

# Diving for the spatio-functional qualities of exclusivity at The Pearl-Qatar

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## ABSTRACT

Rapid urbanization and globalization characterized Doha over the last half-century. Most research focuses on its urban expansion to the north, south, and west. However, urban development also occurred eastward into the Arabian Gulf via land reclamation projects for Al Corniche Road, West Bay, Hamad International Airport, portions of Lusail City, and The Pearl-Qatar. The last is a 400-hectare, US \$15 billion artificial island development. It provides 32 linear kilometers of new coastline in northeast Doha. The Pearl is approaching its built-out date with a 2020 projection of 18,831 dwellings for 45,000 residents. The paper presents a morphological analysis of The Pearl-Qatar and its different districts. It includes figure-ground and pedestrian shed analysis, mapping ground-level land uses and active/inactive frontages, and space syntax analysis of the urban spatial network. The goal is to explain the 'how' and 'why' of The Pearl's design and planning strategies. We argue that The Pearl operates effectively for its purpose as an exclusive residential enclave. The design and planning selectively promote pedestrian walkability via compact mixed-use districts while carefully managing route connections and frontages to maintain a degree of residential exclusivity and privacy in the country's Islamic culture for socio-economic purposes. Nonetheless, there is room for improvement to promote pedestrian movement.

## 1. Introduction

Qatar is a country on the Arabian Peninsula in the Middle East and a member of the Gulf Cooperation Countries (GCC).<sup>1</sup> The Qatari Peninsula projects 160 kilometers (km) into the Arabian Gulf, which bounds the country to the north and east. The Gulf of Bahrain is to the west, with the island country of Bahrain only 22 km to the northwest. Dubai and Abu Dhabi in the UAE are only a half-hour direct flight to the east. The total land area of Qatar is 11,571 square kilometers (km<sup>2</sup>) (Fig. 1). The country consists of low, dusty plains. Hot, humid summers characterize Qatar with average highs of 39–42 °C and lows of 27–31 °C (May–September). Winters are pleasant and mild with average highs of 25–22 °C and lows of 16–14 °C (December–February) (Source: World Weather Online/Wikipedia). It is a climate of extremes for pedestrians, with the short, pleasant winters promoting walkability in settlements and the long, hot summers deterring it. Nonetheless, there is a culture of walking in the country traceable to the origins of historical settlements along coastlines and layouts composed of small, compact urban blocks and narrow, shaded passageways (Tannous, 2020; Khan et al., 2021; Major & Tannous, 2020).

Like other GCC countries, Qatar experienced rapid urbanization and globalization due to the rise of the oil and gas industry. Globalization is a process of interaction and integration amongst people, companies, and governments worldwide. It includes increased international trade and the exchange of beliefs, culture, and ideas during the Information Age due to the rise of the Internet. It is primarily an economic process. Globalization involves capital, data, goods, labor, services, and technology (Albrow and King, 1990; NRC, 1995). For the built environment, it includes increased standardization through international building codes, zoning regulations, and construction methods. Globalization brought significant economic and cultural shifts to Qatar (Wiedmann et al., 2012; Salama & Wiedmann, 2013a-b).

Qatar transformed from a fishing and pearling economy in small villages along the coastline in the late 19th century to a modern economy based on oil and natural gas exportation after the 1950s. Economic development also led to dramatic lifestyle and population changes. It included the migration of long- and short-term residents (expatriates or 'ex-pats') and increased life expectancy (61 years in 1960 to 80 today) due to an enhanced healthcare system. The total population increased from an estimated 47,000 people in 1960 to a projected 2.9 million in

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<sup>1</sup> Common definition of the Middle East includes Cyprus, Egypt, Lebanon, Iran, Iraq, Israel, Jordan, Libya, Palestine, Sudan, Syria, Turkey, with the Gulf Cooperation Countries (GCC) of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, Qatar, and the United Arab Emirates (UAE) as well as Yemen (Source: Encyclopædia Britannica).

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2022 (World Data Bank, 2022). Today, Qataris represent only 10% of the population. The other 90% are ex-pats. Most are from other Arab countries and Southeast Asia, with a few Westerners (14%). Qatar remains an Islamic country (65.5%), with the rest of the population composed of Hindus, Christians, and others (Planning and Statistics Authority, 2022).

Most urban growth focused on Doha (Scholz, 1999; Salama & Wiedmann, 2013a-b). Doha Municipality's urban population increased from an estimated 18,000 in 1950 to 641,000 today (Table 1). Revenues from oil and natural gas exports fed initial rapid urbanization, modernization, and lifestyle changes for Qatari citizens from 1950 until the turn of the century (Salama & Wiedmann, 2013a-b; Al-Mohannadi et al., 2019). In the 21st century, the Qatari government's efforts to promote economic diversification, enhance the country's position in the world's economy, and attract tourists and new investments by hosting high-profile events have sustained efforts in the urban growth and development of Doha (Tannous, Major, & Al-Obaidan, 2021; Al-Amadi et al., 2022). Major et al. (2020) argue that Qatar is effectively a city-state, with more than 80% of its population living in the Doha metropolitan region today. Urban expansion was necessary to accommodate such rapid growth. The town physically grew from ~8 km<sup>2</sup> stretched along the coastline of Doha Bay in 1952 to a metropolitan area of 650 km<sup>2</sup> today, using the modern orbital highway as a guide for the boundaries of the space syntax model of the continuous urban fabric in Metropolitan Doha 2020 discussed later in this paper (Major et al., 2020). It represents the effective expansion of settlement area by an average of 9.2 km<sup>2</sup> (or ~115% the size of Doha in 1952) annually over the last 70 years.

Qatar's growth management policies and development frameworks evolved to spur and accommodate this urbanization. The goal was to attract people to live, work and invest in the country. In the 1970s, British consultant Llewellyn Davis created the first master plan with zoning maps and planning for a ring-road system to manage increased automobile ownership and vehicular traffic in the city. Globalization fed the adoption of standardization with an initial focus on mid- and high-rise buildings, new road infrastructure, suburban residential districts, and iconic skyscrapers in the contemporary West Bay business district. The cumulative effect of lifestyle changes associated with rapid urbanization and globalization led Qataris to effectively abandon the city

**Table 1**

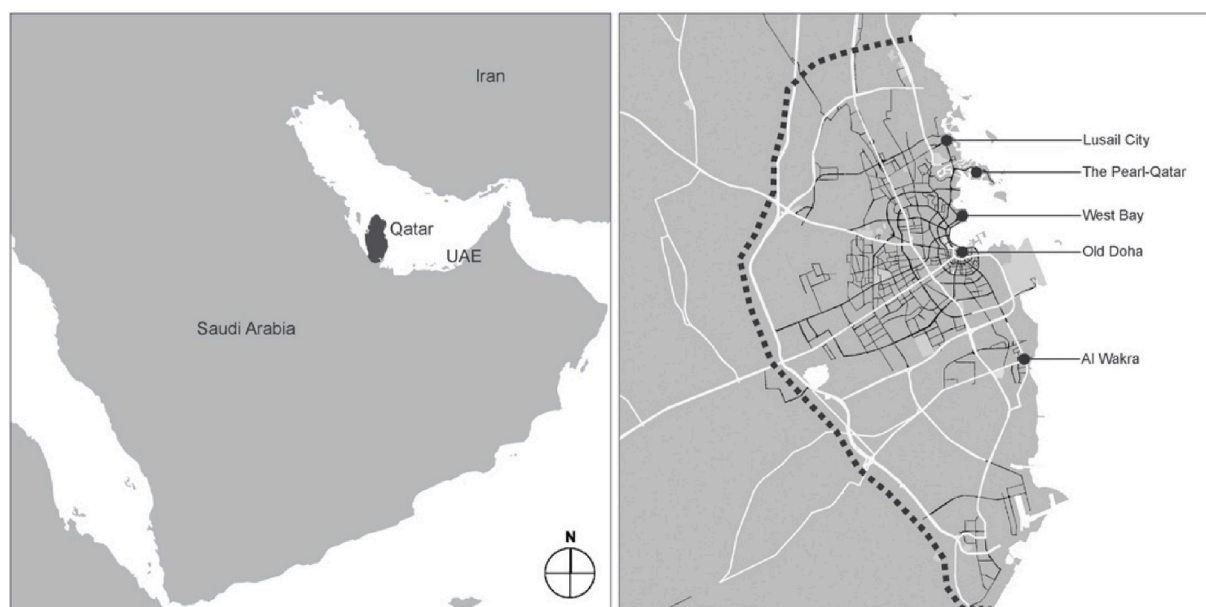
Table showing the population and growth rate of Doha Municipality, 1950–2022 (Source: United Nations).

| Year | Population | Growth Rate |
|------|------------|-------------|
| 2020 | 641,000    | 22.3%       |
| 2010 | 524,000    | 75.8%       |
| 2000 | 298,000    | 26.8%       |
| 1990 | 235,000    | 53.6%       |
| 1980 | 153,000    | 96.2%       |
| 1970 | 78,000     | 151.6%      |
| 1960 | 31,000     | 72.2%       |
| 1950 | 18,000     | –           |

center for luxurious villas with modern amenities in new suburban developments to the north, south, and west (Al-Buainain, 1999; Al-Mohannadi et al., 2019; Salama & Wiedmann, 2013b; Wiedmann et al., 2012).

It also created a 'nonplace urban realm' perception about Qatar's late 20th-century developments, i.e., bland urban environments devoid of active street life (Tannous, Major, & Al-Obaidan, 2021; Webber, 1964). Alraouf (2018) cites a 2008 edition of the *Lonely Planet* guidebook, which describes Doha as one of the duller places on Earth. At the dawn of the 21st century, the Qatari government began investing heavily to change this perception. The aim was to rebrand the country and its capital city to the global market, especially to Indo-European Westerners. It included economic diversification, provision of parks and other recreational facilities, hosting of noteworthy events such as FIFA World Cup 2022, and further expansion eastward into the shallow coast to accommodate new districts with distinctive features, such as Lusail City and The Pearl-Qatar (Adam, 2009; Wiedmann et al., 2012).

The last is the narrow focus of this paper. The Pearl-Qatar ('The Pearl') is a 400-ha, US \$15 billion artificial island development in northeast Doha (The Pearl-Qatar). It began construction in 2004 (Fig. 2). In this sense, The Pearl represents one of the earliest design and planning attempts to alter public perceptions, along with the 2004–2008 Souq Waqif Restoration Project (Tannous, 2020; Tannous et al., 2022; Tannous et al., 2021a). The latter represents the urban regeneration of the historical marketplace at the center of Old Doha. In contrast, the former is a contemporary urban development. The design and planning of The Pearl



**Fig. 1.** Location of the (left) State of Qatar on the Arabian Peninsula in the Middle East and (right) historical settlements of Old Doha and Al Wakra, contemporary developments West Bay, Lusail City, and The Pearl-Qatar, and approximate bounds (dotted black line) to the Arabian Gulf coastline for the space syntax model of Metropolitan Doha 2020 (Source: Authors/Google Maps).



Fig. 2. November 2017 aerial view looking southwesterly at The Pearl in Doha (Source: Wikipedia/Planet Labs, Inc.).

represent one of Qatar's first attempts to find a synthesis between aspects of traditional Islamic and European architectural styles, construction standardization for low-, mid-, and high-rise residential buildings, and the contemporary lifestyle conveniences in large-scale urban development projects. Some architects describe The Pearl as "too artificial" of a synthesis, reminiscent of the Post-Modernist architectural pastiche in many Western countries during the 1980s.<sup>2</sup> Nonetheless, this synthesis caters to a specific population and market segment as an exclusive residential enclave for higher-income Qatari, Arab, and Indo-European Westerner professionals. For this purpose, it has the first land available for freehold ownership by foreign nationals in Qatar, provides 32 linear km of new coastline with beaches mostly reserved for its residents, and includes several mixed-use districts comprising retail, restaurants, hotels, and other commercial services (The Peninsula, 2021; 2020).

