heritage and consider how to most effectively rebuild while maintaining the cultural and historical fabric of the affected regions (Yee and Alami 2023). The built environment in traditional societies of the Al-Haouz mountain villages is not merely a collection of structures; it constitutes an integral part of a cohesive community life revolving around the common good of its inhabitants (Naji 2019). Al Haouz and Morocco's traditional architecture is characterized by its strong identity and the use of local materials and building techniques (Chahrou 2023). These materials and techniques have been honed over the centuries and are deeply rooted in the region's socio-cultural and environmental context.

In rural Morocco, this traditional and intuitive wisdom is similar to what Christopher Alexander (1979) describes as the "*timeless way of building.*"0F[1] Nowadays, modern construction processes are increasingly being introduced at the cost of these resilient and locally adapted building processes. The increasing introduction of concrete and other imported materials in the name of new durability and economy threatens these conventional architectural practices. Like how urban Morocco transformed after its colonization in 1912, these changes do not just alter the physical appearance of the built environment but have broader consequences for the societal frameworks and the identity of the places themselves. The traditional built environment is crucial for maintaining social cohesion, supporting community centrality, and allowing for geometric adaptability in design (Naji 2019).

[1] By The "timeless way of building", Christopher Alexander (1979) refers to this enduring process of building and creating inherently adapted environments well-suited to their purpose appears timeless. That means using building patterns rooted in human nature and resonating with the environment, resulting in satisfying structures.

During the twentieth century, similar dynamics of shifting from socio-generative urban processes to prescriptive and institutional planning have reshaped the urban landscape in Morocco (Caperna 2014). After decades of colonization and until the independence of North African countries, the urban landscape had drastically changed. This included the replacement of traditional urban-forming processes by centralized, prescriptive urban planning that was imported from the West with little to no adaptation to their context (Hakim 2001). The consequences of these imported systems are significant as they have contributed to a mismatch between designers who seek to follow regulations imposed by a central authority and the inhabitants' expectations1F[2], who are accustomed to adaptive housing managed locally.

Considering the high adaptive qualities that traditional cities can offer in terms of adaptability, resiliency, and space flexibility through multiple generations, many contemporary planners and designers are tempted to replicate the characteristics of these settings in their designs. This infatuation was not always present among designers; for a long time, medinas were stigmatized as archaic and against the modern values many Arab rulers were exhorting (Hakim 2001). While there is a clear divide between modern developments and their traditional counterparts, some current developments have considered assimilating traits of Arab-Islamic architecture and urbanism into their design. This integration can often result in mere "*mimicking*" if it is not

Figure 1 Rural village of Tafeghaghte in Al-Haouz Region. The earthquake heavily damaged the built environment, raising pressing concerns about rebuilding processes. Source: Keio SFC Koblab, March 2024.

[2] This divergence has contributed to what is commonly called "catch-up" urbanism, where urban planners are left one step behind, reacting with minor adaptability to urban space developments through reactionary planning policies (Chouiki 2017; Harroud 2017b).

re-interpreted within its context (Radoine 2017a).

In the post-earthquake situation, reconstruction can conceive strategies that emphasize resilience, sustainability, local heritage, and community needs in both rural and urban areas (ICOMOS 2023). It is geared towards creating a built environment that is flexible and resilient to change, reminding us of the capabilities of traditional settlements over time. This involves detailed socio-cultural knowledge dynamics and translating this into practical design and construction methods.

In this regard, it is essential to learn from vernacular design by understanding the system for producing the built environment and activating local customs (Hakim 2001b). What gives vernacular design its appeal is not aesthetic or historical value; instead, it is a rich source of information to understand environment-behavior relationships. Vernacular environments offer clear-cut examples of these relationships that can help design more complex modern settings [Figure 2] (Rapoport 1999). Vernacular architectural forms are never static; instead, they develop with changing needs and conditions, principles that can benefit contemporary building processes and result in an adaptable and resilient built environment (Rapoport 1999; Hakim 2001b).

My interest in this research topic was initiated by my past work on informal settlements in Morocco during my master's studies. As an architect and scholar, I have a particular perspective on the intersection of traditional and modern urban planning, which has informed my approach to this research (Cheddadi 2018). Working on these unplanned settlements, I noticed self-organization and adaptive patterns setting urban space's spatial logic and coherence. At first glance, it seemed as if the inhabitants had not completely forgotten about that *timeless way* of building but that, instead, these practices subsisted at the margins of society, parallel to formal urbanism. These informal settlements exhibit morphological similarities with the medinas, continuing traditional urban processes at society's margins. This sparked my interest in furthering the study of medinas and their principles of generative urbanism, which refers to the self-organizing nature of urban spaces and their ability to adapt and evolve over time.

More intriguing to me was the stark contrast between the naturally growing medinas and the enforced planned urbanization when Morocco was colonized. The Arab-Islamic city is neither spontaneous nor created; instead, it has a coherent logic of growth that is lost in contemporary urban planning (Petruccioli 1997). This "*Amnesia*" of socio-generative processes illustrates the loss of understanding and appreciation for the organic growth of cities and made me question why modern societies stopped being able to produce culturally and environmentally aware spaces

(Petruccioli 2007). Through exploration in marginalized settlements, I realized that a few such generative processes still exist, albeit informally. As a scholar and architect, this inspired me to critically investigate why this "*Amnesia*" has occurred and rediscover the processes that have shaped urban making over millennia.

This research rethinks the creation of contextually appropriate built environments. It is not just about preserving building techniques or conserving singular structures but appreciating and activating the socio-generative processes of spatial production guided by past urban developments. It is a holistic approach that considers the cultural, social, and environmental dimensions of building practices. Insights into the generative processes that led to the design of traditional cities can have considerable value in guiding contemporary urban designers to create flexible and sustainable urban forms that respond to human needs. This research seeks to reinterpret the generative rules of traditional Moroccan urbanism through computational simulations in a way that applies its lessons to contemporary urban challenges.

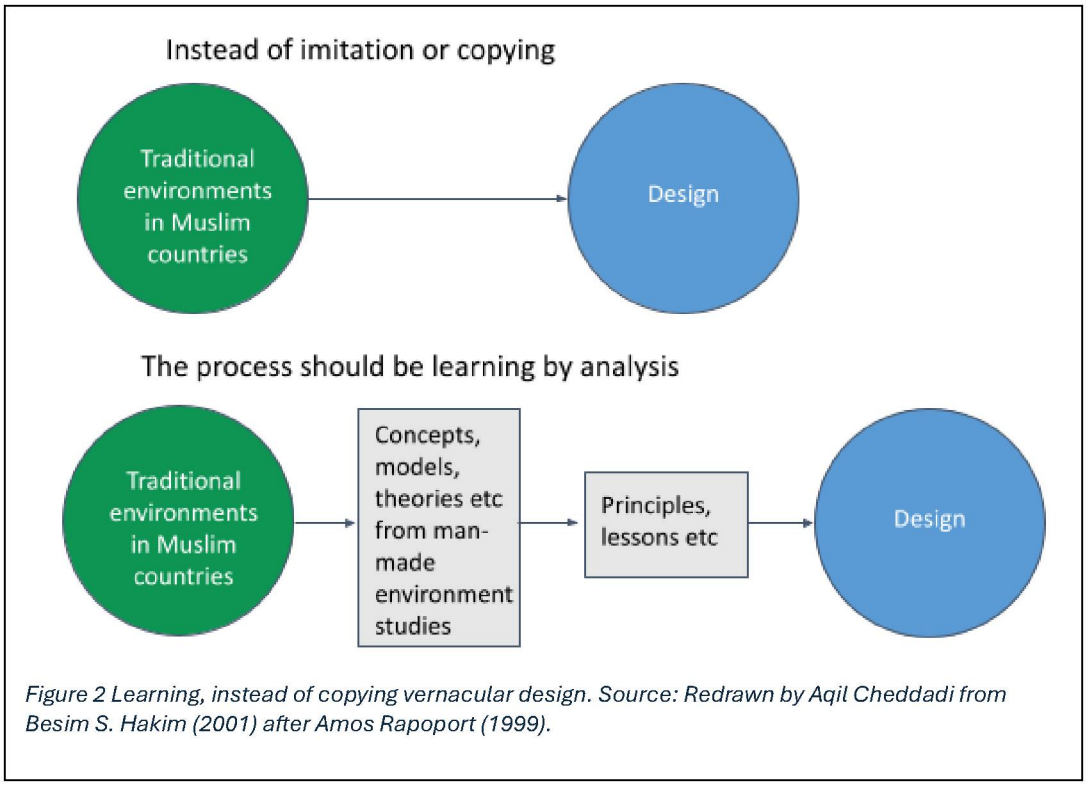


Figure 2 Learning, instead of copying vernacular design. Source: Redrawn by Aqil Cheddadi from Besim S. Hakim (2001) after Amos Rapoport (1999).

Research Purpose

This research seeks to "remember" and document the generative practices in urbanism that, through an organic process, have traditionally given rise to the growth of Moroccan cities. It examines when and why the rupture occurred between premodern and postcolonial planning approaches and whether traditional urban systems still operate in informal or contemporary contexts. Ultimately, translating the findings into a computational generative code will show how some of these rules can be used for designing and defining adaptive urban forms.

Research Significance

This project uses a decolonial perspective to critique colonial planning cultures, re-examining the traditional urban wisdom set aside during colonization and post-independence (Porter 2023; 2016). It highlights how local knowledge and practices can address current challenges: preserving cultural heritage, fostering social cohesion, and informing computational methods that can adapt urban spaces to human needs (Radoine 2017a). This research supports more context-sensitive, community-empowering design approaches by bridging historical understanding and modern technology.

Research Framework

This dissertation intersects three fields of study: the historical-comparative study of Moroccan cities, generative urbanism rooted in traditional and informal settings, and computational simulations. The thesis examines traditional Arab-Islamic and Moroccan cities' growth patterns, redefines those rule-based processes, and integrates them into generative algorithms. Through this integration, the resulting organic forms highlight how centuries-old urban logic can inform adaptive, bottom-up design in contemporary cities.

Research Originality

Positioned in a multidisciplinary framework, this study connects Traditional Built Environments, Computational Design Thinking, and Generative Urbanism [Figure 5]. It challenges colonial and post-colonial planning models by advocating for revitalizing organic, locally grounded practices. In doing so, it proposes a generative code that combines bottom-up processes from the past with contemporary computational tools, revealing how historical socio-generative principles can evolve into viable strategies for present-day urbanism.

This research follows four key steps: first, "unlearning" the colonial planning culture (Porter 2016); second, remembering the generative urban practices from Morocco's history (Petruccioli

2007); third, verifying continuities in informal settlements (Salama 2022); and lastly, reinterpreting these historic generative processes using computational simulations (Hussein 2020). Many knowledge gaps remain where documenting these urban practices is required, along with evaluating those practices for their relevance in the contemporary context, integrating them through computational methods, and assessing how colonial policies disrupted these traditions. This dissertation aims to fill those gaps by offering a decolonial and interdisciplinary perspective.

Objectives and Expected Results

Objectives include clarifying why Morocco's traditional urban models were abandoned and the effects of that shift on cities, synthesizing the generative processes of historic medinas, testing the continuity of these processes in today's informal contexts, and formulating computational simulations of generative rules to see whether they produce resilient, flexible urban forms. Expected outcome: A framework for designing adaptive, context-sensitive urban environments.

Research Methodology

This research combines historical-comparative analysis and computational simulation. The historical-comparative is grounded in the framework of "generative comparison" (Robinson 2023) and compares premodern Moroccan medinas with post-colonial formal planning and informal settlements. It adopts a priori and a posteriori typo-morphological models used in architecture and urban design (Muratori 1967; Petruccioli 2007). The case studies are supported by archival data, field observations, and interviews highlighting morphological features and socio-spatial dynamics.

On the computational side, the principles elicited from historic settlements are modeled by using parametric and algorithmic design methods (Terzidis 2006; Schumacher 2008; Carpo 2017). Rhinoceros 3D and Grasshopper are used to conduct these generative simulations. The simulations implement rules inspired by organic growth and check whether such codes can produce flexible, adaptive environments that remain faithful to local socio-spatial processes.

Dissertation Structure

This dissertation is structured to introduce the basic concepts of generative urbanism through detailed case studies and simulations, situating them in the research's more significant theoretical and practical implications. Each chapter adds to the preceding one, providing a coherent narrative theory, analysis, and application.

The chapters are designed as interconnected segments of a holistic inquiry into generative urbanism. The introduction provides the foundation built upon historical and theoretical analysis

in Chapters II and IV. Chapter V bridges theory with real-world informal settlements. This research was iterative in nature, meaning that Chapters III and VI showcase the practical application of theoretical conceptualization through simulations at different stages of inquiry of the topic matter. The discussion and conclusion tie all findings together, offering a comprehensive view of the study's contributions to urban design and planning.

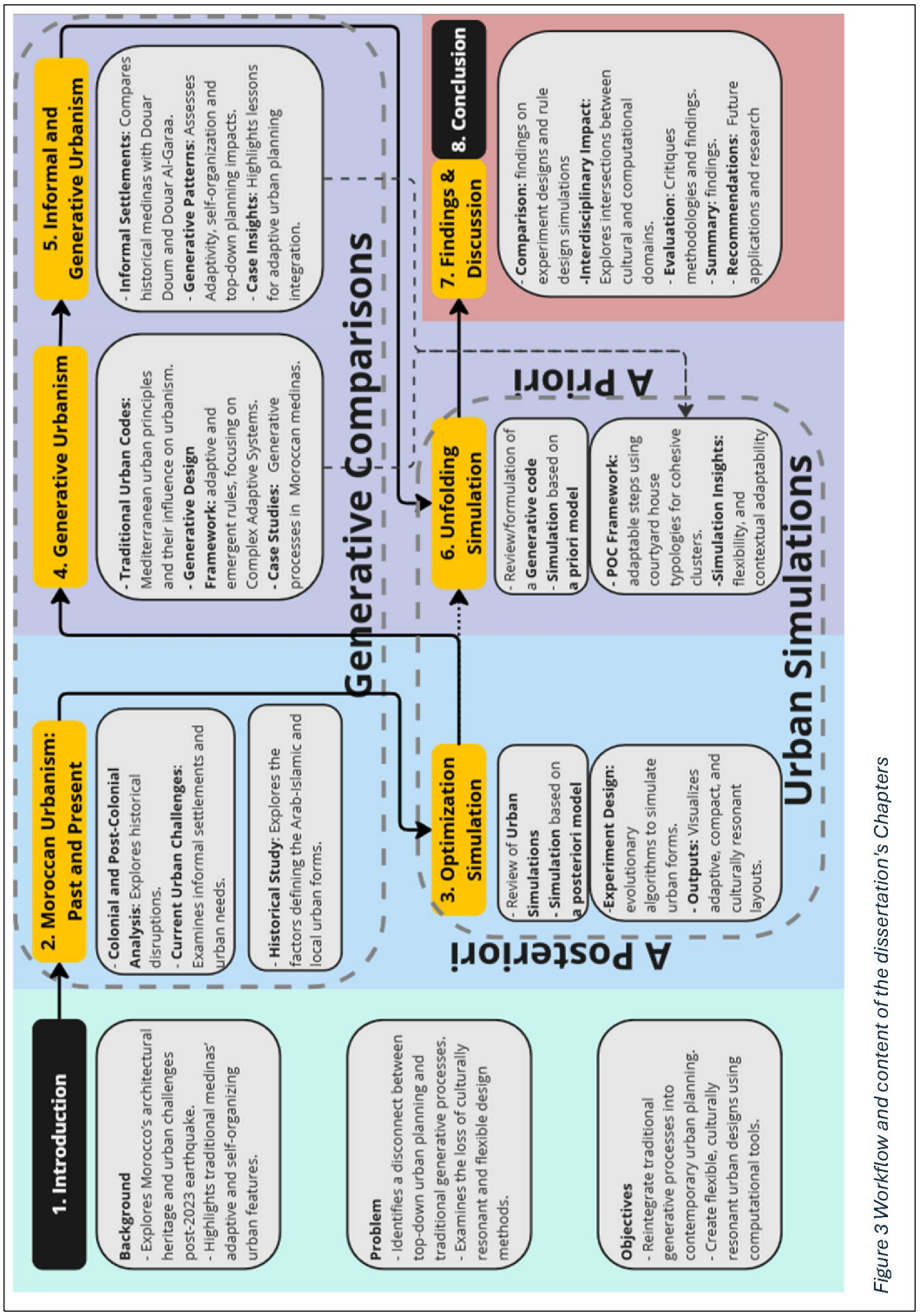


Figure 3 Workflow and content of the dissertation's Chapters

Chapter II: Moroccan Urbanism—Past and Present

Fundamental discontinuities mark the evolution of urbanism in Morocco, the most important being the shift from traditional to contemporary urban practices. The present chapter analyzes these transformations and their consequences using a historical-comparative method. This approach tries to grasp the rupture and discontinuity of urban development processes and the consequences of abandoning traditional urbanism. Later, it constructs a posteriori model of Arab-Islamic cities by investigating the factors contributing to their distinct development from an academic and historical perspective.

Moroccan cities show a rich heritage of traditional urban practices rooted in socio-cultural, environmental, and religious contexts. Such practices have created resilient and adaptive urban forms, most visibly represented within the medinas. The organic form of the medina, with its complex networks of streets, courtyards, and community-oriented spaces, speaks volumes about the bottom-up approach towards urban development sustained over several centuries. In 1912, however, colonial rule was established, and modernization processes introduced top-down planning tools, provoking a profound rupture in the traditional urban fabric.

The central purpose of this chapter is to understand the impact of this rupture. By examining historical and contemporary urban contexts, this research can examine the socio-cultural and architectural consequences that result from such abandonment of traditional urbanism. The research is focused on how, in Morocco, colonial and postcolonial urban policies have reshaped the cities at the expense of local identity and adaptability. It integrates specific examples of urban settings—the historic towns and the informal settlements—to bring to light the consequences of this cultural and political shift. On the other hand, the later part of the chapter investigates, through a literature review, the multifaceted factors in which the Arab-Islamic city has been studied and understood thus far. This study walks the first steps towards “remembering” the social, cultural, and environmental influences that have shaped the organic historical cities and building its a posteriori model. The chapter will determine the factors that define the Arab-Islamic city, thus synthesizing its a posteriori model. It will conclude with a generative comparison of the a posteriori models between traditional and (post)colonial urbanism in Morocco.

Modern and Colonial Urbanism in Morocco

In 1914, Resident-General Lyautey appointed Henri Prost to shape Moroccan cities through what would become the first comprehensive urban planning legislation in France's global territories (Rabinow 1989). In this sense, archaeology was used as a political instrument to legitimize French rule (Ennahid 2022). Lyautey's administration drew connections between ancient Roman settlements and modern French designs, transforming sites like Volubilis into symbols of "civilizing missions" (Ricard 1924; Naji 2011). As such, new European quarters, or villes nouvelles, followed rational grids reminiscent of Roman town planning, strictly separating them from the organic medinas (Naji 2011). This imposed segregation, based on ethnic and later socio-economic divisions, forced large numbers of Moroccans into overcrowded medinas and peripheral slums called douars, or bidonvilles (Abu-Lughod 1980b).

Figure 4 The 13-century Marinide dynasty minaret facing the foundations of the second-century Roman archaeological site's triumphal arch, which stood south of the capitol and faced the forum, Chellah (Sala Colonia), Morocco.
Source: Photo by Aqil Cheddadi, 2024.

