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The Syntax of Campus Planning: A Comparative Analysis of Qatar University and Education City in Doha, Qatar

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Abstract

The paper examines the campus planning of Qatar University (QU) and Education City in Doha, Qatar. The comparative study includes figure-ground mapping, land-use classification, active frontage assessment, building height documentation, pedestrian shed analysis, and space syntax analysis to evaluate the morphological and spatial configuration of these campuses. It serves as a foundation to explore the evolution of the 'campus' concept from its historical roots to contemporary forms. Both campuses are large. Free-standing buildings tend to compose both campuses, distinct from traditional urban-block structures, with a typical block size that is over twice the average for other Doha neighborhoods (Major & Tannous, 2024). Key findings include that the QU campus developed centrifugally (center outward), while Education City grew centripetally (edges inward). Education City shows more active frontages and greater building-height diversity than QU's more uniform low-rise profile. Vast distances and extreme summer heat hinder pedestrian accessibility, which metro, tram, and bus systems only marginally mitigate, favoring 'edge-in' vehicular access. Space syntax analysis reveals poor intelligibility, as peripheral expansions disrupt QU's original masterplan, while Education City's layout lacks any spatial coherence beyond its entry roads. Based on the review and analysis, the paper articulates three theoretical campus models: enclosed, edged, and scattered. Through all-line axial analysis and Visibility Graph Analysis (VGA), we argue that 1) the enclosed model can enhance focal visibility and multi-directional movement, and 2) the edged model can help to prioritize edge-to-edge readability, while 3) the scattered model tends to disperse visual and linear integration, resulting in reduced clarity for users. The paper concludes that contemporary campuses, such as QU and Education City, must integrate elements from all three models as their scale increases. However, they may suffer from compromised walkability and intelligibility if not carefully designed. The practical implications of these findings are significant, as they can inform planning practices and suggest improvements for campus walkability and coherence.

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Introduction

We have used the word 'campus' since the Age of Enlightenment in the 17th century. It derives from Latin origins, meaning 'a flat place, field, or plain,' intrinsically related to the English word for camp. In Arabic, a university campus is haram aljamiea. Haram means restricted, forbidden, or sanctuary, whereas aljamiea means the inclusive or comprehensive gathering or assembly. Relying on hundreds of sources for the Online Etymology Dictionary, Harper (2001) argues that the first use of the word 'campus' in the academic sense occurred in 1774 at Princeton University in the USA, referring to a large open space on the college grounds. In 1826, it was used to describe the open square (~10 acres or 40,500 m²) located between buildings at the University of South Carolina in Columbia. This use expanded in the 19th century, eventually encompassing university buildings during the 20th century. Today, it refers to the physical space of an educational institution, typically a university, encompassing all the buildings and the surrounding land. In the 20th century, the concept of a campus expanded to encompass other, primarily non-educational settings and non-residential land uses, such as medical, business, and industrial facilities. It has evolved to mean that a campus could be 1) a single, identifiable, contiguous area or 2) a collection of buildings dispersed across a wider geographic area. The latter is more of an abstract, legalistic concept (i.e., related to ownership, identity, and economic opportunity). The former is a more concrete, morphological one grounded in a specific place.

Figure 1. Bird's eye views of the campuses of (top left) University College London in the UK (Source: UCL/Polina Bayvel) and (top center) the University of Chicago in the USA (Source: University of Chicago), (top right) Mayo Clinic in Jacksonville, Florida (Source: Mayo Clinic), (middle left) Apple Park in Cupertino, California (Source: Daniel L. Lu/Wikipedia Creative Commons Attribution-Share Alike 4.0 International License), (middle center) Googleplex in Mountain View, California (Source: © 2018 David Oppenheimer), (middle right) the Jebel Ali

Industial Area Free Zone in Dubai, UAE (Source: UAE Ministry of Economy), and the (bottom left) Qatar University campus looking south focused on the central area of the original masterplan (Source: Aga Khan Trust for Culture) and (bottom right) northern part of the main campus in Education City looking east toward the Qatar Foundation Building, the Green Spine, and Qatar National Library (Source: Qatar Foundation).

Our contemporary use of the word 'campus' has become increasingly expansive, abstract, and complex to understand and study. For example, the physical delineation of the urban campuses of universities, such as University College London (UCL) in the United Kingdom (UK) or the University of Chicago in the United States of America (USA), is as much driven by the availability of land/buildings and economic opportunity as anything else. Non-educational campuses rely on other land-use factors, such as large-scale accessibility to major transportation routes and corridors (e.g., vehicular, rail, and water), commuter distances to housing opportunities, or calibrated separation from residential areas (in the case of industrial campuses). Examples of these campus types in the USA include the Mayo Clinic in Rochester, Minnesota, and Jacksonville, Florida; Apple Park in Cupertino, California; the Googleplex in Mountain View, California; and Tesla Giga Texas in Austin, Texas. Even singular, contiguous campuses have become so physically large that they are often referred to as areas or cities, as in the Middle Eastern example of the Industrial City. For instance, Ras Laffan, Mesaieed, and Dukhan in Qatar, or Mafraq in Abu Dhabi and Jebel Ali in Dubai, in the United Arab Emirates (UAE), both of which have a separately defined ‘Industrial City’ located further east and southwest, respectively. Even singular, continuous areas of educational campuses have become so large that they may be considered distinct cities, such as the University City in Sharjah, the Academic City in Dubai, and the Masdar City in Abu Dhabi in the UAE. It is also evident in Qatar, with Education City and Qatar University (QU) campuses in Doha. The latter is in north Doha, whereas the former is in west Doha, in relation to Doha Bay and the city’s historical origins near Souq Waqif in Old Doha (Figure 1). Both campuses are large, spanning 4.32 square kilometers (km^2) (1,068 acres or ac) for the QU campus and 5.57 km^2 (1,376 ac) for the main campus of Education City. They are not as large as some American university campuses. For example, the largest public university campuses in the USA range from the University of Michigan in Ann Arbor (~3,000 acres) and Texas A&M University in College Station (~5,200 acres) to the United States Military Academy in West Point, New York (~16,000 acres) (Carnegie Dartlet, 2025).

The educational campuses in Doha serve as case studies for this paper. It includes a brief literature review of recent research on campuses, focusing on universities that utilize space syntax analysis, and examines the master plans and development strategies of both campuses. The review also outlines the research design and methodology used in our study of Education City and Qatar University. It includes on-site surveys documenting block sizes using figure-ground analysis, ground-level land uses, active and inactive frontages, and building heights, as well as space syntax analysis of their layouts. At the heart of this paper is a general question. What is a campus, in the more traditional sense of the word? We do not pretend to offer a definitive answer to this question. Instead, we use the morphological and spatial analysis of these campuses to lay a foundation. It enables us to have a more in-depth theoretical discussion about the nature of the campus and its potential contributions to future planning efforts for both traditional and non-traditional campuses in diverse locations worldwide. In this study, we are explicitly referring to a campus in its physical sense, i.e., its form. We are not exploring what digitally enabled urbanism can mean for a campus through its functional sense. This distinction is crucial as it sets the boundaries of our research. There are many debates on the meaning of a campus in its ontological sense, especially within digitalization and its accompanying emergent virtual realities. Platform Urbanism, a leading movement that merges digital (hidden) realities with the physical and social (visible) realities, is such an example (Barns, 2020).

Campuses and space syntax in the literature

The spatial dynamics of education settings in building analysis have been of theoretical interest to space syntax researchers for a long time. This interest tends to focus on the interface between inhabitants and visitors – those who belong, i.e., one of us, and those who do not, i.e., the Other – in long and short models of architectural space, emphasizing the role of strong and weak programming in shaping architectural space (Hillier & Hanson, 1984; Hillier, 1996). In this sense, they tend to focus on campuses with well-defined edges, delineating the difference between inside and outside, unlike the urban campus samples mentioned earlier. In urban analysis, space syntax researchers often treat campuses (educational, business, or industrial) as just another means of defining the edges of a site, like any urban development or neighborhood. It is fair to argue that this is correct, as urban issues are always contextual, one way or another, due to broader factors such as urban growth and development, movement patterns, and land-use planning. Stonor and Major's (1997) involvement as consultants for Space Syntax Limited in Michael Hopkins and Partners' (now Hopkins Architects) masterplan project for the University of Nottingham's Jubilee Campus is a classic example. It was an urban regeneration project on a brownfield site, formerly a bicycle factory, designed to subtly separate pedestrian and vehicular movement without detracting from its overall functionality as a place (Stonor & Major, 1997). The original site was 6 hectares (ha) or 15 acres (ac) in size, approximately 3.2 km (2 miles) from the city center (Source: Hopkins Architects). The campus opened to students in 1999 and later expanded to 26 hectares (65 acres) (Source: University of Nottingham). There was little, if any, explicit thought, nor was there time available to contemplate more significant questions, such as what a campus is or should be as a morphological thing.