We present a morphological analysis of The Pearl and its different districts in this paper. It includes pedestrian shed analysis, mapping ground-level land uses, and active/inactive residential and non-residential frontages. Urban morphology is the scientific investigation into the form and space of settlements, analyzing aspects of the urban pattern, particularly the dynamic relationship among and between its various elements (Elzeni et al., 2021). Because such physical and relational aspects take shape according to the needs of society, economy, technology, and the environment, morphological analyses offer insights into settlements' spatial forms and configurations across diverse disciplinary boundaries (Batty, 2013; Gehl, 2011; Madanipour, 2001). Scholars generally divide urban morphology into explanatory (or descriptive) and normative (or prescriptive) strands. Explanatory morphology examines how elements and functions are built and relate to one another in the urban form, assessing the potential impact of development and growth on the people who inhabit such places, whether today or in the past (Samuels, 2008). Normative morphology investigates the infrastructural uniformity of form and function within and around the city to propose design and planning solutions (Al-Amadi,

2023; Goode, 1992; Parolek et al., 2008).

We also conduct an axial analysis of the urban spatial network using space syntax. Many studies have used space syntax over the previous forty years to evaluate the spatial logic of urban developments and the effectiveness of their layouts as realized within their urban context (Hillier, 1996; Hillier and Hanson, 1984; Hillier et al., 1993; Hillier and Vaughan, 2007; Penn et al., 1998). Space syntax is a research program comprising hundreds of academic researchers and industry practitioners worldwide, especially in Europe, China, South America, and the Middle East (Major, 2018; Tannous, Major, & Furlan, 2021). Space syntax researchers utilize a well-established set of representational modeling techniques to objectively measure and evaluate topological attributes of spatial layouts in settlements worldwide (Tannous et al., 2020).

In this sense, our study conducts fieldwork to identify and represent the morphological characteristics of the design and planning strategies deployed in The Pearl. Then, it uses space syntax modeling to evaluate the spatial implications of those strategies. The purpose is to deploy several explanatory tools of urban morphology to illustrate the design and planning of The Pearl and use space syntax to evaluate the effectiveness of its spatial logic as an exclusive residential development. The goal is to understand the 'how' and 'why' of The Pearl's design and planning strategies. As a result, we suggest a potential intervention to enhance the urban vitality of The Pearl as a place – while still sensitively respecting its objectives as a private real estate development promoting exclusivity – using normative morphology. We primarily focus on the role of Pearl Boulevard and the relationship between the mixed-use Porto Arabia, Medina Centrale, and Qanat Quartier districts. Based on this analysis, we argue there is a clear morphological logic to The Pearl intimately tied to its socio-economic status as an exclusive residential area. Despite its clear logic, there are opportunities for infrastructure enhancements to promote walkability between half of the districts at The Pearl and mainland Doha without disrupting its overall functioning and marketing image today.

## 2. About The Pearl-Qatar

Qatar is primarily a flat, low-lying desert terrain rising from the east to a central limestone plateau with a maximum elevation of 103 meters

<sup>2</sup> A renowned European architectural professor described The Pearl as such to one of the co-authors in 2017.



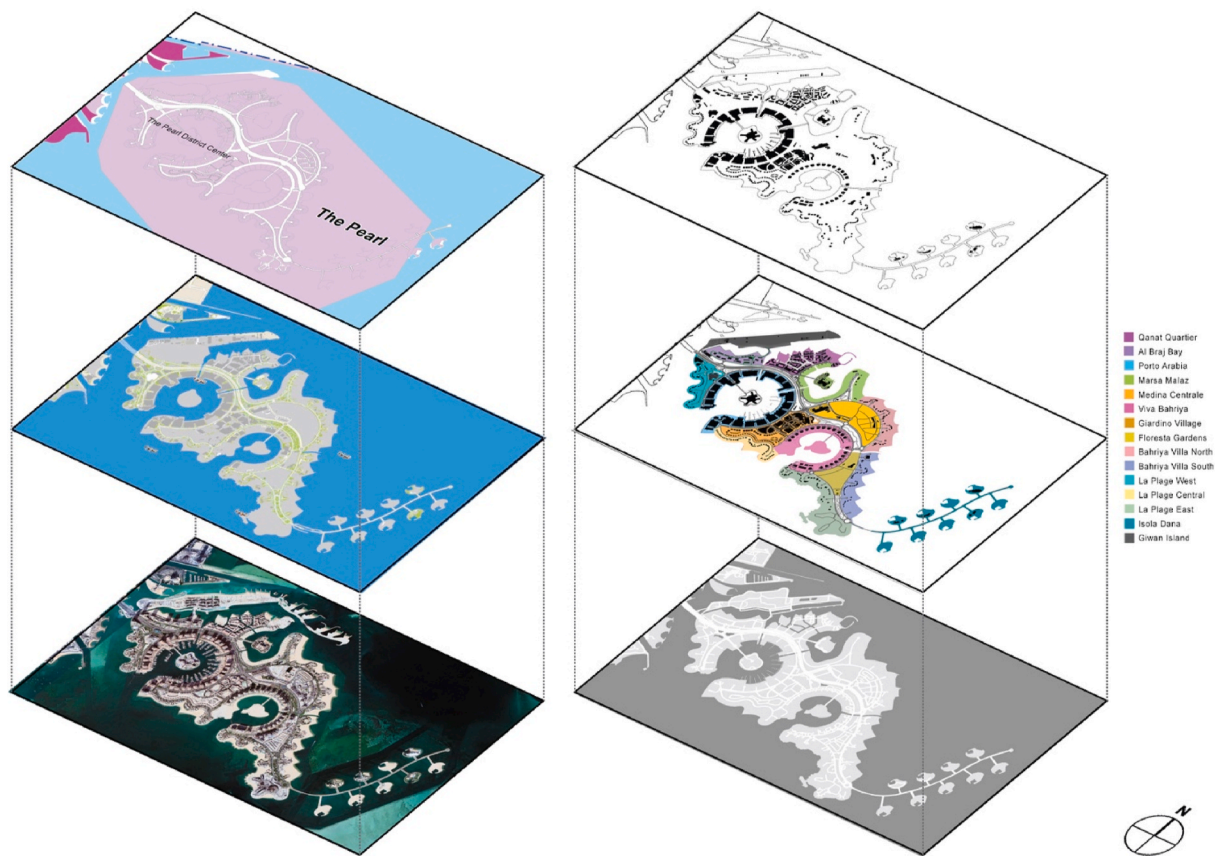
(m). The highest peak in the country is Qurayn Abū al-Bawl Hill, about a half-hour drive north of the Saudi Arabia/UAE/Qatar border. As a peninsular country, it has 560 km of emergent coastline exposed to regular, relative sea-level fall. Because of this, land reclamation, or simply reclamation or landfill, from the Arabian Gulf has been a common feature of urban development since the 1950s. Land reclamation creates new land from oceans, seas, riverbeds, or lake beds. It includes many contemporary features of Doha, including (in chronological order) Al Corniche Road, the Old Doha port and the Al Mirqab area (now associated with the National Qatar Museum or NQM), the West Bay business district, Hamad International Airport, The Pearl, Hamad International Port far to the south, and portions of Lusail City in the north. By definition, many land reclamation projects will tend to be spatially segregated (in space syntax terms) due to their location at the edge of urban settlements in coastal areas. A key question of such developments is whether to work with or seek to overcome that spatial segregation for socio-economic objectives.

The Pearl represents a common development trend to create exclusive residential areas (e.g., work with spatial segregation) using artificial islands in the GCC region over the last 25 years. It includes other examples like Palm Jumeirah, Palm Jebel Ali, and Palm Deira in Dubai, UAE, Durrat Al Bahrain and Amwaj Islands in Bahrain, and Qetaifan Island in Lusail City, Qatar. Such developments may selectively utilize some planning concepts and typologies typically associated with urban sustainability, such as compactness, residential density, mixed land uses, and urban greening, some more so than others (Jabareen, 2006). Their selective planning nature and highly desirable locations delineate them as real estate developments prioritizing economic factors over others, such as resilience. Others have pointed out that locations vulnerable to natural hazards often represent the most desirable and highly valued

ones in the private real estate market (Major & Al-Nabet, 2018; Marthya & Major, 2022). Such artificial island developments may need additional features to promote urban resilience or undermine such aims in pursuing economic gains (Davoudi, 2012; Sharifi, 2019a-b). It means investigating the social and spatial logic of exclusive, contemporary residential developments such as The Pearl before effectively evolving new urban sustainability and resilience models. Most research tends to focus on such developments' construction, engineering, and environmental impacts, not their formal and social dimensions (Gibling, 2013; Afzal et al., 2022, 2023; Mansourmoghaddam et al., 2022; Radhi et al., 2015).

United Development Company (UDC) is the developer of The Pearl. CallisonRTKL is the master planner. The plan concept is an unclashed 'string of pearls' with the three largest 'pearls' being the Porto Arabia district and its marina, the Marsa Malaz district with a large bay surrounding five-star Kempinski Hotel island, and the Viva Bahriya district and its beach (Rizzo, 2019; The Pearl-Qatar). The Pearl is in Zone 66 of the Doha Municipality at the northeastern edge. It is a significant location as a historic site for pearl diving, hence the development's name. The municipality classifies it as a Special Development Zone, which is the Qatari regulatory equivalent of the Planned Development (PD), Planned Development Unit (PUD), or, given its land reclamation component and size as a Development of Regional Impact (DRI), in UK and US terms (Fig. 3). At its onset, The Pearl had a projected development cost of US \$2.5 billion, with a build-out date in 2012. The most recently available projected development cost is US \$15 billion with a build-out date of 2022, which works out to approximately (~) US \$800,000 per dwelling unit (du). Nonetheless, several areas of The Pearl remained under construction at the start of 2023.

There has been a great deal of research on Doha's urban



**Fig. 3.** The Pearl: (left, bottom-to-top) satellite view from 6 km, Qatar GIS Portal Plan, and Qatar National Master Plan zoning designation as a Special Development Area (Sources: Google Earth/Maxar Technologies/Ministry of Municipality); and (right, bottom-to-top) Google Street map, delineation of districts, and building footprints in 2021 (Sources: Google Maps/Authors).



development and growth over the last twenty years (Adham, 2009; Al-Buainain, 1999; Alraouf, 2018; Ferwati et al., 2020; Ibrahim and Harrigan, 2012; Salama & Wiedmann, 2013a,b; Wiedmann et al., 2012). However, there needs to be more research in the literature about The Pearl. The lack is due to its long construction timeline (18 years and counting) and relative lack of publicly available information as a private real estate development. Muneerudeen et al. (2016) studied its social spaces to identify what might be missing in the project and what steps were necessary to improve the quality of spaces for users. However, given the construction status at the time (only achieving an occupancy rate of ~60% in 2017), it is reasonable to question their conclusions since they represent an incomplete picture. Nawaz (2018) studied steps for improving the occupancy rates of residential and retail properties at The Pearl from a business administration point of view, recommending streamlining processes and improving landlord-tenant relations. Alkhelaifi (2017) similarly examined its residential apartments to assess the probable impacts of introducing property taxes to Qatar and the GCC region. Al-Amadi et al. (2022) published a paper based on an earlier version of the study in this paper about the design, planning, and land use mixture of the Porto Arabia district, including a behavioral analysis of promenade users. The rest tend to briefly mention The Pearl within broader debates about rapid urbanization and globalization in the larger GCC region, sometimes accompanying discussions about a perceived loss of cultural identity in Qatar's architecture and urban planning (Ferwati et al., 2020; Ibrahim, 2013, 2016; Al-Amadi et al., 2022).