Colonial policies altered Morocco's urban trajectory. Strict zoning, security-driven planning, and the construction of new towns dedicated to Europeans disrupted older, bottom-up practices (Muchada 2019). The focus on modernist geometry and control ignored local traditions of adaptive settlement, which contributed to new social and spatial imbalances. In this context, after World War II, French architects such as Michel Écochard experimented with "evolutionary grids" (8×8 m trame) to accommodate Morocco's rapidly growing informal districts (Avermaete 2010). Still, the principal emphasis remained on regulating and monitoring local communities (Rachik 2002). These colonial frameworks, geared toward maintaining power and segregation, persisted well after independence.

Figure 5 Carrières centrales in Casablanca. Construction of the low-rise 8x8m grids and high-rise residential buildings, including Nid d'Abeille. Source: Michel Écochard Archive, courtesy of Aga Khan Documentation Center, MIT Libraries (AKDC@MIT), 1948.

Post-Colonial Reactionary Urbanism

After independence in 1956, Morocco inherited rigid, top-down policies initially serving colonial interests (Chouiki 2017; Es-Sallak 2018). Despite the growing housing crisis, especially in Casablanca, post-colonial authorities often recycled colonial urban doctrines without adapting them to local realities. Expanding bidonvilles remained central to government anxiety, especially after riots in the early 1980s (Rachik 2002). Under socio-political pressure, new policies emerged that included massive programs of Social Housing and "urbanism of emergency," which responded haphazardly to crises rather than systematically addressing structural problems.

Rigid zoning and bureaucratic norms frequently collided with Morocco's culturally rooted notions of flexible housing, privacy, and incremental growth (Es-Sallak 2018). Although derogation procedures were introduced to alleviate these tensions, planners often produce an uncoordinated patchwork of urban expansions - dictated more by economic factors than social needs (Kheireddine and Zouiten 2021). Large-scale development plans - such as the villes nouvelles or the national program Villes Sans Bidonvilles (VSB, Cities Without Slums Program) - were unable to completely eradicate informal settlements or successfully integrate local communities into their projects (Bargach 2008; Harroud 2017a; Kharmich and El Harrouni 2019).

Challenges of the Traditional City

During the colonial and post-independence period, the medinas faced their share of dilemmas of over-densification, gentrification, and sometimes "slumification" (Coslado, McGuinness, and Miller 2013). Government-led rehabilitations in places like Fez aimed to balance heritage conservation with modern demands but risked displacing poorer residents (Matsubara 2004). Radoine (2012) argues that colonial myths still distort conservation policies, casting historic districts as fossilized "Islamic" enclaves preserved primarily for tourism. This mindset overlooks how traditional city life was inherently dynamic and responsive to shifting needs.

The dissonance between Morocco's inherited colonial modernism and its historical adaptive urbanism is evident. Imported urban forms like wide boulevards or standardized housing seldom fit many Moroccans' social and climatic realities (Hensens 2002; Saaid and Chaoui 2020). Even in informal settlements, older spatial processes persist, reflecting cultural continuity despite neglect from official planners (Petruccioli 2007; Petonnet 1972). Ultimately, overly centralized urban codes leave little room for the small-scale, incremental transformations that once shaped medinas and still shape the margins of cities (Mrani, Chenal, and Radoine 2022).

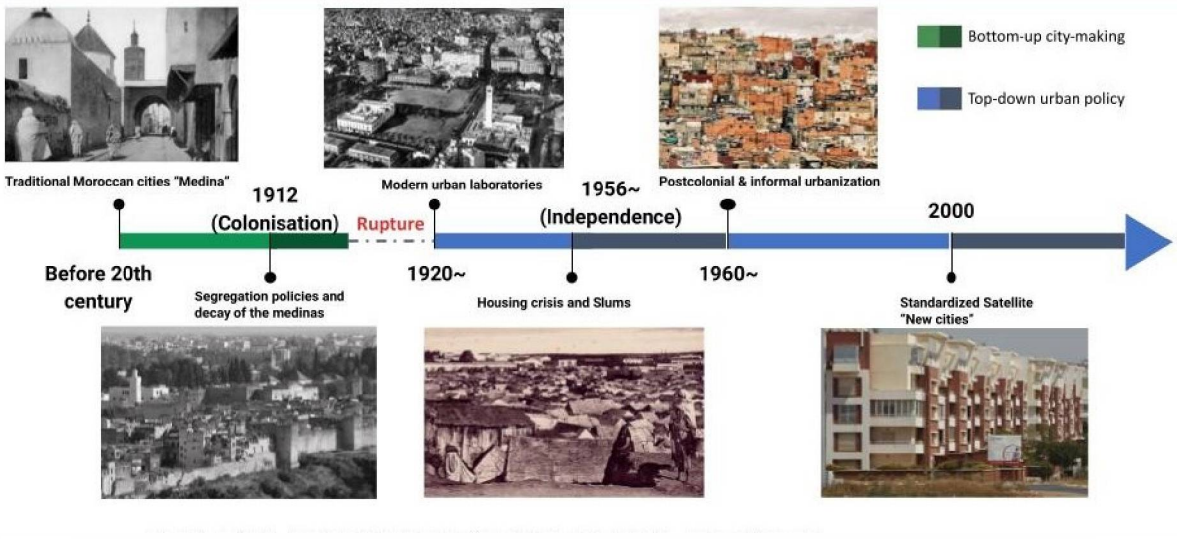


Figure 6 Conceptual timeline of Urban modes in Morocco. Source: Made by the Aqil Cheddadi.

Conceptualizing the Arab-Islamic City

Contrary to Orientalists' depictions of chaos and labyrinthine confusion created by preceding scholars, Arab-Islamic cities are characterized by coherent principles rooted in socio-cultural notions of privacy, community (ummah), and religious life (Bianca 2000; Mortada 2003). Mosques often anchor the neighbourhoods as areas unfold in layered patterns comprising main streets,

secondary streets, and dead-end cul-de-sacs. Courtyard houses and walled enclosures insulate family life from public view, while organic, incremental growth allows for adaptation to changing needs (Akbar 1988; Falahat 2014b). Historical influences on urban tissues—such as Roman or Byzantine foundations—were not simply erased but reconfigured to accommodate local cultural priorities (Correia 2015).

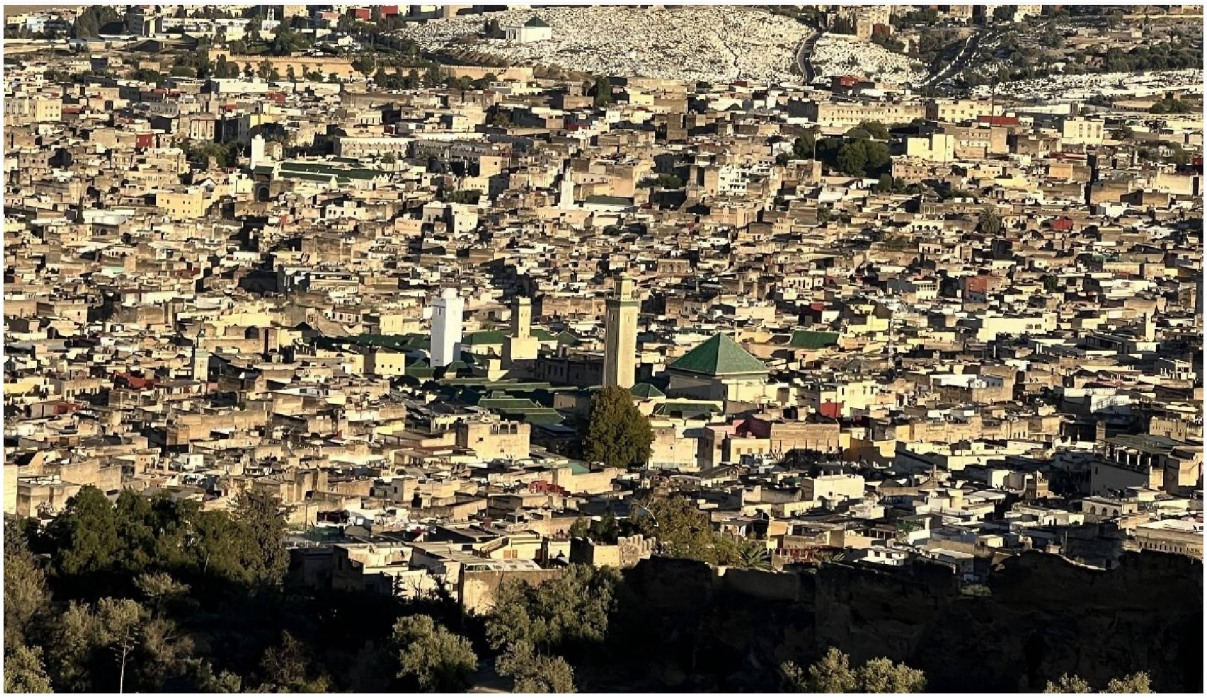


Figure 7 The Historic city of Fez' compact urban form seen from atop surrounding hills. Source: Photo Aqil Cheddadi, 2023.

Throughout the history of the Arab-Islamic region, cities sustained flexible legal and social frameworks within which neighbors could negotiate space and property boundaries based on principles derived from custom, Islamic jurisprudence, and communal consensus (Brunschvig 1947; Abu-Lughod 1989). Inheritance laws fragmented and recombined plots, and daily practices shaped the evolving street network. The resultant "organic" complexity was neither accidental nor disordered but rather a reflection of participatory processes that balanced social, environmental, and religious imperatives (Petruccioli 1997; Bianca 2000).

A Posteriori Synthesis and Generative Comparison

Using a posteriori model clarifies how Arab-Islamic cities align their physical forms with socio-religious rules and historical evolution (Muratori 1967; Petruccioli 1998b). Contrastingly, colonial and post-colonial methods often enforce centralized prescriptions that sideline local practices

(Radoine 2012). Robinson's (2023) notion of a "generative comparison" reveals the divide: Islamic city growth proceeds through bottom-up, incremental negotiation, while post-colonial planning remains top-down and rigid (Hakim 2019). The former yields adaptive, contextually sensitive environments, the latter uniform spaces vulnerable to social and spatial mismatches.

Understanding these divergent paths shows the origins of Morocco's urban fragmentation. It further reflects how remembering the flexible process-based frameworks of spatial production in the medinas might inspire a more adaptive and resilient urbanity. Unpacking Islamic city logics of space—the "software" behind the spatial "hardware"—can exemplify how traditional generative practices may appropriately address shortcomings behind reactionary and disempowering urban planning policies. Thus, reassessing colonial legacies alongside Arab-Islamic urbanism's cultural memory can provide Morocco with a more sustainable, context-sensitive urban future.

Chapter III: Form-finding Urban Simulation

This chapter aims to reinterpret historic Moroccan "medina" urban forms. To concretize this idea, it uses generative design theory as a framework to understand their growth patterns and learn from their adaptive features. Using computational design and simulation models, the research tests this framework through generative design algorithms to better visualize and understand these patterns. These findings are applied to develop urban models based on local interactions, flexibility, and adaptability to be considered in the contemporary urban context of Morocco.

The previous chapter explored the a posteriori mode by examining several factors that allowed medina cities to adapt highly to social, spatial, and environmental change. The study then formulated guidelines for generating some of the characteristics of these urban forms through urban simulations.

This chapter starts by elucidating the similarities between urban simulations and design, as well as Islamic city growth. After reviewing previous case studies of Islamic city-based simulations, the research introduces Multi-Objective Evolutionary Algorithms (MOEA) as a design strategy for a first-case experiment. Using computational design and simulation models, the research explores generative modeling to better understand urban morphologies in a measurable scientific way. These findings are applied to develop, optimize, and visualize intricate urban models that can only be achieved through computation. With this, the simulation seeks to explore the generation of abstract urban forms and their optimization.

Generative Comparison of Islamic City Growth and Urban Simulations

Islamic cities evolved organically, shaped by decentralized interactions among residents adapting to social and environmental factors (Petruccioli 2007; Hakim 2012). Their irregular streets, courtyards, and mixed-use urban tissues formed incrementally through local decision-making (Bianca 2000; Abu-Lughod 1980b). Computational urban simulations, in contrast, systematically generate and optimize spatial forms using rule-based algorithms (Cheddadi, Hotta, and Ikeda 2019a; Soleimani 2019). While simulations excel at handling multiple objectives and producing controlled forms of complexity, they rely on programmed parameters rather than lived cultural practices, meaning they can simulate models of complexity but hardly achieve it (Cogdell 2018). Still, integrating socio-cultural factors into simulation models can help bridge this gap (Denning 2017; Soleimani 2019). By combining organic growth principles with computational power, designers might replicate certain adaptive aspects of medinas while still modernizing the urban realm.

Experiment: Generative Urban Simulation

This chapter's experiment applies Multi-Objective Evolutionary Algorithms (MOEA) to create introverted, high-density housing blocks inspired by medina-like patterns. The simulation relies on Rhinoceros 3D and Grasshopper (GH), coupled with the Wallacei X solver and the Ladybug environmental plugin. Evolving solutions balance three main objectives—solar gain, connectivity, and target density—through the Pareto front approach (Makki, Showkatbakhsh, and Song 2018; Navarro-Mateu, Makki, and Cocho-Bermejo 2018).

Computational Design Framework

Evolutionary solvers in algorithmic design software, mainly applied to generative design, such as Galapagos and WallaceiX plugins in Grasshopper (GH), are programs that apply evolutionary principles to problem-solving in the design process (Navarro-Mateu, Makki, and Cocho-Bermejo 2018; Rutten 2010). Genetic Algorithms (GAs) are one of the most common modeling approaches for Evolutionary Algorithms (EAs), a collection of optimization algorithms inspired by the basic process of natural selection. GAs and EAs, which have several mechanisms analogous to biological evolution, use selection, mutation, and crossover to evolve solutions to optimization problems over successive generations. This means that the chosen input parameters, or "genes," will be selected as variables to be modified by the solver to achieve the best possible range of solutions for the

prescribed problem. The optimization data and geometry are referred to as "phenotypes;" these are logged into GH, and specific solutions can be reinstated as 3D geometry in Rhinoceros 3D.

Evolutionary solvers operate meta-heuristically through exploration of the solution space in a balanced manner of *exploration*, meaning broad search; and *exploitation*, meaning the refinement of known reasonable solutions (Coello Coello 2005; Vikhar 2016).

Optimization Urban-Forming Simulation

This experiment defines its primary purpose as developing an approach for conceiving a city that can consider dynamism. Indeed, one of the main features observed when studying historic urban tissues is that they are highly adaptive to the evolution of social needs and environmental constraints. By offering a degree of flexibility, such an approach allows users to find, through a trial-and-error process, solutions that address their issues by self-organizing and changing the typologies of the urban space. This process is done while considering several social and functional directives adapted from the a priori model study (Chapter II) and integrated as flexible rules in the algorithmic design process [Table 3].

In this experiment, a generative urban model was formulated from the a priori study to explore conceptual solutions for high-density and low-rise urban forms [Figure 23]. For this, the Moroccan compact and introverted urban form is considered, thus acting as a defining pattern (Sibley 2004). This pattern offers coherent urban forms that are organic, incremental, and environmentally

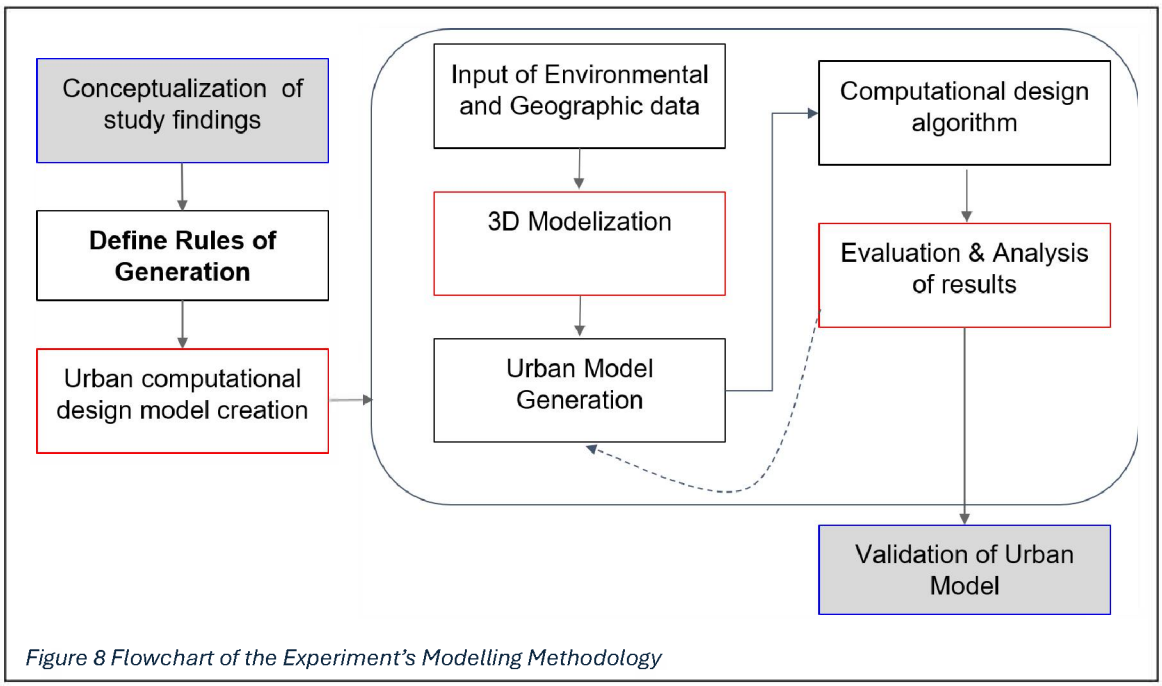
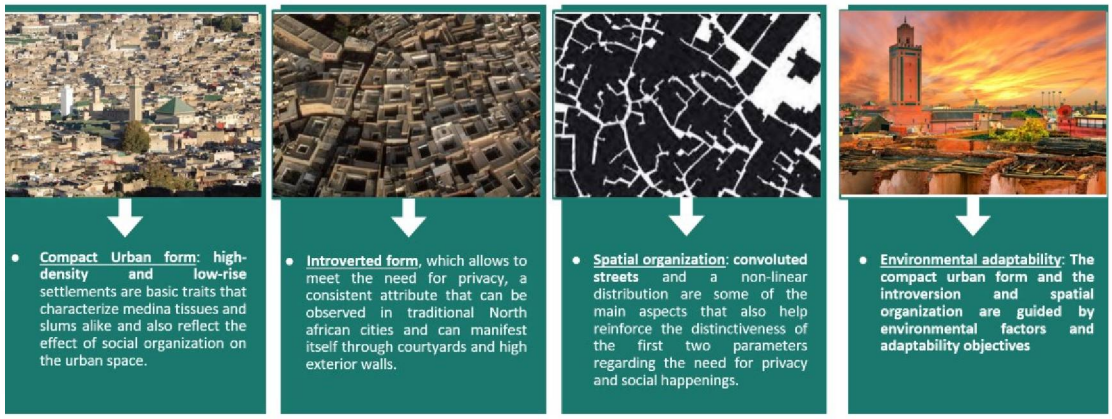


Figure 8 Flowchart of the Experiment's Modelling Methodology

adaptive [Table 3]. Considering the region's hot and arid climate and the intricacy of urban forms, this research deems solar gain an essential factor in environmental adaptivity.

