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Spatial Culture of Traditional Syrian Courtyard Houses in Old Damascus

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ABSTRACT

The paper reviews the form and function of twelve (12) traditional Syrian courtyard houses in Old Damascus. We deploy multiple representational techniques to understand these houses' formal and spatial logic: figure-ground, structural/functional grid, relational (unjustified) graphs of convex spaces, a rank ordering of convex spaces, and space syntax modelling combining convex spaces and axial lines. All houses bear evidence of structural aggregation in the architectural form. Due to their age and setting in one of the oldest, continuously inhabited cities in the world, there is a straightforward articulation between hospitality/everyday living spaces on the ground floor and private domestic rooms on the first floor. However, spatial nuances do appear in the relationship between everyday living spaces associated with the courtyards, hospitality spaces related to the main entry, and private/service spaces (e.g., bedrooms and kitchen), which define the housing genotype of these traditional Syrian courtyard houses. The study's findings add further to our knowledge about courtyard houses in the Middle East.

KEYWORDS

domestic space, courtyard houses, family, function, Middle East

1   INTRODUCTION: PURPOSE AND SETTING

The study began as an exercise for undergraduate students of the Bachelor of Architecture (BArch) Program in the Department of Architecture and Urban Planning (DAUP), College of Engineering (CENG) at Qatar University (QU). Working as teams in a parallel studio, second-year students had the task of redrawing a house plan and deploying a small set of representations based on a sample of traditional Qatari and Syrian courtyard houses. Initially, instructors selected the Syrian case study houses based on comparable size to the Qatari houses. The techniques were figure-ground, structural grid, functional grid, relational graph, and the rank ordering of spaces.

The purpose was to instruct the students on the methods they might deploy to enhance their understanding of precedent studies and develop formal and programmatic conceptual ideas for studio projects based on first-hand experience with a real-world example.

Later, space syntax researchers in the DAUP-CENG at QU corrected, refined, standardised, and expanded the raw material produced by the undergraduate students for this research study. It included increasing the sample size of houses, reorienting the plans to true north, setting to a standard scale, and incorporating space syntax analysis by constructing a model combining the houses' axial and convex mapping. The modelling utilised a loading method in DepthMapX outlined in previous research about an educational building at QU (Major et al., 2019). The space syntax analysis aimed to quantify if there was a discernible housing genotype in the samples.

Based on discussions between the instructors and undergraduate students about their findings, researchers split the traditional Qatari and Syrian courtyard house samples into separate studies. Comparing the courtyard houses in each country (Qatar, Syria) proved more interesting than the initial results across the broader Middle East North Africa (MENA) Region.[1]

The study in this paper consists of twelve (12) traditional courtyard house plans in Damascus, Syria (listed here from smallest to largest building footprint): Uthman Beik House, Al-Kateb House, Umam Bint Al-Harith House, Al-Subahi House, Houraniyya House, Lizbona House, Balud House, Al-Hijazi House, Set Al-Banin House, Abd Al-Noor House, Al-Quwatli House, and Warda House (**Figure 1**). In the Middle East, house names usually derive from the owners' family name most associated with the home, either currently or in the past. All houses are two-storey with floor plans for both floors, except for the primarily single-storey Al-Kateb House and Houraniyya House. The two-storey Warda House is the only house with a basement and floor plans for all three levels. Short descriptions of every house with a site plan, scaled floor plans labelled with functions, cross-sections, exterior and interior elevation drawings, decorative details, and photographs are available in Sakka's (2018) book, *Damascine Traditional Houses*.[2] We did not include seven house plans in the book for this study, primarily due to size for the initial comparison with traditional Qatari courtyard houses. However, researchers also aimed to balance simplicity and complexity in the house plans for the original student exercise.

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[1] MENA is an acronym lacking a standard definition. It means a vast region stretching east-to-west from Iran to Morocco, synonymous with the Arab World. It commonly includes the countries of Algeria, Bahrain, Egypt, Iran, Iraq, Palestine, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates (UAE), and Yemen. Others sometimes include Chad, Cyprus, Mauritania, Northern Cyprus, Sudan, Somalia, and Turkey in the region.
[2] The book was a gift to Dr. Major in 2018 from Dr. Sakka's niece, Salma, then an undergraduate student of the BArch Program in the DAUP-CENG at QU.
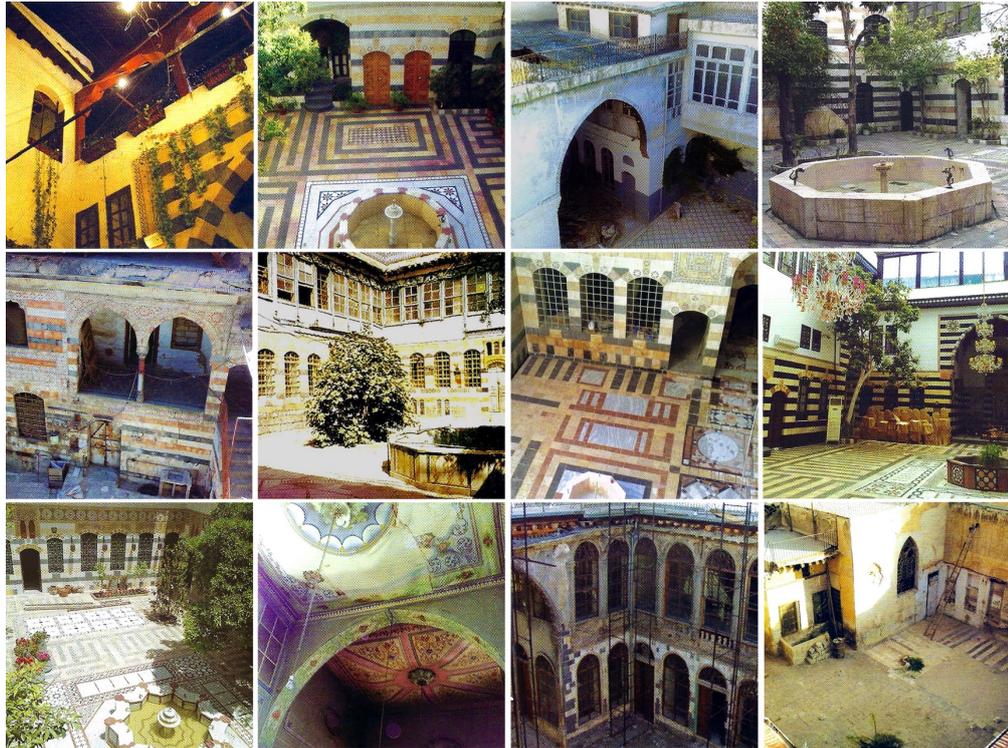
Figure 1: Views of the twelve (12) traditional Syrian courtyard houses of the sample: (top, left to right) Uthman Beik House, Al-Kateb House, Umam Bint Al-Harith House, Al-Subahi House; (middle, left to right) Houraniyya House, Lizbona House, Balud House, Al-Hijazi House; and (bottom, left to right) Set Al-Banin House, Abd Al-Noor House, Al-Quwatli House, Warda House (Source: Sakka, 2018). *NOTE: Sakka's (2018) interest is to promote the preservation of some of these houses. Available images reflect this goal instead of featuring the spaces of the house, especially the last three.*