Officially, The Pearl has twelve districts. However, two (La Plage and Bahriya Villa) are spread across distinct locations. Effectively, fifteen physical districts exist (refer to Fig. 3, center right). The most important are Porto Arabia, Qanat Quartier, Medina Centrale, and Viva Bahriya (Fig. 4). The total land area of The Pearl is 4 km<sup>2</sup>. Pearl Boulevard and its associated frontage roads compose 0.5 km<sup>2</sup> (or 12.4%) of this land area (Table 2). Porto Arabia contains 0.64 km<sup>2</sup> (or 16%), Marsa Malaz is 0.21 km<sup>2</sup> (or 5.3%), and Viva Bahriya is 0.42 km<sup>2</sup> (or 10.5%), exclusive of water associated with their bays. The metric area of the Qanat Quartier is 0.3 km<sup>2</sup> (or 7.5%) inclusive of its canals, and Medina Centrale is 0.2 km<sup>2</sup> (or 5%). The districts Al Braj Bay and La Plage West account for 0.17 km<sup>2</sup> (or 4.3%) and 0.15 km<sup>2</sup> (or 3.8%) of the land area, respectively. All other districts account for 1.41 km<sup>2</sup> or 35.3%, including Giardino Village (still under construction at the time of our study).

At the time of our 2021 study, The Pearl had a projected final residential capacity of 18,831 dwelling units for 45,000 residents (Table 3). A dwelling unit (du) means a single unit of residence for a family or one or more persons, including an apartment or flat within a structure or an attached, semi-attached, or detached single-family home, as defined by the Department of Housing and Urban Development in the U.S. Code of Federal Regulations (24 CFR § 100.201). It does not include hotel room accommodations.

The Pearl's projected final residential capacity includes 1165 du as apartments and townhomes in the Qanat Quartier, 4700 rented and owned apartments in Porto Arabia, and another 1780 du in the Viva

**Table 2**

Total land area and district area (km<sup>2</sup>), length (km) of coastline, and percentage of total land area by the district in The Pearl (Source: QUCG-CENG-22/23-472).

|                                     |                              |                       |
|-------------------------------------|------------------------------|-----------------------|
| The Pearl                           | 4.0 km <sup>2</sup>          |                       |
| Coastline                           | 32 km                        |                       |
| <b>Area by District (w/o water)</b> | <b>Area (km<sup>2</sup>)</b> | <b>Percentage (%)</b> |
| Pearl Boulevard/Frontage Roads      | 0.50                         | 12.4                  |
| Al Braj Bay                         | 0.17                         | 4.3                   |
| Qanat Quartier                      | 0.30                         | 7.5                   |
| Porto Arabia                        | 0.64                         | 16.0                  |
| Marsa Malaz                         | 0.21                         | 5.3                   |
| Medina Centrale                     | 0.20                         | 5.0                   |
| Viva Bahriya                        | 0.42                         | 10.5                  |
| La Plage West                       | 0.15                         | 3.8                   |
| Other                               | 1.41                         | 35.3                  |

**Table 3**

Projected residential units by district and percentage in The Pearl in 2021 (Source: QUCG-CENG-22/23-472).

| Projected Residential Units by District | DU                   | Percentage (%)    |
|-----------------------------------------|----------------------|-------------------|
| Qanat Quartier                          | 1165                 | 6.2               |
| - Apartments                            | - 977                | - 5.2             |
| - Townhomes                             | - 188                | - 1.0             |
| Porto Arabia                            | 4700                 | 25.0              |
| Medina Centrale                         | 1038                 | 5.5               |
| - Above Shop                            | - 538                | - 2.9             |
| - Villas                                | - 500                | - 2.6             |
| Viva Bahriya                            | 1780                 | 9.5               |
| Other                                   | 10,148               | 53.8              |
| <b>Total</b>                            | <b>18,831</b>        | <b>100.0</b>      |
| <b>Residential Density</b>              | <b>47 du/hectare</b> | <b>20 du/acre</b> |
| <b>MEDIUM DENSITY RESIDENTIAL</b>       |                      |                   |

Bahriya apartments. Finally, there is 1038 du in the above-shop flats and individual villas in Medina Centrale. The rest (10,148 du or ~54%) are apartments and villas spread across the remaining districts. It means that the four principal districts (Qanat Quartier, Porto Arabia, Medina Centrale, and Viva Bahriya) accounted for ~47% of the residential density in the development. At build-out, The Pearl would have a residential density of 47 du/hectare or 20 du/acre, which is the standard for medium-density residential. However, UCD announced that The Pearl had a 93% occupancy rate for all residential rentals and a total residential population of 52,000 in June 2021 (The Peninsular, 2021). Further clarification from UDC will be necessary to understand what accounts for this additional 7000+ people compared to the projected built-out estimates. It seems due to a variety of factors, including an increase in rentals of existing dwelling units (and, marginally, the number of people per dwelling unit) in the build-up to FIFA World Cup 2022, as well as UDC increasing residential densities in districts under construction at the time of our study, e.g., Giardino Village, Floresta Gardens, and Al Braj Bay.

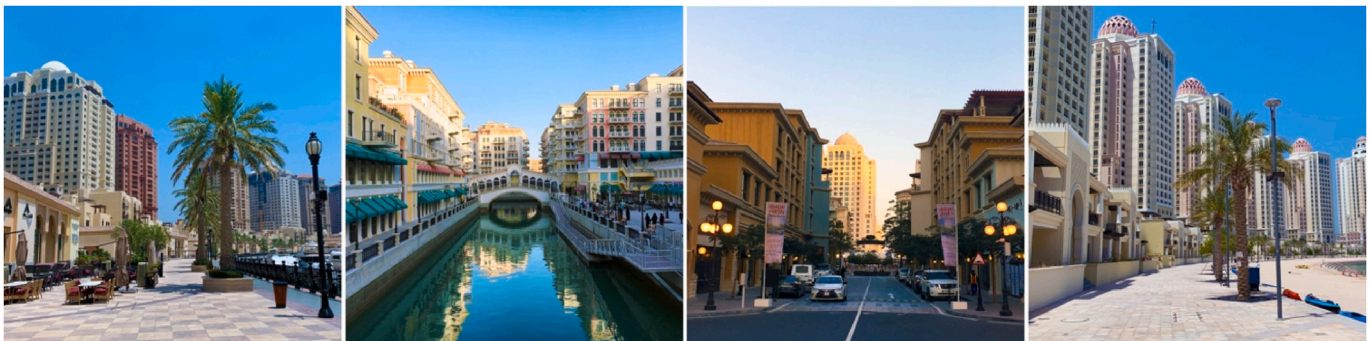


Fig. 4. Views of the (left to right) Porto Arabia, Qanat Quartier, Medina Centrale, and Viva Bahriya districts at The Pearl (Source: Authors).

### 3. Research design and methodology

The research in this paper represents a limited portion of three more extensive studies. The first involved examining the morphological characteristics of various districts in The Pearl – primarily Porto Arabia, Qanat Quartier, Medina Centrale, and Viva Bahriya – related to publicly available physical and economic parameters in early 2021, i.e., dwelling unit floor area, the number of bathrooms/bedrooms, furnished or unfurnished, asking prices for residential rentals and for-sale properties, etc. Though hardly definitive, researchers detected a commonsense trend for floor area as the primary driver of asking prices in Porto Arabia, with furnished/unfurnished conditions playing a secondary but contributory role. In contrast, the floor area was less critical in the family-oriented Viva Bahriya district, where the number of bathrooms was a more potent driver of rental and for-sale asking prices. In this first study, the economic analysis of the Qanat Quartier and Medina Centrale districts was suggestive but inconclusive. We exclude the financial components of this study in the paper for brevity's sake. The second and third studies are discussed in the Discussion and Future Research section. The research in this paper blends the morphological survey work compiled in the first and second studies of The Pearl with mapping standardization for comparability's sake and space syntax analysis of the third study.

The paper's research design and methodology are straightforward and narrowly focused on the urban morphology and spatial functioning of The Pearl (Fig. 5). We briefly discuss and review the background of rapid urbanization and globalization in Doha to establish the setting for investigating The Pearl in more detail. We briefly review the available literature for information about the design and planning of The Pearl. Due to the need for more research about The Pearl, we must primarily rely on UDC public announcements and other public information available in popular media, especially newspaper articles in *The Peninsula* and the *Gulf Times*, and the official websites of UDC, CallisonRTKL, and Qatari government ministries. Researchers carefully reviewed and parsed this material to identify the most relevant information for our purposes.

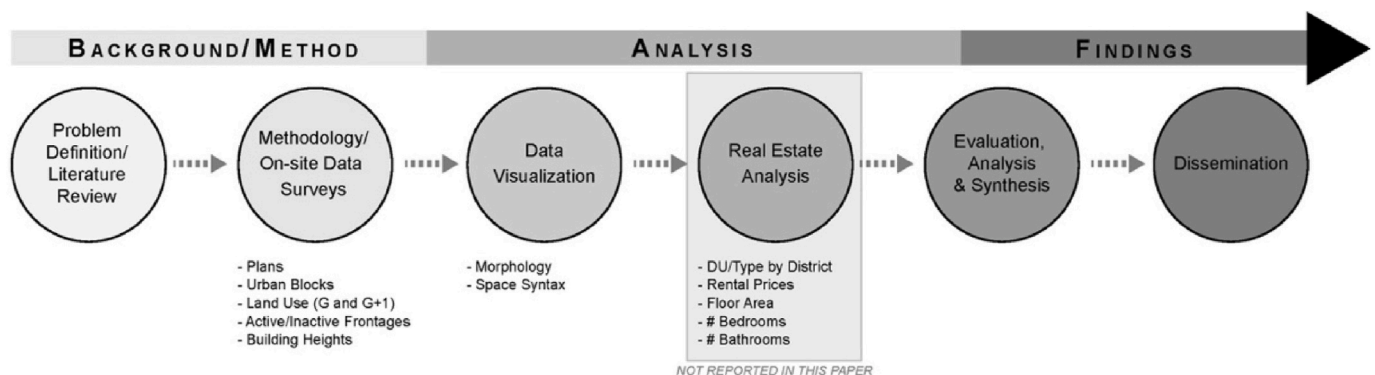
Researchers conducted fieldwork in early 2021 to survey the physical and morphological characteristics of The Pearl, including vacant land and under-construction sites. Teams of two researchers on foot visually surveyed the built environment attributes via map notation in Porto Arabia, Medina Centrale, and Viva Bahriya. Another group did the same for the areas west of Viva Bahriya by car. A single researcher conducted map notation based on visual surveying on foot for Abraj Bay, Marsa Malaz/Kempinski Island, and the Qanat Quartier. Visual surveys by car of low-density residential areas, where applicable, supplemented those initially conducted on foot. Photographic documentation supplemented all visual surveys so researchers could double-check initial map notations. A senior researcher then compiled and standardized the survey work for individual districts/areas into data visualization maps for

The Pearl as a whole. Senior researchers further refined the built form and land use survey work during subsequent site visits in late spring 2021, again double-checking against photographic documentation and Google Earth satellite imagery as necessary and feasible.