The simulation adopts a construction method for diversification through standardized components. This can be achieved using prefabricated modules arranged in different possible combinations to form a variety of urban entities, thus aiming to create diversity through different forms of aggregation of the same basic unit, similar to how the same elementary cells make an organic tissue. By being the most minor component of the system, those modules will be an interpretation of the *dar*, which shows a capacity for the system to adapt through aggregation processes. As for the plot definition method, it allows for urban geometry with patterns that reinterpret the contiguous configuration of the medinas. However, to refute any arbitrariness, it is necessary to evaluate the system's behavior to assess the solution's adaptability. Accordingly, for this case, an algorithm that applies a multi-objective genetic solver is deemed relevant to simulate an urban form-finding model for high-density, module-based housing.

Table 1 Description of the urban form-finding model's characteristics based on the a posteriori synthesis.



Simulation Methodology

This algorithmic model generates a high-density cityscape optimized for multiple conflicting environmental constraints (such as solar gain, heat-island effects, and physical accessibility) while being diversified enough in its spatial configuration. The program randomly permutates and combines basic modules representing housing units to generate a clustered geometry that forms a housing complex evaluated by three objective functions [Table 4].

The results resemble heterogeneous, introverted, and porous units that allow sun rays to get through, consequently allowing aesthetic diversity. I visualize and rank these multiple optimized outputs using analytic tools to better grasp the most fitting solutions to the design problem.

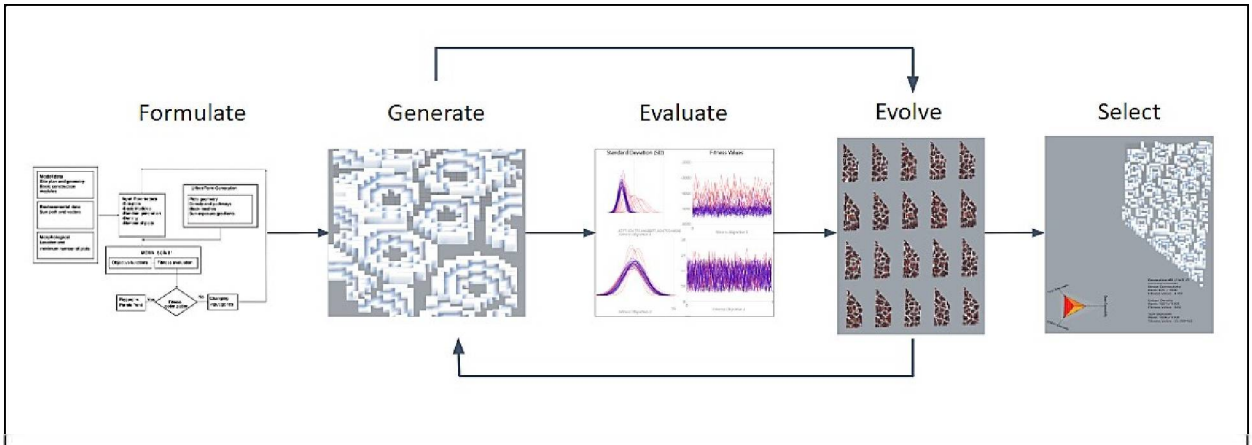


Figure 9 Operational Workflow of the Evolutionary Simulation Loop. Source: Author, 2024.

Software Tools

The parametric model [Figure 25] is designed using Rhinoceros 3D (Rhino) and its visual parametric plugin Grasshopper (GH). The solar gain data (SG) are integrated using the Ladybug environmental add-on. Form-finding is conducted using the multi-objective solver add-on for GH named Wallacei X (Makki, Showkatbakhsh, and Song 2018), based on the SPEA-2 evolutionary algorithm. Built on multi-objective evaluation functions, Wallacei X uses an optimization algorithm that explores viable solutions for the best combination of inputs to generate a best-fitting geometry (phenotype). Wallacei X ranks the results of each generation using the Pareto-front method. Finally, the solutions were evaluated, selected, and visualized using Wallacei Analytics, an analytical tool for MOEA solvers.

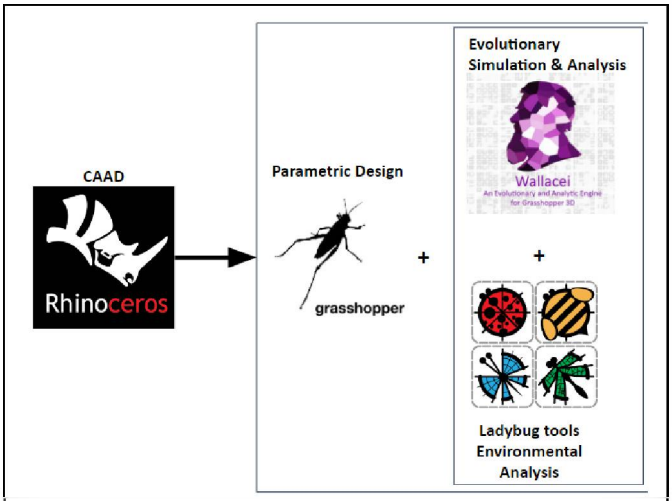


Figure 10 Design Software and Tools Used in the Simulation. Source: Author, 2024.

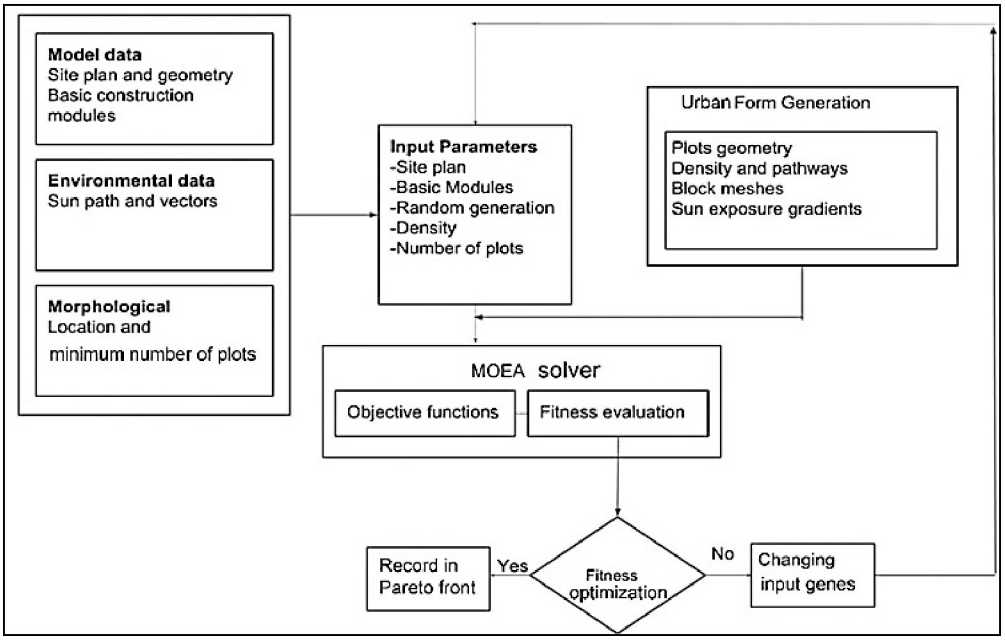


Figure 11 Algorithm flowchart of the parametric model for the urban simulation.

Objectives and Constraints

Urban simulations are tools that can allow for various applications in design, analysis, and planning. With these tools, it is easier to explore many morphological variations that maintain a degree of performance using computational calculations. In this regard, urban simulations are used to explore new methodologies or urban-forming and even re-discover old ones due to contemporary constraints. The present experiment contextualizes the problem-solving process for formulating a framework for generating problem-specific urban morphology. With such a methodology for the

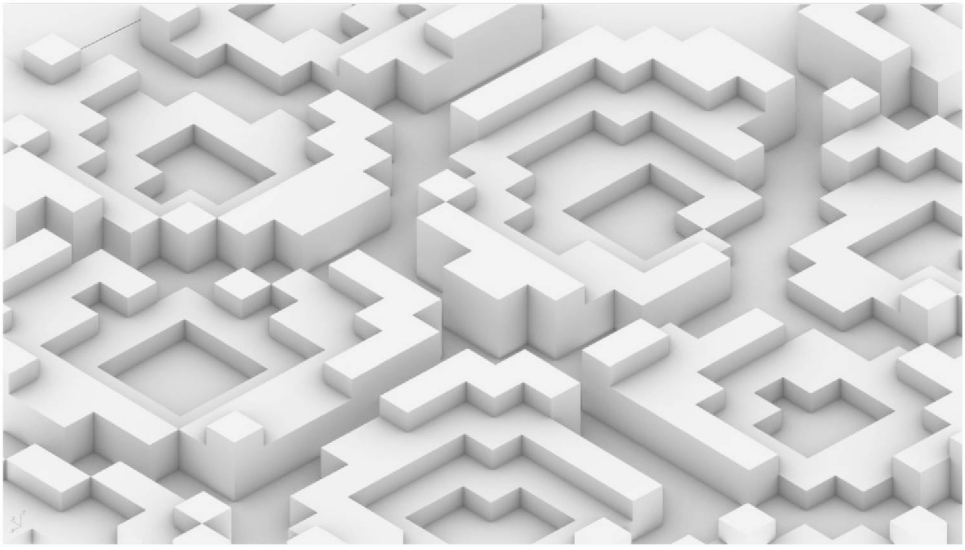


Figure 12 3D-generated compact and introverted urban form with the use of generative algorithms.

initial stages of early design, through a scalable scientific approach, it will be possible, through this experiment, to prototype multiple urban forms and visualize them.

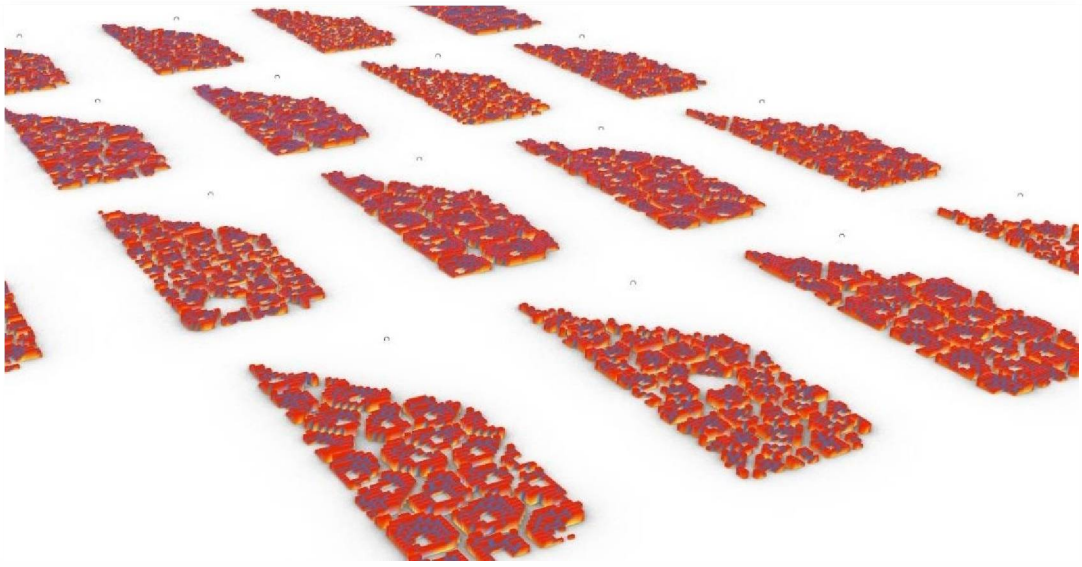


Figure 13 Visualization of color-mapped meshes of the final generation Pareto frontline rendered on a grid.

For this purpose, grid-based operations with base modules representing housing units are used with introverted urban blocks. The street blocks must fulfill the need for walkability and compactness. Urban simulations generate high-density, low-rise morphologies based on generation rules and processes that interpret some generative urbanism characteristics. While urban space is a complex system that can be described through comprehensive models, this research discusses generative design. It generates, evaluates, and ranks many abstract urban morphologies that reinterpret key features of site-specific urban characteristics.

Results and Analysis

Due to the optimization algorithm's heuristic nature, it does not conclude with a definite, single-optimized solution. Instead, it generates a multitude of optimized solutions for conflicting goals. Choosing the right solutions can be challenging for designers and users, so using analytical tools such as Wallacei X Analytics is mandatory. (Makki et al. 2019), which helps better navigate the results and make more informed choices. The MOEA's search space is up to 4.6*e5 to explore optimized phenotypes, so it is necessary to analyze the results statistically. Visual inspection of the solutions might give an idea about the algorithm's global trends but does not help to understand the results better.

Inspecting the fitness values data and standard deviation curves of the Pareto front for the experiment results shows that the genetic solver has shown a trend for optimizing the urban form while keeping enough diversification. In the standard deviation graphs, red represents the first generation, and blue is the last generation. For density and SE distribution (fitness objectives 2 and 3, respectively), the result is close to expectations with a spread-out standard deviation that flattens as generations go by, thus approaching the bell curve in the most SG-optimized phenotypes when compared with baseline results outside the Pareto front. Data analysis also shows that the algorithm can compromise the global SG score for a better SG equalization result.

While analyzing the data, there is a clear trend for further optimizing the mean value of the evaluation scores for all three objectives while spreading the standard deviation curve further. Narrowing the standard deviation graphs through the generations, also seen through the standard value trendline going higher up, proves the system's ability to maintain a diversified solution that can prevent any premature convergence of the solver.

However, due to the stochastic nature of the MOEA, the mean value trendline is constantly fluctuating, showing that the algorithm is still favoring the exploration of the objective space rather than its exploitation. This underscores the need for continuous algorithm optimizations in urban planning.

Table 2 From left to right: Standard deviation, value trendline, and mean value trendline for the three fitness objectives. Numbered in the figure from top to bottom: connectivity, density, and SG. The generation count is represented from red to blue.

Intermediary Findings and Limitations

This chapter illustrates how computational design methods, particularly multi-objective evolutionary solvers, can reinterpret some essential features of Moroccan medinas. The simulation highlights adaptive patterns, compact clustering, privacy, and courtyard organization by treating the urban fabric as a modular, rule-based system. While algorithmic models remain dependent on designer input and cannot replicate lived communities' rich, organic diversity, they offer a valuable tool for exploring complex geometries and measuring performance. The results suggest that combining cultural knowledge with computational sophistication provides a promising avenue for designing human-scale, context-sensitive urban environments—rooted in the spirit of historic medinas yet responsive to modern conditions (Hakim 2012; Davis 2006; Coates 1995; Duarte et al. 2007).

This first simulation experiment also shows that further algorithm optimizations and studies of its behaviors under different constraints are necessary to refine results better. Understanding how the algorithm works can allow for integrating other environmental objectives, thus making it more broadly adaptable.

Additionally, it is essential to note that this simulation model is based on the a posteriori synthesis of the Arab-Islamic urban form. Findings at this stage of the research indicate that the synthesized core characteristics of the a posteriori are insufficient to guide and formulate a simulation model that reinterprets the generative processes of the traditional cities of Morocco. Some of the shortcomings include the top-down design strategy (defining higher-level plots before units), not interpreting neighboring unit-to-unit interaction-which can be done through multi-agent simulation- and adapting an all-at-once instead of a step-by-step generation, all of which are characteristic of the traditional urban environments. To achieve this aim, it is necessary to complement the study with an investigation of the a priori model, as well as the underlying socio-cultural and typo-morphological rules that characterize urban generation.

Chapter IV: Generative Urbanism – Spatial Rules and Typo-Morphological Processes

The previous chapter explored optimization simulations as a set of analytical and generative tools to model and refine the performance of urban systems. These computational approaches make attaining highly efficient and scalable designs possible for urban settings. However, the adopted

method depends mainly on top-down design strategies that do not fully capture the adaptability of the traditional urban environments that have organically evolved over time.

By contrast, the Generative Urbanism phenomena explored in this chapter provide a dynamic lens on how cities grow and adapt over time, driven by emergent bottom-up processes. This approach aligns with the morphology of the historic Mediterranean and Arab-Islamic urban forms, where localized decision-making and adaptive social structures are central in creating resilient urban systems. By investigating the generative principles of traditional cities, this chapter investigates the organic, human-centered adaptability of self-organizing urban systems.

The chapter first situates Moroccan urbanism in the broad Mediterranean context, highlighting similarities and contrasts between Islamic and Byzantine traditions. Then, it explores the influence of historical urban codes and organization principles, including adaptability and emergent growth.

Accordingly, generative urban rules are key to this chapter. They are adaptive rules shaping incremental and participatory development into urban morphology. This chapter synthesizes typo-morphological rules explaining how courtyard house-based aggregation and neighborhood clusters articulate by forming an organic growth mechanism in the Moroccan medina. The chapter describes in detail how generative urbanism is based on the historical development of the pattern and socio-cultural and religious norms in search of designing resilient and culturally coherent contemporary cities.

The chapter concludes by formulating an a priori model of the Arab-Islamic urban form. Thus, it offers a holistic framework setting the stage for a nuanced exploration of adaptive urban design through later simulations (Chapter VI).

Traditional Urban Codes in the Mediterranean

Historic urbanism in Morocco shares broad roots in the Mediterranean across both Islamic and Byzantine traditions, as highlighted by Petruccioli 2007. Ideas of property, shared walls, and street widths were drawn from ancient sources such as Julian of Ascalon in the Byzantine sphere and Ibn al-Rami in the Islamic context (Hakim 2001a; Ibn al-Rāmī and Ibn ʻAlī 2012). Both traditions combine prescriptive elements, often with specific measurements for walls or drainage, for example, combined with proscriptive ones prohibiting actions infringing on the rights of neighbors.

In Islamic jurisprudence, urban codes emphasize on privacy, property rights, and the ethical avoidance of harm (dharar) in ways that preclude the invasion of neighbors' space (Hakim 1986). Equally important is how this was embedded within a sense of local custom (ʿUrf) and community

oversight and responsibility (Hisba) in which ordinary residents have the agency to engage in shaping their built environment (Lafi 2020; Akbar 1988).

Arab-Islamic City Rules and Processes

The organic, courtyard-based fabric of the Arab-Islamic city is based on local, proscriptive rules based on local customs and practices that avoid causing harm rather than rules that prescribe uniform outcomes (Hakim 2019). Such flexible rules, for instance, limiting the height or orientation of buildings overlooking neighbors, allowed for self-organizing urban growth. The principle of pre-emption (Shuf'a) -allowed neighbors to purchase adjacent properties to keep outsiders away, further preserving cohesion in a community (Hakim 1986).

Such rules work within an ethic of distributed responsibility: people were bound by convention to maintain the social and moral order of the city (Lafi 2020). This communal welfare was underpinned by mechanisms such as waqf or charitable endowments and local market inspectors known as Muhtasib (Bianca 2000; Ege and Moser 2020). Rather than zoning uniformity, it is these grassroots initiatives which drive the incremental and adaptive evolution of form.

