THE SMALL SCALE OF THINGS: EMERGING SPATIAL CULTURE IN 19TH CENTURY AL BIDDA AND DOHA IN QATAR

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ABSTRACT

The paper deploys morphological and space syntax analysis on the 1823 settlement layouts of Al Bidda and Doha, Qatar. It examines the metric size, street and block pattern, and pedestrian sheds, as well as least-line and all-lines axial analysis and Visibility Graph Analysis (VGA), of the layouts. We provide a brief review of Qatar's pre-20th-century history. The aim is to understand emergent spatial structure and function in 19th-century Qatar. The analysis reveals two distinct settlement models despite shared origins. Al Bidda exhibits a classic center-to-edge structure, integrating visitors and residents similarly. Conversely, Doha features an edge-in hierarchical structure, prioritizing resident privacy. We argue that these models reflect pre-Islamic and Islamic norms, highlighting crucial differences between insiders (residents) and outsiders (visitors) in socio-cultural activities. They represent an inflection point in Qatar's history that influenced subsequent urban development and rapid urbanization in 20th-century Doha. The findings contribute further to our knowledge about settlements in the Middle East and the GCC regions.

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Introduction

This paper undertakes a spatial archaeology exercise using space syntax. It examines the settlement layouts of Al Bidda and Doha based on the historical record of Guy and Brucks' 1823 trigonometrical plan. In doing so, we provide a brief review of the history of Al Bidda, Doha, and Qatar before the 20th century. The paper also discusses the tendency in the literature to focus on European and American settlement forms, including the formative years of space syntax during the 1970s and 1980s. We deploy space syntax analysis using least-line and all-lines axial analysis, as well as Visibility Graph Analysis (VGA). The aim is to understand the emergent spatial structure and probable functioning of Al Bidda and Doha in 1823. Our analysis relies on the space syntax measures of global choice and integration, supplemented with metric distance – via pedestrian sheds and metric step depth, as well as shortest path length in VGA analysis – to argue that the layouts of Al Bidda and Doha in 1823 represent two distinct models of settlement form, despite their causal similarities. Al Bidda has a classic center-to-edge spatial structure, assimilating visitors and residents similarly within its layout. Doha has an 'edge in' hierarchical spatial structure, fostering privacy for residents within the layout. These models are generally endemic to pre-Islamic and Islamic norms. They underscore essential differences between 'insiders' or residents and 'outsiders' and visitors in these settlements' socioeconomic and cultural activities. We argue that Guy and Brucks' 1823 trigonometrical plan represents an inflection point in the history of Qatar, with implications for subsequent urban development and the rapid urbanization of Doha in the 20th century. In doing so, we highlight the significant findings of this research and its relevance to the historical study of settlements in the Middle East and GCC regions.

Doha in Qatar emerged as one of the most significant socioeconomic and transit hubs in the Gulf Cooperation Countries (GCC) region, alongside other cities such as Dubai and Abu Dhabi in the UAE, in the late 20th and early 21st centuries (Salama & Wiedmann, 2013). The Doha metropolitan region had an estimated population of approximately (~) 2.5 million in 2025, compared to Dubai (~3.8 million) and Abu Dhabi (~1.6 million) (UN, 2024; Dubai Statistics Authority, 2025). This represents a dramatic increase from Doha's estimated 1900 population of only 6,000 (Kurşun, 2002). Doha originated as an offshoot of the Al Bidda settlement in the early 19th century. Chroniclers and visitors often conflated Al Bidda and Doha together as a single settlement under the

banner of 'Al Bidda' due to their proximity, i.e., ~1,000 meters (m). The Carmelite Convent first records Al Bidda in 1681, alluding to a ruler and a fort within its confines while chronicling several settlements in Qatar. Conflicts destroyed Al Bidda (and, by implication, Doha) in 1821, 1828, and 1867. However, Doha began to gain increasing prominence over Al Bidda after the arrival of the Al Thani family circa 1847. Their influence and leadership significantly shaped Doha's history. They assumed control of the town until the 1868 settlement of the Qatari–Bahraini War, imposed by the British, explicitly recognized Qatar as a distinct entity from the Kingdom of Bahrain. This settlement acknowledged Mohammed bin Thani's position as the representative of the tribes of the Qatari peninsula.

Qatar was subsequently administered in one form or another as a protectorate of the Ottoman Empire (1871-1916) and the British Empire (1916-1971) until the Al Thani family became the royal family of an independent Qatar in 1971 (Fletcher & Carter, 2017, 2020). By the time of independence, Al Bidda had disappeared as a distinct, separate settlement as a consequence of Doha's rapid urbanization and eventual globalization, beginning with the discovery of oil in the 1950s and the later exploitation of oil and natural gas reserves in the latter half of the 20th century (Salama & Wiedmann, 2013). Today, Al Bidda only remains as a place name for the area of its original location, which now includes the Amiri Diwan (royal palace) of the State of Qatar and the national Al Bidda Park (Tannous et al., 2021). In contrast, the historic urban fabric of primarily two-story buildings in Souq Waqif (the 'standing market') still marks the original location for the founding of Doha (Tannous et al., 2022) (Figure 1).

This paper focuses on Al Bidda and Doha in the early 19th century. The paper speculates on the emergence of distinct spatial cultures in the two settlements, using various modeling techniques in the space syntax toolkit. Lieutenant (Lt.) Guy and Lt. Brucks' trigonometrical plan of the 'El Biddah'

Figure 1. Contemporary aerial views of (left) Al Bidda looking west at the Amiri Diwan (royal palace) of the State of Qatar in the foreground and Al Bidda Park in the background, and (right) Souq Waqif, the original location for the founding of Doha, looking north with the skyline of the West Bay Business District in the left background.

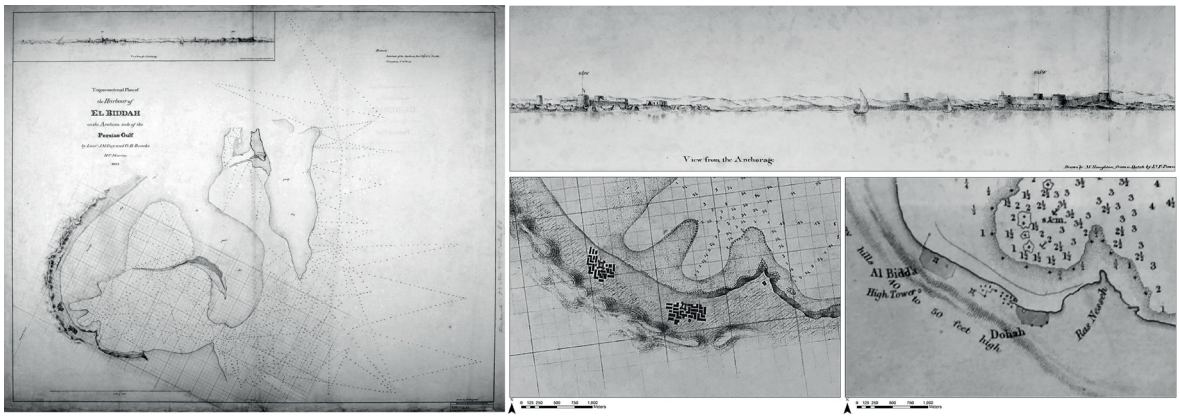

Figure 2. The 1823 trigonometrical plan of 'El Biddah' harbor (Doha Bay today) on the Persian Gulf's Arabian side by Lieuts. J.M. Guy and G.B. Brucks, (top right) 'View from the Anchorage' sketch by Houghton and Powell, and close-up views of the original maps of Al Bidda and Doha in (below left) 1823 and (below right) 1860 showing the town walls.

harbor (Doha Bay today) on the Persian Gulf's Arabian side includes settlement layouts for Al Bidda and Doha at the time. Carter and Fletcher (2017) provide a detailed view of these settlement layouts, scaled and reoriented to true north, which serve as the basis for redrawing the settlement layouts for space syntax analysis (Figure 2). A sketch, 'View from the Anchorage" by Houghton and Powell, was a top-left insert to this 1823 trigonometrical plan. It highlights the prominence of the Al Bidda Fort and Al Bu Aynayn Fort in Doha (to the right and left, respectively, in Figure 2, middle), as the only structures taller than one story. Conflicts would destroy both forts in 1848 and 1828, respectively. Subsequently, Sheikh Abdullah bin Jassim Al Thani constructed the Al Koot Fort in 1927 (renovated in 1978) next to Souq Waqif today (the northern rampart is barely visible in the foreground of Figure 1, left). An 1860 map of Al Bidda and Doha only shows the outline of the city walls. It provides very little information about the settlement layout at that time (Figure 2, bottom left), except for the scattered structures outside the walls.