As part of this fieldwork, researchers surveyed and mapped the ground-level land uses, residential and non-residential active and inactive frontages, and building heights based on the number of stories. Active frontages are those with direct access or visibility from the street to the interior of retail/commercial or residential units, allowing for co-presence or interaction between occupants and users of the public realm. We limit the land use survey to ground level, except for G+1 in the Qanat Quartier district. We use pedestrian shed analysis at the industry standard radii of 400 m and 800 m ( $\frac{1}{4}$  mile and  $\frac{1}{2}$  mile, equivalent to a 5-to-15-min walk) immediately off the island to demonstrate the relationship between the first access road providing entry to Lagoona Mall, the nearest Doha Metro station (Legtaifiya), and The Pearl. Within The Pearl, we primarily rely on pedestrian shed radii of 200 m and 400 m (equivalent to a 3-to-5-minute walk) due to the harsh climatic conditions in Qatar during the summer months. The exception is the pedestrian shed radii of 800 m and 1600 m (a 2-to-4-minute drive at 20 km/h but a 30-to-60-min walk for a pedestrian) at the secured entry point to the Isola Dana water villas at the extreme east of the island, reserved for Qatari royal family members.

Next, we examine the spatial structure of The Pearl using axial analysis of the island within Metropolitan Doha 2020. The space syntax model encompasses more than 24,000 streets over  $\sim 650 \text{ km}^2$  of land in the region. It is ‘all-inclusive’ and includes all vehicular routes with simplified, direct connections for highway interchanges and principal pedestrian-only routes (Major et al., 2020). The bounds of the model are the Arabian Gulf coastline to the east and the Orbital Highway to the west, with its northward extensions to Umm Al Abariq and southward to Mesaieed. Major et al. (2020) review the map sources, modeling techniques, and verification/updating processes for constructing this axial map of Metropolitan Doha, including its various versions, i.e., 2013, 2018, and 2020, with and without public transit system, and one incorporating the entire State of Qatar.

We utilize the space syntax measures of global choice, connectivity, global integration (radius = n), and local integration (radius = 3) to examine and detect any patterns in the design and planning of The Pearl (Major et al., 2020; Tannous, Major, & Furlan, 2021; van Nes & Yamu, 2021). We briefly explain these measures at the beginning of the Spatial Layout and Structure section of the Data Analysis. We also demonstrate the spatial functioning of distinct areas and routes of The Pearl using the second-order measurement of Synergy, i.e., the relationship between global and local integration in The Pearl within Metropolitan Doha (Major et al., 2020; Tannous, Major, & Furlan, 2021; van Nes & Yamu, 2021). Examining contemporary developments like The Pearl offers an important contribution because space syntax researchers rarely investigate such exclusive residential areas, tending to focus on more



**Fig. 5.** Research design and methodology for the current study of morphology, land use, and function in The Pearl (Source: Authors).

intensely urbanized mixed-use settings, especially in historic city centers. Based on our analysis, we draw several conclusions about the design and planning of The Pearl as an exclusive residential area and recommend infrastructure improvements to further promote walkability among its various districts.

#### 4. Data Analysis: urban morphology and land use

An ‘unclasped string of pearls’ plan concept and the economic premium placed on waterfront access/views in the development leads to a single access road, Pearl Boulevard, serving as the spine running through the center connecting all districts (Rizzo, 2019). Twenty-two road segments (in space syntax terms) compose the curvilinear Pearl Boulevard, which is 8 km in length from the mainland access to Lusail Expressway in the west to its termination in the east at the Isola Dana water villas. These road segments become shorter and shorter the further west on the island. Five road segments connect ~3.12 km of Pearl Boulevard from Lusail Expressway to Medina Centrale, representing 39% of its length. Another five segments compose ~1.43 km of Pearl Boulevard from Medina Centrale to Floresta Gardens. Six road segments form the remaining ~1.2 km from Floresta Gardens to La Plage East. The remaining five road segments compose 2.25 km of Pearl Boulevard (or 28% of its length) in the restricted Isola Dana district. Pearl Boulevard’s right-of-way and associated frontage roads are ~0.5 km<sup>2</sup> or 12.4% of The Pearl’s total land area (refer to Table 2).

The ‘pearls’ of individual districts attach and hang from Pearl Boulevard’s ‘string’ (Rizzo, 2019). Pedestrian shed analysis shows the effect of this planning concept (Fig. 6). The 400 m and 800 m pedestrian shed at the first available intersection of Pearl Boulevard off the island include Lagoon Mall and the Legtaifiya Metro Station within comfortable walking distance. However, the only accessible part of The Pearl is the vehicular access roads to the under-construction Giwan Island district (primarily planned as a non-residential island with several hotels and resort facilities). Pedestrian sheds of 200 m and 400 m from the geometric center of (west-to-east) Qanat Quartier, Porto Arabia, Medina Centrale, Giardino Village, and Viva Bahriya each demonstrate more about the planning. Given Qatar’s hot climatic conditions throughout

much of the year, the mixed-use Qanat Quartier district is effectively self-contained. Only Abraj Bay to the west, Kempinski Island to the east, and Porto Arabia to the south (via a pedestrian underpass) are accessible but outside the 400 m radius from the Qanat Quartier’s geometric center. The pedestrian sheds from the geometric center of Porto Arabia and Viva Bahriya emphasize the promenades at their circumference due to their bays for the marina and beach, respectively.

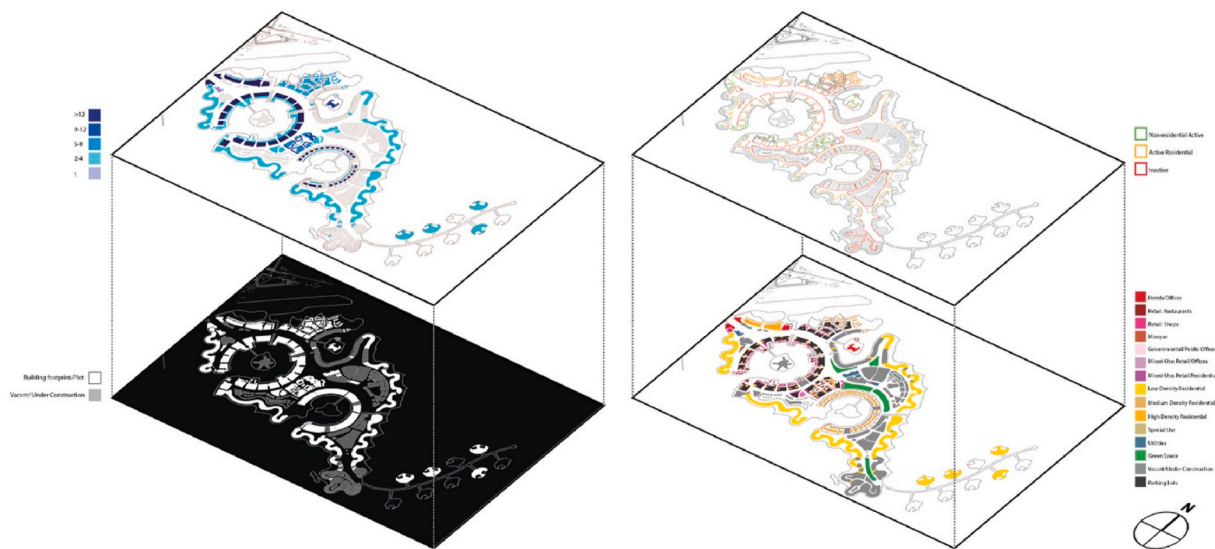
The pedestrian shed from the geometric center of Giardino Village marginally overlaps with the vehicular access entry road to the Viva Bahriya district and Duck Lake/pet parks north of its towers between its frontage road and Pearl Boulevard. However, the northern portions of both Viva Bahriya and Medina Centrale are still accessible within 500 m from Giardino Village’s center after crossing the high-speed Pearl Boulevard (posted speed limit of 80 km/hour west of Viva Bahriya). Medina Centrale (e.g., the town center) is the most accessible district. The Porto Arabia and Viva Bahriya promenades lie within 400 m of its geometric center, and there is easy pedestrian access between the three districts, primarily into Medina Centrale from the other two. Finally, an 800 m and 1600 m pedestrian shed demonstrates the isolation of the restricted Isola Dana water villas at the easternmost edge. The access road to Foster + Partners’ designed water villa for the Father Emir lies marginally outside the 1600 m radius. Of the principal districts in The Pearl, only the western edges of Giardino Village and Viva Bahriya are within 1600 m of the entry point to Isola Dana.

At the time of our 2021 study, ~1.6 km<sup>2</sup> or 40% of The Pearl was still vacant or under construction land (Fig. 7, bottom left). It included individual lots for low-density residential in Marsa Malaz and other districts east of Viva Bahriya, under-construction townhomes/mid-rise residential buildings in Medina Centrale. It also included the entirety of Giardino Village, the hotel resort island of Giwan Island, and the St. Regis Hotel under construction on the marina island of Porto Arabia. Five water villas were also vacant in Isola Dana. Smaller sites for individual buildings in other districts were vacant or under construction, such as townhomes/towers in Abraj Bay, The Pearl Friday Mosque west of Porto Arabia, and one island of apartment buildings in the Qanat Quartier used as a concrete mixing area for the entire development. The tallest buildings in The Pearl are at its western edges on either side of



Fig. 6. Pedestrian shed analysis of (left-to-right) first available street intersection on the mainland, the geometric center of Qanat Quartier, Porto Arabia, Medina Centrale, and the (under construction) Giardino Village, and entry point to restricted Isola Dana water villas in The Pearl (Source: Authors).



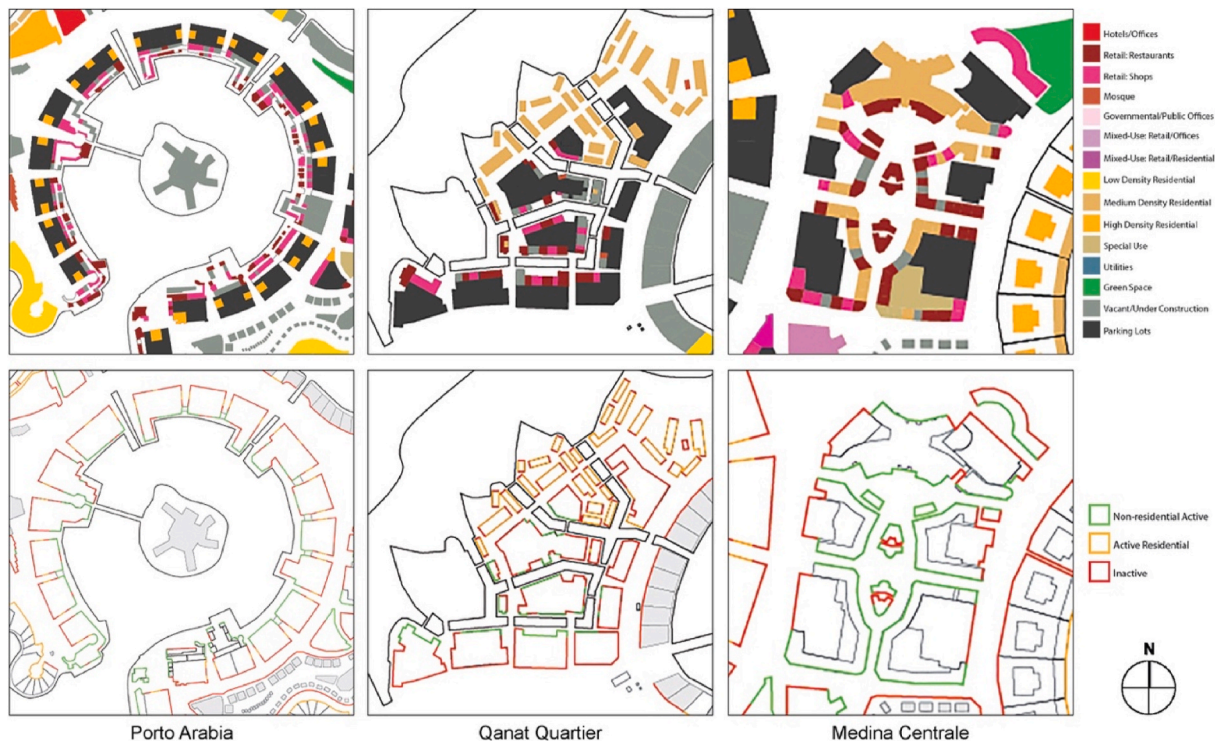


**Fig. 7.** (left, bottom-to-top) Figure-ground (blocks in white, space in black, vacant/under construction in gray) and building heights, and (right, bottom-to-top) ground-level land uses and non-residential/residential active and inactive frontages of The Pearl in 2021 (Source: Authors).