The book focuses heavily on the decorative elements of these houses, including exterior house and interior hall elevations, floor coverings and tiling, type, details, and articulation of arches, niche details, and stone, tile, and wood details. Sakka's (2018) focus is the houses' highly decorative iwans. However, he is also promoting the rehabilitation of some homes in the book to Syrian government officials (Sakka, 2018). An *iwan* is common in Arabic and Persian domestic architecture. It refers to a rectangular hall or space, often vaulted, walled on three sides with one end entirely open to an area, usually the courtyard. The definition of iwan varies across the region for scale, material, and decoration. Calligraphy bands, glazed tilework, and geometric designs often decorate iwans. However, a space can still function as a formal iwan without decorative elaboration. For our purposes, the iwans are of less interest than the entries, courtyard, living, kitchen, and the male and (if any) female majlis spaces related to the domestic functioning of the entire layout. A *majlis* is a common term (meaning 'council') in Arabic and Persian domestic architecture referring to a hospitality space to receive and entertain guests, equivalent to a lounge or salon in the French and English tradition (Jaidah & Bourennane, 2009; Al-Mohannadi et al. 2019). Many Middle Eastern residences possess a majlis, often with separate hospitality spaces for males and females. However, the family's everyday living space often serves a dual function as the female majlis since the private domestic areas of the house were usually the domain of female family members (Zako, 2006; Al-Mohannadi et al., 2019).

The scaled floor plans with functional labels in Sakka (2018) offer an opportunity for closer examination of domestic form and culture in traditional Syrian courtyard houses using space syntax and other representations of architectural morphology research. The labelling of room functions in the floor plans is helpful, though standardised into general types for all houses: iwan, halls, rooms, kitchen, bath, and service. Based on the floor plans, layout organization, and available information, researchers developed more specialised labelling of room functions for the courtyard(s), iwan(s), living room, kitchen, male and female majlis, bedrooms, covered verandas (distinguishable from the iwans), and distinctions between the main and secondary entries, discernible in the site and floor plans for each house. We use the category 'other' for rooms where we could not identify the principal function. The initial comparison with the Qatari courtyard houses sample was influential for assigning probable room functions in the Syrian houses, as were the observations of the undergraduate students during their exercise.
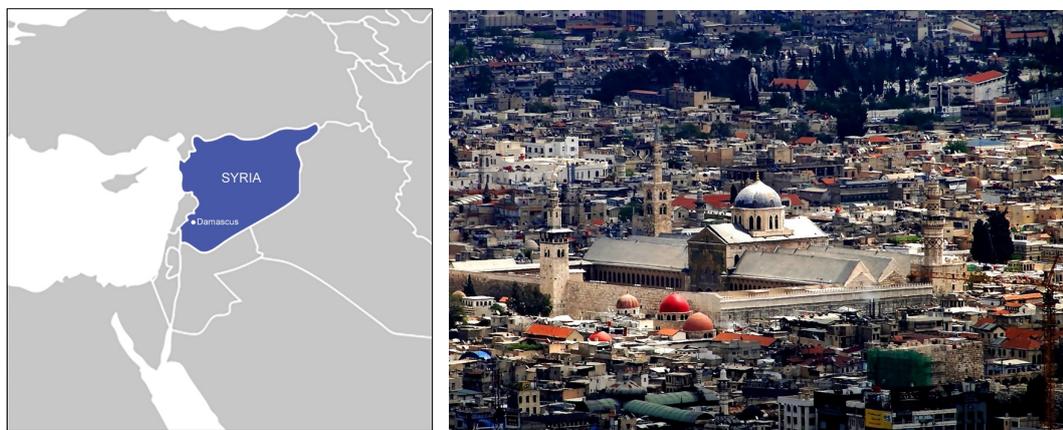
Figure 2: (left) Syria and the City of Damascus in the Middle East and (right) aerial view of the Umayyad Mosque, e.g., Great Mosque of Damascus, in the old city of Damascus, Syria in 2020 (Sources: Authors/Ayman Aumi/Wikipedia).

All the sample houses are in the Ancient City of Damascus (or Old Damascus) in Syria. They are either inside or immediately outside the city walls. Damascus is one of the oldest, continuously inhabited settlements globally, if not the oldest depending on whom you ask (Major & Al-Nabet, 2018) (Figure 2). Historically, there have been lasting cultural influences on Damascus' built environment, but the Hellenistic, Roman, Byzantine, and Islamic are among the most significant ones. The city walls date from the Roman era. These cultural influences resulted in a vibrant architectural heritage in the city, including traditional courtyard houses dating from the late 16th to the 19th centuries. There have also been many significant rehabilitation efforts in the late 20th-early 21st century. These rehabilitations either maintain their functions as private residences or involve adaptive reuse for government buildings, public or private schools, restaurants, and luxury boutique hotels (Sakka, 2018).

Sakka (2018) provides information about the date of construction (if available or relevant), neighbourhood, building footprint and total floor areas in square metres (m²), some brief history, and other features about these houses (Table 1). The metric area of the building footprints ranges

from 280 m² (Uthman Beik House) to 1,280 m² (Warda House), with a mean building footprint of 739.6 m² in the entire sample. The total floor area ranges from 330 m² (Uthman Beik House) to 1,900 m² (Warda House), with a mean total floor area of 1,027.1 m². There are two houses each in the Al-Amin and Al Qanawat neighbourhoods, three each in the Bab Toma and Mazanet Ash-Shahm areas, and one each in the Al-Qaimarryeh and Shaghour Jouwany neighbourhoods of Old Damascus. Al Qanawat lies immediately outside the city walls to the west. This sampling across several neighbourhoods is a consequence of Sakka's (2018) original selection for the book. It is unclear whether it is intentional or not. However, he presents traditional Syrian courtyard houses across a reasonable selection of neighbourhoods in Old Damascus (Sakka, 2018). Nine houses date to the 18th or 19th century. Balud House is the oldest house, dating to the late 16th century (Sakka, 2018). Sakka (2018) does not provide an original construction date for two of the homes (Lizbona and Set Al-Banin).

Table 1: Data available in Sakka (2018) for the date of construction, neighbourhood, building footprint and total floor area (m²) for the houses of the sample (Source: Authors after Sakka, 2018).

ID	House Name	Date Constructed	Location	Footprint (~m²)	Floor Area (~m²)
1	Uthman Beik	19th century	Al-Amin	240	330
2	Al-Kateb	19th century	Bab Toma	400	400
3	Umama Bint Al-Harith	19th century	Al-Qaimarryeh	475	750
4	Houraniyya	19th century	Shaghour Jouwany	670	670
5	Lizbona	Unknown	Al-Amin	730	1050
6	Balud	Late 16th century	Al Qanawat	750	950
7	Al-Hijazi	Mid-18th century	Al Qanawat	750	950
8	Set Al-Banin	Restored 2011	Mazanet Ash-Shahm	850	1190
9	Al-Subahi	1769	Mazanet Ash-Shahm	880	1395
10	Abd Al-Noor	19th century	Bab Toma	900	1450
11	Al-Quawatli	Early 18th century	Mazanet Ash-Shahm	950	1290
12	Warda	19th century	Bab Toma	1280	1900
	Mean			739.6	1027.1

In the following sections, we briefly review the current state of our knowledge about traditional courtyard houses based on the literature, emphasising a selection of studies over the last decade. We then introduce some descriptive information about the sample's traditional Syrian courtyard houses before proceeding to the analysis and findings section. Finally, there is a brief discussion about avenues for future research before bringing the paper to a conclusion.