Of course, there are many space syntax researchers in academia worldwide. It includes researchers taking advantage of the opportunities to investigate the spatial layout and use of educational buildings and university campuses where they work or are familiar. There are several examples in the literature, including by the principal authors of this paper about QU buildings, i.e., the Women's Engineering Building, the BCR Corridors (and, by extension, most of the original campus masterplan), and the QU Main Library, or as case studies within more extensive studies (Major et al. 2019, 2020, 2022; Major & Tannous, 2024). Mohareb and Khalil's (2024) study of the spatial-social inclusivity of open spaces on twelve private university campuses in Cairo, Egypt, focuses on the solid-void ratio (i.e., buildings and open space), layout, visibility graph analysis, and use (based on questionnaires) to identify how design might affect users' perceptions of open spaces on these campuses. They conclude that ease of accessibility in user wayfinding and the perception of public safety, balanced with attractive hardscape and landscape features, best characterize the most successful open spaces on these campuses (Mohareb & Khalil, 2024). Özbil et al. (2018) and El-Darwish (2022) reached similar conclusions in their studies of common spaces on university campuses in Türkiye and Egypt. Hacar et al. (2020) examined the relationship between pedestrian density and space syntax measures at Davutpasa Campus, Yıldız Technical University, in Türkiye, including observational counts of pedestrian movement. They argued that the integration measure in axial analysis was the most reasonable means to explain pedestrian density on the campus. However, their axial maps cover only the campus, lacking a broader context (Hacar et al., 2020).

Ali and Kim's (2020) study employed methods to examine whether university open spaces should be publicly accessible or remain tightly controlled by the university in Cairo, Egypt. They recommend caution for intense urban conditions on a case-by-case basis. Abu Elkhair et al. (2023) examined and ranked the social qualities of university campus outdoor spaces (UCOS) at the American University in Cairo using space syntax —specifically, all-line axial analysis and Visibility Graph Analysis (VGA) — in combination with field observations and the classic classification of public, semi-public, semi-private, and private spaces, derived from Alexander (1987). They conclude that the most critical influences on the social use of outdoor spaces on the campus were mixed-use, accessibility, and density (Abu Elkhair et al., 2023). Alnusairat et al.

(2021 & 2022) follow a similar methodology in Jordan to argue for enhancing the design of university open spaces, considering the Middle East's microclimate and the consequences of the COVID-19 global pandemic. Likewise, Soares et al. (2020) examine the potential for fostering creativity in university open spaces using the case study of the Zernike Campus in Groningen, The Netherlands. Of course, these studies followed the tried-and-true methods of urban analysis in space syntax research (van Nes & Yamu, 2021). They answer specific questions using university campuses as case studies. There is no diving deeper into the generic nature of the campus as a morphological thing itself.

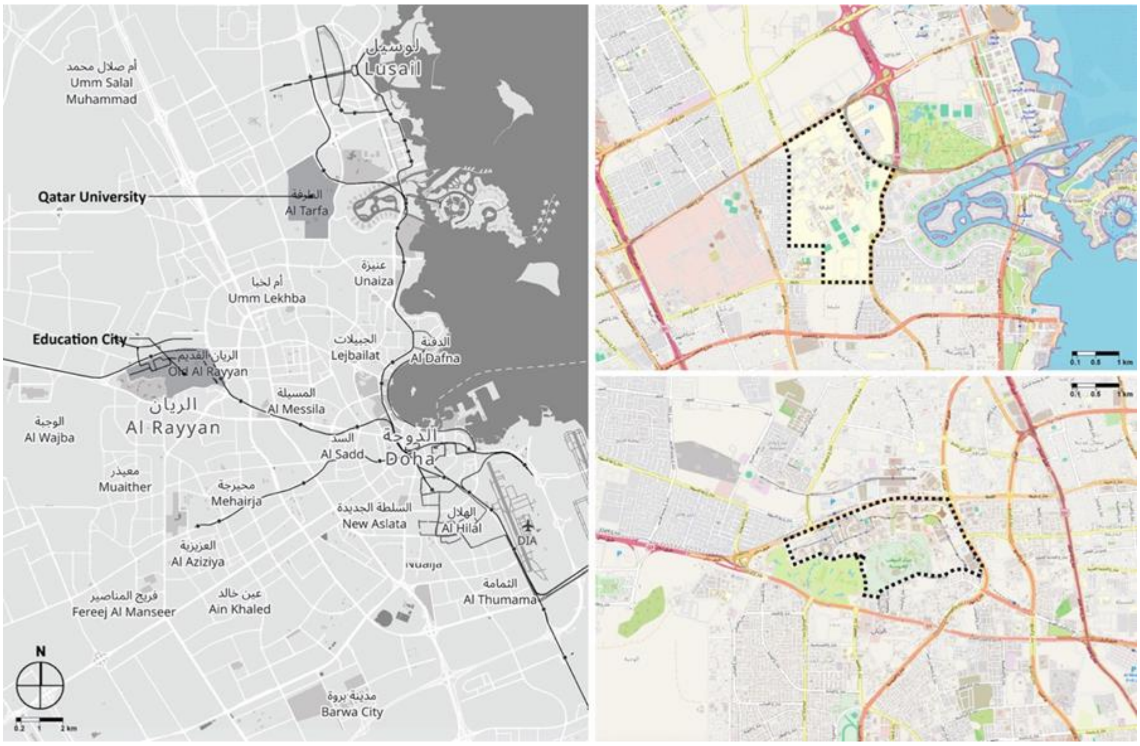

Figure 2. Transport Map of Doha showing the Doha Metro lines (left), and OpenStreetMap views of (top right) Qatar University and (bottom right) Education City outlining the studied bounds of both campuses (Source: Authors/© OpenStreetMap contributors. Tiles courtesy of Andy Allan).

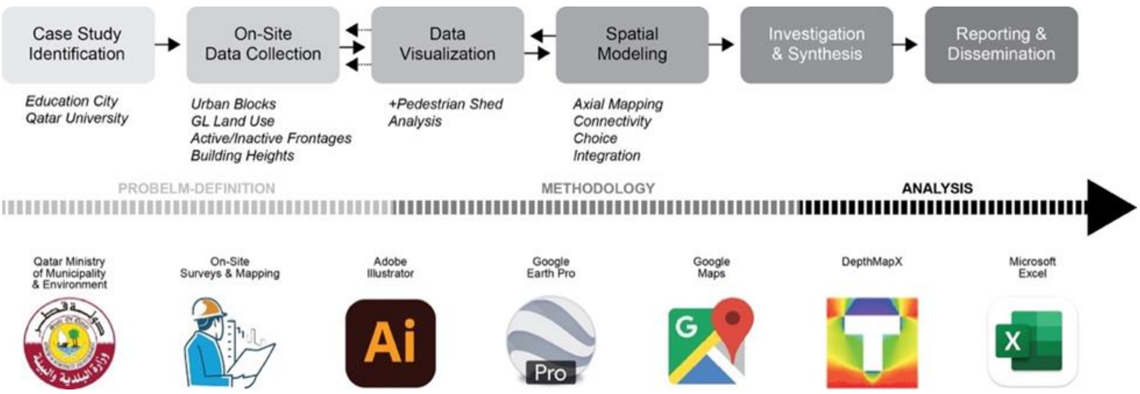

Figure 3. Research design, methodological process, map resources, and software tools of the study and the paper (Images: Authors/Qatar Ministry of Municipality/Google/Adobe/University College London/Microsoft).

One example that does is da Silva's (2017) excellent research on the characteristics of fifty-two (52) university campus layouts worldwide, with the overwhelming majority (~80%) in North America (USA, Canada, and Mexico) and Europe. It is the most comprehensive attempt to classify university campuses as precincts by morphological type and contextual conditions (da Silva & Heitor, 2014; da Silva et al., 2017). In this sense, a precinct refers to an area within the perceived boundaries of a particular place (Source: Oxford English Dictionary). She defines these at the macro-scale by their autonomous and rooted nature in urban conditions, or, more simply, by whether they are inside or outside the recognized bounds of a city, and by the relative dominance of one or the other. For example, consider a university town like Gainesville, Florida, home to the University of Florida, versus a city like London in the UK, which hosts many university campuses (such as UCL and the University of Greenwich) but is not defined exclusively by them. Da Silva (2017) further classifies campus precincts at the micro-scale: autonomous ones are distinct, attached, inner, or central, and rooted ones are self-enclosed, open, scattered, or ubiquitous (as in 'present everywhere'). University campuses differ due to the historical, social, and cultural factors unique to each, which Hillier (1989) termed Type 3 laws of the urban object, in a similar sense as the Lived Space according to Lefebvre's (1974) classification of spaces, which later received more elaborate terminology in the field of urban theory in Soja's (1996) Thirdspace: Journeys to Los Angeles and Other Real-and-Imagined Places. Da Silva's (2017) research is comprehensive and exhaustive, covering nearly 800 pages. Her classifications are as much about the location of university campuses as what they are. Still, her findings suggest the possibility of a more straightforward classification of the generic campus regardless of land use based on Hillier's (1989) Type 1 laws governing the generation of the urban object itself (Major, 2018).