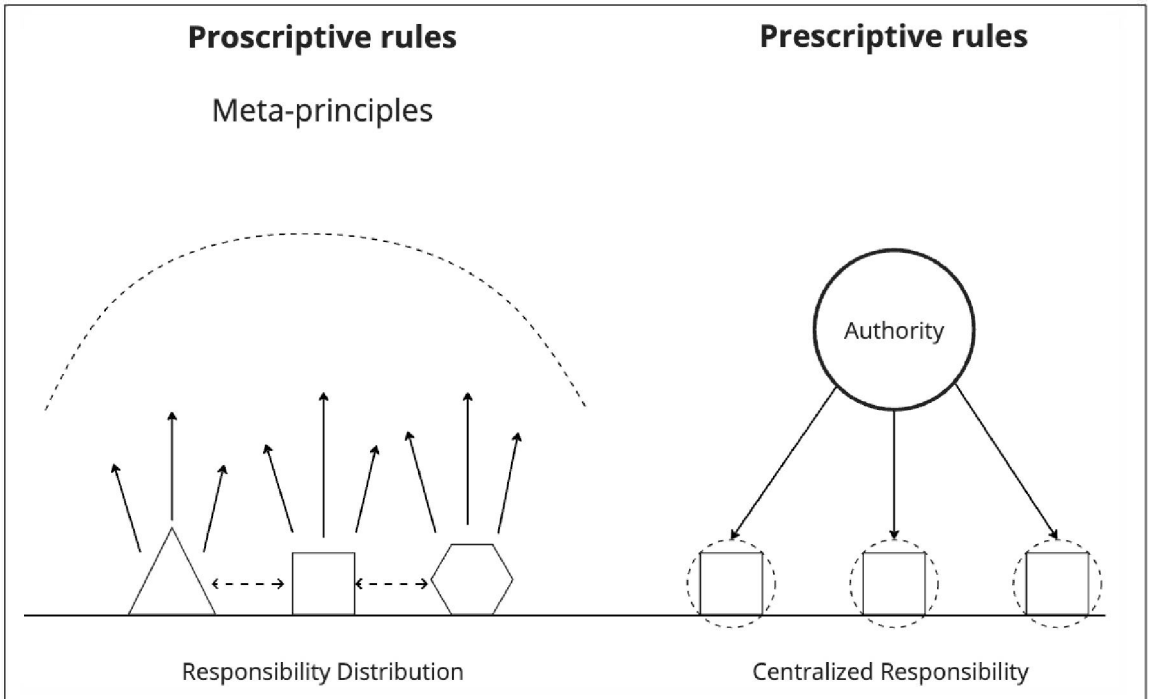


Figure 14 Diagram showing the distinction between proscritive and descriptive design. Source: Redrawn and adapted by Aqil Cheddadi after Hakim (2019).

Generative Urbanism Framework

Echoing Christopher Alexander's (1977, 1987, 2002) writings, Generative Urbanism views cities as complex, adaptive systems wherein each household or "agent" acts within simple, locally acted rules (Batty 2007b). Through feedback loops, the individual decisions of adding a second story or opening a new door aggregate into neighborhood-scale order. This bottom-up growth contrasts sharply with modern top-down planning, which tends to suppress local adaptability.

Besim Hakim (2019) is one of many scholars who have described the self-organization of Arab-Islamic medinas: the incremental expansion of each courtyard house to meet the needs of an expanding family, while prescriptive codes ensure neighbors are not harmed (Hasan 2022; Ben-Hamouche 2009, 2011, 2012). Over time, these cellular blocks cohere around shared alleyways, giving the city a dense but socially adapted network of streets.

Arab-Islamic Cities as Complex Adaptive Systems

Traditional Islamic cities exhibit evident characteristics of Complex Adaptive Systems: they evolve unpredictably through local rules, adapt to demographic or cultural shifts, and maintain internal coherence (Apaydin 2015). The organic streets of traditional Islamic cities reflect historical forces, climatic conditions, and religion-driven privacy norms.

- **Neighborhood Adaptivity:** Cozzolino (2020) identifies criteria like attractiveness, mixed uses, flexible building rules, and incremental construction, all of which are integral to medinas.
- **Self-Building, Self-Governance, Self-Coordination:** From individuals constructing their own courtyard homes to local guilds regulating souks, these decentralizing mechanisms—outlined by Moroni et al. (2020)—drive organic order.

Figure 15 A sabat bridging two houses over a narrow street in the historic walled medina of Assilah. Source: Photo by Aqil Cheddadi, 2022.

- **Feedback Loops:** Negative feedback (enforcing privacy or halting harmful building changes) maintains equilibrium, while positive feedback can reinforce specific successful patterns (Ben-Hamouche 2013).

Courtyard Houses and Neighborhood Aggregation

A core element defining building blocks is the courtyard house, which develops over time, yet remains introverted. Research has shown how these forms adapt socially and spatially, joining or dividing as the family needs change (Petruccioli, 1999; 2007). Since every house aligns with shared customs- high walls and staggered windows- the resulting neighborhood remains cohesive.

Figure 16 A dead-end in a narrow derb in Sidi Youssef Ben Ali. Source: Photo by Aqil Cheddadi, 2024.

As Howard Davis (2006) and Janet Abu-Lughod (1980a) point out, these houses cluster and interlock through intricate alley systems and micro-level neighborhood interactions. Lacking a formally planned street plan, successive additions fit in circulation as "after-the-fact" processes that leave spaces appearing irrational yet functionally logical.

In Marrakech, Wilbaux (2001) shows zribas (animal enclosures), for example, developed to become houses with a small courtyard and eventually dense quarters, like Sidi Youssef Ben'Ali. Other new constructions, such as the extension of previous gardens at the Similarly, expansions of older gardens in Derb Tizougarine adopted more rectilinear layouts, while other neighborhoods remained curvilinear. Both reflect the medina's adaptability: cellular-based incremental development guided by socio-cultural rules.

A Priori Model and Generative Principles

The adaptive rules and typologies discussed above define the a priori model for urban making in the Arab-Islamic tradition (Petruccioli 2007). The system offers socially intuitive guidelines that keep neighborhood life in harmony. The generative logic emerges through small-scale (starting

from the single room-unit) decisions up to citywide development that creates resilient and locally adaptive places.

Key chapter findings include the following:

- Cities function as **complex adaptive systems**, with individual courtyard units aggregating into cohesive neighborhoods.
- **Proscriptive** (rather than prescriptive) rules protect privacy and neighborly rights, allowing flexible, organic growth.
- **Feedback loops** and distributed responsibility create self-regulating development.
- The **courtyard house** remains a core urban cell that adjusts over time and aggregates creating organic urban tissues, adapting to social changes without losing its essential identity.

Building on these foundations, the next step (Chapter V and VI) examines how these historical generative processes persist in contemporary Morocco—especially in informal settlements—and how they might be revived or learned from to address modern urban challenges.

Chapter V: Informal/Generative Urbanism

Building on the a priori model of the Arab-Islamic city formulated above, this chapter examines whether such generative processes remain active in today's Moroccan informal settlements. The analysis is carried out with a focus on two specific Rabat-based slums, Douar Doum and Douar Al-Garaa, to assess and compare if their emergent inhabitant patterns and decentralized urbanism parallel historical medina growth. Through generative comparisons (Robinson 2023), this chapter brings into view continuities in self-organizing practices, cultural norms, and bottom-up building practices that resonate with premodern Islamic urbanism but are transformed by the modern socio-political landscape.

Generative Processes Assessment Framework

Based on Moroni, Rauws, and Cozzolino's (2020) conceptualizations of self-organization (self-building, self-governance, self-coordination) and Cozzolino's (2020) eight criteria for neighborhood adaptivity, this chapter develops an assessment matrix to assess informal settlements' generativity. Factors like attractiveness, design scale, and planning rules help ascertain how well neighborhoods respond to changing needs or external pressures. In this context, proscriptive rules-

anchored in local socio-religious norms-become integral drivers of organic, adaptive growth, much as they did in historic medinas (Hakim 1986).

From Medina to Bidonville: Urban Fractures and Continuities

Many of Morocco's modern housing projects break away from traditional development patterns. The SH (Social Housing) operations and colonial legacies introduce rigid, top-down and centralized models that disrupt community-centered incremental development. However, fragments of *'Urf*, privacy norms, and neighbourly negotiation have survived in the informal settlements (Cheddadi and Rifki 2024). Informal neighborhoods such as Douar Doum and Douar Al-Garaa often reproduce medina-like incremental processes but are stigmatized and pushed to the urban fringes through state interventions.

Emergent Housing Patterns in Douar Al-Garaa and Douar Doum

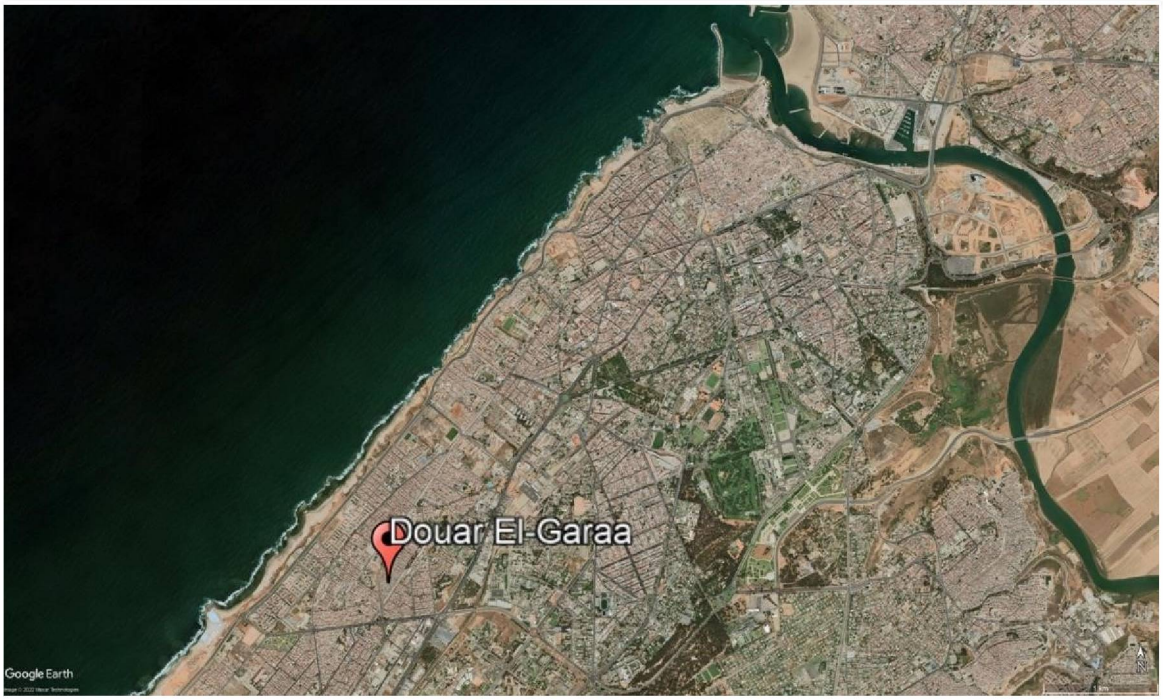


Figure 17 A satellite image showing the position of Douar Al-Garaa in Rabat, Morocco. Source: Google Earth, 2018.

Douar Al-Garaa

Located in the Yaacoub El-Mansour district of Rabat, Douar Al-Garaa was home to over 3,000 families before state-led demolitions began in 2019 (Le Monde.fr 2019). The neighborhood emerged out of earlier colonial-era clearances of bidonvilles and developed incrementally over

generations as rural migrants gradually replaced tents with self-built homes. Residents incrementally upgraded their houses in waves, particularly during electoral periods, where political opportunism for incremental construction (Cheddadi 2018).

Consistent with medina-like residence patterns, through negotiations between neighbors residents rely on maintaining privacy and avoiding harm (dharar) (Hakim 1986). A limited number of open public spaces are evident outside the houses, and informal extensions tend to align with the principle of hishma or modesty. The self-management and coordination exercised by the settlements' inhabitants are constrained; however, the Moroccan regulatory framework under its Villes Sans Bidonvilles (VSB) program reduces inhabitant agency in favor of centralized governance (Bogaert 2018).

Despite strong local solidarity and protest movements, the government demolished Al-Garaa in 2019, displacing families to outlying social housing. Many dwellers perceived relocation apartments as unaffordable and culturally mismatched to their incremental living culture (Beier 2021). The tension between communal right-to-the-city claims and neoliberal urban policies underlines how external interventions can disrupt generative urban patterns (Bogaert 2018).

Figure 18 An example of a straight alleyway in Douar Al-Garaa slowly evolving into a sinuous one with long bare walls, reminiscent of the same street shapes as the medinas. Source: Aqil Cheddadi, 2018.

Douar Doum

Douar Doum emerged at the start of the 20th century, as its original inhabitants were moved several times before settling on the rocky southeast edge of Rabat (Abu-Lughod 1980b; Petonnet 1972). Like Al-Garaa, it expanded organically from tents and *noualas* (rudimentary huts) into more permanent housing.

Residents often self-constructed homes, applying customary rules for privacy and managing neighbor-level negotiations. Government oversight remained sporadic, allowing waves of informal vertical extensions (Abu-Risha 2020). While this preserves bottom-up generative processes, it also permits rampant speculation-what the chapter calls "*degenerative urbanism*"-creating overcrowded, unsafe morphologies without the ethical checks once imposed by the muhtassib or a communal authority (Lafi 2020).

Although courtyard houses were first a common typo-morphology, row-house typologies have emerged under the influences of modernization (Santelli 1998). Still, Douar Doum has maintained a high sense of social cohesion where local negotiation processes have determined the nature of shared walls and semi-private alleys. The settlement shows high self-organization qualities and represents piecemeal organic growth but might sometimes result in dysfunctional urban forms because of the lack of communal oversight.

Figure 19 View of Douar Doum from down the hill showing a compact and high-density urban form. Source: Aqil Cheddadi, 2023.

Synthesis and Generative Comparisons

Comparing Douar Al-Garaa and Douar Doum shows that informal settlements retain core generative elements reminiscent of historic medinas:

- **Self-organization:** Residents create and modify dwellings, and manage their local environments using local know-how and incremental expansions.
- **Local negotiation:** Communal norms, privacy, and *dharar* minimize neighbor conflicts.
- **Adaptive structures:** Frequent changes in household composition or resources drive rapid design improvisation.

In the case of Douar Al-Garaa, repetitive state interventions inhibited generative growth and resulted in forced relocation. Douar Doum, on the other hand, lying peripherally, saw more unrestrained organic development—though with speculative abuses resulting in degenerative patterns. Both testify to how informal generative processes are being distorted in the context of modern authoritarian and neoliberal policies, thus creating frictions between spontaneous and culturally anchored urbanism and rigid regulation (Bogaert 2018).

Findings highlight that traditional generative processes continue in Morocco's informal settlements, strongly embedded in centuries-old sociocultural norms and emergent bottom-up development, yet also strained by top-down demolitions, speculation, and lack of shared ethical oversight. Far from a simple carryover of the medina's socio-spatial patterns, these douars reflect a conditioned generative urbanism shaped by political power, economic constraints, and evolving cultural customs. Understanding these adaptive patterns and the threatening forces is an essential basis for setting up new proposals for community-based planning frameworks that could balance local resilience with broader urban policies.

Chapter VI: Simulating Spatial Unfolding Rules

Following the analysis from previous chapters and building on the findings of the first simulation, this chapter introduces generative codes, a bottom-up design framework based on core characteristics of the synthesized a priori model. The generative code is particularly relevant in the Moroccan context because it balances bottom-up and community-based planning with a system of oversight that is necessary in the current context of the crisis of responsibility in the built environment (see Chapter V) (Akbar 1988). that guides the reconstruction of Moroccan towns devastated by the 2023 earthquake (Alexander et. Al 2005; ICOMOS 2023). Drawing on typo-morphological analyses of traditional settlements, and the a priori model synthesis (Hakim 2019; Petruccioli 2007), the framework encodes courtyard-centered housing patterns—central to North African medina design—into a 3D cellular automata model (Batty 2007). In this generative code,

new housing units emerge into neighborhood clusters by applying iterative rules of aggregation, connectivity, and compactness, reflecting organic processes that formed Moroccan-built environments throughout history (Naji 2019).

To test the formulated generative code, the simulation defines a compact grid where courtyard houses gradually aggregate, forming clusters around a central courtyard. Before adding or modifying one housing unit, the model checks at each step to maintain the local constraints, such as accessibility corridors or neighboring conditions. By encoding these context-sensitive rules, the framework supports phased rebuilding efforts that balance immediate shelter requirements with longer-term social cohesion. For stress-testing resilience, random events are set up in the middle of the simulation, for example, variations in growth speed or the removal of partially built homes, mirroring the unpredictable conditions frequently encountered during post-disaster recovery.

Findings reveal that even under these disruptions, the generative process produces cohesive clusters of courtyard units with adequate daylight, circulation, and communal identity. By leveraging local building processes in a computation model, the simulation greatly emphasizes the role that culturally grounded rules of emergence play in post-earthquake rebuilding (Naji 2019). It balances modern resilience imperatives with heritage preservation and offers one viable avenue toward adaptive and community-centered reconstruction.

Ultimately, this chapter highlights how emergent design tools can preserve heritage while fostering self-organized growth, offering a promising path toward adaptive and community-centered reconstruction. It concludes by comparing the first form-finding simulation (Chapter III) and the second unfolding/spatial rules simulation (Chapter VI) to synthesize findings about the significance of generative urbanism and the relevance of computational design thinking and simulation.

Proof of Concept: (Re)Generative Code

Urban Codes

While zoning or land-use plans in conventional urbanism establish a terminal point, codes can be non-restrictive, and the rules control how the processes by which urban form is wrought at the local community level take place (E. R. Alexander, Mazza, and Moroni 2012; Alfasi 2018). In particular, generative codes outline simple, open-ended sequences and procedures rather than invariable end-states that facilitate incremental development under local oversight (Alexander et al. 2005).

While FBCs (form-based codes) prescribe the detailed building form (Bin Sulaiman and Almahmood 2022), generative codes emphasize iterative transformations. They allow the community to create a distinctive result through rules that ensure coherence and respect for local character (Nguyen 2015). Since generative codes adapt to local conditions, they foster resilience and continuity of culture, an essential issue in Morocco in light of earthquakes (Naji 2019).

Christopher Alexander's Generative Code

Christopher Alexander proposed generative urban codes as sequences of unfolding steps (Alexander et al. 2005). Rather than determine the output form itself, they define how each layer - housing, streets, courtyards-should be brought into being overtime. This befits or parallels the gradual and cumulative evolution of Arab-Islamic neighborhoods throughout history (Hakim 2019). The key lies in explicit steps:

1. **Initial Assessment and Community Input:** Map site conditions and involve locals in setting priorities.
2. **Defining the Steps:** Outline how new structures appear around courtyards or along pathways.
3. **Contextual Adaptation:** Adjust house sizes, courtyard shapes, and cluster formations to local terrain and climate.
4. **Iteration and Feedback:** Continuously refine at each stage, ensuring alignment with communal or environmental needs.

When integrated with Morocco's vernacular patterns, these codes aim to organize future growth without a top-down planning, preserving cultural DNA while ensuring modern resilience (Hakim 2012; Mehaffy 2008).

Generative codes require high social capital and ongoing community involvement or investment (Nguyen 2015). Without local support or a moral framework, self-regulation can lead to inconsistent outcomes. A planning judiciary or semi-judicial body that would help resolve disputes and discipline design decisions is also desirable. Ethical considerations-respect for heritage, equity, and privacy-must be provided as guidelines with the code specifications so that speculative or injurious growth is curtailed (Hakim 2008b).

Case Study: Post-Disaster Regeneration in Morocco

A generative code for rebuilding earthquake-struck Moroccan towns is pertinent to allow for community-based and culturally oriented redevelopment (Alexander et al. 2005; ICOMOS 2023). It can allow for generating an iterative, participatory approach supports that not only sensitive staged reconstruction to urgent, immediate needs and shelter but also to long-held cultural identities identity (Naji 2019). For example, community-driven rebuilding in Haiti and Japan showcases how adaptive frameworks can restore local heritage through a bottom-up approach or upgrade structural resilience (Daher, Kubicki, and Halin 2015; Tomobuchi, Tsukihashi, and Isomura 2024).