2   LITERATURE: OVERWHELMING NEED AND RESPONSE

There is always a need for housing research. Urban land still accounts for only 1% of the world's total inhabitable land (Source: UN Food and Agricultural Organization). However, housing tends to account for 60-80% of the buildings in most cities globally, even though the definition of urban areas, their land uses, and residential types (low-, medium-, and high-density) may vary considerably (Source: American Planning Association). Oliver (2003) argues it is even more with

vernacular architecture representing more than 90% of the world's buildings. It is readily apparent that housing is the most critical building type and urban land use worldwide, affecting everyone's lives.

Unsurprisingly, it means there is a large amount of literature about housing on an assortment of topics (Major and Sarris, 2001; Vaughan et al., 2007; Chiu et al., 2017; Fletcher & Carter, 2017; Karahan & Davardoust, 2020; Park & Ji, 2020; Shi et al., 2020; Xu et al., 2020; Zhen et al., 2020). It is too much to briefly summarize in one book, much less a single paper. Recently, Azad et al. (2018) studied housing layouts to understand better their impact on space openness and quality of space in urban residential areas of Tehran, Iran. Ju et al. (2018) and Tao et al. (2018) used survey data. The former investigated the concept of dualism in five Javanese houses in Indonesia. The latter identifies four housing types with a significant degree of spatial overlap in more than 2,000 traditional villages of the Meizhou region in the eastern Guangdong province of China. Tao et al. (2018) argue their findings are evidence of morphological isomerism at work in China, whereby houses have the same cultural essence based on spatial prototypes despite their varied formal compositions.

An emphasis on vernacular housing, and specifically courtyard houses, is common. Zako (2006) examined gender inequity in traditional courtyard houses in Arab and Islamic cities. Al-Mohannadi et al. (2019 and 2020) studied the socio-cultural factors shaping the spatial form of traditional and contemporary housing in Qatar. The latter parlayed those results into developing a cultural heritage framework to preserve historic courtyard houses in Qatar. Karahan and Davardoust (2020) studied vernacular dwellings in the Uzundere district of Erzurum Province in the Eastern Anatolia region of Turkey, focusing on climate, natural ventilation, and architectural typology. Qiao and Shih (2020) also examined traditional courtyard houses in the Li Canal reach of Huai'an and Yangzhou in China. Their qualitative approach was informative and comprehensive, encompassing structure, architecture style, roof plan features, floor plan, and construction methods.

In contrast, the study of Wang et al. (2019) focused on shared atrium spaces of amalgamated mixed-status-family traditional residential buildings in the West Street area of Quanzhou City, Fujian Province, China. Abdelkader & Park (2018) offered a fascinating study of spatial principles at work in traditional courtyard houses of Cairo. Remali et al. (2016) developed a chronological evolution of housing typologies in four major cities in the Gulf region, namely Doha in Qatar, Dubai and Abu Dhabi in the United Arab Emirates (UAE), and Manama in Bahrain. The latter two focused on the spatial composition of the case studies (as Abdelkader & Park later clarified about their paper's title). It is more consistent with March, Martin, and Steadman's early studies at Cambridge University, instead of domestic spatial structure in the space syntax research of Hillier, Hanson, and others at University College London (Hanson, 1998). Nazidizaji and Safari's (2013) study searched for inverted house genotypes in the spatial

logic of three traditional Persian courtyard house types in the central Iran cities of Kashan, Yazd, and Shiraz using space syntax. It was a collaboration between Instituto Superior Tecnico at Universidade de Lisboa and the Architectural Faculty of Built and Environment of Universiti Teknologi Malaysia, representing a research output in line with the methodologies of Hanson (1998) and others.

The most significant tradition of architectural morphology research ('the study of architectural form and space') for housing, domestic space, and its cultural meaning for the people who live there principally emerges from these two sources: Cambridge University and University College London (UCL). The Built Form and Land Use Studies Group (now The Martin Centre for Architectural and Urban Studies) at Cambridge University and the Unit for Architectural Studies (now Space Syntax Laboratory) at UCL in the United Kingdom. Both UK programs have studied housing for decades. However, we can trace the origins of such research back further to Rapoport's (1969) *House Form and Culture* and Glassie's (1976) *Folk Housing in Middle Virginia*. Collectively, all this research represents a mere fraction of the number of research studies about house form and culture at other academic institutions worldwide. Such analysis relies on a long-established set of techniques – often plan-based – to better understand residential buildings. These methods include figure-ground representations, structural and functional grids, adjacency matrix tables, convex and axial mapping, visibility graph analysis, relational graphs, the rank ordering of room sizes and functions, and more such as shape grammars.

The aim of such research varies – and the techniques accompanying them – depending on the specific problem examined in such studies. It might be the culturally reproductive nature of house form for family life in vernacular housing for different geographical, historical, and cultural realms (Glassie, 1976; Hanson, 1989). It could be decoding the socially productive or innovative nature of design intentions of specific architects and stylistic movements as manifested in residential houses (Major and Sarris, 2001; Vaughan et al., 2007). Nonetheless, the broad intent is the same for developing a deeper understanding of architectural space and form's effect on culturally shaping *and* being shaped by relations amongst distinct functions and types of users in domestic space and how they might change over time. It includes physical and spatial relations between public and private space, everyday living and bedroom spaces, service and served spaces, and so on, as well as social ties between types of users and their roles in domestic space, such as visitors and residents, males and females, adults and children, etc. The study in this paper firmly resides within the tradition of space syntax research on residential housing to identify the role of house form in shaping the domestic life of its users.

3   ABOUT THE CASE STUDY HOUSES

It is somewhat ironic that Balud House and Al-Hijazi House most closely approximate the typical house profile in the sample for building footprint and total floor area based on the information provided in Sakka (2018) (refer to Table 1). These are the only houses immediately outside the

Roman city walls (**Figure 3**). Sakka (2018) provides a site plan encompassing one-half square kilometre (0.5 km²) of the surrounding urban context, including all building footprints indicating the location of each house. In some cases, he also provides descriptive information in the text for orientation purposes. Based on this information, we plotted the approximate location of each house as best as possible. One or two houses were challenging to locate precisely. The northwest quadrant of the city near the Umayyad Mosque (refer to Figure 2, right) is the only area of Old Damascus unrepresented in the sample.
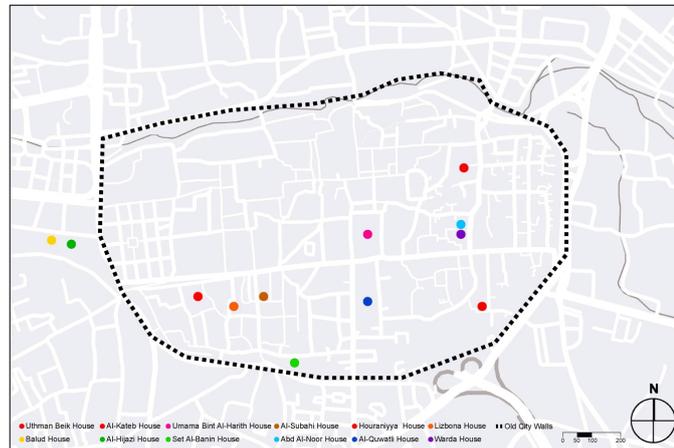

Figure 3: Approximate location for all twelve (12) houses of the sample in relation to the city walls of Old Damascus (Source: Authors/Google Maps).