The design of the research methodology

The study in this paper relies on data collected and collated by graduate and undergraduate researchers in the Education City and Qatar University campuses for data visualization purposes in late 2022 and early 2023. Senior researchers standardized this data collection and conducted on-site verifications in 2023. The QU campus is in north Doha, approximately 10 km north-northwest of Souq Waqif in Old Doha. The major arterials of Al Tarfa Street bound the campus to the north and Al Jamiaa Street (turning into the Al Khor Coastal Road at its northeast corner) to the east. Gliya Street (which becomes a major arterial, Al Duhail Street) bounds the campus to the south. Jeryan Nejaima Street, a local road, defines the western edge of the campus. At Education City, major arterials define the bounds of the main campus to the north and east. It includes Al Luqta Street to the north. For this study, we are excluding the Education City campus north of Al Luqta Street and focusing on the main campus. The whole of the Education City campus is twelve (12) km² in size. Huwar Street, running north-south, defines the eastern edge of the main campus. The local road, Al Shagab Street, and the historic area of Old Al Rayyan define its southern edge. The Education City Golf Club, course, and local perimeter roads define its western edge (Figure 2).

A diagram outlines the research design and methodology, from the case study identification to the methods for on-site data collection, built environment surveys, data visualization, and space syntax modeling, as well as analysis comprising investigation, synthesis, reporting, and dissemination (Figure 3). This diagram also outlines the map resources and the principal software packages used in the study for data visualization and analysis. Researchers collected primary data through on-site surveys of morphological characteristics of the built environment, supplemented by photographic/video documentation, as well as a review of Google Earth/Maps satellite imagery information. This includes a figure-ground representation of urban blocks, where blocks are in black and space is white (or vice versa). The most continuous or standard building line defines the urban blocks, with allowances for free-standing buildings that can compose an entire urban block. The figure-ground representation serves as the basis for quantifying the average block size of the case study areas using Google Earth measurement tools. This is achieved by calculating the metric area, subtracting a standard 20% deduction for public right-of-way, and then dividing the result by the number of blocks reported in previous research (Major & Tannous, 2024). Researchers deducted an additional metric area (either the actual area or a percentage) from the individual case areas to account for vacant land, surface parking lots, etc. It also includes ground-level land-use mapping using a standard color key for land-use types (commercial, retail, low-, medium-, and high-density residential, public, utility, etc.). Both campuses require specialized land-use categories (such as administrative and student center) compared to other typical Doha neighborhoods (Major & Tannous, 2024). Historic resources are typically designated as special use, which is only applicable to Education City.

Figure 4. Kamal El-Kafrawi’s concept for Qatar University's original masterplan (left) (Source: Aga Khan Award for Architecture). and a rendered 2012 version of Arata Isozaki’s masterplan for Education City in Doha focused on the main campus south of Al Luqta Street and north of Old Al Rayyan (right) (Source: Qatar Foundation/Doha News).

Based on this ground-level land-use pattern, we surveyed and mapped active and inactive non-residential and residential frontages: active non-residential frontages in green, active residential frontages in gold, and all inactive frontages in red. An active frontage is one where there is an opportunity for co-presence or interaction between people in public space and those inside the building along at least 50% of the building façade, i.e., windows, doors, and arcades. Allowances are made for the extensive use of opaque reflected tints in windows due to the climate conditions in Qatar, i.e., opportunities for co-presence or interaction between inside and outside the building are more likely at night, or only one-way (inside-to-outside) during the daytime. We also mapped the pattern of building heights using a standard scale for the number of stories, i.e., 1-story, 2-4 stories, 5-8 stories, 9-12 stories, and 12+ stories. Half-stories (0.5) based on high ceilings are rounded down, so the building height mapping accurately accounts for the number of floors, not the vertical height in meters (m). Finally, the study incorporates pedestrian shed analysis using standard radii of 200 and 400 m (i.e., a 3- to 5-minute walk) due to the hot summer months of May to August in Qatar. This differs from the Western standard of 400 and 800 m (e.g., a 5- to 15-minute walk) for more pleasant climates experiencing four seasons. There are no shaded walkways at Education City, other than those provided by natural vegetation. The most significant shading devices at Education City are associated with its tram stops. There is only one significant shaded walkway at the QU campus, running parallel to a large surface parking lot and connecting (more or less) between the QU Main Library and the Women’s Engineering Building. The BCR Corridors in El-Kafrawi’s original master plan utilize shading screens in exterior connections between buildings. Major et al. (2020) already outlined the difficulties that these ground-level shading screens cause for wayfinding in the large BCR Corridors complex. Finally, we examine the pedestrian sheds from the geometric center of the case study areas, as well as from Doha Metro stops, in parallel with Visibility Graph Analysis (VGA) of the metric step shortest-path length (or actual distances considering impediments to route choice) using DepthMapX, with measured distances in meters (m) represented by each color using Google Earth measurement tools. All the gathered information is analyzed and discussed throughout the remaining sections of the paper.

The masterplans

Egyptian architect Kamal El-Kafrawi in consultation with Ove Arup & Partners and the United Nations Educational, Scientific and Cultural Organization (UNESCO) on behalf of His Highness Sheikh Hamad bin Khalifa Al Thani, Emir (now the Father Emir) of the State of Qatar, designed the original Qatar University (then Gulf University) campus masterplan, which was planned and constructed from 1973 to 1985. It included the earliest buildings on campus, such as the Higher Administration Building, Information Technology Services Building, separate Men’s and Women’s Activity Centers, Faculty Office Building (originally Women’s Library), Main Women’s Building, and the BCR Corridors (Figure 4, left). The last three collectively formed part of the BCR Complex, based on a modular design concept by El-Kafrawi, which, in theory, enabled expansion ad infinitum in the future. Its wind tower architectural vocabulary – repurposed as light wells – forms the most iconic image of the campus, later incorporated in the university’s official logo (refer to Figure 1, bottom left). The design was a shortlisted project for the Aga Khan Award for Architecture during the 1989 Cycle. Today, Qatar University is home to over 9,000 students (excluding Foundation Studies) and more than 1,100 faculty members from fifty-two nationalities. At Qatar University, approximately 65% of students are Qatari, and more than 70% are female (Major et al., 2020). The QU campus features a segregated campus layout, separating male and female students. As a result, female students are free to move anywhere on the campus, while male students are restricted to their designated area. In some ways, it could be argued that educational campuses with gender segregation policies like this are a form of gated community with varying definitions of who is an insider and an outsider across scales, such as in campuses. Here, gender plays a crucial role in defining insiders and outsiders: male and female students are insiders at one level, while gender defines outsiders at another. The dividing line between the male and female sides of the QU campus runs (more or less) along the western façade of the BCR Corridors complex and through the QU Main Library. However, this campus division has been effectively abandoned north of the library.

Education City is an initiative of the Qatar Foundation, under the guidance of Sheikha Moza bint Nasser, the mother of the current Emir of Qatar, and was established in 1997, with an official inauguration date in 2003. It was designed and planned to be an educational and research innovation district with educational facilities across school ages to satellite campuses for some of the world's leading universities at the time of our study, including Carnegie Mellon University, Cornell University, Georgetown University, Northwestn University, Texas A& M University, Virginia Commonwealth University and Hamad Bin Khalifa University (HKBU), in buildings and stadia designed by some of the world's most renowned architects. It includes the Qatar Foundation Headquarters and Qatar National Library, designed by Rem Koolhaas/OMA; the Centre for Islamic Studies (home of HBKU), designed by Mangera Yvars Architects; and the 2022 FIFA World Cup Education City Stadium, designed by Fenwick Iribarren Architects. The aim of the Qatar Foundation’s Education City initiative is to integrate tradition and technology while meeting the functional needs of a state-of-the-art campus, advancing education, research, and innovation in the region as a critical component of Qatar National Vision 2030 (QNV, 2008). Qatar Foundation also implemented Smart City initiatives on the campus, utilizing technology to improve operational efficiency and promote sustainability, including a local tram system. Japanese architect Arata Isozaki master planned the Education City campus in 2001 as a piecemeal aggregation of various developments, incorporating a unifying infrastructural axis, a green spine, and the Qatar Foundation Ceremonial Court. Moriyama & Teshima Architects later developed a comprehensive planning framework addressing the functional needs of various institutions and public spaces, the campus’s strategic development, and future expansion (Figure

4, right). The master plan incorporates a diverse mix of land uses, including housing, leisure (parks and a golf course), commercial, social, and cultural facilities, to enhance urban life through a range of diverse activities. The aim is to create spaces that foster social interaction, promoting a sense of community among its users and visitors. Parsons Corporation has overseen the overall planning of construction activities, including roads, infrastructure, cooling plants, parking structures, pumping stations, parks, open spaces, and water treatment facilities. Any gender segregation on the Education City campus occurs exclusively within its buildings.