There is a rich tradition and persistence of courtyard houses in Moroccan medinas and rural mountain villages, as well as their attributes of privacy, thermal comfort, and familial continuity (Bianca 2000; Petruccioli 2007). This built archetype is retained in the generative code to ensure that new units echo the local forms while adapting for safety and modern amenities. Over many centuries, courtyard dwellings demonstrated their typological resilience by growing vertically or combining with neighbors as the need for social or climatic demands changed (Hakim 2012).

POC Simulation: Spatial Rules / Unfolding System

This study takes the village of Tafeghaghte as a site for its experimental case study. The village is situated south of Marrakech, at a 10 min ride from the town of Amizmiz. In its pre-disaster condition, the village exhibited cohesive courtyard-based architectural typologies common in the western parts of the High Atlas region.

Figure 20 Satellite image of pre-earthquake Tafeghaghte showing the courtyard typology.

Based on the a priori model study, the formulated generative code is tested through the formulation of a 3D cellular automata-like model in Rhinoceros 3D+Grasshopper, using Anemone for iterative logic (Batty 2007; Liu et al. 2021). The model encodes courtyard formation, adjacency checks, and incremental house expansion, approximating the organic clustering seen in historic Moroccan towns (Hakim 2012).

The simulation's rules revolve around:

- **Courtyard Formation:** Each house cell must wrap around a small courtyard, sharing at least one wall with an existing structure.
- **Incremental Aggregation:** New houses attach themselves to prior units step by step. If the system's density threshold is reached, vertical expansion begins.
- **Local Privacy:** Windows or open walls cannot overlook a neighboring courtyard. Paths remain unobstructed, echoing proscriptive norms (Hakim 1986).
- **Adaptation via Feedback:** Random disruptions alter growth speeds or remove partially built homes, mimicking real post-disaster unpredictability (Mouloudi 2020).

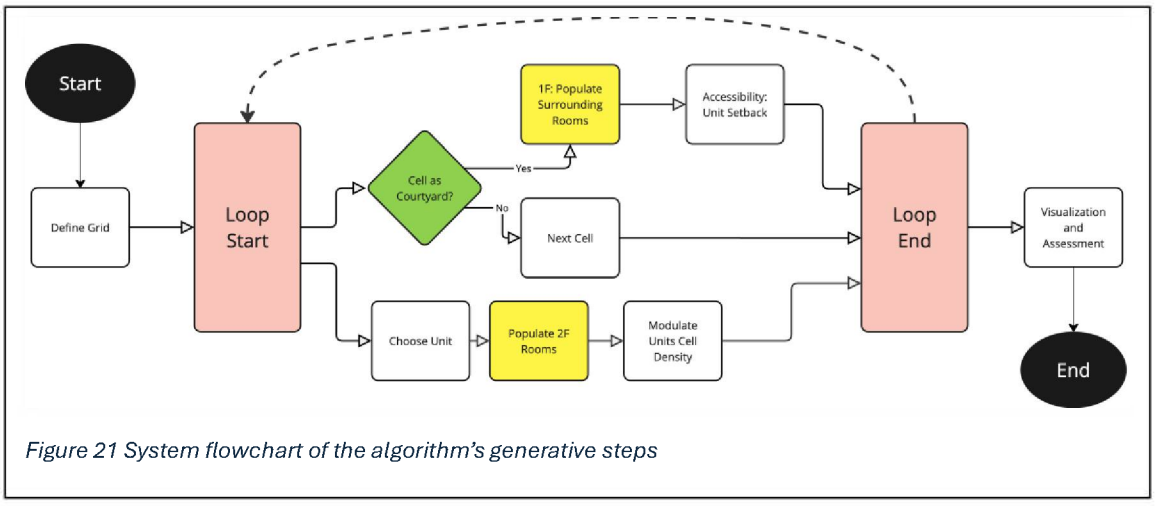


Figure 21 System flowchart of the algorithm's generative steps

The goal is to simulate emergent neighborhoods emanating from courtyard modules, testing how well the unfolding process retains accessibility, daylight, and communal identity. Instead of seeking a "best" plan, the model checks if the code can maintain coherence under varied conditions as proof of resilience (Alexander et al. 2005).

The simulation remains grid-based for simplicity of calculation. Real life's topography and preexisting structures impose a more flexible arrangement. Despite such modeling constraint, iterative "micro changes" approximates organic patterns that allow the code to develop organic alleys and shared walls (Petruccioli 2007).

It also yields cohesive neighborhood clusters with a simplified grid: courtyard forms stay feasible, and the alleys avoid blocking access to other houses despite the inclusion of random disruptions in the simulation process. These systems reorganize as new units crop up or partial houses disappear without harming the integrity of the entire structure. The following shows just how stable and adaptive the generative rules of a courtyard-based one would be.

Nevertheless, grid logic can hardly capture the complete spontaneity of real medinas, and it does not represent nuances like inheritance or micro-negotiations on shared walls (Hakim 2001). Still, the test confirms that the core formulated generative code premises can create emergent culturally grounded neighborhoods through local rule sets.

Comparison of Simulation Approaches

Earlier, (Chapter III) presented a form-finding simulation that used multi-objective optimization to get "compact introverted blocks." That more top-down approach sought "optimized" configurations. Accordingly, the un-folding simulation here grows space iteratively in an emergent, bottom-up manner.

The form-finding model is particularly good at optimization but represents the continual local building process poorly. The unfolding generative code, though computationally simpler, shows better coherence with historical patterns and emergent capability for adaptation (Alexander et al. 2005).

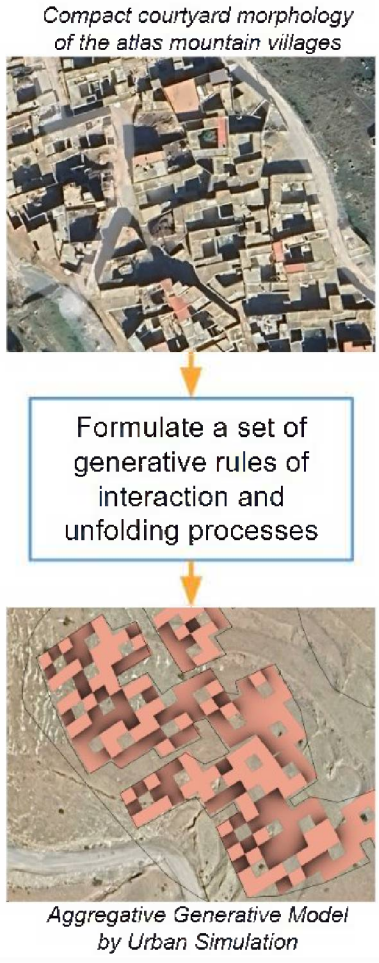


Figure 22 Unfolding Simulation Approach

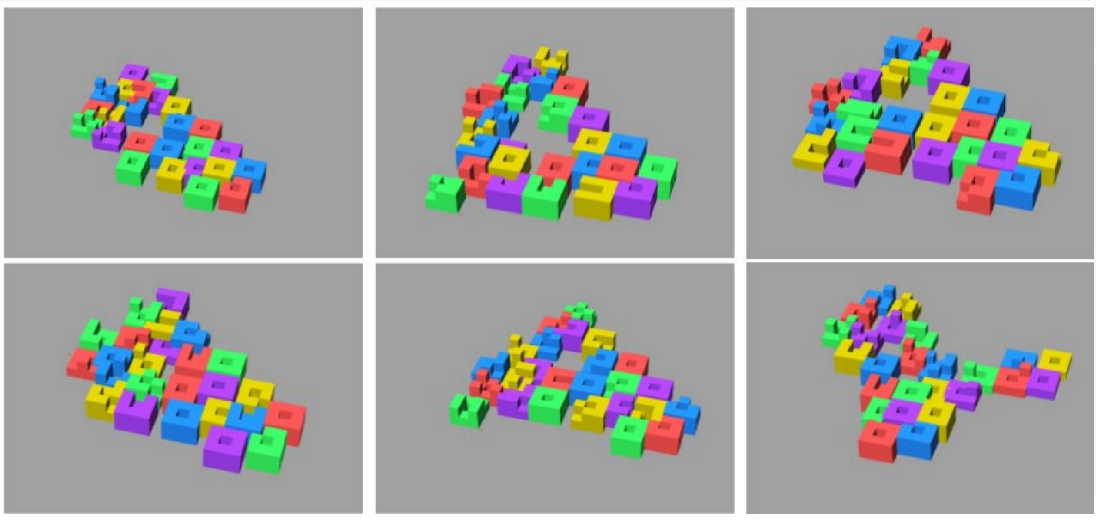


Figure 23 Variable neighborhood cluster outputs after 25 generative loops

Figure 24 3D and plan of multiple simulation clusters in late-state form, generated on-site in Tafeghaghte and adapted to local topography.

Chapter Findings and Synthesis

Rather than converging to an "optimal" outcome, this present chapter's generative code and its simulation consider urban form a stable, continuous process subject to negotiated change (Batty 2007a). In this case, simulations test how well rules can handle unexpected events and shifting priorities by embracing complexity in local culture, climate, and community dynamics (Alexander et al. 2005; Hakim 2019).

In top-down designs, adaptation refers to the performance of the final solutions when the initial top parameters change. In contrast, throughout bottom-up "unfolding," its adaptability stems from resilience acquired at each incremental step within the process. Both approaches confirm that robust guidelines—cultural privacy norms, courtyard geometry, or path continuity—help produce stable, coherent spaces (Petruccioli 2007; Naji 2019).

The second simulation demonstrates that courtyard-based generative codes can systematically rebuild damaged neighborhoods in a heritage-oriented framework around local customs, thus fostering step-by-step restoration of social bonds and community identity after a disaster (ICOMOS 2023).

In conclusion, emergent generative processes and computational design present a promising route for post-earthquake Moroccan towns. While performance optimization might ensure quality and resource efficiency, an unfolding code maintains cultural embeddedness and ongoing adaptability. By merging these insights into future planning codes and governance frameworks, Morocco's rebuilt environments could respect both tradition and resilient modernization.

Chapter VII: Findings and Discussion

The present chapter consolidates the research findings and discusses their practical, theoretical, and ethical implications. It shows how traditional Moroccan urban processes, rooted in adaptive cellular-based growth, can inform contemporary planning through computational simulations and generative codes. Comparing historical medinas, post-colonial cities, and informal settlements, the research underlines both ruptures in Moroccan urban practices and the enduring resilience of bottom-up generative principles.

Practical Findings

Traditional Urban Morphology in Simulations

While today's computation is primarily oriented towards efficiency, it can often neglect some of the socio-cultural and human aspects of design and planning (Carpo 2023; Cogdell 2018). This thesis fills this gap by embedding local cultural practices within generative simulations in an incremental courtyard logic that was common in the historical medinas (Petruccioli 2007; Hakim 2012). Initially in this research, cultural and environmental principles such as privacy, introversion and solar gain were merely treated as performance criteria (Cheddadi, Hotta, and Ikeda (2019a; 2019b; 2021). However, building on the first simulation experiment, these characteristics were refined into morphological rules driving cell-based, incremental growth in the second simulation.

This typo-morphological conceptualization reintroduces the courtyard houses as cellular, aggregative units. This is well suited to achieve incremental self-organization within computation models (Batty 2007b). For instance, socio-spatial rules in the form of minimal overview or boundary negotiations at every stage of the unfolding process enabled some emergent forms that resembled the historic medina (Duarte et al. 2007; Coates 1995). In fact, this provides confirmation that the shift from static end states to open-ended generative rules, that are oriented towards stability rather than optimization, offers more fine-grained adaptability. This step-by-step environmental adaptability allows for incremental changes and is similar to how a traditional Moroccan settlement would grow and adapt to changing conditions, through incremental local decisions rather than from centralized designs.

Generative Urbanism in Traditional and Informal Settlements

Drawing from the previous chapters (IV, V), "generative urbanism" assumes that Moroccan medinas were never instances or products but rather continuous processes that developed incrementally through intuitive socio-religious rules. Sociocultural Meta-principles such as Dharar (do not harm) and Hurma (protection of privacy) shape organic layouts, building an adaptive urban fabric that historically matched local cultural norms in the past (Hakim 1986; Bianca 2000; Mortada 2003). In Douar Doum, Douar Al-Garaa, and elsewhere in Moroccan informal areas where local decision making is possible to some degree, these grassroot generative processes persist. Such generative processes are sustained by everyday appropriations of space, adapting interior living spaces, or negotiating expansions of dwellings, still they are under marginal conditions (Cheddadi and Rifki 2024).

However, these systems were disrupted by both colonial and post-colonial policies through rigid zoning and modernist designs (Abu-Lughod 1980b; Cohen and Eleb 2019). While medinas used to grow following decentralized rules, nowadays authorities often enforce top-down planning and tend to marginalize self-built neighborhoods (Hensens 2002). These findings suggest that the reactivation of historic generative insights may thus help heal urban fragmentation, *only if* governance supports community-driven initiatives. On the other hand, *degenerative* tendencies can happen when self-generated urban tissues are strictly unregulated leading to overcrowding and urban dysfunctions. This comes into evidence especially when community oversight, ethical responsibility and institutional frameworks are weakened.

Proof-of-Concept Applications

In this research, computational simulations are both "archeological" and forward-looking tools. First, in Chapter III, an evolutionary algorithm explored courtyard layouts that balanced density, solar gain, and privacy but lacked organic self-organization (Cheddadi, Hotta, and Ikeda 2019a; 2019b). Then, in Chapter VI, emergent, culturally consistent patterns helped formulate a generative code that tested the bottom-up unfolding of courtyard clusters through local rules. Although it simplified modeling the organic street layout into grids, it has shown in what ways generative codes such as iterative steps, adjacency checks, and user negotiations can yield adaptive neighborhood forms (Alexander et al., 2005).

These simulations position incremental design and community planning as an alternative, or complementary framework to centralized planning, bringing together adaptive architecture and digital methods. Neighborhoods can be incrementally assembled in ways that resonate with local building and dwelling customs insofar as changing demands for density and environmental comfort are met. This requires a minimal but flexible regulation and community consensus, a hybrid governance model combining generative bottom-up processes with institution-based oversight to prevent degenerative outcomes.

Theoretical Findings

Traditional Urbanism as a Complex Adaptive System

Chapters IV and V reframe historic medinas and ongoing informal growth as complex adaptive systems (Apaydin 2015; Ben-Hamouche 2009b). Rather than static relics of the past, Morocco's traditional neighborhoods reflect distributed decision-making, climate constraints, and cultural norms, continually negotiating space at the local scale. Each incremental addition or modification

of a room, courtyard, or shared wall is a local action that, in complex aggregation, yields emergent, socially cohesive morphologies (Hakim 2012; Bianca 2000).

This conceptualization underlines how the resilience of historic Arab-Islamic cities, in their centuries-long development, is derived from decentralized rules that enable small-scale changes to adapt to social, political, or environmental shifts. Top-down colonial planning often conflicted with these bottom-up adaptive processes and created fragmentation and inequality (Navez-Bouchanine 2003; Cheddadi and Rifki 2024). Looking at traditional urbanism as a CAS, therefore, not only explains its historical relevance and continuity but also how reactivating local generative rules and processes could be part of decolonizing urban narratives and answering contemporary challenges (Porter 2023).

Synthesizing Typo-Morphological Models

By synthesizing a posteriori (observed) and a priori models (conceptual and intuitive), drawing on Muratori (1967) and Petruccioli (2007), shows that medinas and informal douars alike have courtyard-centered, incremental, and privacy-driven generative principles that shape their typo-morphological models. A posteriori analyses show how morphological characteristics came into being; while a priori synthesis of culturally intrinsic, bottom-up codes provides understanding of how these may continue to influence inhabitants' practices of intuitively shaping today's informal settlements (Hakim 2012; 2019)

Rethinking Computational Urbanism

While the focus of digital urban design to date has often rested on performance, generative urbanism regards the making of a city as a never-ending negotiation-—a process responsive to emergent conditions. Combining such outlooks implies that digital computation can move beyond a performance-output-oriented focus toward process-oriented adaptive rules explorations stemming from local building tradition (Hussein 2020; Denning 2017). This approach hereby unlocks parametric and computational design from the capabilities offered by strictly geometric or ecological data, sociocultural logics of space and processes, and incremental building processes.

Historical insights combined with algorithmic modeling bring about a "process-oriented" perspective in computational urbanism. Instead of being concerned with the final form, it focuses on how rules adapt under changing inputs—mirroring the generative dynamics in centuries-old Moroccan cities.

indings reveal how far colonial and post-colonial planning diverged from local generative practices and, in so doing, caused socio-spatial mismatches leading to social disruptions and cultural alienation (Abu-Lughod 1980). Conversely, the prevalence of incremental and bottom-up building processes within both the medinas and the informal settlements reveals how the "traditional" dwelling patterns persist under modern urban governance.

Simulations have verified that top-down performance optimization cannot capture the adaptive, bottom-up essence of medinas (Chapter III), while unfolding and process-oriented simulations (Chapter VI) provide a better fit with incremental formation at the expense of geometrical simplicity. This research suggests a need for hybrid governance: minimal centralized frameworks while legalizing local generative rules and checking speculative excess.

The application of generative codes in contemporary Morocco raises questions about community, self-determination, gender norms, and the contested relevance of Islamic jurisprudence (Abu-Lughod 1987). Without a deeply anchored rooting in genuine participation of local residents, generative codes might turn into yet another technocratic instrument-losing that organic interaction between social and spatial adaptation. Thus, the "revival" of historic rules is highly sensitive to modern-day values and should involve inclusive participation (Hakim 2001).

The models use grid-based simplifications without capturing all the irregularities of real medinas. They also lack detailed legal, economic, and community dynamics driving incremental building, which may oversimplify sociocultural complexity. Meanwhile, centralized Moroccan planning frameworks could stifle the bottom-up generative principles. Future work might integrate richer agent-based modules, real-time community data, and nuanced governance overlays to refine the approach.

Considering the above, this research recommends the following:

1. **Policy Reforms:** Adopt *flexible zoning* or partial legalization of incremental building, bridging formal regulations and local generative norms (Alexander et al. 2005; Moroni 2015).
2. **Pilot Projects:** Implement small-scale generative codes in informal settlements or earthquake-stricken sites, enabling community-led iteration (Naji 2019; ICOMOS 2023).
3. **Education & Training:** Encourage cross-disciplinary urban design curriculums merging computational simulation, anthropology, and local building knowledge (Salama 2022; Hussein 2020).

4. **Community Participation:** Leverage participatory workshops or digital platforms so that generative codes reflect actual user needs, fostering local ownership and avoiding top-down misapplication (Denning 2017).

Ultimately, the combination of incremental, cellular-based processes of Moroccan medinas with modern computational tools can yield adaptive planning frameworks that leverage local identity while meeting contemporary demands. Yet, success hinges on a careful balance between bottom-up autonomy and decentralized governance, a framework that does not lose its sociocultural realities and invites genuine community collaboration. In this way, remembering Moroccan cities' historic resilience -once forgotten in "amnesia"-could become the starting point for innovative, culturally embedded urban solutions to the challenges of the twenty-first century (Petruccioli 2007).

Chapter VIII: Conclusion

This research underlines the transformative potential of integrating traditional generative urban process with current computational design methodologies. The investigation into Moroccan historic urbanism revisits the deeply rooted sociocultural, environmental, and religious principles at the origin of such resilient and adaptive forms, especially in historic medinas (Bianca 2000; Hakim 1986). Despite the qualities associated with indigenous urban practices, their abandonment and the imposition of imported Western urban models, along with rigid planning policies, resulted in (post)colonial urban dysfunctions such as spatial and social segregation, inequalities in infrastructure, and loss of cultural identity (Abu-Lughod 1980b; Navez-Bouchanine 2002; Muchada 2019; Beqqal and Chaoui 2020). In other words, standardized and subjected the built landscape to strict zoning practices, and disrupted organic growth patterns that had been characteristic of and deeply rooted in the traditional Moroccan cities (Petruccioli 2007; Lamzah 2014; El Malti 2006). Centralized governance frameworks added to rigid regulations only made such conditions worse, eventually resulting in rapidly deteriorating anti-adaptive cities that contribute to marginalization (Hensens 2002; Aljem and Bkiri 2019; Rahmouni and Saizen 2023a; 2023b; Cheddadi and Rifki 2024).