The study in this paper is an exercise in spatial archaeology. Today, the city of Doha is a large metropolis, and within it is a place called Al Bidda. However, the settlement layouts in Guy and Brucks' map no longer exist, probably after 1828. The Bedouin Al-Buainain tribe was evicted from Al Bidda and Doha to the northern and western shores of the Qatari Peninsula in 1828, later migrating to eastern Saudi Arabia (Rentz, 1997). So, what is the value of this exercise in spatial archaeology? People tend to reconstruct previous settlements and dwellings using similar concepts, making some improvements where feasible rather than overthrowing them for new, untested ones (Hanson, 1989; Rossi, 1982). Of course, there are always exceptions, such as the effective abandonment of Pompeii after the catastrophic eruption of Mount Vesuvius in 79 CE, the temporary abandonment of Philadelphia (later Amman) in Jordan from the 15th Century to 1878 CE after a series of devastating earthquakes, and the reconstruction of

Lisbon, Portugal, after a 1755 CE earthquake, which led to the development of the Baixa Pombalina. Despite such upheavals and exceptions, the continuity of settlement patterns in many cases is a testament to a people's connection to their past.

Based on the historical record, we know several things about Al Bidda and Doha in the early 19th century, including:

- People supported themselves primarily through fishing and pearling.

- Trade occurred via water transportation without formal port facilities. Ships would anchor in Doha Bay (like the expedition that led to Lieutenant Guy and Lieutenant Brucks' 1823 trigonometrical plan) and beach shallow-draft boats on the coast due to the emergent coastlines (a stretch along the coast exposed by a relative fall in sea levels) of Qatar.

- Al Bidda served as the main port on Doha Bay, though Doha would later assume this role after 1867.

- The defensive role of the forts in both settlement layouts for guarding the towns from the coast.

- Most structures in these layouts were one story in height (except the forts), using locally available natural materials like rammed earth and palm fronds, which was a common practice.

- The majority of Qatari tribes historically adhered to Islam (Jaidah & Bourennane, 2009; Carter & Eddisford, 2013; Salama & Wiedmann, 2013; Fletcher & Carter, 2017, 2020).

According to Jaidah and Bourennane (2009), adherence to orthodox Islam began to sweep the Arabian Peninsula in 1745. In part, Al Bidda's 1823 settlement layout predates this movement, while Doha's is after it. However, it is reasonable to conclude that Al Bidda and Doha in 1823 looked similar to the photographs of Doha in January 1904 (Figure 3). Besides this, we know little about the day-to-day lives of the people who lived and visited there, as well as their experiences of Al Bidda and Doha as settlements at the time. For this, we

Figure 3. Photograph of Doha, Qatar, in January 1904.

must draw conclusions based on the available material: the settlement layouts, their relationships to each other and the coast, and the relationships of the dwellings within them as realized in space.

Our investigation models the settlement layout of Al Bidda and Doha in 1823 as a single system, separate within a defined settlement boundary and excluding the settlement perimeter spaces. This modeling technique serves as a proxy for understanding how the two settlements might have functioned together, how the settlement might have been viewed by visitors or 'outsiders' based on the emergent spatial structure related to the settlement's periphery (and, by definition, to the coastline and hinterlands), and how the settlement might have been viewed by residents or 'insiders' based on a purely internal understanding of spatial structure in each settlement. We examine metric distances in terms of 'as the crow flies' and shortest path measurements, block sizes/types and their morphological structure, connectivity patterns, and spatial route choices and integration/segregation using all-line and least-line axial analysis and visibility graph analysis (VGA) in the space syntax toolkit. Based on this, we derive conclusions about the emergent spatial structure of Al Bidda and Doha in the early 19th century that suggest there might have been contributory spatial factors that favored the eventual emergence of Doha as a contemporary metropolis – and led to the 'disappearance' of its ancestor settlement – related to Islamic values of gender segregation and privacy (Jaidah & Bourennane, 2009; Salama & Wiedmann, 2013; Al-Mohannadi et al., 2019).

About the Middle East and GCC Settlements

The literature on cities and urban morphology has traditionally focused on North American and European settlement forms (Fleischmann, 2017). Noted urban morphologist J.W.R. Whitehand refers to this as the problem of Euro-American myopia or 'anglophone squint' (Whitehand, 2005; 228). In many ways, this nearsightedness is understandable due to the emergence of urban planning and landscape architecture as distinct professions in Britain and the United States during the late 19th and early 20th centuries and its later specialist offshoots, such as urban ecology at the University of Chicago in the 1920s and 1930s (Major, 2018).

The historical literature about cities in Arabic texts tends to focus primarily on descriptive interpretations, ranging from classical poetry and travelogues to modern novels. They de-

scribe various aspects of urban life, such as social dynamics, political structures, and the individual's relationship with a city. They also describe the impact of urbanism on literature and culture, typically in individual settlements – rather than a general plan or morphologically based surveys – across the Arab region (Head & Hermes, 2018). This is exemplified by the travelogues of Ibn Battuta, filled with observations about the wandering of cities, including the southern part of the Arabian Peninsula in the modern-day GCC region (Battuta, 1377). Major et al. (2019, 2021) also note that urbanism in the Middle East is challenging to categorize. It is an intercontinental phenomenon, with influences from Africa, Asia, and Europe, leading to spatio-physical variations ranging from highly structured deformed grids (often called organic cities) to strongly ordered geometric ones (called regular cities), numerous (seemingly opposing) socio-cultural influences, i.e., Fertile Crescent/River Nile Delta, Greco-Roman/Turkish Ottoman, Christianity/Islam, Arabian/Persian, and so forth, and the factor of time, therefore often lacking a comprehensive or consistent historical record. People have continuously inhabited certain settlements for approximately 5,000 years (Kostof, 1991, 1992; Major et al., 2021). Others are (relatively) younger, i.e., less than five hundred years old, like Manama, Bahrain. The region also encompasses the rapid urbanization and globalization of 20th-century cities, such as Riyadh in Saudi Arabia and Dubai in the United Arab Emirates (Major et al., 2019).

A brief review of references to Middle Eastern settlements in several Western texts reveals a noticeable bias. However, it is not feasible to conduct an exhaustive review of the entire literature. For example, in Weber's (1958) *The City*, the only physical description of Islamic settlements discusses the spatial separation of fortified camps (*kasbeh* or *casbah*) from the *bazaar* or market street. He discusses the socio-political nature of Arabian settlements as close-knit groups of powerful interrelated families (clans), the relative political weakness of artisan and merchant associations (guilds), and Islam's inability to overcome these Arab tribal and clan associations (Weber, 1958). However, Weber's (1958) perspective typically skews toward European settlements and the Ancient Mediterranean region (North Africa and the Levant), except for the singular case of Mecca, Saudi Arabia, on which he seems to rely on Hurgronje (1931). In their first two chapters, Gallion and Eiser's (1963) *The Urban Pattern* discusses the Near East and the Mediterranean region, concerning Ancient Egypt, Jerusalem, Babylon, and, in particular, Ancient Greece. Otherwise, they primarily focus on Europe and North Ameri-

ca, with no mention of the Middle East during the Common Era. Similarly, Moholy-Nagy's (1968) *The Matrix of Man* only encompasses the Middle East when discussing the Ancient World and the Mediterranean region. She discusses the physical nature of linear merchant cities and, in particular, "the *suk* (e.g., market) or *bazaar* street (as) the principal planning feature of the Eastern merchant center," which she claims was an Arab adaptation of the Ancient Roman *cardo*, i.e., a principal north-south street (Moholy-Nagy, 1968; 199). She only mentions 19th-century Cairo, Egypt, as a Middle Eastern settlement from 1500 CE onwards (Moholy-Nagy, 1968). Jellicoe and Jellicoe's (1975) *The Landscape of Man* devotes four brief chapters to the 'central civilizations' of the Middle East, focused on the Ancient World and the expansion of Islam in Mesopotamia, India, and the Mediterranean region, specifically Spain. They briefly mention the oil economy of Arab states in the 20th century and, in their concluding chapter, a (now realized) master plan based on classical Renaissance planning principles by Western architects for Sultan Qaboos University in Muscat, Oman (Jellicoe & Jellicoe, 1975). Otherwise, after the opening chapters, they devote most of the remaining text to Western civilizations (Ancient Egypt is among them) and the Western Hemisphere, with a brief chapter on the Chinese or Oriental School of landscape design (Jellicoe & Jellicoe, 1975).