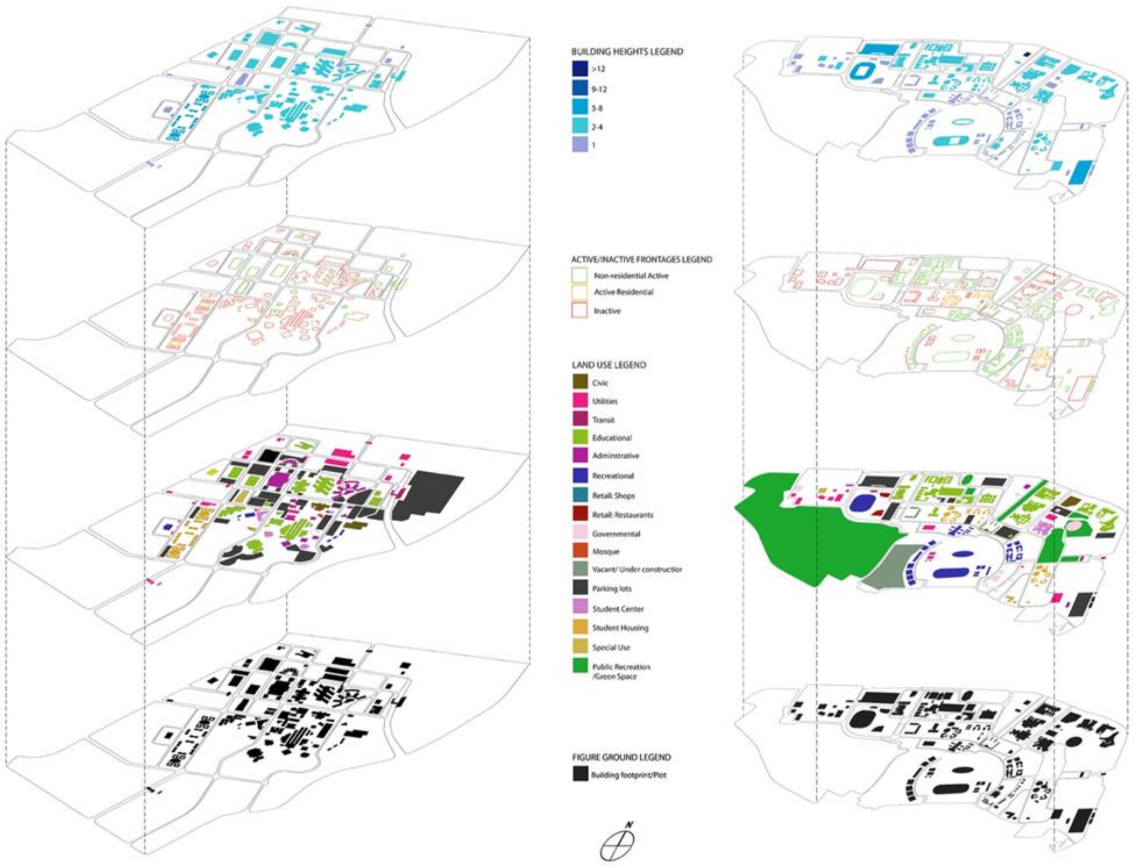

Figure 5. Axonometric layered views of the data visualization maps for the (from bottom to top) figure-ground (blocks in black, space in white with key routes outlined), ground level land uses, active and inactive non-residential and residential frontages, and building heights in (left) the QU campus and (right) the main campus of Education City (Source: Authors).

Data analysis and findings

Axonometric layers summarize the morphological data for urban blocks/free-standing buildings, ground-level land use, active and inactive non-residential and residential frontages, and building heights in the QU and Education City campuses (Figure 5). The figure-ground representation (bottom layer) illustrates the significant open space (in white), including vacant land for future expansion, surface parking lots (especially on the QU campus), and recreational facilities. One difference discernible between the two campuses is that the QU campus has developed from the geometric center outward towards its defined edges. In contrast, the main campus of Education City has developed from its edges inward toward the geometric center. Large, free-standing buildings tend to characterize both campuses to the north than to the south, with the exception being the oval Al Shaqab Equestrian Center to the south and a large, 5-story parking structure at the southwest corner of Education City. There is a large amount of open space surrounding this equestrian facility. In the ground-level land use map, we can see a larger amount of vacant land to the immediate west of the equestrian center for the Al Shaqab village (which will include 100 housing units) and the massive grounds of the Education City Golf Club and Course, which define the entire western perimeter of Education City. The large footprint of the FIFA World Cup 2022 Education City Stadium is immediately north of the golf course. East of the equestrian center is Oxygen Park, a public park designed to promote physical activity and social interaction with recreational and sports zones. The Green Spine of Education City is also clearly visible to the northwest of Oxygen Park. Educational facilities in the northern portion of the main campus dominate the ground-level land-use map. There are clusters of smaller-footprint residential housing (dorms) south of these education facilities and Oxygen Park, as well as utility/governmental facilities in the northwest. Education facilities in the central portions, residential housing dorms for students and faculty to the west, and the clustering of surface parking lots (approximately twenty) throughout characterize the QU campus. There is only one multi-story parking structure located immediately to the north of the large footprints of the new College of Engineering and College of Business and Economics buildings. Most utility buildings are in the north of the QU campus.

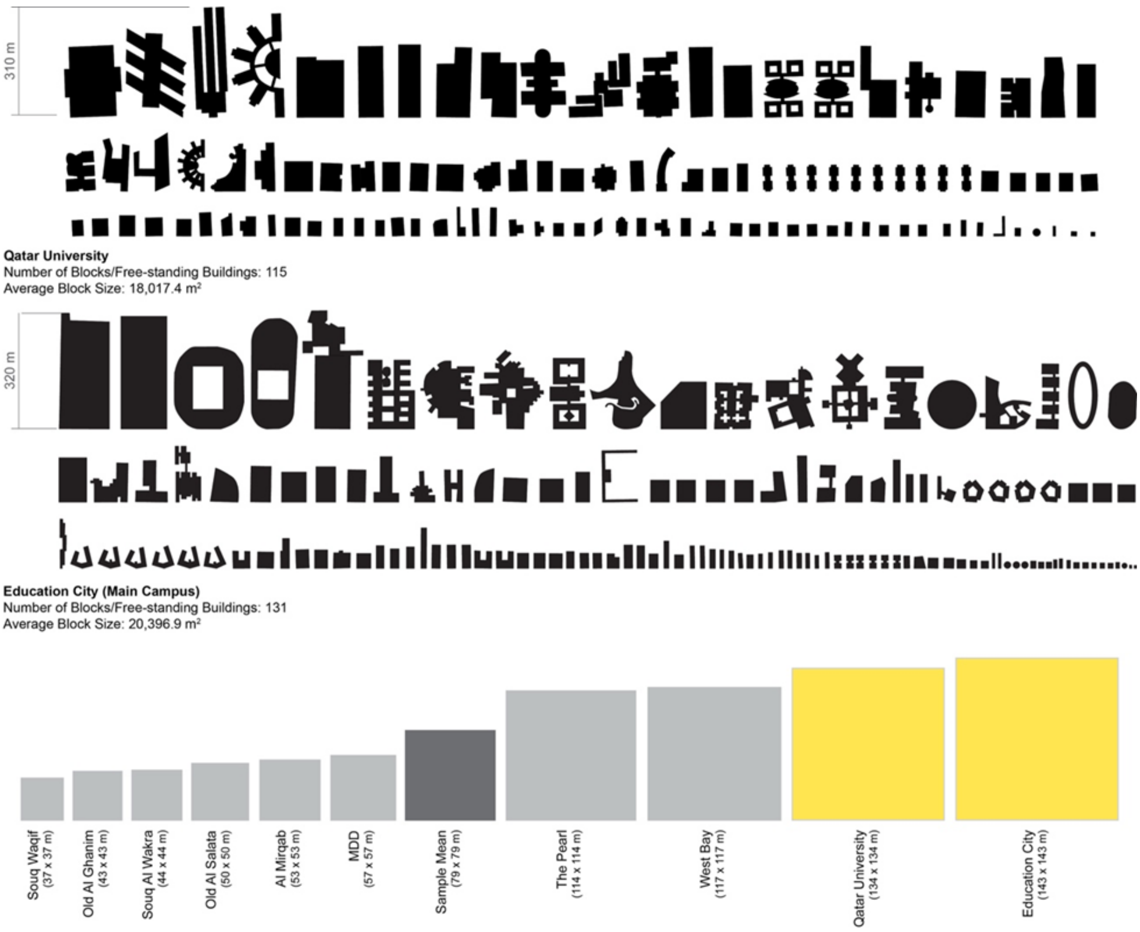

Figure 6. The rank order of urban blocks/free-standing buildings from the largest to the smallest for metric area (left to right in three rows) for (top) Qatar University and (middle) the Education City main campus, and (bottom) a visual representation of the average block size in ten (10) Doha neighborhoods including the QU campus and Education City main campus (highlighted in yellow) with the sample mean (in dark grey) (Source: Authors/Major & Tannous, 2024).