Uthman Beik House is a 19th-century house in the Al-Amin neighbourhood of Old Damascus, previously inhabited by a well-known Syrian family but adaptively reused today as a restaurant serving traditional Syrian cuisine. Al-Kateb House is a 19th-century house in the Bab Toma area. It does have a 155 m² first floor, but the first-floor plan is unavailable (Sakka, 2018). However, the first floor seems mostly a roof terrace with only a single room, perhaps a summer majlis based on photographs. Umama Bint Al-Harith House is a 19th-century house in the Al-Qaimarryeh. The Syrian Ministry of Education used the house as a school for decades. Because of this, researchers assigned room labels to the floor plans based on the most probable scenario for its original domestic functions. Sakka (2018) deems Umama Bint Al-Harith House in poor condition, requiring urgent rehabilitation. It possesses a 90 m² basement. The basement floor plan is unavailable. Sakka (2018) pinpoints the date of construction for Al-Subahi House as 1769 CE. It is in the Mazanet Ash-Shahm neighbourhood. Houraniyya House is a 19th-century house in the Shaghour Jouwany neighbourhood inside the city walls. Owned by the City of Damascus, Sakka (2018) considers the house of high archaeological value but in an extreme state of deterioration. It does possess a first floor. However, it appears to only consist of a summer majlis with an iwan based on the section drawings, location of stairs in the ground floor plan, and photographic documentation (Sakka, 2018). We did not consider the first floor in the analysis. The date of construction is unknown for Lizbona House in the Al-Amin neighbourhood. It contains some of the most luxurious halls in Old Damascus, but Sakka (2018) characterises its physical condition as poor, requiring urgent rehabilitation efforts.

Al-Kateb House

Uthman Beik House

Balud House

Lizbona House

Umama Bint Al-Harith House

Al-Subahi House

Al-Hijazi House

Houraniyya House

Al-Quwatli House

Abd Al-Noor House

Set Al-Banin House

Warda House

C=Courtyard   Mm=Male Majlis
L=Living   Mf=Female Majlis
K=Kitchen   B=Bedroom

KEY
▲ Main Entry
▲ Secondary Entry

N
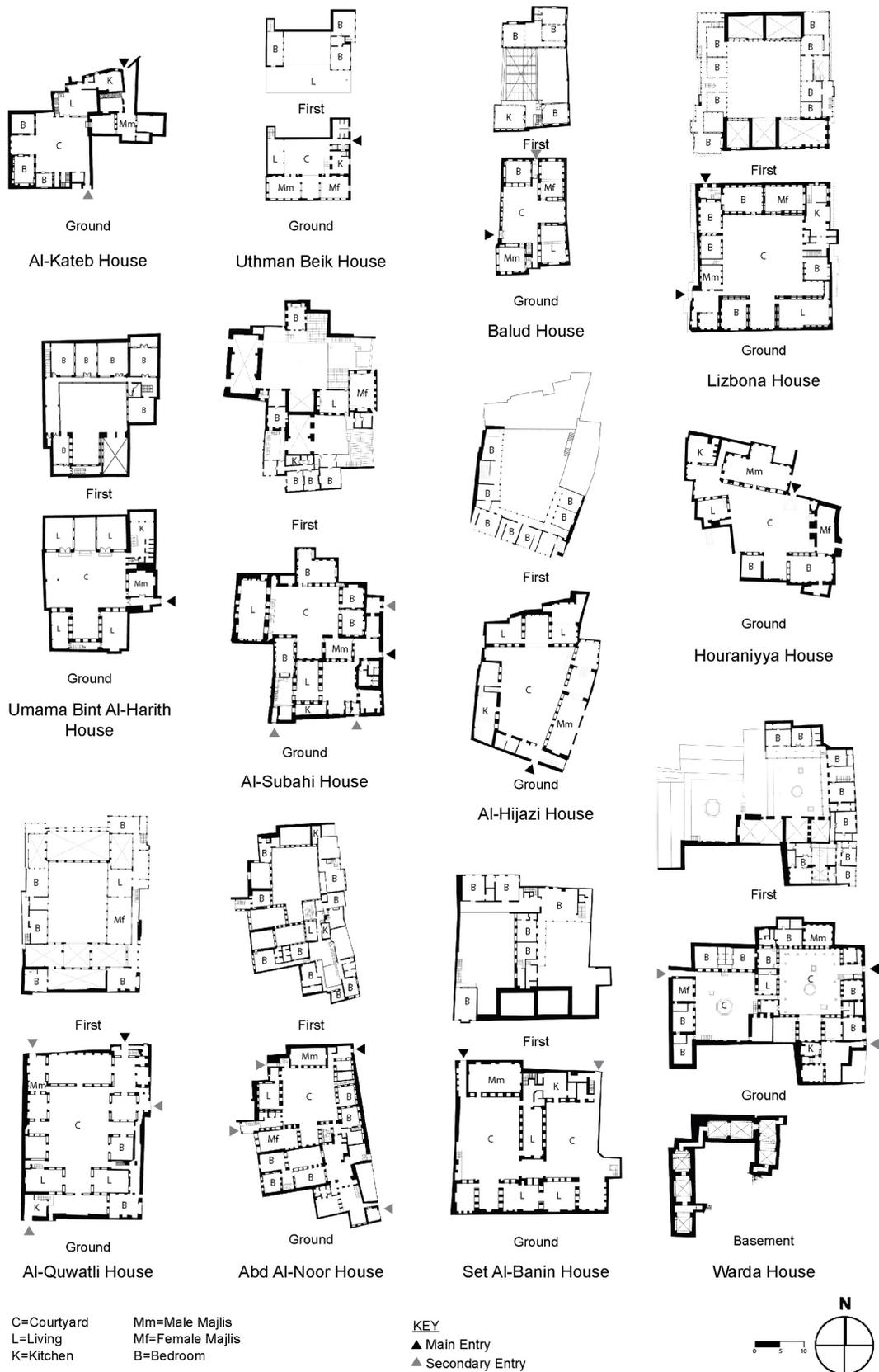
Figure 4: Floor plans for the twelve (12) Syrian courtyard houses of the sample, indicating the main/secondary entries and assigning of room functions (Source: Authors after Sakka, 2018).