Despite these adversities, the bidonvilles, douars, and other popular dwellings continue to demonstrate extraordinary resilience, characterized by their ways of reshaping spaces to suit the needs and aspirations of people inhabiting them informally (Cheddadi and Rifki 2024; Navez-Bouchanine 1997; Mrani, Chenal, and Radoine 2022; Zerraf, Kharmich, and Radoine 2022).

Rooted in traditional socio-cultural models, a priori models, through which the inhabitant renews his domestic space by increments via spatial appropriation, in balance between opening and privacy with functionality. As attested by case studies of Douar Doum and Douar Al-Garaa, such patterns reflect deep-seated metaprinciples like *ḥishma*, *ḥurma*, and *jiwār*. The everyday socio-spatial negotiations, testify that even in marginalized settings, communities hold fast to traditional notions of sociability and solidarity, forging dense social connections through which neighborhood life is maintained and sometimes scales into collective socio-political action (Cheddadi and Rifki 2024; Beier and Strava 2020). These practices are increasingly influenced, however, by exogenous Western-inspired extroverted models, which bring about subtle transformations accommodating new ways of living without entirely abandoning traditional principles (Santelli 1998).

This research synthesizes these socio-spatial dynamics with generative models that mimic traditional urban patterns. Using a more top-down and output-driven approach with multi-objective evolutionary algorithms, the first simulation optimized urban forms for environmental performance, accessibility, and density (Cheddadi et al. 2019a, 2019b, 2021). Though this model yielded adaptable urban configurations as end-state designs, it did not fully capture the organic step-by-step complexity, incremental growth, and interaction that characterizes historic traditional Moroccan urbanism. By contrast, the second simulation was based on a bottom-up agent-based model and simulated the aggregation of courtyard houses around central courtyards, similar to the self-organizing principles of historic medinas (Hakim 2012; Alexander et al. 2005). This approach effectively captured essential principles such as privacy, community interaction, and environmental adaptation, demonstrating that traditional generative processes can indeed be translated into computational design.

As such, the results of the second rule/unfolding simulation, which took post-earthquake reconstruction as a scenario, are particularly informative. Within the limitation of grid-based calculation, the simulation showed that the generative code formulated following essential features of the synthesized a priori and a posteriori models- generates coherent, functional clusters of courtyard house typologies forming a compact neighborhood segment. These findings constitute a framework for robust and adaptive, responsive urbanism that can yield emergent urban forms that are context-sensitive and resilient to change (Alexander et al. 2005). They affirm that traditional principles can contribute to decolonizing architecture and planning by integrating them into computational frameworks that can inform decision-making processes without losing their cultural resonance.

However, translating such computational insights into real-world practice remains a significant challenge. Morocco's centralized planning system conflicts with the decentralized, participatory logic at the core of generative urbanism (Rahmouni and Saizen 2023a; 2023c). Current urban development models do not meet the pressing demand for "housing for the greatest number," while social housing schemes often ignore the embedded socio-spatial practices of housing (Rouissi 2021). These rigid frameworks do not consider the cultural and functional adaptations crucial for long-term sustainability, risking what Mohammed El Malti called a "*civilizational error*" (El Malti 2006; Bailly 2001).

Despite these systemic obstacles, the present study points toward a path forward. A reform of governance structures and the integration of participatory processes could allow generative codes to guide the development in emergent neighborhoods that are adaptive, sustainable, and meaningful. Mixed-use neighborhoods, informed by "*open-ended development*" models, could accommodate incremental growth and long-term adaptability (Alfasi et al. 2020; Joffroy 2016). Communication and exchange could be done by participatory platforms, interviews, and workshops that would let the designers and policymakers learn from the inhabitants themselves and include their needs within the urban planning-moving out of anti-adaptive practices. Generative simulations can also prove favorable in post-disaster situations, such as rebuilding after the 2023 Morocco earthquake. In this way, these generative frameworks may support the development of resilient urban environments, indicative of local identities and practices through the preservation of cultural heritage for contemporary usage (Naji 2019; K. E. Harrouni 2019).

Ultimately, this dissertation affirms the necessity of connecting historical wisdom to technological innovation. Principles of traditional urbanism are not relics of the past but living repositories of approaches pertinent to sustainability, human scale, and social cohesion in contemporary contexts. Generative models, which are computational models that use algorithms to generate spatial strategies, can offer designs respectful of local identities and capable of adapting to evolving needs if informed by historical precedents and cultural contexts. The present research demonstrates a way of combining tradition with contemporary approaches in the urban environment, and it hopes to inspire new discussions by contributing to the future of urban design in Morocco and beyond.

In sum, three significant contributions emerge in this dissertation: (1) confirmation of the relevance of historic Moroccan urban principles to contemporary sociocultural and environmental resilience; (2) advancement of computational regionalism sensitive to local identity and

incremental, bottom-up processes; and (3) decolonizing planning by embedding community-driven generative rules into contemporary design practice. The dissertation confirms that past knowledge does not need to be nostalgic or romanticized but can actually inform and guide nowadays' generative and participatory urbanism.

Appendice 1:

List of Works Originating from this Dissertation

I. Original peer-reviewed papers:

1. Cheddadi Mohammed Aqil, Hotta Kensuke, Ikeda Yasushi. "An Urban Form-Finding Parametric Model Based on The Study of Spontaneous Urban Tissues", the 24th International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA), vol. 2, pp.181-190, (Young CAADRIA Award), 15-18 April 2019.
2. Cheddadi Mohammed Aqil, Hotta Kensuke, Ikeda Yasushi. "Reinterpreting self-organizing urban tissues by designing a generative model", 53rd International Conference of the Architectural Science Association (ANZAScA), pp.175–184 India, Roorkee, 28 November 2019.
3. Cheddadi Mohammed Aqil, Hotta Kensuke, Ikeda Yasushi. "Exploring the Self-Organizing Structure of the Moroccan Medina: A Simulation Model for Generating Urban Form", The 9th International Conference of the Arab Society for Computer-Aided Architectural Design (ASCAAD), pp.672-685 Cairo, Egypt, 3 March 2021.
4. Cheddadi Mohammed Aqil, Rifki Hafsa "Moroccan Sociocultural Practices of Space: Coping with Marginalization in Bidonvilles and Social Housing", International Journal of Islamic Architecture, vol. 13, no. 1, pp. 75-105, 2024.

II. International conference presentations:

1. Cheddadi Mohammed Aqil, "Exploring the Morphology of the Moroccan Islamic Cities: Urban Forming Simulations for Adaptive Developments", (Online Oral presentation), 2nd World CAAD PhD Workshop, Federal University of Juiz de Fora, Juiz de Fora, Brazil, November 05, 2021.
2. Cheddadi Mohammed Aqil, "Moroccan Bidonville Residents' Resistance Against Displacement Policies: Community Activism and the Right to the City", (Oral presentation) Urban Poverty and Homelessness Interdisciplinary World Congress of Urban Studies, Istanbul Topkapi University, Istanbul, Turkey, August 26, 2022.
3. Cheddadi Mohammed Aqil, "Bidonvilles in Colonial and Post-Colonial Morocco: Shifting Policies from Racial Segregation to Socio-Spatial Marginalization", (Oral presentation), II International Congress on Colonial and Postcolonial Landscapes: Architecture, Colonialism and War, Calouste Gulbenkian Foundation, Lisbon, Portugal, January 20, 2023.
4. Cheddadi Mohammed Aqil, "Moroccan Bidonville's Resilience and Adaptation in the Face of Marginalisation: Subversive tactics against displacement in Douar El-Garaa", (Oral presentation) Royal Geographical Society (with IBG) Annual International Conference 2023, United Kingdom, London, September 1, 2023.

Appendice 2: Full References List

- Abu Risha, Abd al-Latif. 2020. *Tārīkh Al-Aḥyā' al-Hāmishīyah Bi-Madīnat al-Rabāṭ Min 1930 Ilá 1980: Ḥālat Dawwār al-Dūm Wa-Dawwār al-Dabbāgh Namūdhajan (History of Marginalized Neighborhoods of Rabat City from 1930 to 1980: The Case of Douar Doum and Douar Dabbagh)*. First Edition. Kenitra, Morocco: Éditions du Haut Commissariat aux Anciens Résistants et Anciens Membres de l'Armée de Libération.
- Abu-Lughod, Janet. 1980a. "Contemporary Relevance of Islamic Urban Principles (Extract)." *Ekistics* 47 (280): 6–10.
- ———. 1980b. *Rabat: Urban Apartheid in Morocco*. Princeton University Press.
- ———. 1989. "What Is Islamic about a City? Some Comparative Reflections." In *Proceedings of International Conference on Urbanism in Islam*. Tokyo, Japan.
- Agence Urbaine de Marrakech. 2012. *Evolution Urbaine de Marrakech - Histoire et Perspectives -*. Marrakech.
- Ahmed, Suneela. 2022. "Critical Regionalist Approach to Architecture: Lessons to Be Learnt From Three Case Studies From Karachi." *Journal of Architecture and Planning - King Saud University* 34 (1). https://doi.org/10.33948/JAP-KSU-34-1-5.
- Akbar, Jamel. 1988. *Crisis in the Built Environment: The Case of the Muslim City*. A Mimar Book. Leiden: Brill.
- Aksoy, Yazgı Badem, Gülen Çağdaş, and Özgün Balaban. 2015. "A Model for Sustainable Site Layout Design of Social Housing with Pareto Genetic Algorithm: SSPM." In *Computer-Aided Architectural Design Futures. The Next City - New Technologies and the Future of the Built Environment*, edited by Gabriela Celani, David Moreno Sperling, and Juarez Moara Santos Franco, 527:113–33. Communications in Computer and Information Science. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-47386-3_7.
- Alexander, Christopher. 1977. *A Pattern Language: Towns, Buildings, Construction*. Oxford university press.
- ———. 1979. *The Timeless Way of Building*. Center for Environmental Structure Series. New York: Oxford University Press. http://bvbr.bib-bvb.de:8991/F?func=service&doc_library=BVB01&doc_number=017473621&line_number=0001&func_code=DB_RECORDS&service_type=MEDIA.
- ———. 2002. *The Nature of Order: The Process of Creating Life*. Taylor & Francis.
- Alexander, Christopher, Brian Goodwin, Ian Stewart, and Brian Hanson. 2004. *The Phenomenon of Life*. Vol. 1. 3. Routledge.
- Alexander, Christopher, Hajo Neis, Artemis Anninou, and Ingrid Fiksdahl King. 1987. *A New Theory of Urban Design*. Vol. 6. Oxford University Press New York.
- Alexander, Christopher, Randy Schmidt, Maggie Moore Alexander, Brian Hanson, and Michael Mehaffy. 2005. "Generative Codes: The Path to Building Welcoming, Beautiful, Sustainable Neighborhoods."
- Alexander, E.R., Luigi Mazza, and Stefano Moroni. 2012. "Planning without Plans? Nomocracy or Teleocracy for Social-Spatial Ordering." *Progress in Planning* 77 (2): 37–87. https://doi.org/10.1016/j.progress.2011.12.001.
- Alexandre, Nicolas, and Emmanuel Neiger. 2019. *Lire Casablanca: une grammaire d'urbanisme et d'architecture*. Senso Unico Éditions.
- Alfasi, Nurit. 2018. "The Coding Turn in Urban Planning: Could It Remedy the Essential Drawbacks of Planning?" *Planning Theory* 17 (3): 375–95. https://doi.org/10.1177/1473095217716206.
- Alfasi, Nurit, Amitai Raphael Shnizik, Maureen Davidson, and Alon Kahani. 2020. "Anti-Adaptive Urbanism: Long-Term Implications of Building Inward-Turned Neighborhoods in Israel." *Journal of Urbanism: International Research on Placemaking and Urban Sustainability* 13 (4): 387–409. https://doi.org/10.1080/17549175.2019.1705377.
- Aljem, Sanae, and Imane Bkiri. 2019. "Limites du « plan », comme instrument de l'action publique dans la « fabrique urbaine » des grandes villes marocaines. Cas de Casablanca et de Rabat." *African and*

Mediterranean Journal of Architecture and Urbanism, February, 35–45. https://doi.org/10.48399/IMIST.PRSM/amjau-v0i1.15427.
- Allen, Barry. 1991. "Government in Foucault." *Canadian Journal of Philosophy* 21 (4): 421–39. https://doi.org/10.1080/00455091.1991.10717255.
- Al-Murabit, Zakariya. 2018. *al-Takhṭīṭ wa al-Bunyān fī al-Fiqh al-Islāmī (Planning and Construction in Islamic Jurisprudence)*. Cairo: Dar Al-Salam.
- Alsaafin, Linah. 2023. "Morocco Quake Toll Nears 3,000 as Rescuers Reach More Towns." Al Jazeera. 2023. https://www.aljazeera.com/news/liveblog/2023/9/12/morocco-earthquake-live-hope-fades-for-finding-survivors.
- AlSayyad, Nezar. 1993. "Squatting and Culture." *Habitat International* 17 (1): 33–44. https://doi.org/10.1016/0197-3975(93)90044-D.
- ———. 2004. "Urban Informality as a 'New' Way of Life." *Pouvoirs et Contre-Pouvoirs*, 7–30.
- Apaydin, Marina. 2015. "Reframing the Islamic City: From Definition to Deconstruction." *The Maghreb Review* 40 (4): 473–92. https://doi.org/10.1353/tmr.2015.0034.
- Argiolas, Claudia. 2011. "Douar Doum : un'altra povertà : ipotesi di riqualificazione urbana e architettonica di un quartiere povero,urbano e moderno." Laurea, Politecnico di Torino. https://webthesis.biblio.polito.it/2166/.
- As, Imdat, and Prithwish Basu. 2022. *Artificial Intelligence in Urban Planning and Design: Technologies, Implementation, and Impacts*. San Diego: Elsevier.
- Atia, Mona. 2022. "Refusing a 'City without Slums': Moroccan Slum Dwellers' Nonmovements and the Art of Presence." *Cities* 125 (June):102284. https://doi.org/10.1016/j.cities.2019.02.014.
- *Aujourd'hui le Maroc*. 2021. "Villes sans bidonvilles : Plus de 301.000 familles bénéficiaires à fin 2020," 2021. https://aujourdhui.ma/societe/villes-sans-bidonvilles-plus-de-301-000-familles-beneficiaires-a-fin-2020.
- Avermaete, Tom. 2010. "Framing the Afropolis: Michel Ecochard and the African City for the Greatest Number." *L'Afrique, c'est Chic. Architecture and Planning in Africa 1950–1970, OASE Architectural Journal* 83:77–100.
- Bargach, Jamila. 2008. "Rabat: From Capital to Global Metropolis." In *The Evolving Arab City: Tradition, Modernity and Urban Development*, edited by Yasser Elsheshtawy, 99–117. Planning, History and the Environment Series. London: Routledge.
- Batty, Michael. 2007a. *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals*. The MIT press.
- ———. 2007b. "Complexity in City Systems: Understanding, Evolution, and Design," 36.
- ———. 2008a. "Fifty Years of Urban Modeling: Macro-Statics to Micro-Dynamics." In *The Dynamics of Complex Urban Systems*, edited by Sergio Albeverio, Denise Andrey, Paolo Giordano, and Alberto Vancheri, 1–20. Heidelberg: Physica-Verlag HD. https://doi.org/10.1007/978-3-7908-1937-3_1.
- ———. 2008b. "The Size, Scale, and Shape of Cities." *Science* 319 (5864): 769–71. https://doi.org/10.1126/science.1151419.
- ———. 2009. "Cities as Complex Systems: Scaling, Interaction, Networks, Dynamics and Urban Morphologies."
- ———. 2013. *The New Science of Cities*. MIT Press.
- ———. 2017. *The New Science of Cities*. Cambridge, Massachusetts London, England: The MIT Press.
- Belfquih, M'Hammed, and Abdellatef Fadloullah. 1986a. *Mécanismes et formes de croissance urbaine au Maroc: cas de l'agglomération de Rabat-Salé. De la médina à l'agglomération millénaire*. Vol. 1. 3 vols. Rabat: Librairie El Maârif.
- ———. 1986b. *Mécanismes et formes de croissance urbaine au Maroc: un modèle d'urbanisation critique*. Vol. 3. 3 vols. Rabat: Librairie El Maârif.
- Ben-Hamouche, Mustapha. 2009a. "Can Chaos Theory Explain Complexity In Urban Fabric? Applications in Traditional Muslim Settlements." *Nexus Network Journal* 11 (2): 217–42. https://doi.org/10.1007/s00004-008-0088-8.
- ———. 2009b. "Complexity of Urban Fabric in Traditional Muslim Cities: Importing Old Wisdom to Present Cities." *URBAN DESIGN International* 14 (1): 22–35. https://doi.org/10.1057/udi.2009.7.