There are significantly more active non-residential and residential frontages in Education City than on the QU campus. It is difficult to discern any pattern in the distribution of active and inactive frontages on the QU campus, almost to the point where it seems random. In contrast, active frontages in Education City are clustered around the equestrian, northern, and northwestern sections. Its northern portions include Qatar Academy Primary School, Virginia Commonwealth University, and Education City Female Housing. Its northwestern portions include the Qatar Foundation Headquarters, the Centre for Islamic Studies/HBKU, and Northwestern University. The profile of building heights on both campuses is low-rise, though there is greater variation in Education City. Building heights on the QU campus are predominantly 2-4 stories, with a scattering of one-story buildings throughout. 12% of the blocks/free-standing buildings on the QU campus (14) are one-story in height. All the rest are in the 2- to 4-story range. The average building height on the QU campus is approximately two stories (1.83). In Education City, the buildings surrounding the Al Shaqab Equestrian Center (except for the arena itself) are one-story structures. The northern portions of the Education City campus feature buildings ranging from 2 to 8 stories in height, with most falling within the 2- to 4-story range, typically four stories. Half of the urban blocks/free-standing buildings on the main campus of Education City are one-story (67, or 51.1%), primarily driven by the large number of structures associated with the equestrian center. More than a quarter of the urban blocks/free-standing buildings on the main campus of Education City are 5- to 8-story (36 or 27.5%). The rest are free-standing buildings nine stories or higher, including the Qatar Foundation Headquarters and the Education City Stadium. Collectively, this translates to an approximate building height average of two and a half stories (2.47).

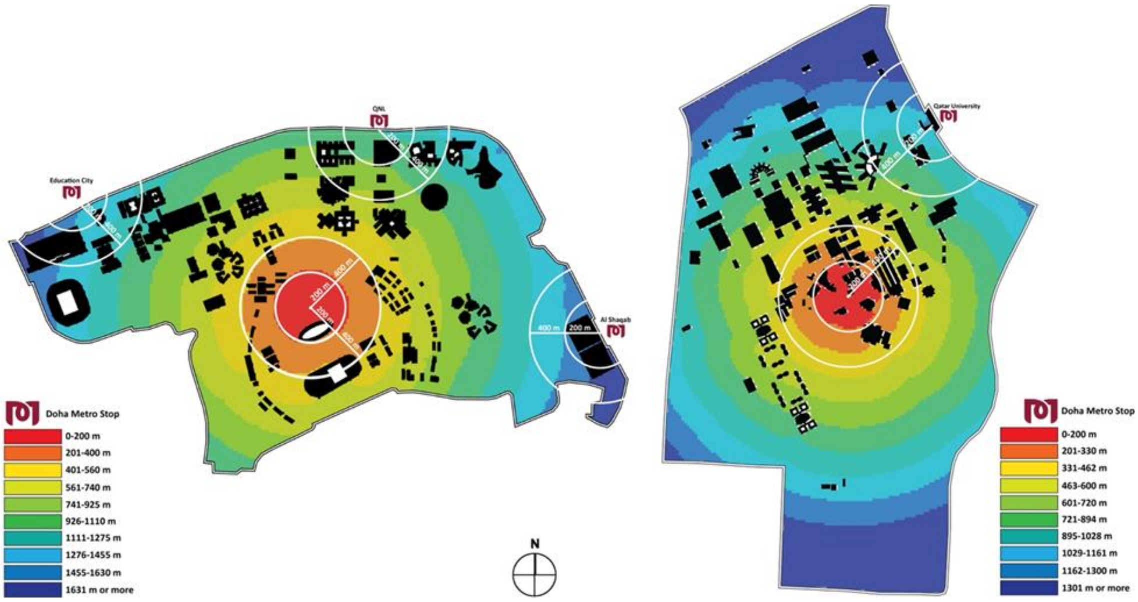

Figure 7. Pedestrian shed analysis of 200 m and 400 m from the available Doha Metro stops and the geometric center based on the formal shape of the (left) main campus of Education City (without the Education City Golf Club grounds) and (right) QU campus, overlaid on analysis of the metric step shortest-path length. The metric distances associated with the color ranges of metric step, shortest-path length (or actual distance considering built forms) (Source: Authors).

Neither campus is composed of urban blocks in the traditional sense, i.e., using shared walls. Every building is a free-standing structure (Figure 6). The only exceptions might be the BCR Corridors complex on the QU campus and the residential areas on both campuses, depending on how flexible or rigid the selected definition of an urban block. Our survey treats them as free-standing buildings because they do not share a common wall. What is clear is that the larger the building footprint, the stronger the tendency for a building to be an irregular polygon, except for stadiums, multistory parking structures, and the Qatar National Library. Predictably, this is due to the need to introduce natural light into the interiors of these large buildings, as they incorporate small courtyards or light wells. The smaller the building footprint, the greater the tendency for a regular polygon shape, i.e., square-ish or rectangular. Major and Tannous (2024) have already shown that the average urban block size (or building footprint, in the case of these two campuses) is significantly larger than the rest of the metropolitan region, based on their study of urban centrality in 10 Doha neighborhoods. The average block sizes at Qatar University and the main campus of Education City are 18,017 m² and 20,397 m², respectively (Major & Tannous, 2024). This translates into a typical block/building footprint (if square) of 134 m x 134 m at the QU campus and 143 m x 143 m on the main campus of Education City. However, the largest blocks/buildings on campuses are more than 310-320 m in their longest direction. The average urban block/building footprint on these two campuses is 23% larger than the average for The Pearl-Qatar and the West Bay Business District, almost two and a half times larger (2.43) than the sample mean for ten Doha neighborhoods, and over eight times larger (8.22) than the average block size of the five Old Doha neighborhoods within the B-Ring Road (Major & Tannous, 2024).

Metric step depth, or actual distances (in combination with pedestrian shed analysis), reveal key features of these campuses (Figure 7). First, Education City has an enlarged core for metric step depth, as there is ample open space at its geometric center. In contrast, the buildings of the original El-Kafrawi masterplan populate the geometric center of the QU campus. Nonetheless, due to the greater distances within the color ranges, Education City's east-west extended shape is less walkable (up to 300 m more at the extremes) than the QU campus's north-south extended shape, when accounting for building locations. In part, this might explain a greater need for public transportation options (metro and tram stops) in Education City, options provided by the Qatari government and Qatar Foundation. Second, there is their size. It is 1,000 m to reach 'as the crow flies' the eastern and western edges, and an average of ~1,500 m to reach the northern and southern edges of the QU campus from its geometric center, located adjacent to the Women's Engineering Building and Women's Health Facility on the female side of the campus. It is ~1,000 meters to the QU stop on the Doha Metro, on the northeast edge of the campus. To date, the only significant academic buildings within 400 m of the Doha Metro stop are the College of Medicine and the Research Complex at QU. Most everything within 400 m of the campus's geometric center follows the original El-Kafrawi masterplan. Most everything outside this 400 m radius is an extension of that masterplan. A local bus system serves the QU campus, with multiple stops, easing movement around the campus. At Education City, the distances to the northern and southern edges are 1,000 m, to the northwestern and eastern edges are 1,400 m, and to the western edge of the golf club are 600 m from the geometric center of the main campus of Education City. The only structures within 400 m of this geometric center are equestrian center facilities. However, the Doha Metro better serves Education City, with three stops (two on the northern edge and one on the southeastern edge), than the QU campus. There are eleven structures within 400 m of these metro stops, including two massive, multistory parking structures affording 'park and ride' opportunities. Local bus and tram systems also serve Education City, with multiple stops, making it easier to move around the campus. Nonetheless, despite these local transportation options, the distances to walk on both campuses are prohibitive due to the hot summer conditions in Doha from May to September. Lastly, the public transportation options for the Doha Metro emphasize an 'edge-in' reading of the campuses, which will be reinforced by the later expansion of the Doha Metro and the opening of an additional stop, located somewhere west of the QU campus in the Duhail area. On both campuses, a local bus or tram system supplements movement within the campuses. This generates distinct experiences between 'getting to' the campuses and 'getting about' them.

In planning terms, it appears that the strategy for both campuses is to set up distinct 'parts' within the urban 'whole' of each campus (Education City more so than the QU campus), centered around the Doha Metro and, by implication, vehicular entry points. But is that how they function spatially? The space syntax model of the spatial layout of both campuses provides more information. Based on the analysis, the answer is problematic. Highly integrated globally and locally, high global-choice routes define the perimeter roads of both campuses, highlighting the importance of vehicular access (Major et al., 2023).