Balud House is a late 16th-century house in the Al Qanawat area, immediately outside of the city walls. Al-Hijazi House is an 18th-century house in the Al Qanawat neighbourhood in the southwest, immediately outside of the city walls near to Balud House. In the late 20th century, it became a school before rehabilitation in the early 21st century into a traditional Syrian restaurant on the ground floor with a boutique hotel on the first floor. The Syrian Architecture and Heritage Foundation finished the restoration of Set Al-Banin House in the Mazanet Ash-Shahm neighbourhood in 2011. The restoration aggregated Set Al-Banin House from two smaller courtyard houses, connecting them via a wide covered portico. Because of this, it does not possess a historical construction date (Sakka, 2018). Currently, it is a private residence. It has a 150 m² basement, but the plan is unavailable.

Abd Al-Noor House is a 19th-century house in the Bab Toma neighbourhood of Old Damascus. The current building consists of three smaller houses aggregated into a luxury hotel during an early 21st-century rehabilitation project. Al-Quawatli House is an early 18th-century house in the Mazanet Ash-Shahm neighbourhood. Sakka (2018) describes it as one of Damascus' most important old houses, arguing its original design prioritised social events over domestic functions. Finally, Warda House is a 19th-century house in the Bab Toma area, immediately north of the Abd Al-Noor House. It consists of two courtyard houses aggregated together in the past (date unknown) to become the Angelical School. Subsequently, a private company purchased Warda House, intending to rehabilitate the building into a luxury hotel. Based on satellite imagery, it is unclear whether this rehabilitation project is pending, underway, or complete as of 2021. It is the only house in the sample where the basement floor plan is available and included in the analysis.

4   FORMAL ARRANGEMENT

Researchers redrew the house plans, set them to a standard scale, and oriented to north based on the information available in Sakka (2018) (Figure 4). Seven houses possess a building footprint with a rectangular shape, or nearly so with small extensions or protrusions. This number increases to ten if accounting for the aggregation of two courtyard houses into a single structure for Al-Subahi House, Set Al-Banin House, and Warda House. The other five houses possess irregular polygon footprints due to either conforming to the land plot shape or arising from the aggregation of building extensions, out of which the courtyard emerged over time. There are seven houses with courtyards surrounded by rooms on all four sides; nine if accounting for Warda House and the eastern portion aggregated into the enlarged Al-Subahi House. There are five houses with courtyards on three sides, increasing to eight if accounting for aggregated courtyard houses into large structures for Set Al-Banin House, the southern part of Al-Subahi house, and the western house in the enlarged Warda House. These courtyards possess (or once did) a common wall with the adjacent house/plot or an exterior yard. All these formal characteristics appear unrelated to age or neighbourhood.

The structural grid indicates some evidence for the widespread aggregation of rooms and block extensions in all these houses. The current courtyard form emerges instead of being designed as a courtyard house with a cohesive structural logic. Based on Sakka (2018), it appears as if the structure of load-bearing walls remains mostly intrinsic to specific parts or sub-blocks of each house, except for the perimeter walls. However, we must be careful about drawing too many conclusions about the structural grids. Sakka (2018) does not represent overhead structural beams on his floor plans and provides only two or three building sections per house (most often a central cross-axis). There is also limited photographic evidence. He does not give 1) many photographs of individual rooms in these houses nor 2) descriptive captions for any of the available photographs (Sakka, 2018). A closer examination might reveal a more consistent structural logic within some houses instead of the individual sub-blocks.

A functional grid is like a structural grid but focuses on the adjacent relationship of specific room functions instead of load-bearing elements in the plan. It does this by ignoring minor deviations of architectural form in favour of a more rigid geometrical grid composition. In our sample, we do this by ignoring the angle of walls at less than 15º and incorporating ones greater than 15º of a parallel and perpendicular relationship, following the geometric logic for deformed grids at the urban level (Hillier, 1999).
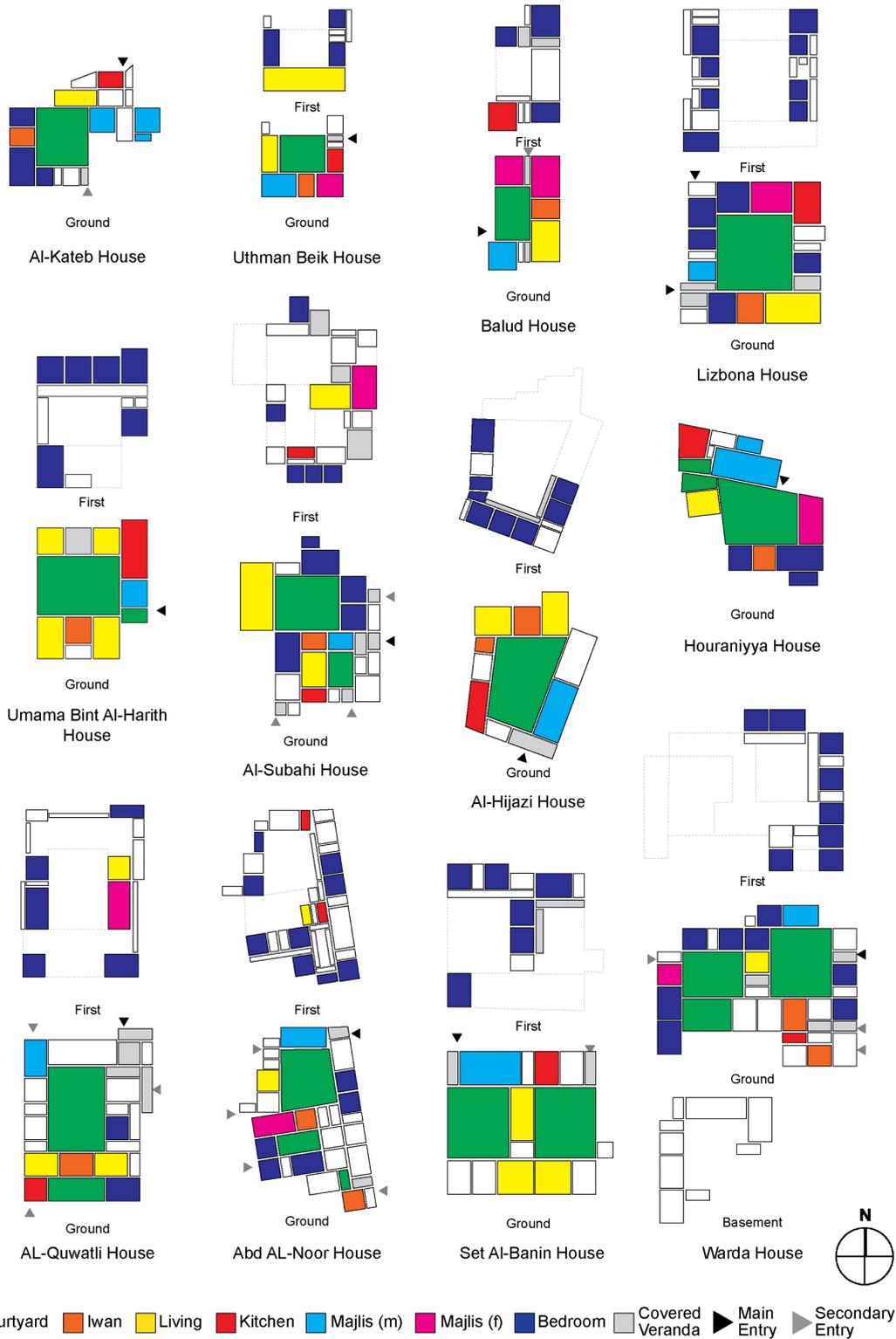
Figure 5: Functional grid of the twelve (12) Syrian courtyard houses of the sample, colour-coded to indicate the courtyards, iwans, living, kitchen, male majlis, female majlis, bedrooms, and covered veranda (Source: Authors).