Pearl Boulevard and north of this location in Abraj Bay. Both Porto Arabia and Viva Bahriya also possess high-rise towers. The typical tower footprints in Porto Arabia are  $\sim 2500$  square meters ( $m^2$ ), whereas they are  $\sim 1500 m^2$  in Viva Bahriya, excluding base platforms for parking, recreational facilities, and other tower communal areas. These building bases (G+4) in Porto Arabia include the same facilities as Viva Bahriya, with the addition of the retail/commercial land uses mostly fronting the Porto Arabia promenade. The 40% smaller tower footprint in Viva Bahriya compensates for the general trend as building heights and residential densities decrease from west to east on the island (Fig. 7, top left).

In the mixed-use districts, ground-level land use planning adopts a

clearcut inward-facing strategy for non-residential uses (Fig. 7, right). Correspondingly, the pattern of active and inactive frontages mimics this strategy. There are two aims. First, focus non-residential uses inward within each district. Second, stack multi-level parking garages (both public and resident-only) around the perimeter of the individual district. The design of buildings and land use planning dedicate a substantial proportion of the building footprint at the ground level for parking provisions. It is more apparent when zooming in on individual districts such as Porto Arabia, Qanat Quartier, and Medina Centrale (Fig. 8). In Medina Centrale, non-residential land uses extend around the parking garages to street corner locations to produce three-sided outward-facing blocks. This characteristic most clearly distinguishes



**Fig. 8.** Close-up of (top) ground-level land uses and (bottom) non-residential/residential active and inactive frontages in the Porto Arabia, Qanat Quartier, and Medina Centrale mixed-use districts of The Pearl in 2021 (Source: Authors). *NOTE: Not set to a common scale.*

Medina Centrale as the development's town center from the more rigorously realized inward focus of non-residential land uses and active frontages to the marina in Porto Arabia and the canals/plazas of the Qanat Quartier. The last possess a sizable proportion of active residential frontages due to street-oriented townhomes in its northern areas. Districts primarily composed of low-density residential – attached villas and single-family homes – have mostly mono-functional land uses and non-active frontages, except for mosques and recreational facilities.

## 5. Data Analysis: Spatial Layout and Structure

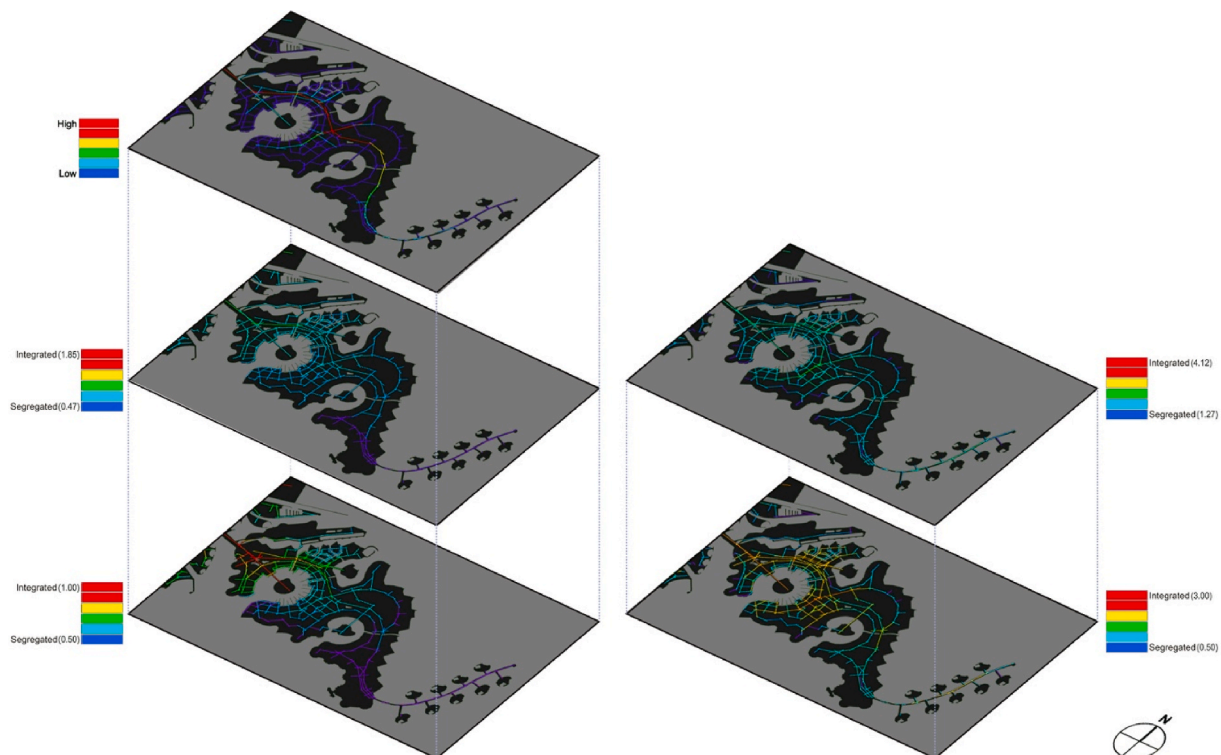
Examining The Pearl's layout within Metropolitan Doha for the space syntax measures of global choice, connectivity, global integration, and local integration reveals key characteristics of its spatial structure (Fig. 9). Connectivity is a primary, static measure of how many other spaces a single space (represented as an axial line) immediately connects within the network. Choice measures 'through-movement' by giving every space in the network a value of 1, then proportionally sharing that value amongst all its immediate connections, which is then totaled up for each space. Integration is the relativized mean depth of a space to all other spaces in the network based on directional changes using connections. Whether a measure is global or local depends on whether the measure is to all other spaces in the network in the former or limited to three changes of direction for the latter (Tannous, Major, & Furlan, 2021; van Nes and Yamu, C, 2021).

Our modeling of The Pearl's spatial layout comprises 256 routes, excluding more detailed modeling of some localized pedestrian routes in Porto Arabia and the Qanat Quartier. The mean global integration of The Pearl is 0.67, or 37% less integrated on average, compared to 1.06 for Metropolitan Doha. The island's dependency on Pearl Boulevard is also apparent in the pattern of relativized global choice (meaning values range from 1, meaning high, to 0, representing low). The only other routes with any degree of choice are the eastern and western segments of Porto Arabia Boulevard, facilitating vehicular access to its towers (Fig. 9, top left). The pattern of global and local integration in the spatial

structure shows the isolated nature of The Pearl within the metropolitan region (Fig. 9, center). Limiting the global integration color range (between a high of 1.0 and a low of 0.5) illustrates better how Pearl Boulevard and The Pearl spatially operate based on metric distance from the mainland. The most globally integrated routes and districts are in the west, becoming more segregated as one moves east through The Pearl to the extreme isolation of the restricted Isola Dana water villas (Fig. 9, bottom left). The mean global integration of Pearl Boulevard (excluding the Isola Dana road segments) is 0.65. Furthermore, the mean values of various Pearl Boulevard segments reinforce the development's west-to-east spatial logic, mirroring its land use planning and building height strategy.

The mean global integration value of the five Pearl Boulevard segments from Lusail Expressway to Medina Centrale is 0.86, individually ranging 28–32% above the Pearl Boulevard mean value. This portion of Pearl Boulevard provides access to Porto Arabia, Qanat Quartier, and Medina Centrale. The five segments from Medina Centrale to Floresta Gardens are 0.63, ranging only 3–6% below the Pearl Boulevard mean. Finally, the six segments from Floresta Gardens to La Plage South are 0.49, ranging 24–27% below Pearl Boulevard's mean. Collectively, it is unsurprising given The Pearl's status as a development on reclaimed land jutting eastward into the Arabian Gulf and its marketing as an exclusive residential area for a select segment of people in Qatar.

On the other hand, limiting the local integration color range (between 3.0 and 0.5) reveals the spatial focus on Medina Centrale, distribution into Porto Arabia (via a segment of Pearl Boulevard directly connecting to the district), and the Qanat Quartier from its frontage road access as well as between the latter two. The last is due to the pedestrian underpass connecting these two districts (Fig. 9, bottom right). The focus in Medina Centrale skews to a series of west-to-east routes in Medina Centrale from Porto Arabia to Viva Bahriya (refer to Fig. 4, center right, and Fig. 8, right). It also includes the segments of Medina Centrale access road from Pearl Boulevard and those of Porto Arabia Boulevard, forming the western edge of Medina Centrale and providing access to the Porto Arabia towers.



**Fig. 9.** (left, top-to-bottom) The pattern of global choice, global integration (radius = n), and calibrated range for global integration and (right, top-to-bottom) local integration (radius = 3) and calibrated range for local integration in the urban spatial network of The Pearl within Metropolitan Doha 2020 (Source: Authors).

The west-to-east spatial logic for global integration and intensification of local integration in The Pearl becomes more apparent in the structure of Synergy within Metropolitan Doha when we highlight the development and identify several routes (Fig. 10, left). Much of the island development hovers above the correlation slope for the metro region in the higher ranges of local integration. It does so in a series of vertical layers, with the entire Isola Dana occupying the lowest areas of the distribution with the most central segments of its access road hovering way above the rest of the district for local integration. It reflects the restricted-access district's highly isolated and the entry road's controlled nature in The Pearl and Metropolitan Doha. At the opposite end of the spectrum, the most integrated, significant routes in The Pearl (from highest to lowest) are the Pearl Boulevard segment connecting directly to Lagoona Mall/Lusail Expressway, the pedestrian underpass between Porto Arabia and the Qanat Quartier, the main pedestrian promenade in the Qanat Quartier, the Porto Arabia Boulevard access to Medina Centrale from Pearl Boulevard, and the Malaga Way route through Plaza Andalucia connecting from Porto Arabia via Medina Centrale to Viva Bahriya.

In many ways, The Pearl might look like a typical urban development of the late 20th-early 21st century. It emphasizes spatial and metric depth based on a single road from the mainland to the most isolated locations. However, unlike the American suburban sprawl, The Pearl does not accomplish this by prioritizing cul-de-sacs within its spatial layout (Major, 2013 and, 2018). Instead, it keeps everything connected in a careful balance, increasing connectivity in its western, mixed-use districts and decreasing it in the eastern low-density residential portions. There are few lengthy cul-de-sacs or cul-de-sac sequences in the spatial layout of The Pearl, except for the restricted-access Isola Dana district (Fig. 10, right). Mean connectivity in The Pearl is only 3.34, and most routes possess 2-to-6 connections. Two routes have a maximum of 10: Pearl Boulevard segment connecting to Lagoona/Lusail Expressway on the mainland and Malaga Way via Plaza Andalucia in Medina Centrale connecting between Porto Arabia and Viva Bahriya. Collectively, the central districts of The Pearl possess an average connectivity higher than the entire development's average. Mean connectivity in Medina Centrale is 4.27 (+25% above the average). Viva Bahriya is 3.8 (+11%) due to Malaga Way via the town center. Porto Arabia and the Qanat Quartier districts are 3.6 (+4–5%) above The Pearl's average.