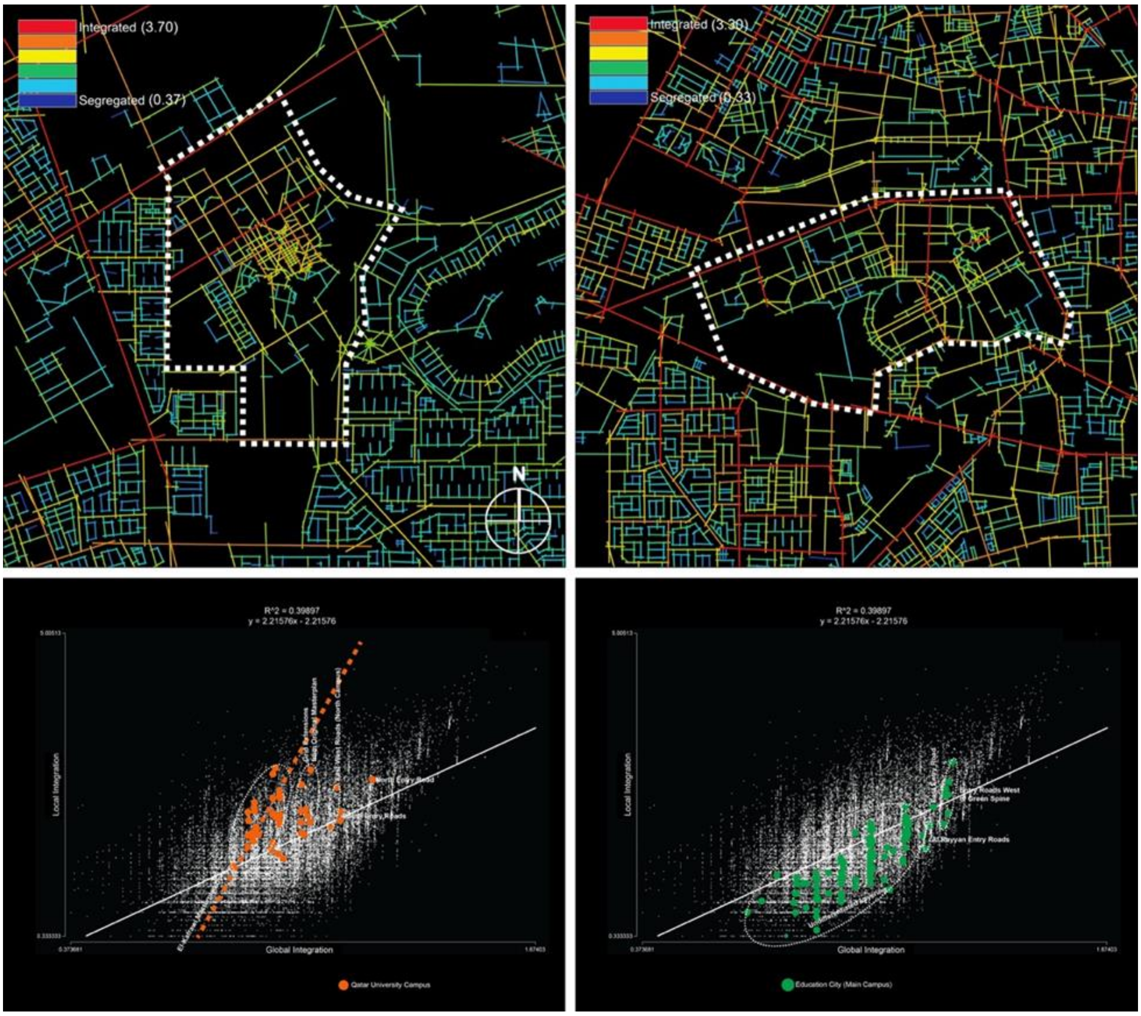

Figure 8. Calibrated pattern of local integration (radius=3) for the (top left) QU campus within its north Doha urban context and (top right) the main campus of Education City within its west Doha urban context, and the Intelligibility scatter (per global vs. local integration) in the (bottom left) QU campus (in orange) and (bottom right) Education City main campus (in green) within the space syntax model of Metropolitan Doha 2020, including identifying critical routes in each area (Source: QUCG-CENG-22/23-472).

The model of the QU campus includes detailed pedestrian route modeling through the BCR Corridors (part of the original masterplan) within the urban context of north Doha. This north Doha context extends east from the coastline, including The Pearl-Qatar, to the Doha Expressway in the west, and north from Meraijeel Street in Lusail City and Zekreet Street in Umm Salal Muhammed, and to Khalifa Street in the south, encompassing the West Bay Business District. We calibrate the color range for the measure of local integration (radius=3) so that the maximum (3.70) is 10 times the minimum (0.37), thereby highlighting the more significant local routes in the model (Figure 8, top left). The most locally integrated route on the QU campus is the one running northeast-southwest across the campus, connecting two entry points at the eastern and western perimeters. This route runs adjacent to the Main Library and effectively defines the northern boundary of the original El-Kafrawi masterplan. The second most locally integrated route runs parallel to this primary route, one block (~360 m) north. There are also four locally integrated routes connecting and running perpendicular to the primary route, three of which enter the heart, and one that defines the western edge of the original masterplan.

The model of the Education City main campus is within the urban context of west Doha. Its urban context stretches from the Doha Expressway in the east to the western edges of the Metropolitan Doha. It incorporates the urban context from Al Rufaa Street in Umm Salal Muhammed in the north to Al Waab Street in the south, including Villagio Mall and Aspire Park. Again, we calibrate the color range for the measure of local integration so that the maximum (3.30) is 10 times the minimum (0.33), thereby highlighting the more significant local routes in the model (Figure 8, top right). It includes detailed pedestrian route modeling within the main campus and the northern campus of Education City. The most locally integrated route on the main campus of Education City is the simplified Green Spine, a single pedestrian space. However, unlike the most integrated route at the QU campus, this Green Spine is unrelated to any entry points (or Doha Metro stops) on the perimeter. It is contained wholly within the campus. In addition, the other locally integrated routes are associated with vehicular entry roads, distinctly marking Education City with an edge-in spatial structure. We can see the effect of this planning strategy in the Intelligibility scatter for QU and the Education City main campus within Metropolitan Doha 2020.

The original master plan of the QU campus has the potential to form a relatively well-defined, intelligible local area effect in the lower ranges of global integration (circled to the left of the scatter in Figure 8, bottom left). However, it currently hovers entirely above the correlation slope at the higher ranges of local integration. Its potential is undermined by the grid extensions to the new northern parts of the campus, which differentiate its entry roads by cardinal direction at the higher ranges of global integration. The same phenomenon occurs in the Education City main campus (Figure 8, bottom right). The only routes within Education City that possess any spatial logic for intelligibility are its entry roads. The rest of the layout in Education City exhibits unstructured vertical layering, with no discernible spatial logic. It indicates the poor planning strategies deployed in Education City over time. It also points to a concern that the planning of the QU campus may be trending in the same direction. It is due to the abandonment of small blocks and walkability within the original QU master plan. The emerging emphasis is on the entry roads and depth from the perimeter (Major et al., 2023). However, numerous remediation opportunities remain on the QU Campus. In the case of Education City, it is challenging to envision design and planning solutions to its poor planning that do not involve large-scale remediation and high costs, i.e., a complete rethink of the original master plan. It highlights the consequences of the different approaches to development in these campuses: from the center outward to the edges at the QU campus, and from the edge inward at the main campus of Education City. Nonetheless, the space syntax analysis also points the way for a deeper theoretical discussion about the nature of campuses in general.

Discussion: what is a campus?

Let us now return to the definitions of a campus outlined at the beginning of this paper. At this point, we can further refine it to a more generic statement: a campus is an abstract collection or the physical space of a specific land use, encompassing all the buildings and their associated land. This generic definition covers all types, including Da Silva's (2017) variations in educational institutions, non-educational variations that share similarities with her classifications, and the campuses of Education City and Qatar University. However, the latter also fall into the narrower definition of the physical space of an educational institution, typically a university, encompassing all the buildings and the surrounding land. This definition is fundamentally rooted in its American origins, likely deriving from the abundant lands of the New World during the Age of Enlightenment (Major, 2018). In a 1922 lecture, the British architect and urban planner Patrick

Abercrombie attempted to contrast the American-style campus with that of the Medieval cloistered environments of the Oxbridge colleges (Cambridge University and Oxford University in the UK), arguing that American formal enclosed quads with manicured grass contrasted with the park-like garden and trees to the side of buildings in the Oxbridge example. He further clarified that the campus planning method at the time encompassed all departmental buildings scattered across a landscape, e.g., a park filled with trees, as described by Abercrombie, in line with Modernist planning principles at the time (Le Corbusier, 1925; Gropius, 1965; Major, 2018; Chapman, 2006). We can interpret his clarification as an allowance for the already-expanding scale of what would become the twentieth-century campus. Abercrombie's description is useful. It allows us to identify three simplified, theoretical models of campus planning that encompass all variations and scales, if we accept the urbanscape within a broader definition of the landscape for contemporary urban campuses. We can describe these models as 1) enclosed, 2) edged, and 3) scattered.

Prototypical examples of the enclosed model include the first comprehensively planned campus in the USA, Joseph-Jacques Ramée's original plan (circa 1813) for Union College in Schenectady, New York (Turner, 1996). It also includes Thomas Jefferson's concurrent, more famous 1817 Academical Village masterplan for the University of Virginia in Charlottesville (Figure 9). Both master plans are informative. Ramée's plan for a central quad or lawn at Union College incorporates edged conditions at a large scale, if we define the (no longer existing) modulating ring road and parallel U-shaped watercourse as the campus's initial perimeter.