- ———. 2013. "The Paradox of Urban Preservation: Balancing Permanence and Changeability in Old Muslim Cities." *Journal of Urbanism: International Research on Placemaking and Urban Sustainability* 6 (2): 192–212. https://doi.org/10.1080/17549175.2013.820213.
- Benredjem, Amel, and Nastasia Dhomps. 2017. "MAROC - Un urbanisme d'urgence." *Agora Francophone*. https://www.agora-francophone.org/MAROC-Un-urbanisme-d-urgence.
- Bensaïd, El Montacir. 2013. Le Maroc a un urbanisme de l'urgence et non un urbanisme planifié. https://www.lodj.ma/Le-Maroc-a-un-urbanisme-de-l-urgence-et-non-un-urbanisme-planifie_a56593.html.
- Beqqal, Najoua, and Mohamed Omrane Chaoui. 2020. "Beyond the Colonial Paradigm: Local Dynamics and the Shift from Social Separation to Spatial Segregation in Casablanca's Urbanism." *African and Mediterranean Journal of Architecture and Urbanism* 2 (1). https://doi.org/10.48399/IMIST.PRSM/amjau-v2i1.20242.
- Bernasconi, Edoardo. 2019. "Learning from the Douar . Michel Écochard and the Modern Invention of the Semi-Rural Moroccan Habitat." *SHS Web of Conferences* 63 (January). https://doi.org/10.1051/shsconf/20196304002.
- Bettencourt, Luis, and Geoffrey West. 2010. "A Unified Theory of Urban Living." *Nature* 467 (7318): 912–13. https://doi.org/10.1038/467912a.
- Bianca, Stefano. 2000. *Urban Form in the Arab World: Past and Present*. London ; New York, NY: Thames & Hudson.
- Billig, Noah. 2019. *Istanbul: Informal Settlements and Generative Urbanism*. Built Environment City Studies. Abingdon, Oxon ; New York, NY: Routledge.
- Bogaert, Koenraad. 2011. "The Problem of Slums: Shifting Methods of Neoliberal Urban Government in Morocco: The Problem of Slums: Urban Government in Morocco." *Development and Change* 42 (3): 709–31. https://doi.org/10.1111/j.1467-7660.2011.01706.x.
- ———. 2018. *Globalized Authoritarianism: Megaprojects, Slums, and Class Relations in Urban Morocco*. Globalization and Community 27. Minneapolis: Univ Of Minnesota Press.
- Bousmid, Rym. 2022. "Maroc – Urbanisme : quand les autorités tirent la sonnette d'alarme - Jeune Afrique.com." *Jeune Afrique*, 2022. https://www.jeuneafrique.com/1317541/politique/maroc-urbanisme-quand-les-autorites-tirent-la-sonnette-dalarme/.
- Brown, Barbara B., and Douglas D. Perkins. 1992. "Disruptions in Place Attachment." In *Place Attachment*, edited by Irwin Altman and Setha M. Low, 279–304. Human Behavior and Environment. Boston, MA: Springer US. https://doi.org/10.1007/978-1-4684-8753-4_13.
- Brunschvig, Robert. 1947. *Urbanisme médiéval et droit musulman*. P. Geuthner.
- Caperna, Antonio. 2014. "Interview with Besim Hakim: Mediterranean Codes and Sociogenerative Design." May 19, 2014. https://www.biourbanism.org/interview-besim-hakim/.
- Carmona, Matthew, Stephen Marshall, and Quentin Stevens. 2006. "Design Codes: Their Use and Potential." *Progress in Planning* 65 (4): 209–89. https://doi.org/10.1016/j.progress.2006.03.008.
- Carpo, Mario, ed. 2013. *The Digital Turn in Architecture 1992-2012*. AD Reader. Chichester: Wiley.
- ———. 2017. *The Second Digital Turn: Design beyond Intelligence*. Writing Architecture. Cambridge, Massachusetts: The MIT Press.
- ———. 2023. *Beyond Digital: Design and Automation at the End of Modernity*. Cambridge, Massachusetts: The MIT Press.
- Carter, Ian, and Stefano Moroni. 2021. "Adaptive and Anti-Adaptive Neighbourhoods: Investigating the Relationship between Individual Choice and Systemic Adaptability." *Environment and Planning B: Urban Analytics and City Science* 49 (2). https://doi.org/10.1177/23998083211025542.
- Cataldai, Giancarlo, Gian Luigi Maffei, and Paolo Vaccaro. 2002. "Saverio Muratori and the Italian School of Planning Typology." *Urban Morphology* 6 (1): 3–14. https://doi.org/10.51347/jum.v6i1.3899.
- Chahrou, Jamal. 2023. "Patrimoine Architectural de La Vallée Des Ait Bouguemez." Béni Mellal: Université Sultane Moulay Slimane.
- Cheddadi, Mohammed Aqil. 2018. "Towards a Digital Design Approach For Rehousing Slums: The Case Of Douar Al Garaa in Morocco." Master of Media and Governance, Tokyo, Japan: Keio University.
- Cheddadi, Mohammed Aqil, Kensuke Hotta, and Yasushi Ikeda. 2019a. "An Urban Form-Finding Parametric Model Based on the Study of Spontaneous Urban Tissues." In , 10.

- ———. 2019b. "Reinterpreting Self-Organizing Urban Tissues by Designing a Generative Model." In *Revisiting the Role of Architecture for Surviving Development.*, 175–84. IIT Roorkee, India.
- ———. 2021. "Exploring the Self-Organizing Structure of the Moroccan Medina: A Simulation Model for Generating Urban Form." In *Abdelmohsen, S, El-Khouly, T, Mallasi, Z and Bennadji, A (Eds.), Architecture in the Age of Disruptive Technologies: Transformations and Challenges [9th ASCAAD Conference Proceedings ISBN 978-1-907349-20-1] Cairo (Egypt) [Virtual Conference] 2-4 March 2021, Pp. 672-685*. CUMINCAD. http://papers.cumincad.org/cgi-bin/works/Show?ascaad2021_069.
- Cheddadi, Mohammed Aqil, and Hafsa Rifki. 2024. "Moroccan Sociocultural Practices of Space: Coping with Marginalization in Bidonvilles and Social Housing." *International Journal of Islamic Architecture* 13 (1): 75–105. https://doi.org/10.1386/ijia_00130_1.
- Choi, Jason, Phat Chi Thanh Nguyen, and Mohammed Makki. 2020. "The Design of Social and Cultural Orientated Urban Tissues through Evolutionary Processes." *International Journal of Architectural Computing*, September, 1478077120951948. https://doi.org/10.1177/1478077120951948.
- Chouiki, Mustapha. 2017. *Un siècle d'urbanisme: Le Devenir De La Ville Marocaine*. Paris: Editions L'Harmattan.
- Coates, Paul, ed. 1995. "Generative Modelling." *London: University of East London*. https://core.ac.uk/reader/219371020.
- Coello Coello, Carlos A. 2005. "An Introduction to Evolutionary Algorithms and Their Applications." In *Advanced Distributed Systems*, edited by Félix F. Ramos, Victor Larios Rosillo, and Herwig Unger, 3563:425–42. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/11533962_39.
- Cogdell, Christina. 2018. *Toward a Living Architecture? Complexism and Biology in Generative Design*. Minneapolis: University of Minnesota Press.
- Cohen, Jean-Louis, and Monique Eleb. 2019. *Casablanca: mythes et figures d'une aventure urbaine*. Nouvelle éd. Vanves: Hazan.
- Cozzolino, Stefano. 2020. "The (Anti) Adaptive Neighbourhoods. Embracing Complexity and Distribution of Design Control in the Ordinary Built Environment." *Environment and Planning B: Urban Analytics and City Science* 47 (2): 203–19. https://doi.org/10.1177/2399808319857451.
- Creswell, John W., and J. David Creswell. 2018. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.
- D'Acci, Luca. 2019a. "On Urban Morphology and Mathematics." In *The Mathematics of Urban Morphology*, edited by Luca D'Acci, 1–18. Modeling and Simulation in Science, Engineering and Technology. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-12381-9_1.
- D'Acci, Luca, ed. 2019b. *The Mathematics of Urban Morphology*. Modeling and Simulation in Science, Engineering and Technology. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-12381-9.
- Davis, Howard. 2006. "Regulation." In *The Culture of Building*. New York, NY: Oxford Univ. Press.
- Denning, Peter J. 2017. "Computational Design." *Association for Computing Machinery*.
- Département des projets d'urbanisme. 1978. "Projet d'aménagement Urbain à Rabat Rapport de La Mission d'évaluation." Morocco: World Bank.
- Derix, Christian. 2009. "In-Between Architecture Computation." *International Journal of Architectural Computing* 7 (4): 565–85. https://doi.org/10.1260/1478-0771.7.4.565.
- Dorigo, Marco, Mauro Birattari, and Thomas Stutzle. 2006. "Ant Colony Optimization." *IEEE Computational Intelligence Magazine* 1 (4): 28–39. https://doi.org/10.1109/MCI.2006.329691.
- Duarte, José P, Gonçalo Ducla-Soares, Luisa G Caldas, and João Rocha. 2006. "AN URBAN GRAMMAR FOR THE MEDINA OF MARRAKECH." In *Design Computing and Cognition '06*, edited by John S. Gero, 483–502. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-1-4020-5131-9_25.
- Duarte, José P., João M. Rocha, and Gonçalo Ducla Soares. 2007. "Unveiling the Structure of the Marrakech Medina: A Shape Grammar and an Interpreter for Generating Urban Form." *Artificial Intelligence for Engineering Design, Analysis and Manufacturing* 21 (4): 317–49. https://doi.org/10.1017/S0890060407000315.

- Écochard, Michel. 1950. *Urbanisme et construction pour le plus grand nombre: conférence donnée le 10 février 1950 à la Chambre de commerce et de l'industrie de Casablanca*. Institut Technique Français du bâtiment et des travaux publics.
- ———. 1955. *Casablanca : le roman d'une ville*. Éditions de Paris. https://gallica.bnf.fr/ark:/12148/bpt6k3344614r.
- El Ghmari, Safiya, and Adil Zabadi. 2021. "Urban Informality: Its Genesis and Future beyond Stigma and Abolition." *African and Mediterranean Journal of Architecture and Urbanism*, July. https://doi.org/10.48399/IMIST.PRSM/amjau-v3i1.26746.
- El Malti, Mohammed. 2006. "L'urbanisme et La Question de La Ville." In *Accès Aux Services de Base et Considérations Spatiales*, 177–94. Rapport Du Cinquantenaire de l'indépendance Du Royaume Du Maroc, 50 Ans Du Développement Humain et Perspectives 2025. Rabat. https://www.ires.ma/images/modele-de-developpement/perspectives.pdf.
- Ennaji, Kawtar. 2019. "Residents of Douar El Garaa in Rabat Clash with Moroccan Police." Morocco World News. 2019. https://www.moroccoworldnews.com/2019/08/281181/douar-garaa-rabat-clash-police.
- Epstein, Joshua M., and Robert Axtell. 1996. *Growing Artificial Societies: Social Science from the Bottom Up*. Growing Artificial Societies: Social Science from the Bottom Up. Cambridge, MA, US: The MIT Press.
- Es-Sallak, Nada. 2018. "Dérogations en urbanisme et rapports de pouvoirs au Maroc. Le cas de la ville de Fès." *Les Cahiers d'EMAM. Études sur le Monde Arabe et la Méditerranée*, no. 30 (April). https://doi.org/10.4000/emam.1448.
- Falahat, Somaiyeh. 2014a. *Re-Imaging the City*. Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-04596-8.
- ———. 2014b. "The Model of 'Islamic City.'" In *Re-Imaging the City*, by Somaiyeh Falahat, 7–49. Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-04596-8_1.
- Faludi, Andreas. 2013. *A Reader in Planning Theory*. Elsevier.
- Fendri, Senda. 2019. *Morphologie structurale et systémique de la médina de Tunis: Un modèle topologique de re-connaissance*. Illustrated édition. Paris: Editions L'Harmattan.
- Fuller, Mia. 2008. "Mediterraneanism: French And Italian Architects' Designs In 1930s North African Cities." In *The City in the Islamic World (2 Vols.)*, edited by Salma Khadra Jayyusi, Renata Holod, Antillio Petruccioli, and André Raymond, 983–98. BRILL. https://doi.org/10.1163/ej.9789004162402.i-1500.263.
- Gardner, Martin. 1970. "Mathematical Games." *SCIENTIFIC AMERICAN*.
- Geiger, Joseph. 1992. "Julian of Ascalon." *The Journal of Hellenic Studies* 112 (November):31–43. https://doi.org/10.2307/632151.
- Gell-Mann, Murray. 1994. "Complex Adaptive Systems." In *SANTA FE INSTITUTE STUDIES IN THE SCIENCES OF COMPLEXITY-PROCEEDINGS VOLUME-*, 19:17–17. ADDISON-WESLEY PUBLISHING CO.
- Giamarelos, Stylianos. 2022. *Resisting Postmodern Architecture: Critical Regionalism before Globalisation*. UCL Press. https://doi.org/10.2307/j.ctv1v090hv.
- Gilbert, Nigel. 2019. *Agent-Based Models*. SAGE Publications.
- Grillo, Alessandra. 1988. "Traditional Building Techniques in Fes." *Environmental Design: Journal of the Islamic Environmental Design Research Centre*, 38–47.
- Hajo, Neis. 2011. "Generative Process, Patterns, & the Urban Challenge." In .
- Hakim, Besim. 1986. *Arabic-Islamic Cities: Building and Planning Principles*. London: New York : KPI.
- ———. 1991. "Urban Design in Traditional Islamic Culture: Recycling Its Successes." *Cities* 8 (4): 274–77. https://doi.org/10.1016/0264-2751(91)90043-Q.
- ———. 1994. "The 'Urf' And Its Role in Diversifying the Architecture of Traditional Islamic Cities." *Journal of Architectural and Planning Research* 11 (2): 108–27.
- ———. 1997. "Rule Systems: Islamic." In *Encyclopedia of Vernacular Architecture of the World*, 1:566–68. Cambridge University Press. https://historiccitiesrules.files.wordpress.com/2011/09/1997-encyvernarch.pdf.

- ———. 2001. “Reviving the Rule System.” *Cities* 18 (2): 87–92. https://doi.org/10.1016/S0264-2751(00)00060-3.
- ———. 2008a. “Law And The City.” In *The City in the Islamic World (2 Vols.)*, 71–92. Brill. https://brill.com/display/book/edcoll/9789047442653/Bej.9789004162402.i-1500_004.xml.
- ———. 2008b. “Mediterranean Urban and Building Codes: Origins, Content, Impact, and Lessons.” *URBAN DESIGN International* 13 (1): 21–40. https://doi.org/10.1057/udi.2008.4.
- ———. 2010. “The Generative Nature of Islamic Rules for the Built Environment.” *Archnet-IJAR : International Journal of Architectural Research* 4 (1). https://doi.org/10.26687/archnet-ijar.v4i1.72.
- ———. 2012. “Neighborhood Test Design Based on Historic Precedents.” *Archnet-IJAR : International Journal of Architectural Research* 6 (2).
- ———. 2014. *Mediterranean Urbanism: Historic Urban/Building Rules and Processes*. Dordrecht ; New York: Springer.
- ———. 2019. *Urban Rules and Processes: Historic Lessons for Practice*. EmergentCity Press. https://books.google.co.jp/books?id=pHOXywEACAAJ.
- Hall, Peter. 2002. *Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century*. Wiley.
- Haneda, Masashi, and Tōru Miura, eds. 2010. *Islamic Urban Studies: Historical Review and Perspectives*. Abington, Oxon: Routledge.
- Harroud, Tarik. 2017a. “Handicaps et contradictions du Programme de villes nouvelles au Maroc. Mode de gouvernance et processus de mise en œuvre.” *Les Cahiers d’EMAM. Études sur le Monde Arabe et la Méditerranée*, no. 29 (May). https://doi.org/10.4000/emam.1333.
- ———. 2017b. “Le programme des villes nouvelles au Maroc : rupture ou prolongement d’un urbanisme de rattrapage ?” *Revue internationale d’urbanisme* 4:18.
- Harvey, David. 2015. “‘The Right to the City.’” In *The City Reader*, 6th ed. Routledge.
- Hensens, Jean. 1970. “Que faire des médinas ?” *Bulletin économique et social du Maroc* 118–119.
- ———. 1971. “Doum : Rabat Sud, Reconversion Des Bidonvilles de Chella, Doum, Maadid-Extension.-Rabat.” Rabat: Centre d’expérimentation, de recherche et de formation (CERF).
- ———. 1972. “L’habitat Rural Au Maroc.” Rapport de recherche. Rabat: Ministère de l’Intérieur, Direction de l’urbanisme et de l’habitat.
- ———. 1986. “Les Limites Permises à La Conception et à La Construction Autonomes de l’espace Local Au Maroc.” *Annuaire de l’Afrique Du Nord* 25. https://doi.org/10.34847/nkl.7b0esd8m.
- ———. 2002. “L’autoconstruction et la centralisation,” 2002.
- ———. 2005. “Chemin.” Autobiography. Maussane.
- Hillier, Bill, and Julienne Hanson. 2005. *The Social Logic of Space*. Repr. Cambridge: Cambridge Univ. Press.
- Holland, John H. 1996. *Hidden Order: How Adaptation Builds Complexity*. Cambridge, Mass.: Basic Books.
- Hussein, Waleed. 2020. “Regionalism, Computational Design, Parametric Design, Architectural Identity, Local Urbanism, Urban Development.” *International Journal of Arts*, 12.
- Ibn al-Rāmī, Muḥammad ibn Ibrāhīm, Besim S. Hakim, and Mohd Dani Muhamad. 2017. *Rules for Compact Urbanism: Ibn al-Rami’s 14th Century Treatise*. Place of publication not identified: EmergentCity Press.
- Ibn al-Rāmī, Muḥammad ibn Ibrāhīm, and Aḥmad Ibn ʻAlī. 2012. *Al-I‘lān Bi-Aḥkām al-Bunyān*. Al-Ṭab‘ah al-Ūlá. al-Dār al-Bayḍā’ : Bayrūt: Markaz al-Turāth al-Thaqāfī al-Maghribī ; Dār Ibn Ḥazm.
- ICOMOS. 2023. “Maroc Seisme Hawz Impact Sur Le Patrimoine.” ICOMOS.
- Jacobs, Jane. 1989. *The Death and Life of Great American Cities*. Knopf Doubleday Publishing Group.
- Jelidi, Charlotte. 2012. *Fès, la fabrication d’une ville nouvelle (1912-1956). Fès, la fabrication d’une ville nouvelle (1912-1956)*. Sociétés, Espaces, Temps. Lyon: ENS Éditions. https://books.openedition.org/enseditions/959.
- Johnson, Steven. 2001. *Emergence: The Connected Lives of Ants, Brains, Cities, and Software*. New York: Scribner.

- Kelly, Nick, and John S. Gero. 2021. "Design Thinking and Computational Thinking: A Dual Process Model for Addressing Design Problems." *Design Science* 7 (January):e8. https://doi.org/10.1017/dsj.2021.7.
- Kharmich, Hassane, and Khalid El Harrouni. 2019. "Les Bidonvilles Au Maroc: Entre Résorption et Résistance." *African and Mediterranean Journal of Architecture and Urbanism*, no. 1, 27–34.
- Kheireddine, Mostafa, and M Zouiten. 2021. "Le système dérogatoire au Maroc, d'un simple contournement à un détournement de l'urbanisme réglementaire." *Espace Géographique et Société Marocaine*, March, No 4546 (2021). https://doi.org/10.34874/IMIST.PRSM/EGSM/25476.
- Kijima, Yasufumi. 1989. "Street Networks and Open Space in Islamic Cities." In *Urbanism in Islam*, Vol. I:314–35. Tokyo.
- Kostof, Spiro. 1991. *The City Shaped : Urban Patterns and Meanings through History*. Boston : Little, Brown. http://archive.org/details/cityshapedurbanp0000kost.
- Kropf, Karl. 2017. *The Handbook of Urban Morphology*. The Urban Handbook Series. West Sussex, UK: Wiley.
- Lafi, Nora. 2020. "Urbanity as an Ethic : Reflections on the Cities of the Arab World." In *Urban Ethics: Conflicts Over the Good and Proper Life in Cities*, edited by Moritz Ege and Johannes Moser, 1st ed. Routledge. https://doi.org/10.4324/9780429322310.
- Landis, John D. 2012. "Modeling Urban Systems." In *The Oxford Handbook of Urban Planning*, edited by Randall Crane and Rachel Weber, 1st ed., 323–51. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195374995.013.0017.
- Lang, Jon. 2005. *Urban Design: A Typology of Procedures and Products*. London: Routledge. https://doi.org/10.4324/9780080458656.
- ———. 2020. *The Routledge Companion to Twentieth and Early Twenty-First Century Urban Design: A History of Shifting Manifestoes, Paradigms, Generic Solutions, and Specific Designs*. 1 Edition. Routledge Companions. New York: Routledge.
- Laoust, Émile. 1935. *Les Transhumans du Maroc Central*. Vol. 6. Collection Hespéris. Paris: Institut des hautes études marocaines.
- Le Corbusier, and Saugnier. 1923. *Vers une architecture*. 1 vols. Paris: G. Crès.
- *Le Monde.fr*. 2019. "Au Maroc, l'abandon des bidonvilles," January 4, 2019. https://www.lemonde.fr/afrique/article/2019/01/04/au-maroc-la-colere-des-bidonvilles_5405003_3212.html.
- Lefebvre, Henri. 1967. "Le Droit à La Ville." *L'Homme et La Société* 6 (1): 29–35.
- Lynch, Kevin. 2008. *The Image of the City*. 33. print. Publication of the Joint Center for Urban Studies. Cambridge, Mass.: M.I.T. Press.
- Makki, Mohammed, and Milad Showkatbakhsh. 2018. "Control of Morphological Variation Through Population Based Fitness Criteria." In *T. Fukuda, W. Huang, P. Janssen, K. Crolla, S. Alhadidi (Eds.), Learning, Adapting and Prototyping - Proceedings of the 23rd CAADRIA Conference - Volume 1, Tsinghua University, Beijing, China, 17-19 May 2018, Pp. 153-162*. CUMINCAD. http://papers.cumincad.org/cgi-bin/works/paper/caadria2018_065.
- Makki, Mohammed, Milad Showkatbakhsh, and Yutao Song. 2018. "Wallacei, Evolutionary Engine for Grasshopper3D." Wallacei. 2018. https://www.wallacei.com.
- Makki, Mohammed, Milad Showkatbakhsh, Aiman Tabony, and Michael Weinstock. 2019. "Evolutionary Algorithms for Generating Urban Morphology: Variations and Multiple Objectives." *International Journal of Architectural Computing* 17 (1): 5–35. https://doi.org/10.1177/1478077118777236.
- Marçais, Georges. 1946. *La Conception Des Villes Dans l'Islam*.
- Marçais, William. 1928. "L'islamisme et la vie urbaine." *Comptes-rendus des séances de l année - Académie des inscriptions et belles-lettres* 72 (1): 86–100. https://doi.org/10.3406/crai.1928.75567.
- Maretto, Marco. 2013. "Saverio Muratori: Towards a Morphological School of Urban Design." *Urban Morphology* 17 (2): 93–106. https://doi.org/10.51347/jum.v17i2.3990.
- Maricchiolo, Luca. 2018. "The Modern Appropriation of Urban Space through Mediterranean Medinas." In *Regionalism, Nationalism & Modern Architecture International Conference*, 221–36. Porto, Portugal: Centro de Estudos Arnaldo Araújo / ESAP-CESAP. https://hal.science/hal-04309506.