The development's high degree of spatial isolation within Metropolitan Doha and the State of Qatar is an interesting design and planning strategy. The Pearl is the most segregated area within the 650 km<sup>2</sup> land area, and the 'tail end' access roads to the Isola Dana water villas — including the Father Emir's villa — is its most segregated location served by road infrastructure (Fig. 11, left). It occurs despite Old Doha — Souq

Waqif, Msheireb Downtown Doha, and the Amiri Diwan — being only a 30-min drive to the south. The Isola Dana access roads are the most segregated location in the space syntax model for the entire State of Qatar 2020, covering a total land area of 11,571 km<sup>2</sup> (Major et al., 2020). However, collectively, The Pearl is still more integrated (0.63 or +18%) than the Dukhan (0.54) or Zekreet (0.53) peninsulas in western Qatar (Major et al., 2020). Essentially, The Pearl achieves spatial exclusivity based on location, supplemented by its design and planning, i. e., it works with being spatially segregated on the edge of the metropolitan system.

In this sense, The Pearl depends entirely on Pearl Boulevard's connection to a 9.2 km stretch of Lusail Expressway running northward through Lusail City and southward to the edge of the West Bay business district. (Fig. 11, right). The catchment contour map of The Pearl within Metropolitan Doha demonstrates this dependency. It is based on all routes within three changes of direction or fewer from all routes within the development (Furlan et al., 2022; Salaheddin et al., 2022). The catchment area of The Pearl is 12.2 km<sup>2</sup>, or a ratio of 2:1 compared to its size (4.0 km<sup>2</sup>). In this sense, it is a contemporary urban development designed and planned as an exclusive residential area 'attached' to the city. It carefully manages intra- and inter-connectivity, i.e., connections between districts and within them, to feature that exclusivity for socio-economic reasons.

## 6. Discussion and Future Research

The study aimed to explain the 'how' and 'why' of The Pearl's design and planning strategies. In doing so, we have demonstrated that The Pearl is well-designed and planned for its economic purpose as an exclusive residential enclave, primarily serving Qatari Nationals and upper-middle-class professional ex-pats, especially Indo-Europeans and Westerners. The Pearl is the most spatially segregated area of Doha at the northeastern edge of the metropolitan region, jutting out into the Arabian Gulf. The restricted-access district of Isola Dana, water villas reserved for the Al-Thani Royal Family, is the most spatially segregated area served by road infrastructure in the entire State of Qatar. However, Old Doha is still only 30-minutes away by car. The principal districts of The Pearl — Porto Arabia, Qanat Quartier, Medina Centrale, and, to a lesser extent, Viva Bahriya — promote walkability via metric distance in relatively compact areas. The design and planning achieve this in the first instance based on the spatial exclusivity of its location. However, in the second instance, it also balances a west-to-east spatial logic with fulfilling the demands on connectivity necessary for its mixed-use districts to function successfully by carefully managing inter-connectivity ('connections within') and intra-connectivity ('connections area-to-

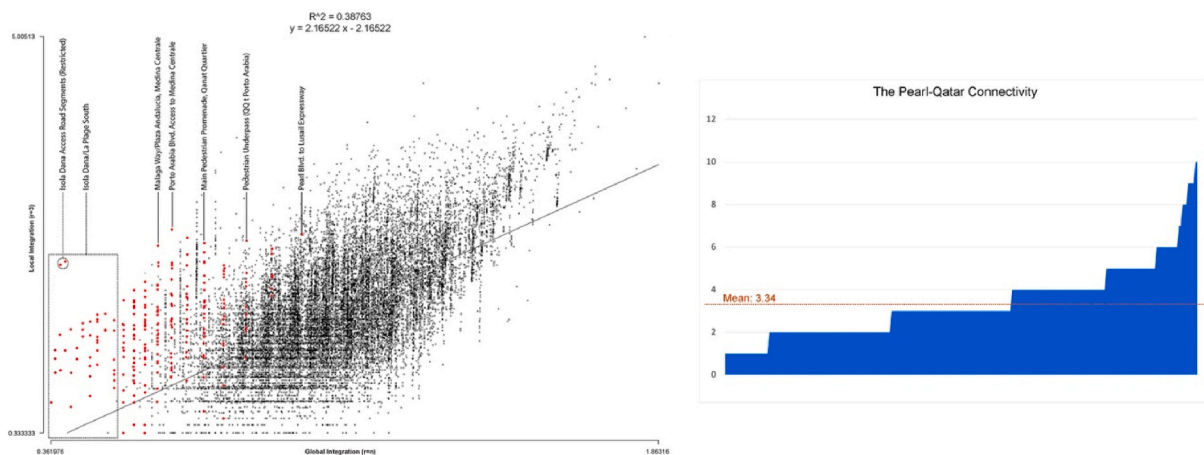
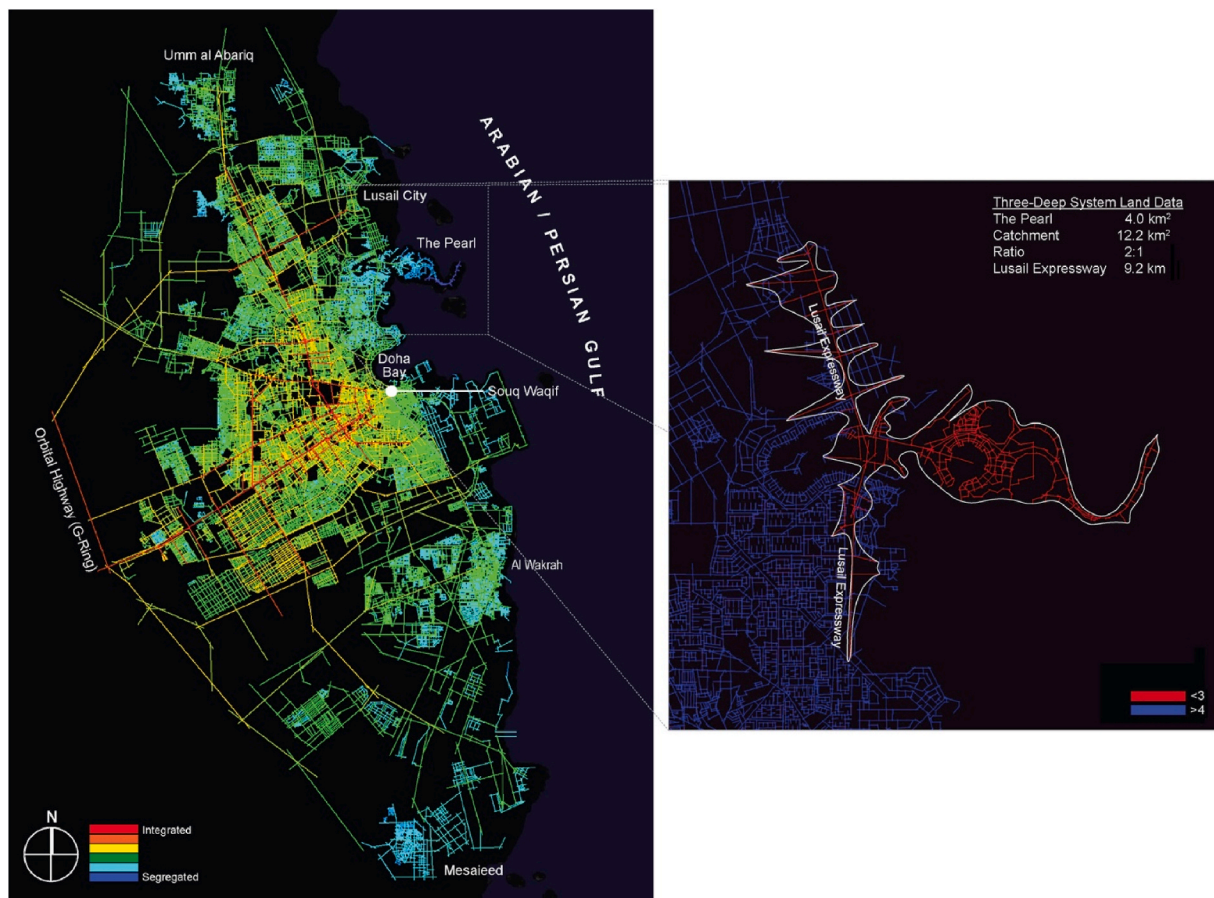


Fig. 10. (left) Synergy scattergram (global integration vs. local integration) identifying key routes of various districts in its urban spatial network of The Pearl (in red) within Metropolitan Doha 2020, and (right) bar chart of connectivity indicating a mean of 3.34 connections per route in The Pearl (Source: Authors).





**Fig. 11.** (left) The pattern of global integration (radius =  $n$ ) in the space syntax model of Metropolitan Doha 2020 encompassing a land area of 650 km<sup>2</sup> and (right) a three-deep catchment contour map of The Pearl with relevant land data including area and ratio (Source: Authors).

area'). Connectivity within these mixed-use districts is slightly higher than The Pearl's average. A selective amount of intra-connectivity occurs, principally between Medina Centrale and the western portions of Porto Arabia/eastern part of Viva Bahriya and between Porto Arabia and the Qanat Quartier.

There is housing everywhere in The Pearl. However, this careful connectivity management maintains a degree of residential privacy in the Islamic culture of Qatar. There are more privacy provisions around villas, such as compound walls, than apartments to conserve social and class segregation. The highest connectivity values (+191% relative to the mean) are Pearl Boulevard and Malaga Way, i.e., Porto Arabia via Plaza Andalucia in Medina Centrale to Viva Bahriya. Connectivity moderation occurs elsewhere, emphasizing a managed or sequential visibility between 2-to-6 connections per route. It indicates that you can see many residential units where you are in The Pearl but fewer or not at all in the following sequence beyond what you immediately see. The exception to this includes looking upward or over rooftops to mid- and high-rise buildings. However, the impact on the residential privacy of such dwelling units is negligible. The speed and scale of sequential visibility (length, width, and height) changes based on metric distance and spatial depth from the mainland west to east, then Pearl Boulevard from north and south, and finally from the edges of individual districts inward. Ground-level land uses in mixed-use neighborhoods reinforce this strategy by turning away from their perimeter streets in favor of an inward-looking pattern, i.e., to Porto Arabia promenade and marina, Plaza Andalucia in Medina Centrale, and the canals and plazas of the Qanat Quartier.

Further study of this connectivity management phenomenon in The Pearl could be enlightening. It could help to define and examine visual fields in The Pearl, especially a series of visual sequences in movement

from one part of a district to another part or even district to district (Benedikt, 1979; Turner et al., 2001; van Nes & Yamu, 2021). It could also be tied to economic factors such as real estate prices of dwelling units per building in gross terms to highlight how the physical design of The Pearl and its dwelling units segments its markets into and within individual districts. However, such as study lies outside the scope of the current, ongoing investigations of The Pearl.

The limitations of our study address specifically artificial island developments incorporating a significant percentage of residential units in tandem with mixed-use features, especially in a Middle Eastern setting. There seems little doubt that future research of The Pearl after its built-out date – and similar developments elsewhere – will provide an even clearer picture of the effectiveness of such design and planning strategies. This can be supplemented with research into other factors of the urban environment. For example, a second study examines the pattern of urban voids (vacant lands, surface parking, etc.) in three Doha neighborhoods: Al Mirqab/NQM, West Bay, and The Pearl (Al-Amadi, 2023). It makes several design and planning recommendations for improvements in the areas through incremental development, small-scale urban design enhancements, or significant planning interventions (Al-Amadi, 2023). A third ongoing study includes data visualization of the morphological characteristics (block structure, pedestrian sheds, ground-level land uses, active/inactive frontages, and building heights) and neighborhood structure in the spatial layout of nine (9) neighborhoods using space syntax within Metropolitan Doha. The neighborhood study – Generation and Evolution of Neighborhoods Investigated as Urban System Localities of Configurational Inequalities (GENIUS LOCI): Using Space Syntax to Understand Urban Centrality and Neighborhood Structure in Doha – includes several case studies in the city, such as Souq Waqif, Msheireb Downtown Doha, West Bay, Old Al Ghanim, the Al

Mirqab/NQM area, The Pearl, and others.