Kostof (1991, 1992) provides the most comprehensive view of Middle Eastern settlements. For example, he adeptly illustrates the likely adaptation of a gridded Roman colony into an Islamic layout and *vice versa* based on the premise that the Roman block is predominantly outward-facing, and the Islamic block is involuted, i.e., complicated, due to inward access to individual dwellings. He categorizes Islamic settlements under 'organic patterns,' which he analogizes to biological growth, suggesting that these settlements develop more naturally and less planned. Major (2018) points out that the dichotomy of organic and regular cities or patterns classifies urban form based on process in the first case and form/process in the second case. Like Weber (1958), Kostof (1991) notes the strong ties of ethnicity, kinship, and tribal affiliation, as well as custom, ownership, and the Muslim right to privacy (especially for females), in shaping Islamic settlements. He notes that Islamic laws and customs controlled the location of doors and windows on built forms; namely, a front door should not be directly opposite someone else's front door, and windows should never overlook another's yard, in addition to other simple rules for aggregating dwelling units (Hillier & Hanson, 1984; Kostof, 1991; Major, 2018; Khan,

2021). He also mentions the prominence of mosque minarets as a dominant feature in the skyline of Muslim settlements.

Otherwise, like others, Kostof's (1991, 1992) focus remains firmly on the Western World and the Far East, particularly Mesopotamia and the Mediterranean before the Common Era, when discussing Middle Eastern settlements. The exception is a solitary mention of Kuwait City, Kuwait, in the 1950s as evidence of Haussmann's 19th-century Parisian boulevards influencing modern planning worldwide. More recently, Burdett and Rode's (2018) *Shaping Cities in an Urban Age* mentions Dubai, UAE, and other cities, such as Singapore, demonstrating that the Modernist concept of high-rise living coexisting with a green townscape is a viable option for cities. They briefly discuss urban expansion and mobility in Kuwait City. There is also a brief mention of Masdar City regarding the 'Smart City' agenda. However, this area of Abu Dhabi in the UAE remains underdeveloped in 2025, highlighting the implementation challenges for Smart City ideas. These limited references to GCC settlements in the classic literature underscore the need for broader perspectives in urban studies, considering the global nature of urbanization and its diverse forms.

About Space Syntax, Pure Research, and Method

Space syntax also initially focused on European settlements when emerging in the late 1970s and early 1980s, based on the research of Bill Hillier, Julienne Hanson, and many others at University College London in the UK. Space syntax researchers had to draw axial maps of spatial networks by hand and calculate the accompanying spatial measurements, such as integration and connectivity, until the late 1980s. The constraints of the time – available materials, labor, and rudimentary computer programming – defined much of this early research. Hillier and Hanson's (1984) *The Social Logic of Space* presents only thirty-three unique settlement plans. Of these, 79% are in Europe, 9% in South America, 6% in Africa, and two are in North America and Turkey. 91% are historical plans. The only exceptions are the contemporary case studies of Barnsbury, Somerstown, and the Marquess Road Housing Estate in the UK. The town plan of Gassin, France, is the primary example of modeling settlements using space syntax methods. Hillier and Hanson (1984) do not state whether this is a historical or contemporary town plan. Satellite imagery suggests their Gassin plan is a historical one.

Hillier and Hanson's (1986) subsequent search for consisten-

cies and variations between spatial measurements expressing different configurations developed by space syntax relied on axial maps of seventy-five mostly historical European plans, including Winchelsea and other Medieval town plans available in Carter (1983). For convenience's sake, we can mark the beginning of the widespread software use in space syntax in 1990. However, it began a year or two earlier, most notably with the processing of the axial map of London within the North and South Circular Roads in 1989 (Hillier, 1996). Hillier's (1996) *Space is the Machine* relies heavily on theoretical models as 'tools to think with' while still demonstrating the value of this software evolution for space syntax. Hillier (1996) only presents fourteen unique settlement plans and axial maps. Of these, 76% are in Europe, 18% are in South America, and the last is Karimi's (1997) space syntax model of Shiraz, Iran. Of course, as space syntax expanded into a worldwide research program, this initial geographical basis has become considerably less pronounced over time (Tannous et al., 2021; van Nes & Yamu, 2021).

The exponential growth in computer processing power – Routley (2017) refers to a trillion-fold increase from 1959 to the present – has enabled researchers to build increasingly larger space syntax models since 1990. Space syntax researchers can now autogenerate based on road centerlines or draw in the computer models of entire regions and countries (Koch et al., 2009; Major et al., 2020; Space Syntax Ltd., 2021; van Nes & Yamu, 2021). Building more urban context for a space syntax model of existing cities is good practice. Space syntax measures rely on relational calculations. If there is not enough urban context, for example, when examining a neighborhood within a city, then the researcher may be working with a partial or unrealistic picture of the neighborhood's spatial structure. It is also practically easier in space syntax mapping to edit down a large model to appropriate urban boundaries rather than the other way around. However, as space syntax researchers follow good practice, they tend to leave behind the small-scale historical plan analysis that characterized space syntax in the 1970s and 1980s. The exceptions are usually young researchers in different parts of the world who are learning about space syntax at a more manageable model scale, or archaeologists using space syntax to develop more data about past settlements (Bustard, 1997; Shapiro, 1997, 2015; Morton et al., 2012; Tirado, 2015). However, there is still great value in experienced space syntax researchers investigating the historic plans of small settlements. For example, in *The Syntax of City Space*, Major (2018) surveyed more than 725 historical town plans in the

United States (98% of which were before 1945), classifying them based on their geometric characteristics. He demonstrated that the 1785 Land Ordinance, which divided land ownership based on a national grid, only intensified Americans' preference for the European Renaissance principles of regular grid planning before the 20th century. He modeled most of these historical town plans using space syntax. However, Major (2018) only presents the modeling of San Franciso, California (1847, 1848, 1849), New Haven, Connecticut (1623, 1748, 1830, 1852), and the historic Savannah, Georgia ward plan (1733, 1735, 1790, 1799, 1801, 1815, 1841, 1856) for his arguments about American urbanism. The understandable but gradual disappearance of historical plan analysis in space syntax is unfortunate. It is pure research, i.e., exploratory, without any practical end-use in mind. Nonetheless, there is still much that these plans can teach us about human settlements and the nature of places at the small scale of things.

We redraw the Al Bidda and Doha layouts based on Guy and Brucks' 1823 trigonometrical plan, relying on Fletcher and Carter's (2017) scaling and proper north reorientation. The study includes pedestrian sheds based on the 'as the crow flies' radius of 200 m and 400 m, or a 3-to-5-minute walk. The Western industry standard is 400 m and 800 m (or a 5-to-10-minute walk) worldwide (Talen, 2013). The calibrated radii are due to the hot desert climate of Qatar, which experiences long, extremely hot summers (ranging between 32.5° and 41.9° C) and short, mild to warm winters (between 22° and 29.6° C), making longer walks less viable most of the time (Source: Qatar Meteorological Department). We examine the type, size, and pattern of urban blocks and free-standing buildings in each layout. For the latter in Al Bidda, this is only the fort. For Doha, this includes the fort and an unidentified circular/octagonal building at its southern edge. The current head of the Heritage Department at Qatar Museums suggested it might have been a pigeon tower or perhaps a mausoleum. The study models these layouts as separate settlements within a defined boundary. Both boundaries have twenty-six vertices or endpoints, placed in line with street vistas and aligned with the shoreline to guard against skewed results due to the settlement bounds. We also model these settlements as a single system, aligning with the individual boundary vertices, except in the direction of each other, where the boundary parallels the coastline. Finally, we model both layouts independently of the settlement periphery by connecting the nearest built-form vertices. It includes all-lines axial analysis, where the software autogenerates lines of

sight from each vertex to every other visible one in the model and processes the space syntax measures. It also includes the researchers' drawing of the least-line axial map for each settlement, processed similarly using space syntax software (Hillier & Hanson, 1984; Hillier, 1996; Major, 2018; van Nes & Yamu, 2021). We examine connectivity and intersections in each settlement based on Major's (2018) parameters. We standardize and calibrate all measurement ranges, detailed in the next section, to compare or visually demonstrate our findings about these settlements more clearly. The study relies on the measures of global choice (through-movement), global integration (to-movement based on the relative mean depth of every line to all others), and local integration (localized to-movement, i.e., relative mean depth of every line to all others for three directional changes) (Tannous et al., 2021). Finally, the study conducts Visibility Graph Analysis (VGA) with and without the settlement periphery based on grid elements of ~10 m^2 in size – relying on Fletcher and Carter's (2017) scaling – to examine visual integration (visual mean depth from every grid element to every other) and metric step depth shortest path length from a selected element, i.e., the geometric center (Benedikt, 1979; Dalton, 2001; Turner et al., 2001).