We colour-code the courtyard, iwans, verandas, kitchen(s), living/female majlis, male majlis, and bedrooms for reference. The most striking thing about the functional grids of these houses is the separation across floors (**Figure 5**). The ground floor prioritises everyday living and hospitality spaces, whereas bedrooms separate on the first floor to generate privacy. The only exceptions are

the houses primarily single-story in nature, i.e., Al-Kateb House and Houraniyya House. These houses generate privacy for the bedrooms using the farthest possible metric distance from the main entry. Abd Al-Noor House does the same for some bedrooms in the southern portion, aggregated into its large structure, originally three separate courtyard houses. All but two houses have covered outdoor verandas. Perhaps surprisingly, none associated with the perimeter of the courtyard spaces on the ground floor. There is an outdoor covered veranda partially along the edge of the courtyard spaces on the first floor of Al-Hijazi House and Set Al-Banin House. All iwans tend to have an adjacent relationship with a courtyard and everyday living space(s). The male majlis hospitality spaces also tend to be near or adjacent to main or secondary entries. Houses with a female majlis tend to locate these spaces near ground floor entries but require a notable change of direction to access the room. Alternatively, the female majlis is on the first floor, with more privacy due to the elevation change. Kitchens tend to occupy the corner of the building footprint or did before aggregation into a larger structure. However, it is not consistent for the entire sample. Two houses (Abd Al-Noor House and Al-Subahi House) even have small kitchen spaces on the first floor.

5   SPATIAL LOGIC

Figure-ground representations are two-dimensional maps illustrating the relationship between the built form and unbuilt space in a building or place where the form appears in white and space in black. Such maps highlight spatial groupings by differentiating the figure, i.e., space, from the back*ground,* i.e., form. The figure-ground of each dwelling in the sample highlights the proportions of the central courtyard or individual courtyards relative to the size of separate rooms (Figure 6). Unsurprisingly, the courtyard(s) occupy a significant percentage (26.9%) of the total building footprint across the sample (Table 2). There is an average of 1.4 courtyards per house, and the courtyard proportion of the building footprint ranges from a low of 18.8% for Abd Al-Noor House to a high of 37.7% for Set Al-Banin House.

Table 2: Approximate number and size of the courtyards in square meters (m²) and percentage of building footprint in the courtyard houses of the sample (Source: Authors after Sakka, 2018).

ID	House Name	Building Footprint (~m²)	Courtyards (#)	Courtyard Area (~m²)	Courtyard (~%)
1	Uthman Beik	240	1	58.90	24.5%
2	Al-Kateb	400	1	93.08	23.3%
3	Umama Bint Al-Harith	475	1	153.90	32.4%
4	Houraniyya	670	1	172.10	25.7%
5	Lizbona	730	1	221.02	30.3%
6	Balud	750	1	172.90	23.1%
7	Al-Hijazi	750	1	239.33	31.9%
8	Set Al-Banin	850	2	320.23	37.7%
9	Al-Subahi	880	2	184.80	21.0%
10	Abd Al-Noor	900	3	169.00	18.8%
11	Al-Quawatli	950	1	209.77	22.1%
12	Warda	1280	2	366.54	28.6%

| Mean	739.6	1.4	196.80	26.9%
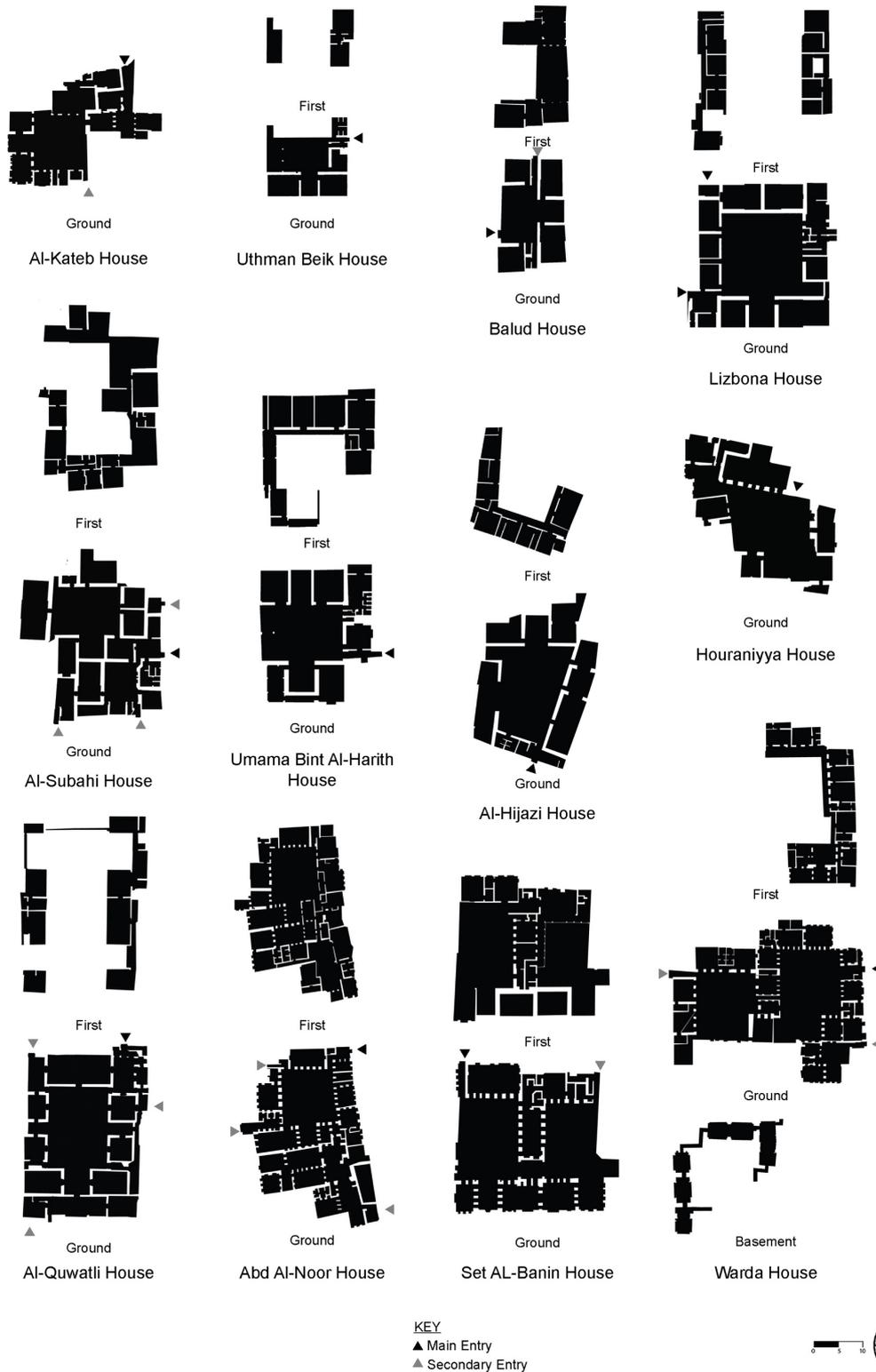
Figure 6: Figure-ground representation of the Syrian courtyard houses of the sample, showing the spaces of the houses in black and the built form in white (Source: Authors).