Given its location, cost, and nature as an artificial island development, it is challenging to imagine The Pearl being anything other than what it is today, as long UDC maintains the operation and maintenance of its buildings and grounds. However, the spatial layout and a large amount of land reserved for right-of-way associated with Pearl Boulevard and its frontage roads ( $\sim 0.5 \text{ km}^2$ ) offer an opportunity to enhance intra-connectivity between its mixed-use districts. The Pearl could easily accommodate a local tram system, connecting several sections of the island to the mainland within easy walking distance of the Lagoon Mall and the Legtaifiya station of the Doha Metro (Fig. 12). It could include tram stops intermediate to the new Pearl Friday Mosque and Abraj Bay, the Qanat Quartier and Porto Arabia, Medina Centrale and recreational facilities of Pearl Park, and loop lines through Medina Centrale (providing access also to Viva Bahriya and the southern housing areas of town center) and Giardino Village. By necessity, such a local tram network would have to incorporate urban design enhancements at street level so pedestrians could effectively and safely access the tram stops.

Such a tram network could be accomplished without penetrating further to the east, thus reinforcing the existing west-to-east spatial logic and land use planning of The Pearl without disrupting its careful provisions for residential privacy. It would promote more significant and convenient intra-connectivity between The Pearl's mixed-use districts, i. e., Qanat Quartier, Porto Arabia, Medina Centrale, and Giardino Village. Indeed, the drop in connectivity for the segments of Pearl Boulevard accessing Giardino Village indicates that a local tram network might become necessary to support its village center functions effectively. The other mixed-use districts already share more privileged locations with higher intra- and inter-connectivity than this easternmost mixed-use district.

This study of The Pearl has contributed to our knowledge by examining the morphological and spatial dimensions of a contemporary, mixed-use but exclusive residential area on an artificial island development in the GCC region. Such development types enjoy a high profile in popular media, yet their social dimension, as shaped by the urban environment, needs to be researched more. It is usually limited to construction, engineering, and environmental impact issues. In doing so, the

study adds to our understanding of the design and planning issues of how such developments work and policy implications of how they might be enhanced to promote walkability for pedestrians further in our contemporary places.

## 7. Conclusions

Rapid urban growth due to globalization characterized the city of Doha in Qatar over the last half-century. Research about its remarkable development – from 80,000 people at the dawn of Qatari independence in 1971 to a contemporary metropolitan region of 2.4 million – has primarily focused on urban and suburban expansion to the city's north, south, and west. However, a key component of Doha's urban growth included eastward development into the Arabian Gulf via land reclamation projects. It was responsible for creating strategic sites for Al Corniche Road, Al Mirqab and the National Qatar Museum, West Bay, Hamad International Airport, Hamad International Port, portions of Lusail City, and The Pearl. The last is a 400-hectare, \$15 billion artificial island development begun in 2004, providing an additional 32 linear kilometers of coastline at the northeast edge of the city. The Pearl will soon be approaching its built-out date with a projected residential capacity of 18,831 dwellings for 45,000 residents. The paper presented a morphological and spatial analysis of this development. The goal was to deploy several explanatory tools of urban morphology to illustrate the design and planning in The Pearl and then use space syntax analysis to evaluate the effectiveness of its spatial logic as an exclusive residential development. We wanted to understand the 'how' and 'why' of The Pearl's design and planning strategies. Our analysis focused on the mixed-use Porto Arabia, Medina Centrale, and Qanat Quartier districts and Pearl Boulevard's role as the principal movement distributor in the development. These three districts, plus Viva Bahriya, account for  $\sim 50\%$  of all residential and most multi-family residential units in The Pearl. Based on this analysis, we argued that there was a clear morphological logic to the design and planning of The Pearl, intimately tied to its socio-economic status as an exclusive residential area. We concluded that The Pearl operates effectively for this purpose by selectively promoting walkability via compact mixed-use districts but carefully managing

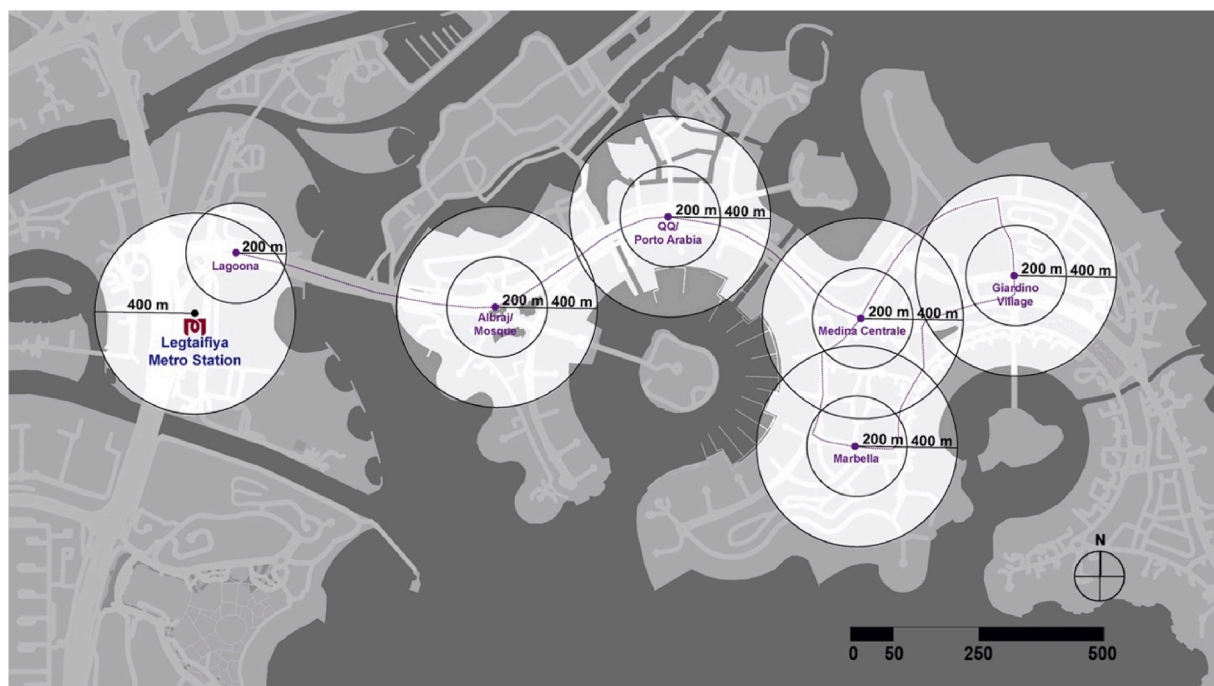


Fig. 12. Potential for a local street-level tram network linking to the Doha Metro and promoting an additional degree of intra-connectivity ('area-to-area connections') between districts in The Pearl (Source: Authors).

route connections and active frontages to maintain a degree of residential exclusivity and privacy in the Islamic culture of the country. Nonetheless, we concluded there was room for improvement. We recommended sensitively incorporating a local tram network as a link to the Doha Metro with corresponding enhancements necessary for pedestrians to access tram stops, thereby promoting further intra-connectivity ('area-to-area connections') for visitors to The Pearl and the people who live there in the future.

### Author statement

We declare that the article has not been published previously, it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright holder. The iThenticate Similarity Index Report of the journal article without the reference section is 7%. Any similarity with any individual publication is 1% or less.