Analysis of Emerging Spatial Culture

At first glance, the blocks in the layouts of Guy and Brucks' 1823 plan appear more geometric than anticipated for historical settlements in the Middle East based on restricted random aggregation – or a restricted random process as defined by Hillier and Hanson (1984) – whereby the layout emerges following simple, customary rules about locating new dwellings related to existing ones (Major, 2018) (Figure 4). The plans also do not show any blind alleys or cul-de-sacs. It is unclear if this is because Guy and Brucks utilized a common building line for their survey, eliminating minor deviations in dwelling form and unintentionally regularizing the layouts. It is unclear if these were the actual conditions or Guy and Brucks' drawing technique for their survey. Based on historical and contemporary precedents in Europe and Doha, respectively, we would expect no more than one or two blind alleys in these layouts if they even existed at the time, especially since all blocks are narrow in one dimension (Major, 2015; Major et al., 2020). Fletcher and Carter (2017) neither comment nor provide insight on either point.

However, a closer examination reveals that near-right angles (<10° of a perfect right angle) compose most of the blocks in

Al Bidda. We can only characterize one block in Al Bidda as perfectly rectangular. Near-right angles (<5° of a right angle) also characterize most blocks in Doha. Its layout does have more right angles. The southeastern area utilizes a formalized pinwheel axis using near-right angles, the first recorded instance in the history of Qatar, and more than a century and a half before becoming a widespread organizing mechanism for the suburban development of Doha (Major et al., 2019; Major et al., 2021). We can characterize four of Doha's blocks as perfectly rectangular. The exceptions are the forts in each layout and one circular/octagonal-ish-shaped block in Doha. This suggests Guy and Brucks did use a common building line in their survey. We will proceed as if their drawings are conceptually correct, even if they might not be a precise survey in the contemporary sense. It is also evidence of rudi-

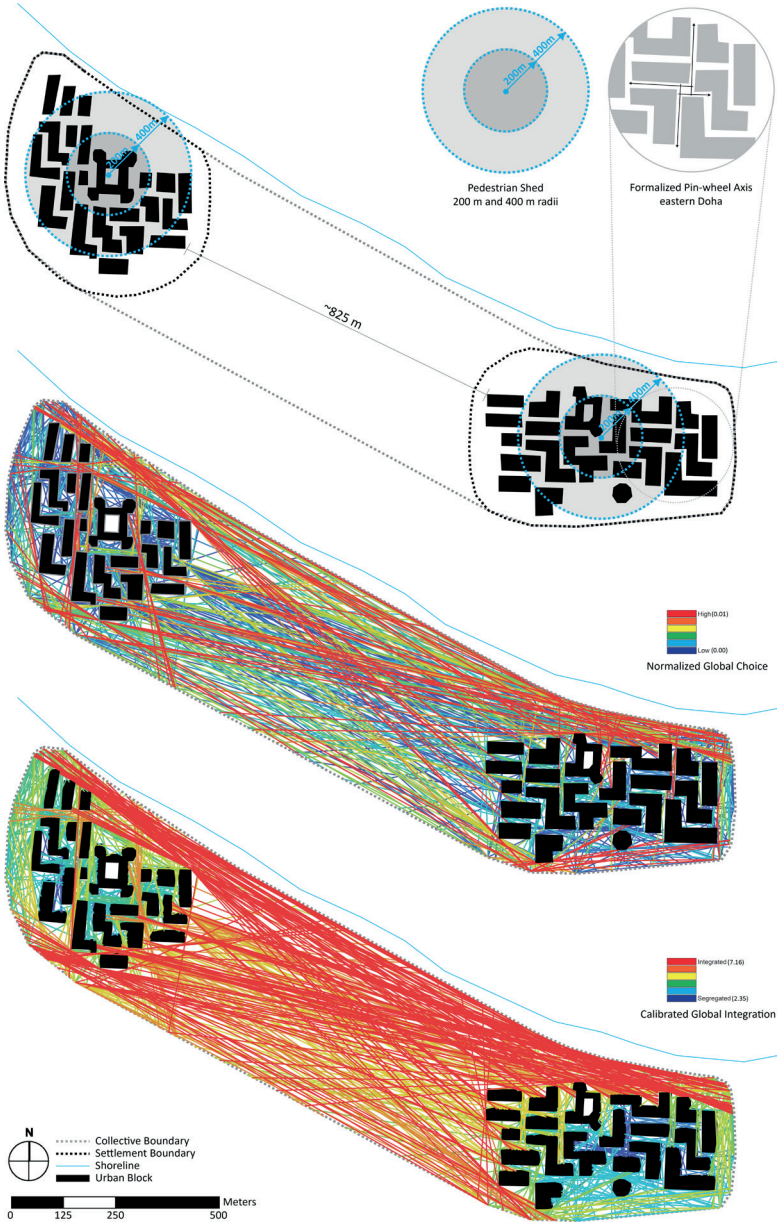

Figure 4. (top) The settlement layouts of (left) Al Bidda and (right) Doha in 1823 indicating the shoreline (in light blue) and individual and collective settlement modeling boundaries and pedestrian sheds from the geometric center of each settlement with an insert of eastern Doha, and all-line axial analysis of Al Bidda and Doha as a single spatial system for (center) normalized global choice and (bottom) calibrated global integration.

mentary survey techniques at work on a dwelling-by-dwelling basis in the settlements. Qatar National Library has five trigonometrical plans of the Persian Gulf region (specifically, Qatar) by Lieutenant J.M. Guy and Lieutenant G.B. Brucks available in its digital collection. However, the trigonometrical plan of 'El Biddah' harbor is the only one to include dwellings and structures. Other than this, there is no explicit evidence of planning other than the defensive role of the forts. Since no other surveys existed before this time, it is impossible to know with certainty which came first: the fort or the dwellings. Presumedly, a fort would only be constructed after there was something to protect.

There are no dwellings immediately north of the forts, maintaining an elevated, unobstructed vista of the bay. There are no built forms that are immediately recognizable as mosques in either settlement based on a footprint oriented in the direction of Mecca, Saudi Arabia, like we would see today. There is a possibility that two small, squarish-shaped blocks, each adjacent to the east and west of the fort, could be potential mosques in Al Bidda. This might make sense if one served the western half of the town and the other the eastern part. Doha's only candidate block is the centrally located circular or octagonal block at the southern perimeter. If so, it appears to be located to serve the entirety of Doha. However, we must consider the presence of mosques in Al Bidda and Doha as uncertain without corroborating evidence. William Gifford Palgrave (1871) said that there were no mosques in Al Bidda in 1863, as noted in his travel descriptions of the town, although two mosques were built shortly thereafter. In the absence of mosques, people probably worshiped in multi-functional spaces or structures. For example, the historical record is clear about the multi-functional characteristic of rooms in Qatari households before rapid urbanization in the 20th century (Jaidah & Bourennane, 2009; Carter & Eddisford, 2013).

The two settlements are ~825 m away at their nearest point. The geometric center of one settlement is ~1,325 m from the other, using the geometric center as a proxy for a location more or less equally distant for all residents of each town. The geometric center of Al Bidda is inside the fort, whereas it is immediately southwest of the fort in Doha. The settlements' relationship with each other derives from their relationship to the coastline of Doha Bay. The overall shape of Al Bidda is more compact, with blocks elongating away from the shoreline. Doha extends along the coastline, featuring a mixture of blocks that elongate parallel or perpendicular to the shoreline. The pedestrian sheds make clear that the entire settlement is accessible within 500 m of each geometric

center, with the overwhelming majority of locations within a five-minute walk.