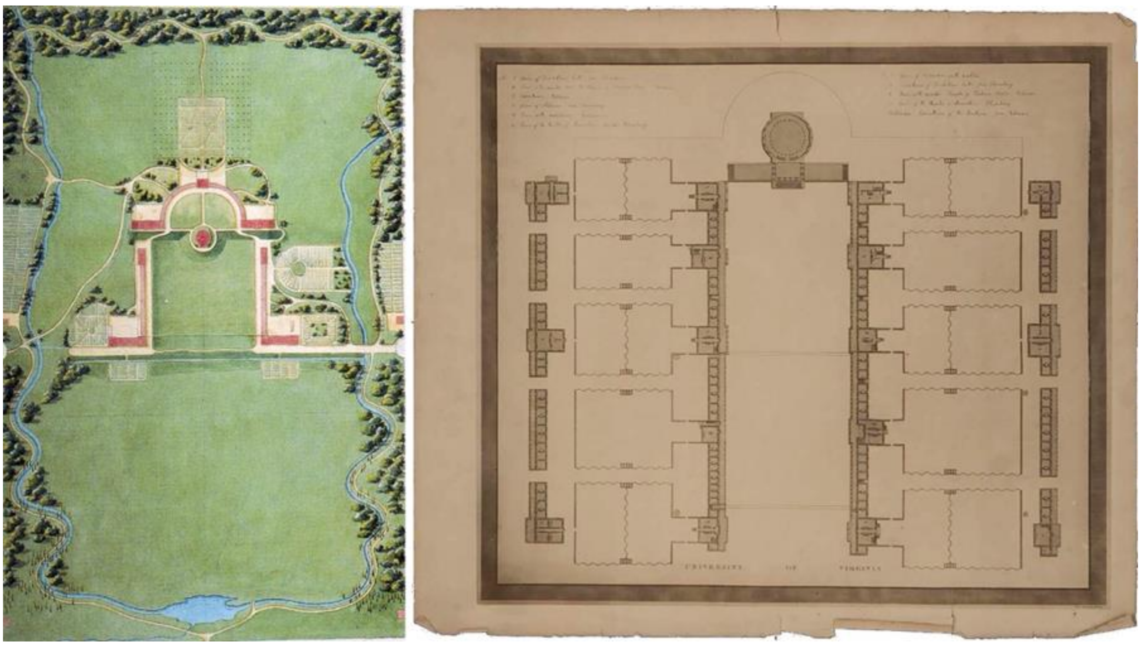

Figure 9. Joseph-Jacques Ramée's 1813 masterplan for Union College in Schenectady, New York (left) (Source: Wikipedia/Hedinger & Berger, 2003) (NOTE: Top of the drawing is southeast, true north is toward the left corner of the drawing) and the Maverick Plan of the University of Virginia, 1923 facsimile of 1822 engraving of the ground plot based on Thomas Jefferson's 1817 masterplan (right) (Source: Thomas Jefferson, architect; original designs in the collection of Thomas Jefferson Coolidge, Junior. E332.J48 1916, Special Collections, University of Virginia, Charlottesville, Virginia, USA) (NOTE: Drawing is oriented ~20 degrees off true north, which is towards the top right corner of the drawing).

In contrast, the University of Virginia's Maverick Plan demonstrates how Jefferson's Eastern and Western Gardens of the masterplan effectively serve as edge conditions for the central Lawn and academic buildings. In this sense, Jefferson replicates the enclosed model, i.e., buildings surrounding a central green. The secondary gardens serve as an edged green for the central buildings and lawn, and the outer student housing (literally called hotels) serves as the edge for the enclosed gardens.

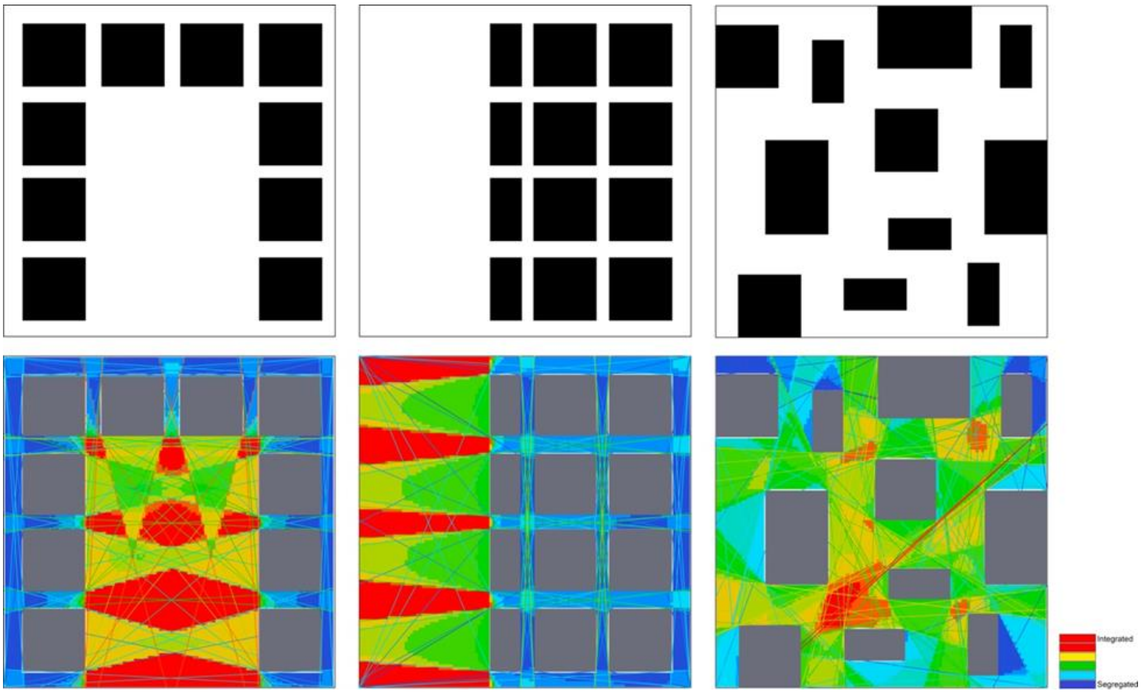

Figure 10. Simplified theoretical models for a (a) enclosed, (b) edged, and (c) scattered campus layouts using the same amount of building footprint area with a standard metric plot, with (bottom row) the all-line axial analysis overlaid on the visibility graph analysis (both for global integration, radius=n) (Source: Authors).

Our articulation of these simple, theoretical models – enclosed, edged, and scattered – for the campus, in combination with the morphological and spatial analysis of the QU and Education City campuses in the previous section, leads us, perhaps inevitably, towards the Hillierian concept of ‘parts’ and ‘whole’ in spatial layouts and how the parts might or might not intelligibly fit within that whole, especially with expanding scale of the campus itself during the twentieth century, as implied by Abercrombie (Hillier, 1996; Chapman, 2006; Major, 2018). Due to their large scale, we can see evidence of all three theoretical models at work in the spatial layout of Qatar University and Education City. For example, the Education City Club and course, as well as the Al Shaqab Equestrian Center grounds, form the edged conditions to the west and south of Education City. The availability of land for future expansion creates edge conditions on both campuses, particularly on the QU campus, in all directions, and to the east on the Education City campus. The piecemeal, phased development of buildings on both campuses incorporates aspects of the scattered model, at least temporarily over the years until they achieve full build-out. This is more obvious in Education City than on the QU campus, which originated as a centralized master plan within its land allocation. Indeed, the original El-Kafrawi masterplan for the QU campus explicitly incorporated small, centralized courtyards within its modular concept, supplemented by opportunities for cross circulation, representing a Middle Eastern variation of the enclosed American campus model. Similarly, the Green Spine at Education City features a central quad with opportunities for cross-circulation in the northern part of the main campus, aligning with the enclosed model. Oxygen Park does something similar for the western part of the main campus at Education City, at least in a formal sense. Its design is explicitly for recreational uses, i.e., walking, running, etc., on-site rather than to ease cross-circulation in this part of the campus. Given that this is the case, what exactly do these enclosed, edged, and scattered campus models do for visibility and movement in spatial terms?