However, these proportions appear unrelated to age, neighborhood, or size. Only three (3) courtyards are square or square-ish (Figure 7). One square(ish)-shaped courtyard is marginally a quadrilateral or a four-sided polygon. Twelve courtyards are rectangular, slightly longer in one

dimension than the other. Two courtyards are quadrilaterals, also a little longer in one dimension than broader in the other.

Figure 7: Rank ordering from largest to smallest of the convex spaces for the courtyards of the houses in the sample. (Source: Authors).

The permeability graph is a relational (unjustified) graph based on the arrangement of convex spaces and 'permeable' thresholds between them, i.e., allowing people to pass through. We represent each space as a node (e.g., circle) and the threshold connection between them as a line, colour-coding the nodes based on room function. Permeability graphs help illustrate relationships between domestic functions and various parts of the house. We only include thresholds between rooms as a separate, small convex space if the wall thickness is sufficient to obscure an average human being. It does occur in every house to one degree or another (Figure 8). The graphs make clear the separation across floors. All possess at least one ring of circulation connecting the first floor to the ground floor, except for the single-storey Al-Kateb House and Houraniyya House, Uthman Beik House, Balud House, Warda House, and the eastern first-floor wing of the Lizbona House. However, all these circulation rings between the ground and first floor tend to occur at the end of long spatial sequences, indicating a heightened degree of privacy on the first floor.

Seven houses possess two or more stairwells connecting the ground floor and first floor; eight if you include the circulation ring between the ground floor and basement in Warda House. Four houses possess three stairwells each, and one has five stairwells. The last is Abd Al-Noor House, which is a consequence of aggregating three courtyard houses into a single structure. The graphs highlight the importance of the courtyard(s) as a control point in every house, where these spaces facilitate, but mainly mediate, access to distinct parts of the house. It is most apparent in the single-storey Al-Kateb House and Houraniyya House and the ground floor of Lizbona House and Al-Hijazi House. However, it is consistent in every house. Al-Quwatli House appears to possess the courtyard with the most interconnectivity between other parts of the house. Twelve distinct circulation rings pass through its courtyard, and only a single sequence leads to a storage space under a stairwell. Al-Kateb House offers the most evident distinction between the main house and a hospitality wing, including the main entry and male majlis. The same occurs in most other houses but with subtler differences in the spatial layout. Half of the houses locate the male majlis on a separate, usually short tree sequence. It occurs in houses at the opposite end of the size range, i.e., the smallest and largest. The other six houses locate the male majlis on a circulation ring localised to a specific house wing, meaning the route tends to return to the courtyard. Due to fire safety concerns, kitchens tend to locate on tree sequences or circulation rings localised to separate wings.
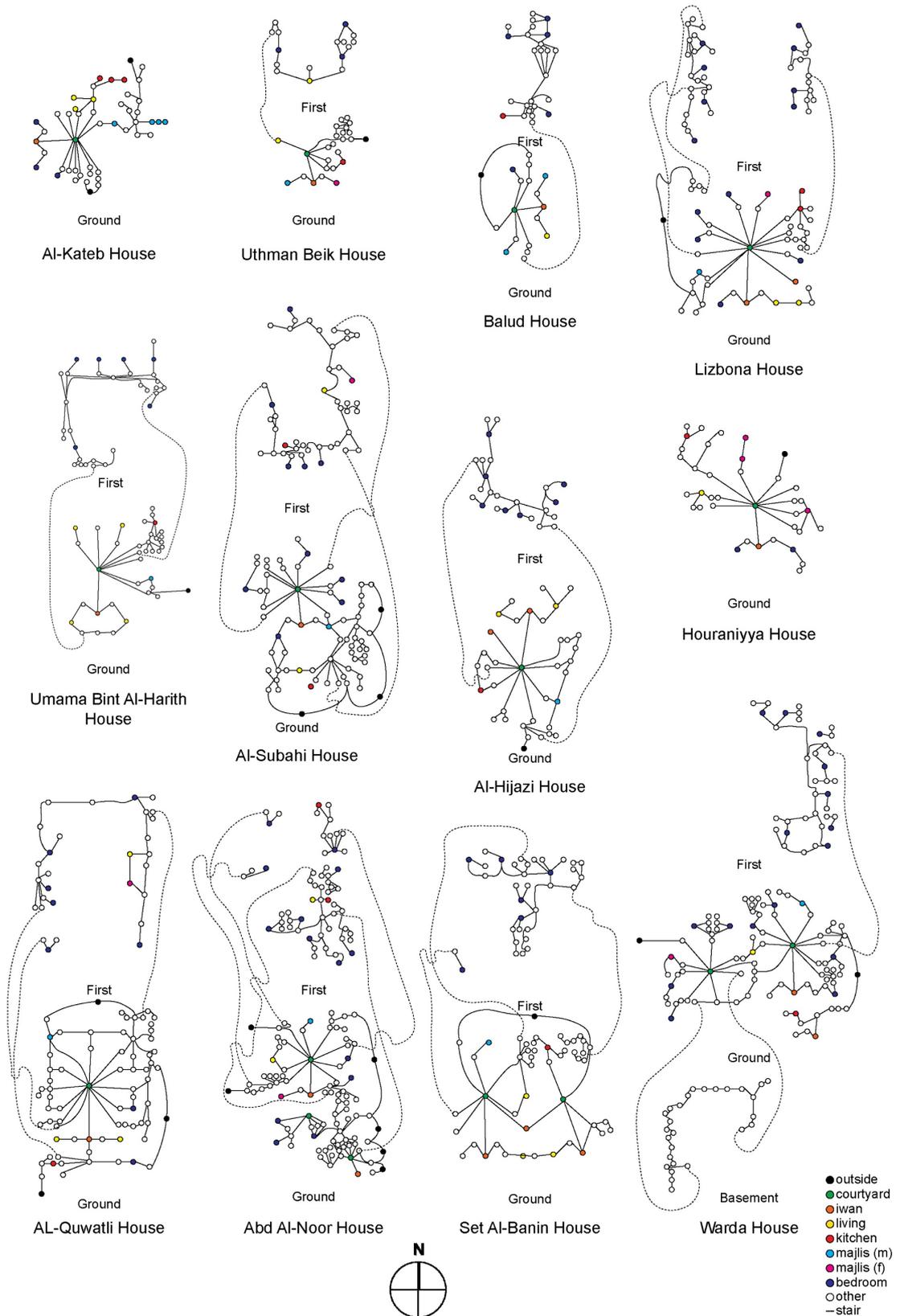
Figure 8: Permeability or relational (unjustified) graphs of the convex space map in the Syrian courtyard houses of the sample, colour-coded to indicate the courtyards, iwans, living, kitchen, male majlis, female majlis, bedrooms, and covered veranda (Source: Authors).