The all-line axial analysis of normalized global choice (range: 0.00-0.01) and integration (a calibrated range of 7.16-2.35, where the maximum equals the total range) as a single system within the defined boundary reveals several insights. First, it underscores the crucial role of the undifferentiated space in connecting the settlements. Second, it brings to light the subtle skewing of this undifferentiated space towards the shoreline over the inland periphery. Third, it highlights a couple of routes that penetrate into and entirely through Al Bidda in a north-south direction, more or less perpendicular to the coast, with the subtle emergence of another route beginning to parallel the coast south of the northern blocks adjacent to the coast. In contrast, routes penetrating but not through the settlement characterize global choice in Doha, resulting in a clearcut hierarchy from integrated edge to segregated center for integration.

The rank ordering of blocks and free-standing blocks in Al Bidda and Doha reorients the blocks on their narrowest side, positioning them from largest to smallest for the metric area (Figure 5). At first glance, it looks like there are more blocks in Doha. However, this is an artifact of its larger block sizes. There are two more blocks in Al Bidda, with the largest being the fort (~15,625 m^2). Of its twenty-two blocks, 13 (or 60%) are near-regular polygons, i.e., <10° of a perfect right angle. The rest are irregular polygons, including five L-shaped (or nearly so) and two step-shaped blocks. The Al Bu Aynayn Fort (<10,000 m^2) is the second-largest block in Doha. The largest is an irregular polygon immediately east of the fort, running 135 m parallel to the coast with a sizeable pseudo-courtyard facing the bay. There are only eight near-regular polygon blocks (40%), i.e., <5° of a perfect right angle, all on the smaller side relative to the rest of the blocks. There are six L-shaped and two Z-shaped blocks, as well as a single circular/octagonal-ish-shaped block. Two irregular polygon

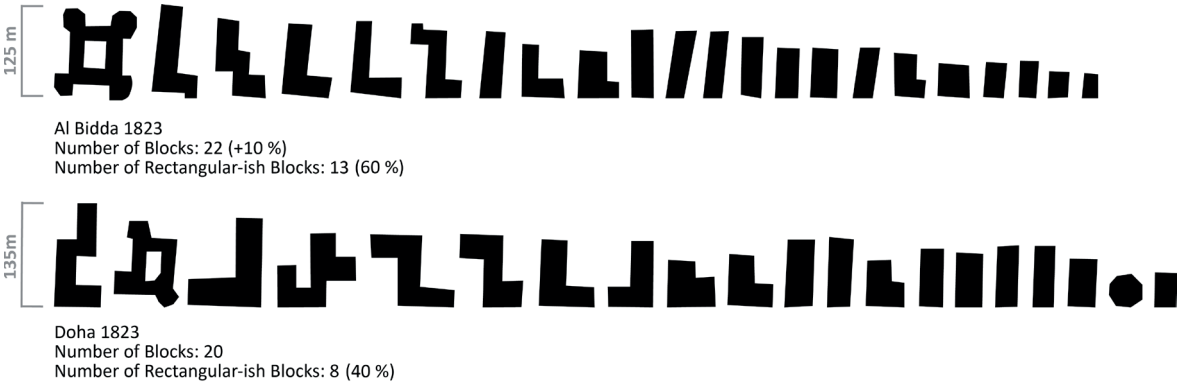

Figure 5. The rank ordering of urban blocks/free-standing buildings from the largest to the smallest for the metric area in (top) Al Bidda and (bottom) Doha in 1823.

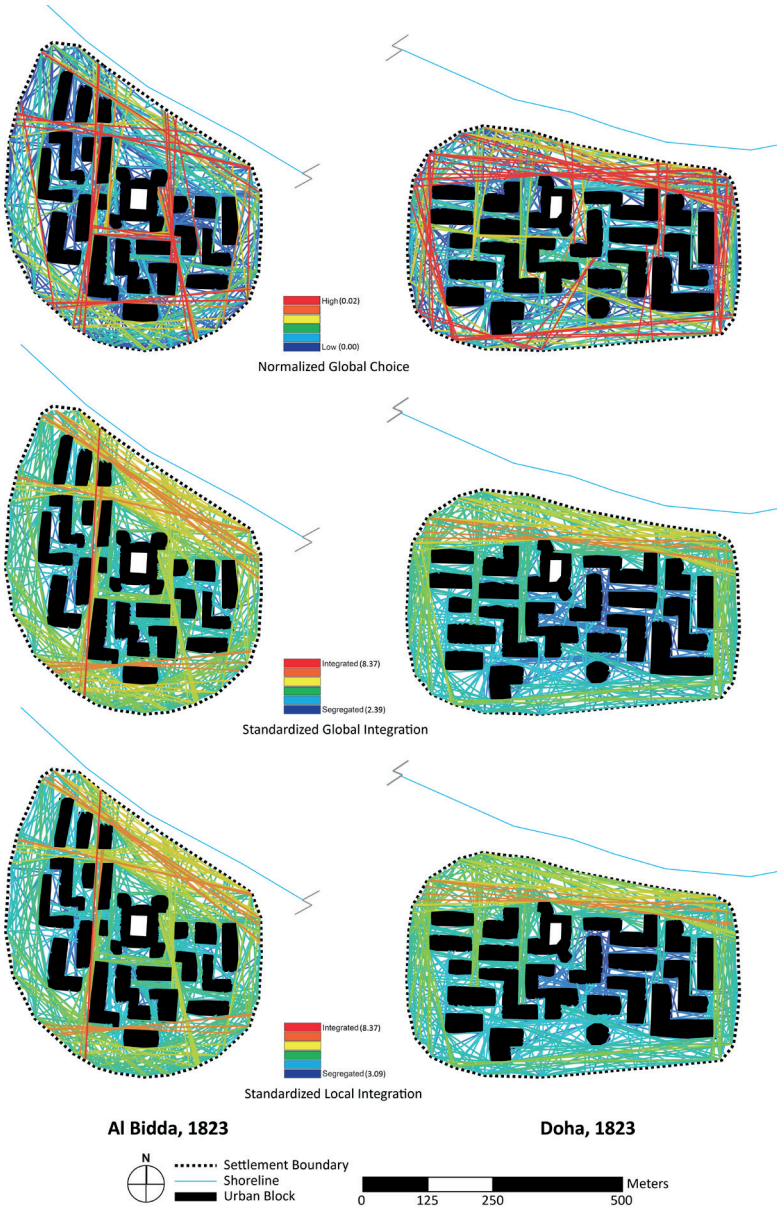

Figure 6. All-line axial analysis of the 1823 layouts in (left) Al Bidda and (right) Doha within the settlement boundary for (top) normalized global choice, (center) standardized global integration (radius=n), and (bottom) standardized local integration (radius=3).

blocks exist, including one immediately south of the fort. Generally, we can conclude that the Doha layout is more geometrical than Al Bidda, primarily due to its <5° of perfect right-angle logic.

We can examine the effect in the all-line axial analysis for global choice, global integration, and local integration of each layout as an independent system within the boundary, incorporating the periphery of the settlement (Figure 6). Calibrating the individual settlement boundaries helps ensure comparability, as there is only a <5% difference in axial size. Al Bidda (492 lines) is marginally larger than Doha (471 lines), which is unsurprising given that it has two additional blocks. We standardized the range for the measures of normalized global choice (0.00-0.02), global integration (2.39-8.37), and local integration (3.09-8.37). For the global and

local integration, we set the maximum value to the minimum value plus the total range for visual purposes.

The global choice in Al Bidda highlights the importance of the coastal route to the north, its emerging parallel route in the western part of the layout that becomes part of the shoreline perimeter north of the fort, and the east and west perimeter routes running perpendicular to the settlement. A single route runs along the entire length of the southern perimeter, with a solitary block south of it, which connects the north-south routes of the eastern and western perimeters. Within Al Bidda, it highlights dual north-south routes – composed of overlapping axial lines as pseudo-*cardines* (Latin plural of *cardo*), as described by Moholy-Nagy (1968) – running parallel on either side of the fort entirely through the layout. The eastern one is adjacent to the fort. The western one is located one block away (approximately 100 m). There is a central route connecting the two immediately south of the fort. In Moholy-Nagy's (1968) terms, we can describe this as an abbreviated *decumanus*, as it connects the *cardines* but does not extend further east or west of the layout. The spatial structure of Al Bidda represents a classic example of Hillier and Hanson's (1984) deformed wheel core, reaching from the center to the edges of the settlement.