### Declaration of competing interest

None

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### References

- Adham, K. (2009). Petro urbanism: The geo-politics of urban development in Doha, Qatar. *International Journal for Housing Science and its Applications*, 33(2), 77–87.
- Afzal, M. S., Tahir, F., & Al-Ghamdi, S. G. (2022). Recommendations and strategies to mitigate environmental implications of artificial island developments in the Gulf. *Sustainability*, 14, 5027. <https://doi.org/10.3390/su14095027>
- Afzal, M. S., Tahir, F., & Al-Ghamdi, S. G. (2023). The role of environmental impact assessment in the sustainable artificial island development: A Qatar's island case study. *Cleaner Environmental Systems*, 9. <https://doi.org/10.1016/j.cesys.2023.100111>
- Al-Amadi, D. (2023). *The pattern of urban voids and negative spaces in Doha and their implications: An opportunity for place-making*. MUPD 760 thesis focus on urban design, master of urban planning and design (MUPD) program. Doha, Qatar: Department of Architecture and Urban Planning, Qatar University. Copies available from QU Main Library.
- Al-Amadi, D., Major, M. D., Atour, R. M., Al-Ansari, D. Y., Al-Maiki, N., Amleh, R. A. A., Mareeva, V., & Mohammedsheriff, H. (2022). Form and function in the pearl-Qatar artificial island development, 11–13 May 2022. In J. M. P. Madrigal, & M. Nikoofam (Eds.), *5th international conference of contemporary affairs in architecture and urbanism (ICCAUA-2022) conference proceedings book* (pp. 617–627). Alanya, Turkey: Municipality of Alanya: Alanya HEP University. [https://doi.org/10.38027/ICCAUA2022EN0100\\_978-605-71006-2-7](https://doi.org/10.38027/ICCAUA2022EN0100_978-605-71006-2-7)
- Al-Buainain, F. A. A. (1999). *Urbanisation in Qatar: A study of the residential and commercial land development in Doha city, 1970–1997*. Salford: Doctoral Dissertation, University of Salford.
- Al-Mohannadi, A., Furlan, R., & Major, M. D. (2019). Socio-cultural factors shaping the spatial form of traditional and contemporary housing in Qatar: A comparative analysis based on space syntax. In *12th international space syntax symposium proceedings* (Vol. 285, pp. 1–19). Beijing, China: Beijing Jiao Tong University, 8–13 July 2019 <http://www.12ssbeijing.com/upload/file/1562672230.pdf>.
- Albrow, M., & King, E. (Eds.). (1990). *Globalization, knowledge and society*. London: Sage Publications.
- Alkhelaifi, M. A. (2017). *Property assessment in Qatar (case study the pearl residential apartments)*. Graduate project, master of business administration (MBA). Doha, Qatar: Collage of Business and Economics, Qatar University. at <https://qspace.qu.edu.qa/handle/10576/5388>. (Accessed 1 January 2023).
- Knowledge-based urban development in the Middle East Alraouf, A. A. (Ed.). *IGI Global*, (2018) <https://doi.org/10.4018/978-1-5225-3734-2>
- Batty, M. (2013). *The new science of cities*. Cambridge, MA: MIT Press.
- Benedikt, M. L. (1979). To take hold of space: Isovists and isovists fields. *Environment and Planning B: Planning and Design*, 6, 47–66.
- Davoudi, S. (2012). Resilience: A bridging concept or a dead end? *Planning Theory & Practice*, 13(2), 299–333.
- Elzeni, M., Elmokadem, A., & Badawy, N. (2021). Classification of urban morphology indicators towards urban generation. *Port-said Engineering Research Journal*, 26(1), 43–56.
- Ferwati, M. S., Salman Wadi, R., Ferwati, O., Keyvanfar, A., & Shafaghhat, A. (2020). Emerging factors shaping identity of indigenous urbanism concurrently adopting modernity in Qatar: The application of diffusion theory. *ACE - Architecture, City and Environment*, 14(42), 1–25.
- Furlan, R., Al-Mohannadi, A., Major, M. D., & Paquet, T. (2022). *A planning methodology for the adaptive transit oriented development: The case of Souq Waqif in Doha*, 20 September 2022. Qatar: Open House International, Emerald Publishing. <https://doi.org/10.1108/OHI-05-2022-0121>. ISSN: 0168-2601 <https://www.emerald.com/insight/content/doi/10.1108/OHI-05-2022-0121/full/html>.
- Gehl, J. (2011). *Life between buildings*. Washington, DC: Island Press.
- Gibling, C. (2013). *Construction process and post-construction impacts of the Palm Jumeirah in Dubai, United Arab Emirates. Proto-type 1*. <https://journals.library.mun.ca/ojs/index.php/prototype/article/view/458>. (Accessed 20 April 2023).
- Goode, T. (1992). Typological theory in the United States: The consumption of architectural authenticity. *Journal of Architectural Education*, 46, 2–13.
- Hillier, B. (1996). *Space is the machine: A configurational theory of architecture*. Cambridge: Cambridge University Press.
- Hillier, B., & Hanson, J. (1984). *The social logic of space*. Cambridge: Cambridge University Press.
- Hillier, B., Penn, A., Hanson, J., Grajewski, T., & Xu, J. (1993). Natural movement: Or, configuration and attraction in urban pedestrian movement. *Environment and Planning B: Planning and Design*, 20, 29–66.
- Hillier, B., & Vaughan, L. (2007). The city as one thing. *Progress in Planning*, 67(3), 205–230.
- Ibrahim, H. G. A. (2013). Contemporary architecture through the concept of regionalism: A sustainable approach for Doha-Qatar. *Int. J. Sustain. Hum. Dev.*, 1(3), 94–103.
- Ibrahim, H. G. A. (2016). Regeneration of sustainability in contemporary architecture: Approach based on native function and activities to strengthen identity. *Proc. Soc. Behav. Sci.*, 216, 800–809. <https://doi.org/10.1016/j.sbspro.2015.12.077>. <https://www.sciencedirect.com/science/article/pii/S1877042815062576>
- Ibrahim, I., & Harrigan, F. (2012). Qatar's economy: Past, present and future. *QScience Connect*, (1), 9, 2012.
- Jabareen, Y. R. (2006). Sustainable urban forms: Their typologies, models, and concepts. *Journal of Planning Education and Research*, 26(1), 38–52. <https://doi.org/10.1177/0739456X05285119>
- Khan, A. H., Major, M. D., Tannous, H. O., & Paquet, T. (2021). Tradition, transformation, and Re-creation in two marketplaces: Souq Al wakrah and Souq Waqif, Qatar. *Habitat International*, 116, Article 102438. <https://doi.org/10.1016/j.habitatint.2021.102438>. ISSN 0197-3975 <https://www.sciencedirect.com/science/article/pii/S0197397521001272>
- Madanipour, A. (2001). How relevant is “planning by neighbourhoods” today? *Town Planning Review*, 72(2), 171–192.
- Major, M. D. (2013). The City's Essential DNA: Formal design and spatial processes in the urban pattern. University College London *Journal of Space Syntax*, 4(1), 160–164. ISSN: 2044-7507.
- Major, M. D. (2018). *The syntax of city space: American urban grids*. New York/London: Routledge.
- Major, M. D., & Al-Nabet, S. F. (2018). *Buildings don't bounce: The design paradox of urban resilience*. New urban research session, congress for new urbanism (Vol. 26, pp. 16–19). May 2018, Savannah, Georgia USA <https://www.cnu.org/new-urban-research/papers>.
- Major, M. D., & Tannous, H. (2020). Form and function in two traditional markets of the Middle East: Souq mutrah and Souq Waqif. *Special Issue on Space Syntax Theory, Methods and Applications, Sustainability: Sustainable Urban and Rural Development*, 12(17), 7154. <https://doi.org/10.3390/su12177154>. <https://www.mdpi.com/2071-1050/12/17/7154>
- Major, M. D., Tannous, H. O., Al-Thani, S., Hasan, M., Khan, A., & Salaheldin, H. (2020). Macro- and micro-scale modeling of multi-modal transportation spatial networks in the city-state of Doha, Qatar. In P. Lorens, & H. H. Magidimisha (Eds.), *Proceedings of the 56th ISOCARP virtual world planning congress* (pp. 394–415). Doha, Qatar: International Society of City and Regional Planners. November 2020–February 2021 <https://doha2020.isocarp.org/paper-platform/abstract/public/51/macro-and-micro-scale-modeling-of-multi-modal-transportation-spatial-networks-in-the-city-state-of-doha-qatar>.
- Mansourmoghaddam, M., Ghafarian Malamiri, H. R., Roustai, I., Olafsson, H., & Zhang, H. (2022). Assessment of Palm Jumeirah island's construction effects on the surrounding water quality and surface temperatures during 2001–2020. *Water*, 14, 634. <https://doi.org/10.3390/w14040634>
- Marthya, K. L., & Major, M. D. (2022). Real estate market trends in the first new urbanist town: Seaside, Florida. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*. <https://doi.org/10.1080/17549175.2022.2071966>. <https://www.tandfonline.com/doi/full/10.1080/17549175.2022.2071966>



- Muneerudeen, A., Al Khani, F., & Furlan, R. (2016). Urban revitalization of public spaces in the pearl in Qatar. *American Journal of Sociological Research*, 6(1), 1–9. <https://doi.org/10.5923/j.sociology.20160601.01>, 2016.
- National Research Council (NRC). (1995). *Following the money: U.S. Finance in the world economy*. Washington, DC: The National Academies Press.
- Nawaz, M. S. A. (2018). *Improving tenant occupancy rate for retail and residential properties at the Pearl Qatar (TPQ). MBA Management Field Study Research Projects*, Nugegoda, Sri Lanka: University of Sri Jayewardenepura. at <http://dr.lib.sjp.ac.lk/handle/123456789/9677>. (Accessed 1 January 2023).
- van Nes, A., & Yamu, C. (2021). *Introduction to space syntax in urban studies*. Cham, Switzerland: Springer.
- Parolek, D., Parolek, K., & Crawford, P. (2008). *Form-based codes: A guide for planners, urban designers, municipalities and developers*. New York: John Wiley & Sons, Inc.
- The Peninsula (2021). UDC nears full rental occupancy at the Pearl Island. *The Peninsula*, 21 June 2012. <https://thepeninsulaqatar.com/article/21/06/2022/udc-nears-full-rental-occupancy-at-the-pearl-island>. (Accessed 1 January 2023).
- Penn, A., Hillier, B., Banister, D., & Xu, J. (1998). Configurational modeling of urban movement networks. *Environment and Planning B: Planning and Design*, 25, 59–84.
- Planning and Statistics Authority. (2022). *Qatar national government*. <https://www.psa.gov.qa/en/statistics1/Pages/default.aspx>. (Accessed 22 March 2022).
- Radhi, H., Sharples, S., & Assem, E. (2015). Impact of urban heat islands on the thermal comfort and cooling energy demand of artificial islands-A case study of AMWAJ Islands in Bahrain. *Sustainable Cities and Society*, 19, 310–318. <https://doi.org/10.1016/j.scs.2015.07.017>
- Rizzo, A. (2019). Predatory cities: Unravelling the consequences of resource-predatory projects in the global south. *Urban Geography*, 40(1), 1–15.
- Salaheldin, H. T., Major, M. D., Ahmad, A. M., & Tannous, H. O. (2022). *Analyzing walkability in the vicinity of three metro stations in Doha, Qatar*, 13 December 2022. *Open House International*, Emerald Publishing. <https://doi.org/10.1108/OHI-08-2022-0207>. ISSN: 0168-2601 <https://www.emerald.com/insight/content/doi/10.1108/OHI-08-2022-0207/full/html>.
- Salama, A. M., & Wiedmann, F. (2013a). The production of urban qualities in the emerging city of Doha: Urban space diversity as a case for investigating the 'lived space'. *Archnet-IJAR: International Journal of Architectural Research*, 7(2), 160–172.
- Salama, A. M., & Wiedmann, F. (2013b). *Demystifying Doha: On architecture and urbanism in an emerging city*. New York/London: Routledge.
- Samuels, I. (2008). Typomorphology and urban design practice. *Urban Morphology*, 12, 58–62.
- Scholz, F. (1999). *Die kleinen golfstaaten [the small Gulf states]*. Klett; 2. vollst. neubearb. Aufl. edition, 1 January 1999.
- Sharifi, A. (2019a). Resilient urban forms: A macro-scale analysis. *Cities*, 85, 1–14. <https://doi.org/10.1016/j.cities.2018.11.023>
- Sharifi, A. (2019b). Urban form resilience: A meso-scale analysis. *Cities*, 93, 238–252. <https://doi.org/10.1016/j.cities.2019.05.010>
- Tannous, H. O. (2020). Traditional markets in context: A morphological comparison of Souq Waqif in Doha, Qatar and Mutrah Souq in Muscat, Oman. In *MUPD 760 thesis focus on urban design, copies available from the authors and Qatar university library*.
- Tannous, H. O., Major, M. D., & Al-Obaidan, M. (2021a). Past traditionalism, present modernism, and the new Qatari regionalism: Architectural vocabularies over time in Qatar. In *18th annual international architectural humanities research association (AHRA) conference, 11-13 November 2021*. United Kingdom: Loughborough University.
- Tannous, H. O., Major, M. D., Aravassery, F. A., Mohammed, H., Shakerpoor, G., & Ellath, L. A. (2022). Space, time and natural movement in Old Doha: The morphological case of Souq Waqif. In *13th international space syntax symposium proceedings*. Bergen, Norway: Western Norway University of Applied Sciences (HVL), 20-24 June 2022.
- Tannous, H. O., Major, M. D., & Furlan, R. (2020). Accessibility of green spaces within the spatial metropolitan network of Doha, state of Qatar. In P. Lorens, & H. H. Magidimisha (Eds.), *Proceedings of the 56th ISOCARP virtual world planning congress* (pp. 1173–1189). Doha, Qatar: International Society of City and Regional Planners. November 2020-February 2021 <https://doha2020.isocarp.org/paper-plate-form/abstract/public/50/accessibility-of-green-spaces-within-the-spatial-metropolitan-network>.
- Tannous, H. O., Major, M. D., & Furlan, R. (2021). *Accessibility of green spaces in a metropolitan network: Using space syntax to objectively evaluate the spatial locations of parks and promenades in Doha, state of Qatar* (Vol. 58). Urban Forestry & Urban Greening. <https://doi.org/10.1016/j.ufug.2020.126892>, 2021 <https://www.sciencedirect.com/science/article/abs/pii/S1618866720307093>.
- The Peninsula. (2021). *Delivery of new projects in the pearl-Qatar to begin by year-end: UDC CEO. The peninsula, 18 february 2021*. <https://thepeninsulaqatar.com/article/18/02/2021/Delivery-of-new-projects-in-The-Pearl-Qatar-to-begin-by-year-end-UDC-CEO>. (Accessed 13 April 2022).
- The Pearl-Qatar (nd). Porto Arabia. <https://www.thepearlqatar.com/The-Island/Porto-Arabia>. (Accessed 12 February 2021).
- The Peninsula. (2020). *Qatar allows foreigners to own properties in more areas. The Peninsula, 6 October 2020* <https://thepeninsulaqatar.com/article/06/10/2020/Qatar-allows-foreigners-to-own-properties-in-more-areas>. (Accessed 24 March 2022).
- Turner, A., Doxa, M., O'Sullivan, D., & Penn, A. (2001). From isovists to visibility graphs: A methodology for the analysis of architectural space. *Environment and Planning B: Planning and Design*, 28(1), 103–121.
- Webber, M. (1964). *Explorations into urban structure*. Philadelphia: University of Pennsylvania Press.
- Wiedmann, F., Salama, A. M., & Thierstein, A. (2012). Urban evolution of the city of Doha: An investigation into the impact of economic transformations on urban structures. *METU Journal of the Faculty of Architecture*, 29(2), 35–61.
- World Data Bank. (2022). *Life expectancy at birth, total (years) – Qatar*. <https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=QA>. (Accessed 13 June 2022).