- Matsubara, Kosuke. 2020. "A Shift from 'Habitat Pour Le plus Grand Nombre' to 'Habitat Évolutif' in Post-war Francophonie: A Study on the History of International and Regional Exchange Activity of ATBAT(Atelier Des Bâtisseurs), Part 2." *JAPAN ARCHITECTURAL REVIEW* 3 (4): 601–14. https://doi.org/10.1002/2475-8876.12179.
- Mehaffy, Michael. 2008. "Generative Methods in Urban Design: A Progress Assessment." *Journal of Urbanism: International Research on Placemaking and Urban Sustainability* 1 (March):57–75. https://doi.org/10.1080/17549170801903678.
- Menges, Achim, and Sean Ahlquist, eds. 2011. *Computational Design Thinking*. AD Reader. Chichester, UK: John Wiley & Sons.
- Mitchell, Melanie. 2009. *Complexity: A Guided Tour*. Oxford University Press.
- Montagne, Robert, ed. 2016. *Naissance du prolétariat marocain : Enquête collective exécutée de 1948 à 1950*. Les rééditions du CJB. Maroc: Centre Jacques-Berque. https://books.openedition.org/cjb/556.
- Morel, Philippe. 2014. "Chapitre 9. Géométrie polymorphe et jeux de langages formels : sur l'usage de la géométrie et des modèles dans l'architecture contemporaine." In *Modéliser & simuler – Tome 2*, 293–335. Éditions Matériologiques. https://www.cairn-sciences.info/modeliser-et-simuler-tome-2--9782919694730-page-293.htm.
- Morestin, Henri. 1950. "Les faubourgs indigènes de Rabat." *Cahiers d'outre-mer* 3 (9): 66–76. https://doi.org/10.3406/caoum.1950.1663.
- Moroni, Stefano. 2015. "Complexity and the Inherent Limits of Explanation and Prediction: Urban Codes for Self-Organising Cities." *Planning Theory* 14 (3): 248–67. https://doi.org/10.1177/1473095214521104.
- Moroni, Stefano, Ward Rauws, and Stefano Cozzolino. 2020. "Forms of Self-Organization: Urban Complexity and Planning Implications." *Environment and Planning B: Urban Analytics and City Science* 47 (2): 220–34. https://doi.org/10.1177/2399808319857721.
- Mortada, Hisham. 2005. *Traditional Islamic Principles of Built Environment*. London; New York: RoutledgeCurzon. http://public.eblib.com/choice/publicfullrecord.aspx?p=182047.
- Mouloudi, Hicham. 2020. "La mobilisation des architectes contre la loi n°12.66 relative au contrôle et à la répression des infractions dans le domaine de l'urbanisme et de la construction au Maroc." *African and Mediterranean Journal of Architecture and Urbanism*, July. https://doi.org/10.48399/IMIST.PRSM/amjau-v2i1.20248.
- Mrani, Rim, Jerome Chenal, and Hassan Radoine. 2022. "Informalities as Resistance: Case Study of a Middle-Class Housing Neighborhood in Rabat, Morocco." *Journal of Engineering and Architecture* 10 (December):31–47. https://doi.org/10.15640/jea.v10n2a5.
- Muchada, Alejandro. 2019. "Between Modernization and Identity: Colonial Social Housing as a Specific Theoretico-Practical Corpus of Colonial Architecture – the Case of Tetouan (Morocco, 1912–1956)." *Planning Perspectives* 34 (4): 601–20. https://doi.org/10.1080/02665433.2018.1437553.
- Mumford, Lewis. 2016. *The Culture of Cities*. Open Road Media.
- Muratori, Saverio. 1946. *Saggi Di Metodo Nell'impostazione Dello Studio Dell'architettura*. Roma.
- ———. 1967. *Civiltà e Territorio*. Centro Studui di Storia Urbanistica. Rome.
- Naji, Salima. 2009. *Art et architectures berbères du Maroc: atlas et vallées présahariennes*. Eddif.
- ———. 2019. *Architectures du bien commun: pour une éthique de la préservation*. VuesDensemble. Genève: MētisPresses.
- Navarro-Mateu, Diego, Mohammed Makki, and Ana Cocho-Bermejo. 2018. "Urban-Tissue Optimization through Evolutionary Computation." *Mathematics* 6 (10): 189. https://doi.org/10.3390/math6100189.
- Navez-Bouchanine, Françoise. 1994. "Que faire des modèles d'habiter?" *Architecture et comportement : Modèles d'habiter au Maghreb (numéro spécial)* 10 (3): 295–316.
- ———. 1997. *Habiter La Ville Marocaine*. Casablanca, Maroc : Paris: G. Morin ; L'Harmattan.
- ———. 2002. *LA FRAGMENTATION EN QUESTION : Des villes entre fragmentation spatiale et fragmentation sociale ?* Editions L'Harmattan.
- ———. 2003. "The Case of Rabat-Salé, Morocco." *Part IV: Summary of City Case Studies, UN-Habitat Global Report on Human Settlements 2003*, 195–228.

- ———. 2005. “L’habitat Informel, Ressource Pour La Fabrication de La Ville?” In *Villes Réelles, Villes Projetées: Villes Maghrébines En Fabrication*, edited by Nadir Boumaza, 547–59. Paris: Maisonneuve & Larose.
- Nazar, Bagh-e. 2017. “Recognition of Islamic Urbanism and Architecture with Chaos Theory and Fuzzy Rule Case Study: Yazd, Meybod, Tabriz,” January.
- Noel, Vernelle AA. 2022. “Computational Regionalism: De-Familiarization of Tectonics in the Wire-Bending Craft.” *International Journal of Architectural Computing* 20 (2): 277–96. https://doi.org/10.1177/14780771221097685.
- Oliveira, Vítor. 2016. *Urban Morphology*. The Urban Book Series. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-32083-0.
- O’Meara, Simon. 2007. *Space and Muslim Urban Life: At the Limits of the Labyrinth of Fez*. 1st ed. Routledge. https://www.taylorfrancis.com/books/9780203947074.
- Ortman, Scott G., José Lobo, and Michael Smith. 2020. “Cities: Complexity, Theory and History.” Edited by Peter F. Biehl. *PLOS ONE* 15 (12): e0243621. https://doi.org/10.1371/journal.pone.0243621.
- Oxman, Rivka, and Robert Oxman, eds. 2014. *Theories of the Digital in Architecture*. London ; New York: Routledge, Taylor & Francis Group.
- Ozkan, Suha. 1985. “Introduction - Regionalism within Modernism.” In *Regionalism in Architecture*, edited by Robert Powell, Concept Media/The Aga Khan Award for Architecture. Singapore. https://s3.us-east-1.amazonaws.com/media.archnet.org/system/publications/contents/3590/original/DPC0276.pdf?1384775689.
- Parish, Yoav I H, and Pascal Müller. 2001. “Procedural Modeling of Cities.”
- Petonnet, Colette. 1972. “Espace, distance et dimension dans une société musulmane: A propos du bidonville marocain de Douar Doum àRabat.” *L’Homme, T. 12*, no. 2, 47–84.
- Petruccioli, Attilio. 1997. “The Arab City: Neither Spontaneous nor Created.” *Environmental Design*, 22–33.
- ———. 1998a. “Alice Dilemma.” In *Typological Process and Design Theory*, 57–72.
- ———. 1998b. *Typological Process and Design Theory*. Aga Khan Program for Islamic Architecture at Harvard University Massachusetts Institute of Technology.
- ———. 1999. “Historical Processes of the Building Landscape.” *Architectural Knowledge and Cultural Diversity, Ed. W. O’Reilly, Comportements,* 39–50.
- ———. 2004. “The Courtyard House: Typological Variations over Space and Time.” In *Courtyard Housing*, edited by Brian Edwards, Magda Sibley, Mohammad Hakmi, and Peter Land, 0 ed., 24–48. Taylor & Francis. https://doi.org/10.4324/9780203646724-11.
- ———. 2007. *After Amnesia. Learning from the Islamic Mediterranean Urban Fabric*. Theory and Method in Islamic Architectural Design. Bari, Italy: ICAR.
- ———. 2008. “House And Fabric In The Islamic Mediterranean City.” In *The City in the Islamic World (2 Vols.)*, edited by Salma Khadra Jayyusi, Renata Holod, Atillio Petruccioli, and André Raymond, 857–81. BRILL. https://doi.org/10.1163/ej.9789004162402.i-1500.224.
- Porter, Libby. 2016. *Unlearning the Colonial Cultures of Planning*. London: Routledge. https://doi.org/10.4324/9781315548982.
- ———. 2023. “Decolonial Approaches to Thinking Planning and Power.” *Chapters*, 165–80.
- Rachik, Abderrahmane. 2002. *Casablanca: L’urbanisme de l’urgence*. Casablanca: Najah El Jadida.
- Rachik, Hassan. 2022. *Le Maroc rural: dictionnaire socio-anthropologique : essai*. Editions La Croisée des Chemins.
- Radoine, Hassan. 2011. “Planning Paradigm in the Madina : Order in Randomness.” *Planning Perspectives* 26 (4): 527–49. https://doi.org/10.1080/02665433.2011.601607.
- ———. 2012. “TRADITION AND MYTH IN THE MADINA: CONSERVATION AND CHANGE.” *Traditional Dwellings and Settlements Review* 24 (1): 1–37.
- ———. 2017. *Architecture in Context: Designing in the Middle East*. 1st edition. Chichester, W. Sussex: Wiley.
- Rapoport, Amos. 1999. “A Framework For Studying Vernacular Design.” *Journal of Architectural and Planning Research* 16 (1): 52–64.

- Rebotier, Julien. 2012. “Enhancing Informality as an Opportunity for the Reflexivity of Social Sciences,” January.
- Reynolds, Craig W. 1987. “Flocks, Herds and Schools: A Distributed Behavioral Model.” *ACM SIGGRAPH Computer Graphics* 21 (4): 25–34. https://doi.org/10.1145/37402.37406.
- Ricard, Prosper. 1924. “Preface.” In *Les Merveilles de l’autre : France, Algérie, Tunisie, Maroc, Le Pays, Les Monuments, Les Habitants / with a Preface Letter by General Lyautey*. https://gallica.bnf.fr/ark:/12148/bpt6k3343189f.
- Robinson, Jennifer. 2022. “Introduction: Generating Concepts of ‘the Urban’ through Comparative Practice.” *Urban Studies* 59 (8): 1521–35. https://doi.org/10.1177/00420980221092561.
- ———. 2023. *Comparative Urbanism: Tactics for Global Urban Studies*. IJURR Studies in Urban and Social Change Book Series. Hoboken, NJ: John Wiley & Sons, Ltd.
- Roesler, Sascha, ed. 2015. *Habitat Marocain Documents: Dynamics Between Formal and Informal Housing*. Zurich: Park Books.
- Rouissi, Karim. 2021. “Housing for the Greatest Number: Casablanca’s under-Appreciated Public Housing Developments.” *The Journal of North African Studies* 26 (3): 439–64. https://doi.org/10.1080/13629387.2019.1692411.
- Roy, Ananya. 2005. “Urban Informality: Toward an Epistemology of Planning.” *Journal of the American Planning Association* 71:147–58.
- Ruphy, Stéphanie. 2014. “Chapitre 2. Simulations numériques de phénomènes complexes : un nouveau style de raisonnement scientifique ?” In *Modéliser & simuler – Tome 2*, by Franck Varenne, Marc Silberstein, Sébastien Dutreuil, Philippe Huneman, Jean-Luc Bernaud, and Lin Lhotellier, 49. Editions Matériologiques. https://doi.org/10.3917/edmat.varen.2014.01.0049.
- Rutten, David. 2010. “Evolutionary Principles Applied to Problem Solving.” September 25, 2010. https://www.grasshopper3d.com/profiles/blogs/evolutionary-principles.
- ———. 2013. “Galapagos: On the Logic and Limitations of Generic Solvers.” *Architectural Design* 83 (2): 132–35. https://doi.org/10.1002/ad.1568.
- Salingaros, Nikos A. 2000. “Complexity and Urban Coherence.” *Journal of Urban Design* 5 (3): 291–316. https://doi.org/10.1080/713683969.
- Salingaros, Nikos A. 2013. “Unified Architectural Theory: Form, Language, Complexity.” *Kathmandu: Vajra Books*.
- Santelli, Serge. 1998. “The Central Space in North African Architecture.” In *Typological Process and Design Theory*, edited by Attilio Petruccioli. Vol. 1. 1. Aga Khan Program for Islamic Architecture at Harvard University Massachusetts Institute of Technology.
- Schumacher, Patrik. 2008. “Parametricism as Style-Parametricist Manifesto.” *11th Architecture Biennale, Venice* 14.
- Sebti, Mohamed. 1985. “L’habitat Des Douars de Marrakech : Un Héritage Compromis.” *Annales de Géographie* 94 (521): 63–84.
- Sebti, Mohammed. 2009. “La place de l’habitat populaire aujourd’hui.” In *Gens de Marrakech : Géo-démographie de la ville Rouge*, by Mohamed Sebti, Patrick Festy, Youssef Courbage, and Anne-Claire Kurzac-Souali, 221–53. Les Cahiers de l’Ined. Paris: Ined Éditions. https://doi.org/10.4000/books.ined.3153.
- Sibley, Magda. 2004. “The Courtyard Houses of North African Medinas, Past, Present and Future.” In *Courtyard Housing*, 89–107. Taylor & Francis.
- Sitri, Zineb, and Mohamed Hanzaz. 2016. “Pouvoirs et contre-pouvoirs en matière de planification urbaine au Maroc : pour une nouvelle régulation des pouvoirs de décision.” *Revue internationale d’urbanisme*, no. 2. http://www.riurba.review/Revue/pouvoirs-et-contre-pouvoirs-en-matiere-de-planification-urbaine-au-maroc-pour-une-nouvelle-regulation-des-pouvoirs-de-decision/.
- Smith, Michael. 2019. “Energized Crowding and the Generative Role of Settlement Aggregation and Urbanization.” In *Coming Together: Comparative Approaches to Population Aggregation and Early Urbanization*, edited by Attila Gyucha, 8:37–58. State University of New York Press Albany.
- ———. 2023. *Urban Life in the Distant Past: The Prehistory of Energized Crowding*. 1st ed. Cambridge University Press. https://doi.org/10.1017/9781009249027.

- ———. 2024. “Institutions, Generative Processes, and Urban Order in Early Cities.” OSF. https://doi.org/10.31235/osf.io/d7mye.
- Sobh, Rana, and Russell W. Belk. 2011. “Privacy and Gendered Spaces in Arab Gulf Homes.” *Home Cultures* 8 (3): 317–40. https://doi.org/10.2752/175174211X13099693358870.
- Soleimani, Arash. 2019. “Computational Design Thinking and Thinking Design Computing.” In *2019 Reynolds Symposium: Education by Design*. https://doi.org/10.21428/f7d9ca02.b7daadcc.
- Stephens, Adrian. 2010. Simulated city generation. United States US7707012B2, filed May 19, 2004, and issued April 27, 2010. https://patents.google.com/patent/US7707012B2/en.
- Strava, Cristiana. 2021. *Precarious Modernities: Assembling State, Space and Society on the Urban Margins in Morocco*. London: Zed Books.
- Suisse, Pierre. 1956. “Physionomie Du Douar ‘Doum.’” *Bulletin Économique et Social Du Maroc* 20 (69): 101–22.
- Tabbarah, Faysal. 2014. “Teaching Computational Regionalism.” *Open Cities: The New Post-Industrial World Order*, 9.
- Terzidis, Kostas. 2006. *Algorithmic Architecture*. 1st ed. Amsterdam ; Boston: Architectural Press.
- ———. 2015. *Permutation Design*. 0 ed. Routledge. https://doi.org/10.4324/9781315795911.
- Troin, Jean-François. 1993. “Urbanization and Development: The Role of the Medina in the Maghreb.” In *Urban Development in the Muslim World*. Routledge.
- Varenne, Franck, Sébastien Dutreuil, Philippe Huneman, Marc Silberstein, and Cairn.info. 2014. *Modéliser simuler - Tome 2 Epistémologies et pratiques de la modélisation et de la simulation*. Paris (51, rue de la Fontaine au Roi 75011): ÉditionsMatériologiques. https://go.openathens.net/redirector/umoncton.ca?url=https%3A%2F%2Fwww.cairn.info%2Fmodeliser-et-simuler--9782919694730.htm.
- Vikhar, Pradnya A. 2016. “Evolutionary Algorithms: A Critical Review and Its Future Prospects.” In *2016 International Conference on Global Trends in Signal Processing, Information Computing and Communication (ICGTSPICC)*, 261–65. Jalgaon, India: IEEE. https://doi.org/10.1109/ICGTSPICC.2016.7955308.
- Wagner, Lauren, and Claudio Minca. 2014. “Rabat Retrospective: Colonial Heritage in a Moroccan Urban Laboratory.” *Urban Studies* 51 (14): 3011–25. https://doi.org/10.1177/0042098014524611.
- Weinstock, Michael. 2010. “Emergence and the Forms of Cities.” *Architectural Design* 80 (3): 118–21.
- Wilbaux, Quentin. 2001. *La médina de Marrakech: formation des espaces urbains d’une ancienne capitale du Maroc*. L’Harmattan.
- Wolfram, Stephen. 2002. *A New Kind of Science*. Wolfram Media.
- Yee, Vivian, and Aida Alami. 2023. “Withstanding the Passage of Time, but Not the Shaking of the Earth.” *The New York Times*, September 16, 2023, sec. World. https://www.nytimes.com/2023/09/16/world/middleeast/morocco-earthquake-heritage.html.
- Yuan, Philip. 2016. “Parametric Regionalism.” *Architectural Design* 86 (2): 92–99. https://doi.org/10.1002/ad.2029.

Appendice 3:

Table of Contents of The Full Dissertation