The pattern of global and local integration in Al Bidda further reflects this, with the *cardo* west of the fort gaining significant prominence over the eastern one in terms of integration. This western *cardo* might have been the *bazaar* street in the classic manner of other Islamic settlements. The spatial structure of Doha for global choice and integration is more unique. The global choice highlights all perimeter routes, emphasizing the coastline perimeter and the north-south routes that enter the layout. However, these routes do not directly traverse to the opposite periphery. The focus on global choice is more pronounced in the areas east of the fort than in the west, i.e., further away from Al Bidda. The subsequent effect of standardized integration in the layout is profound, with high integration concentrated at the northern perimeter adjacent to Doha Bay and segregated spaces defining the internal layout of Doha.

The least-line axial analysis of Al Bidda and Doha as independent settlements for the global choice and integration pattern reiterates the importance of the coastline perimeter as it has the highest choice and integration values in both layouts (Figure 7). This is unsurprising given the importance of fishing, pearling, and trade in the socioeconomic life of both settlements at the time. Both global choice (0.00-0.30) and

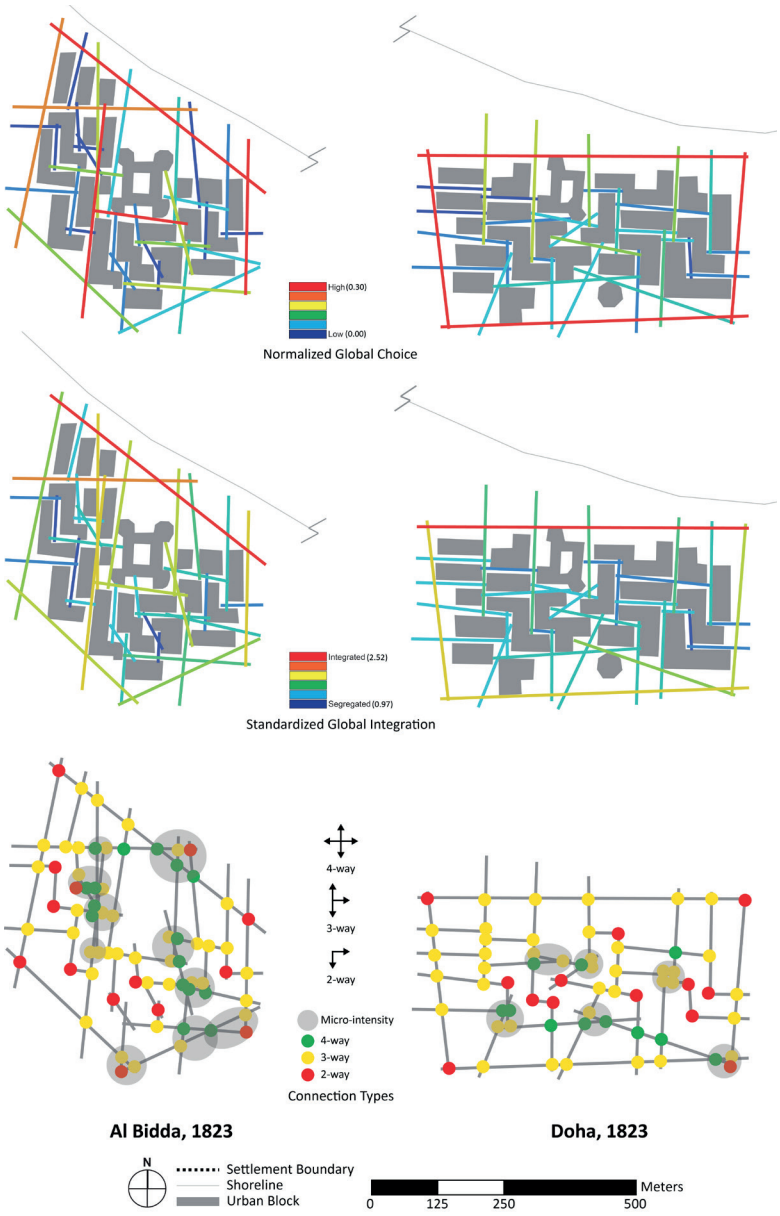

Figure 7. Least-line axial analysis in the 1823 layout of (left) Al Bidda and (right) Doha within the settlement boundary for (top) normalized global choice, (center) standardized global integration (radius=n), and (bottom) a representation of connection types (2-, 3-, and 4-way) indicating the micro-locations of intense connectivity.

integration (0.97-2.52) have a standardized range for comparison's sake. The segregation and low choice within the internal layout of Doha are again evident. The eastern *cardo* of Al Bidda becomes much less prominent for integration and choice in the least-line analysis. Global choice emphasizes the western *cardo* and the abbreviated *decumanus* south of the fort in Al Bidda.

We can discern other features by examining a representation of connectivity in Al Bidda and Doha, following Major's (2018) classifications. Connections at the edge of the settlement are not included in this classification if they lead to an undifferentiated periphery, i.e., corner connections are two-way, and edge connections are three-way.

Doha has 11 four-way connections in the layout. Al Bidda possesses 16 such connections (+45%). Both Al Bidda and

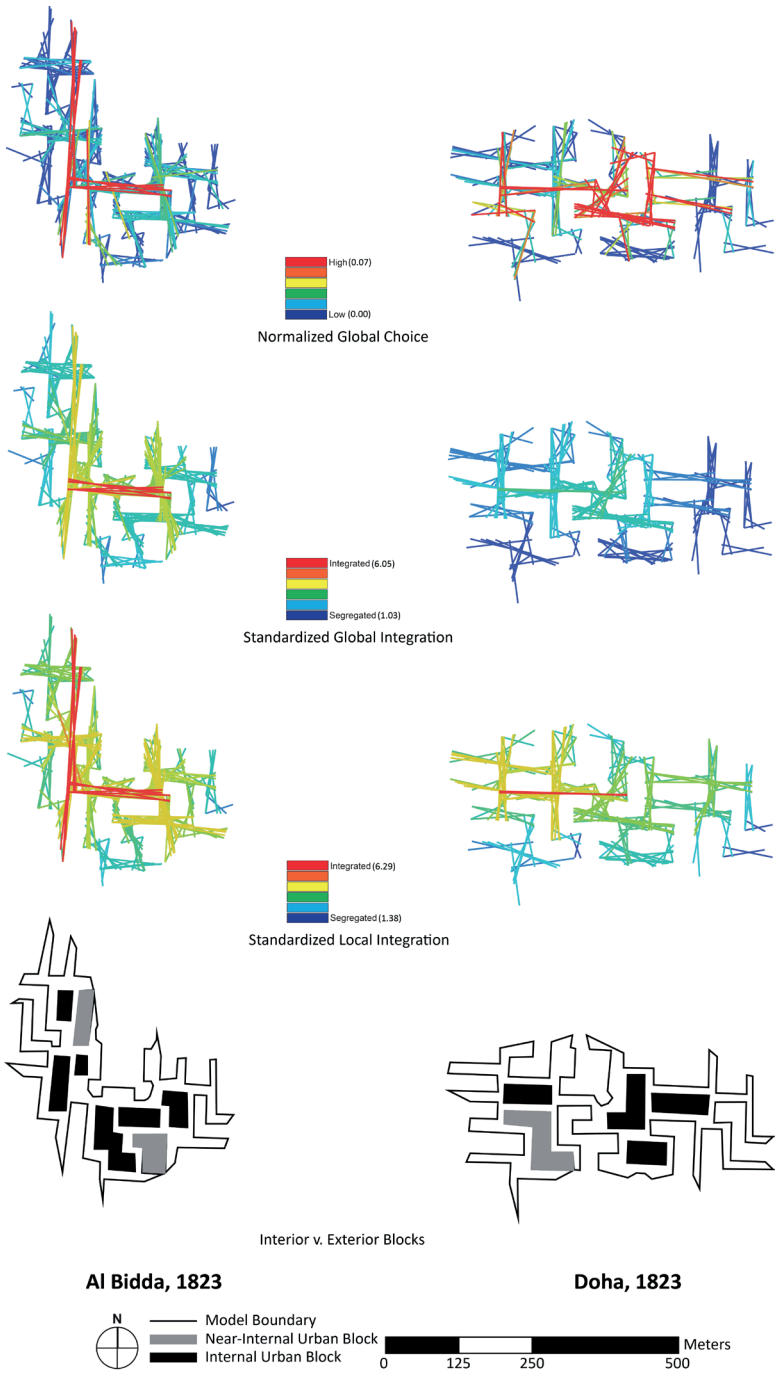

Figure 8. All-line axial analysis in the 1823 layout of (left) Al Bidda and (right) Doha excluding the settlement periphery for (top) normalized global choice, (top center) standardized global integration (radius=n), (bottom center) local integration (radius=3), and (bottom center) a representation of the model bounds indicating fully and nearly internalized urban blocks.