Discussion: theoretical models of campus morphology

We can construct a generic, theoretical layout for the enclosed, edged, and scattered campus models, controlling for a consistent plot size and overall building footprint area (Figure 10, top). All blocks are parallel or perpendicular to each other and the edge. The enclosed model comprises 10 square blocks, running parallel to the plot edges, to define a three-sided central quad space. The edged model contains a total of twelve blocks, consisting of eight square blocks and four downsized, rectangular ones (half the area of the square blocks), arranged in an orthogonal layout along one side of the plot, to form a large, open space at the edge, presumedly adjacent to a notable topographical feature, i.e., creek, river, etc. The scattered model consists of eleven blocks with three square blocks, three upsized rectangular blocks, and five downsized rectangular blocks. We align one block with each edge and randomize the layout as much as possible to avoid generating a spatially dominant central or edge space, or an orthogonal grid layout, like in the other theoretical models. In the scattered model, we assume the open space is a vegetated landscape with trees, grass, and paths. For an urban campus based on a scattered model, we can safely assume that the urban street network will form the primary spatial framework of the campus, regardless of its configuration at the micro- or macro-scale. We can overlay and analyze these generic layouts for their impact on visibility and movement using all-line axial analysis and Visibility Graph Analysis (VGA). The former autogenerates a linear spatial structure from the vertex of every building footprint to every other one in each layout (Dalton, 2001; Turner et al., 2001; van Nes & Yamu, 2021) (Figure 10, bottom). The latter draws the visual field from each grid element to every other visual field, which is based on a standardized grid. The color range for the VGA analysis is specific to each layout. We standardize the color range for the all-line axial analysis based on the most extensive range (14.14-3.31 of the scattered model). We accept as given that we designed these theoretical layouts to highlight key differences. Because they involve design, an underlying logic is at work. The enclosed and edged layouts are more formally geometric, incorporating a primary open space within an explicit orthogonal layout, whereas the scattered layout attempts to reduce formal geometry to a degree without losing the formal controls established from the outset, i.e., plot size, overall footprint area, and parallel/perpendicular relationships.

All three models generate an abundance of angular route choices, either across a nominal street space/segment or an open space. In the enclosed model, there is a notable increase in the number of angular route choices crisscrossing through the central quad compared to the edged model. In the enclosed and edged models, the high degree of visibility within the primary open space shifts the primary focus for linear movement to the nominally north-south routes (if we treat the top of the figure as true north). In the enclosed model, these routes pass through the geometric center or edge of the central quad. In the edge model, these occur primarily along the roads through the blocks. In the edged model, the most integrated areas for visibility (in red) are more clearly extensions of the street vistas opening through the open space towards the western perimeter. In the enclosed model, the most integrated areas for visibility (in red) are also extensions of street vistas. However, they ‘merge’ to define rounder convex shapes, six distinct ones to the north of the central quad, and two larger ones in the south of the space. There are also two distinctly defined, moderately integrated spaces for visibility (in green) in the north of this central quad. In the edged model, there are four moderately integrated spaces for visibility (in green) next to the blocks. These spaces are metrically larger than two similar areas in the enclosed version. In the edged model, there are larger, less integrated spaces for visibility (in light green) available at the western edge of the open space and overall plot. In both the enclosed and edged models, the orthogonal layout places more emphasis (moderately so) on the street intersections than the segregated street segments, offering spatial variation along the facades in a typical urban fashion. In the scattered model, there are no distinctly defined street spaces, despite the parallel/perpendicular relationships of blocks. Therefore, the all-line axial analysis highlights the large number of angular routing choices throughout the layout.

In this sense, integration primarily derives from route length; hence, the most integrated one stretches from the eastern edge in the north to a block near the southwest corner of the layout. Four key locations within the layout are the most integrated for visibility (nominally defining quarters). However, they are significantly smaller in metric area than the most integrated areas for visibility in the enclosed or edged models. One in the southwest, through which the most integrated route passes, is larger than the others. There is much greater variation in the size and shape of integrated-to-segregated visibility in this scattered model than in the enclosed or edged ones. The scattered model tends to differentiate block facades, rather than along their length in the more traditional urban sense. In the scattered model, this would place greater emphasis on the location of doors to access blocks and how movement would navigate from block to block rather than pass by, thereby generating desire lines through the landscaped environment (Major et al, 2021). This model aligns with Atour's (2024) approach to describing, analyzing, and recommending urban permeability to enhance spatial navigation within the Education City campus.

What can we conclude from the experiment with these theoretical models? The enclosed model creates a focal point for visibility and static use within its central quad, emphasizing movement through and next to it, with the 'quieter' areas for visibility centrally found within that space, especially in the north of the quad. You can be seen but not disturbed, depending on your choice of location within its spatial variations. The edged model subtly differentiates the static use of its open space for visibility by marginally distancing from the primary movement routes passing through the blocks. The further you locate yourself in the open space away from the blocks, the less likely you are to be disturbed or seen. However, in both cases, the moment you cease static activity and begin to move, this is likely to change. Movement from the central quad in the enclosed model becomes multi-directional, i.e., towards blocks in three directions. This emphasizes the need for center-to-edge readability within the layout. We can see the effect of this in the potential for the intelligibility scatter of the original masterplan at the QU campus (refer to Figure 8, bottom left). However, as noted by Major et al. (2020), ground-level screening devices and multiple design interventions over decades in the building fabric of the BCR Corridors (forming a large part of the original QU masterplan) have led to the emergence of an 'edge-in' navigation experience and wayfinding problems.

Movement from the open space in the edged model is more likely to be unidirectional, i.e., towards the blocks in one direction. It emphasizes edge-to-edge readability within its layout. However, such edge-to-edge readability becomes compromised in the Education City masterplan, as its large open spaces along the western and southern edges (Doha Golf Club and Al Shaqab Equestrian Center) have limited public access. In the scattered model, visibility and axial integration become dispersed through the layout. This means that static use or movement can disperse in any direction or location. However, it does mean that the scattered model will tend to be more readable from an 'edge-in' perspective, since these plots will have a larger context. There is more variation across everything (parts, block sizes, visible integration, and angular route choices), which makes everything less clear. Spatially, more variation becomes less clear. There is evidence for this occurring in the intelligibility scatter for Education City, and an emerging possibility in the QU campus due to its recent expansions (Major & Tannous, 2024).

Conclusion

Based on morphological and space syntax analyses of Qatar University and Education City in Doha, the study concluded that these contemporary campuses constitute a distinct urban typology characterized by extreme spatial scale, fragmented layouts, and compromised spatial intelligibility. Key findings reveal fundamental differences in development patterns. QU evolved centrifugally (center outward), preserving traces of its original enclosed modular design with courtyards. Education City developed centripetally (edges inward), resulting in a disjointed aggregation of parts around perimeter transit nodes and vehicular routes. Both campuses face critical challenges due to their vast footprints (average block sizes that are more than twice Doha's urban average), the dominance of freestanding buildings, and limited active frontages. Pedestrian shed analysis confirms prohibitive walking distances (up to 1,500 m from geometric centers), due to Doha's harsh climate, which forces reliance on vehicular and metro systems, reinforcing 'edge-in' accessibility but not integrating internal movement to a significant degree, more so in Education City than at Qatar University. Space syntax models further show poor spatial intelligibility in both campuses. Peripheral expansions have begun to erode QU's original intelligible structure (centered on the original master plan), prioritizing entry roads and disrupting center-to-edge readability. Education City's layout shows severe fragmentation: only the entry roads exhibit spatial logic, while internal routes lack coherence, suggesting ad hoc planning despite an overarching master plan. This manifests as unstructured vertical layering in the intelligibility scatter, undermining wayfinding and social interaction.

Theoretically, this paper advances a tripartite campus typology — enclosed, edged, and scattered models — to frame global campus morphologies. Visibility Graph Analysis (VGA) of these models shows their distinct socio-spatial impacts:

- Enclosed models (e.g., the American central quad campus model) can foster focal visibility and multi-directional movement but require center-to-edge coherence and ample cross-circulation opportunities.
- Edged models (e.g., the Oxbridge cloistered model) can emphasize edge-to-edge readability but risk underutilizing open spaces if limiting general access to such spaces or restricting such spaces for future expansions as vacant land.
- Scattered models end to disperse visibility and movement, increasing navigational ambiguity, though they can offer greater flexibility of developmental expansion, especially in intensely urban conditions, with the preexisting street layout providing a spatial framework.

In practice, both campuses in Doha amalgamate elements of all three models, yet their scale amplifies inefficiencies. QU's abandonment of small-block walkability and Education City's disconnected open spaces (e.g., Al Shaqab Equestrian Center, Doha Golf Club, Oxygen Park) highlight planning oversights. The implications for campus planning include prioritizing human-scale elements while integrating transit, theoretical hybridization, and climatic and cultural adaptation. Campuses must strike a balance between expansion and pedestrian-scaled blocks, active frontages, and cross-circulation pathways to mitigate scale barriers. Metro and tram systems should penetrate campus cores, not just perimeters, to unify access and internal circulation. Successful campuses must integrate enclosed centrality (social hubs), edged buffers (environmental/climatic adaptation), and controlled scattering (flexibility) without sacrificing intelligibility and readability for users. In arid regions, compact forms, sheltered walkways, and nighttime-activated frontages can be crucial for offsetting climate-driven spatial fragmentation. The research underscores that campuses, as 'cities within cities,' cannot thrive as mere abstract land-use zones. Their functionality depends on configurational clarity, i.e., the harmonious fitting of parts within a legible whole. Future planning must recenter on morphological principles to avoid self-isolating academic enclaves and ensure that campuses evolve into integrated, socially vibrant, and resilient urban ecosystems.

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The authors declare no competing interests.

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