Doha have 34 three-way connections. Al Bidda has 14 two-way connections; seven are internalized within the layout, while the rest are located on perimeter spaces. Doha has 13 such connections, of which nine are internalized within the layout (+29%) and four at the layout's corners as a straightforward feature of its geometrical order. What differentiates connectivity in Al Bidda and Doha is how they are distributed within the layout. Doha features some two-way connections relatively close to its geometric center. The internal two-way connections in Al Bidda's layout are distributed to the interstitial areas away from its geometric center to the east, west,

and south. The overlapping micro-intensity of connections, i.e., intersections with multiple route choices, in Al Bidda focuses centrally on the cardines, coastline, and the entire southeastern edge. There is a distinct separation occurring among instances of overlapping micro-intensity connections in Doha, with only two immediately south of the fort, near each other. This mapping of connection types in the two layouts makes the geometrical order underlying Doha's spatial structure even more evident.

The all-line axial analysis of global choice, global integration, and local integration in Al Bidda and Doha, independent of their periphery spaces, provides an even starker contrast (Figure 8). The axial size difference is now more prominent: Al Bidda (233 or +26%) compared to Doha (185). Researchers again established a standard range for normalized global choice, global integration, and local integration for comparison purposes. The spatial structure of Al Bidda remains consistent for insiders/residents and outsiders/visitors, emphasizing the western *cardo* for global choice and integration, and abbreviated *decumanus* globally and locally within the layout. The eastern *cardo* is more prominent for local integration, effectively defining the 'edge' of the eastern area of town. Contrastingly, global choice highlights a series of internal routes within Doha's layout, which remain segregated for global integration. Local integration highlights the east-west route immediately south of the fort. On the western end of this route lies the geometric center of the layout. Doha has only five blocks wholly or nearly internalized within the layout, whereas Al Bidda has eight (+60%). Because of this, Al Bidda and Doha are divided into distinct east and west areas, located on opposite sides of their respective forts. However, the most apparent demarcation is the structured nature of Al Bidda and the hierarchical one of Doha as a spatial system. In Hanson's (1989) terms, Al Bidda is structured, and Doha is ordered. The difference arises from prioritizing socioeconomic or cultural factors in aggregating dwellings to Al Bidda and Doha, respectively. Like many other world settlements, Al Bidda's layout prioritizes socioeconomic activities for residents and visitors alike. Doha's layout prioritizes the customary norms of Islam for residential privacy.

Finally, the VGA analysis of visual integration and metric step depth shortest path length in Al Bidda and Doha in 1823 with and without their settlement periphery reiterates our findings (Figure 9). Researchers set a calibrated range for visual integration with (3.70-11.10) and without (1.92-5.79) the settlement periphery, where the maximum value equals

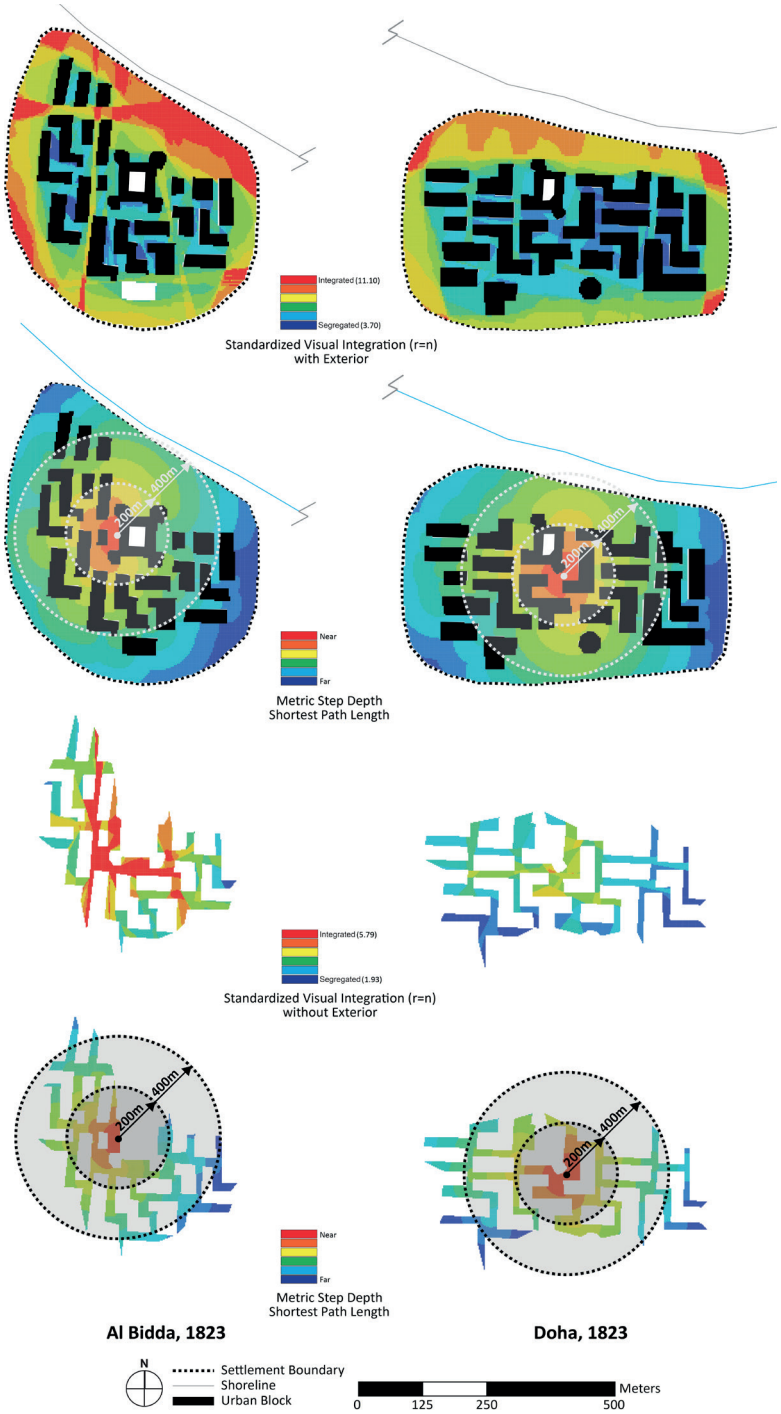

Figure 9. VGA analysis of the 1823 layout in (left) Al Bidda and (right) Doha within the defined settlement boundary for (top) standardized visual integration (radius=n) and (top center) metric step depth shortest path length with pedestrian sheds, and excluding the settlement periophery for (bottom center) standardized visual integration (radius=n) and (bottom) metric step depth shortest path length with pedestrian sheds.

three times the minimum in both cases. Since the geometric center of Al Bidda lies inside the fort, we shift it to the nearest grid element outside the fort to the west for the metric step depth shortest path. We overlay a pedestrian shed on each settlement from the grid element, defining its geometric center for reference. Both settlements possess strong visual integration along the coastline. Segregated visibility characterizes the internal layout of Doha. In Al Bidda, visual integration also focuses on the northern periphery of the coastline but also highlights the vistas into the settlement associated with

the western *cardo* and the coastal parallel route in the west. Otherwise, the internal layout of Al Bidda also remains relatively segregated for visibility. Without the periphery, visual integration in Al Bidda shifts to the west and east *cardines* and the central, abbreviated *decumanus*, replicating the all-line axial analysis. The internal layout of Doha remains entirely segregated.

For the metric step depth shortest path length, walking distances skew with the overall shape of the settlement related to the coast. The most extensive walking trips in Al Bidda are from its eastern blocks and inland periphery to the northwest blocks and coast. Likewise, the metric step depth shortest path length skews northward from the geometric center towards Doha Bay. Due to Doha's elongated shape along the coast, the metric step depth shortest path length for walking trips similarly skews towards the Doha Bay and inland periphery. The shortest walking trips are north-south. Doha's most extensive walking trip is from the block or corner in the southwest, somewhat skewed southward, to the facades on the western periphery. This marginally separates the easternmost and westernmost blocks for privacy in Doha. However, the ones in the west are even more private when considering both settlements as a single spatial system, as seen in the all-line axial analysis. It is a straightforward consequence of metric distance in the settlement pattern.

Discussion

Initially, the 1823 plans of Al Bidda and Doha appear to have similar features, perhaps due to the drawing techniques in Guy and Brucks' trigonometrical plan. However, spatial analysis reveals that these are, in fact, two distinct models of settlement form in mediating the relationship between insiders and outsiders, i.e., residents and visitors. Broadly, we can attribute these differences to pre-Islamic and Islamic views of settlement form in the GCC region. Al Bidda's spatial structure fulfills its socioeconomic role as the port. Fletcher and Carter (2017) state that Al Bidda was the only port from which trading vessels regularly sailed in Qatar in the early 1820s (Rahman, 2005). Again, it is unclear if this description conflates Al Bidda and Doha as a single settlement under the name 'Al Bidda' or treats them as distinct settlements.

Nonetheless, the layout of Al Bidda represents a classic example of Hillier and Hanson's (1984) deformed wheel structure (in red in Figure 10, top left) connecting from the center to most settlement edges. Al Bidda offers a typical picture of the settlement at the global and local scale of space for residents

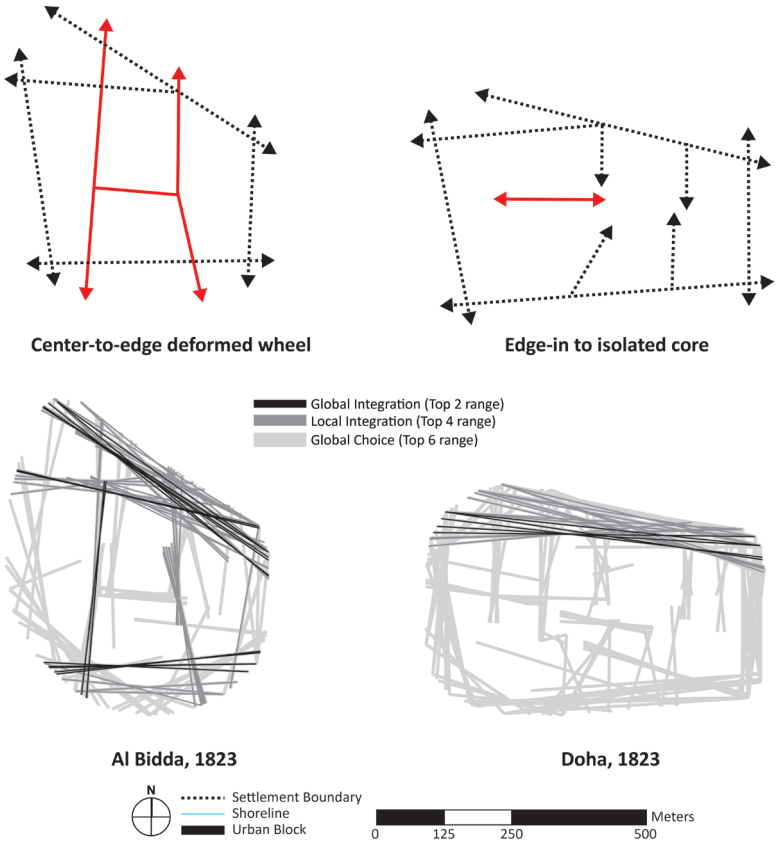

Figure 10. (top) The pre-Islamic and Islamic settlement models in the 1823 layout of (left) Al Bidda and (right) Doha and (bottom) the 'Ascendent or 246' map summarizing global choice, local integration, and global integration in each, respectively.

and visitors, thereby successfully assimilating them alike internally within its layout (Figure 10). Conversely, Doha's layout represents a new model of Islamic settlement in Qatar. It incorporates subtle geometry and block size and shape changes that affect connectivity and visibility, introducing internal segregation within its layout in a hierarchical model that operates 'edge-in' to generate privacy for residents. It constrains visitors to its more integrated and functionally important spaces along the coast. This necessitates generating an isolated, highly localized core within the settlement (in red in Figure 10, top right), nominally for the principal use of residents. It is more or less consistent with the geometric center based on the overall shape of Doha. It also underscores a shift from traditional settlement configurations (in Al Bidda) towards a more organized hierarchy (in Doha), wherein accessibility is regulated.

The 'Ascendent or 246' map of 1823 Al Bidda and Doha layouts, based on all-line axial analysis of each settlement within the settlement boundary, reveals these significant differences.[1] The map is 'ascendent' because the summarized graphic includes an ascending number of ranges from the top 2 of global integration (as thin black lines) through the top 4 of local integration (as dark grey lines of intermediate thickness) to the top 6 of normalized global choice (as thick, light

[1] *This representation, deriving from a 2024 idea discussed by Space Syntax Ltd.'s Tim Stonor in an invited presentation at the 14th International Space Syntax Symposium, provides a clear and comprehensive overview of their different spatial structure.*

grey lines) (Figure 10, bottom). This clarity allows us to understand the center-to-edge spatial structure of Al Bidda and its edge-in counterpart in Doha.

It is essential to reiterate that the historical development of Doha was not the result of top-down planning, but rather the individual application of simple, customary rules in a restricted, random aggregation. The process of incorporating rules on locating doors and windows in new dwelling units related to their neighbor's existing dwelling based on Islamic cultural norms, as suggested by Kostof (1991) and Khan (2021), is a key factor in giving rise to subtle changes in layout in Doha compared to Al Bidda in 1823. However, there is no indication of where the doors and windows are in the 1823 trigonometrical plan of Doha, so it is impossible to verify. However, it is a reasonable hypothesis, given what we know and what we learned in this analysis. Nonetheless, it would make our findings even more remarkable, as they derive from the collective sum of individual actions that contribute to the emergence of a new settlement form. Despite the later destruction of these settlements, Guy and Brucks' plan appears to document a critical inflection point in the history of Qatar and Doha with significant implications for its initial development and later rapid urbanization and globalization during the 20th century (Major et al., 2019).

Conclusion

This paper was an exercise in spatial archaeology, utilizing space syntax to examine the settlement layouts of Al Bidda and Doha in the historical record, based on a 1823 plan. We briefly reviewed the history of Al Bidda, Doha, and Qatar before the 20th century. The paper also discussed the tendency of urban researchers to focus on European and American settlements, downplaying those of the Middle East and the GCC regions. It included a review of space syntax's tendency to do so during its formative years in the 1970s and 1980s. The space syntax analysis in the paper relied on least-line and all-lines axial analysis, as well as Visibility Graph Analysis (VGA), to demonstrate the emergent spatial structure in Al Bidda and Doha during the early 19th century. Based on our findings, we argued that the 1823 layouts of Al Bidda and Doha, despite their apparent similarities, actually represent two distinct models of settlement form in the history of Qatar. Al Bidda possessed a classic center-to-edge spatial structure, enabling visitors and residents to assimilate similarly within its layout. Doha had an 'edge in' hierarchical spatial structure, fostering privacy for residents within its layout.

Generally, these model types were endemic to pre-Islamic and Islamic norms, underscoring the essential differences between 'insiders' or residents and 'outsiders' or visitors in terms of socioeconomic activities and cultural norms, as reflected in settlement forms. We concluded that Guy and Brucks' 1823 plans mark a critical inflection point in the history of Qatar, with profound implications for subsequent urban development and the rapid urbanization of Doha during the 20th century. In doing so, we highlighted the historical significance of this research and its relevance to the study of settlements in the Middle East and GCC regions, inviting a deeper appreciation for the rich history of these areas.

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Illustrations

All images by authors unless otherwise noted below.

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Figure 2: British Library, Oriental and India Office Collections via Wikipedia/Fletcher & Carter, 2017.

Figure 3: Public Domain, original photographs by Hermann Burchardt via Wikipedia. Obtained from Volume II of the Gazetteer of the Persian Gulf, 'Omān and Central Arabia (Government of India: 1908) compiled by John Gordon Lorimer.

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