A rank order is a visual arrangement from the largest convex space to the smallest of each house.

We generate this visual arrangement by 'blowing apart' the plan's convex map and re-ordering

the convex spaces based on the metric area with the narrowest width of the space aligned along the bottom (Figure 9). In this case, the convex spaces in the space syntax model of these houses are the basis of the rank ordering after eliminating all linear strips representing axial lines (refer below). Unsurprisingly, the quantity of convex spaces and convex complexity in the layout tends to increase with the size of the houses and the number of floors. However, some variations arise from wall thicknesses and the number of threshold spaces. The overwhelming majority of convex spaces are either square-ish or rectangular. There is a notable 'spike' of long, thin rectangular convex spaces in the rank ordering of almost every house associated with hallways connecting the first floor around the perimeter of an open courtyard.
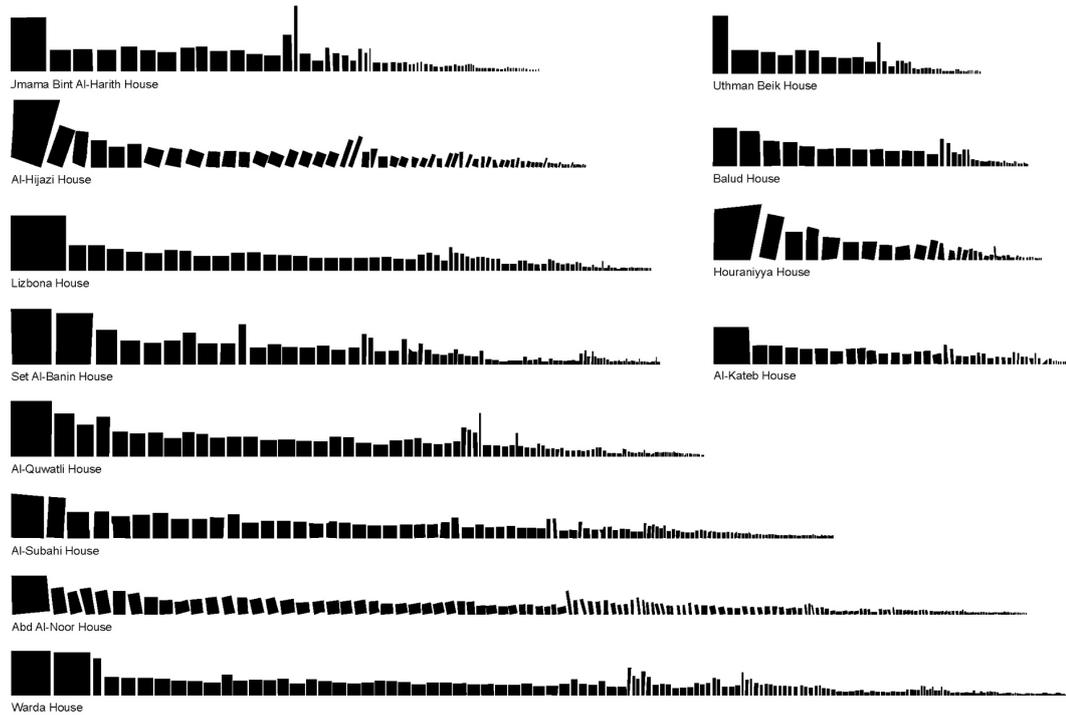

Figure 9: Rank ordering from largest to smallest convex space for each of the Syrian courtyard houses of the sample set to a common scale (Source: Authors).

The number of convex spaces in these houses ranges from 35 in the single-story Houraniyya House to 153 in the three-story Warda House (Table 3). The average size of convex spaces ranges from 8.0 m^2 in Uthman Beik House to 25.0 m^2 in Balud House. Even though it possesses the fewest convex spaces, Houraniyya House has the second-highest mean convex space size (19.1 m^2). Al-Subahi House includes a high degree of convex complexity (108 spaces) for one of the smaller houses of the sample. On average, a typical house profile for the sample is 79 convex spaces measuring 13.4 m^2 in size, making Set Al-Banin House the most typical example of convexity in the layout.

Table 3: Total number and approximate size of convex spaces in square meters (m²) in the twelve (12) courtyard houses of the sample (Source: Authors after Sakka, 2018).

ID	House Name	Floor Area (~m²)	Convex Spaces (#)	Convex (~m²)
1	Uthman Beik	330	41	8.0
2	Al-Kateb	400	43	9.3
3	Umama Bint Al-Harith	750	67	11.2
4	Houraniyya	670	35	19.1
5	Lizbona	1050	78	13.5
6	Balud	950	38	25.0
7	Al-Hijazi	950	61	15.6
8	Set Al-Banin	1190	79	15.1
9	Al-Subahi	1395	108	12.9
10	Abd Al-Noor	1450	147	9.9
11	Al-Quawatli	1290	94	13.7
12	Warda	1900	153	12.4
	Mean	**1027.1**	**78.7**	**13.8**

The convex map was the basis for a space syntax model combining axial lines represented as linear strips using a previous methodology (Hillier et al., 1996; Major et al., 2018) (Figure 10). The colour-coding for global integration is not set to a standard range across the sample but specific to each house. These models were the basis for a table of global integration values for room function in each house and averaged across the sample (Table 4). The models demonstrate that every house integrates via the axial structure, even the smallest ones. Only the courtyards of the Lizbona House and the eastern courtyard of the aggregated Warda House achieve higher levels of global integration (coloured orange) within the spatial layout. Fourteen (14) of the courtyards in the houses achieve moderate levels of global integration (coloured yellow and green). The Balud House courtyard is even segregated (coloured light blue) due to integration focusing on the first floor, especially a covered terrace space likely associated with female use. Besides Balud House, spatial segregation characterises the first floor with most bedrooms and basement level of all multi-story houses in the sample. The integration core skews towards the principal inter-connected route(s), tying the aggregated spatial layouts together like Al-Subahi House, Set Al-Banin House, Abd Al-Noor House, and Warda House.

A clear-cut house genotype emerges based on the rank ordering of mean global integration values of specific room functions across the sample (Table 5). The courtyard is the most integrated space in the houses by a significant margin (+27%) compared to the next most integrated room function, e.g., everyday living space. The mean global integration value for iwans (1.38) strongly relates to the everyday living space (1.40) by being functionally equivalent within the spatial layout. The mean global integration value of these three spaces – courtyard, living, and iwan – form a distinct domestic subset associated with everyday living above the mean value for all principal room functions (1.31). Something similar happens for hospitality spaces, i.e., the main entry and majlis (male and female). The mean global integration value for the male majlis space (1.30) is equivalent to the mean value for the entire sample.
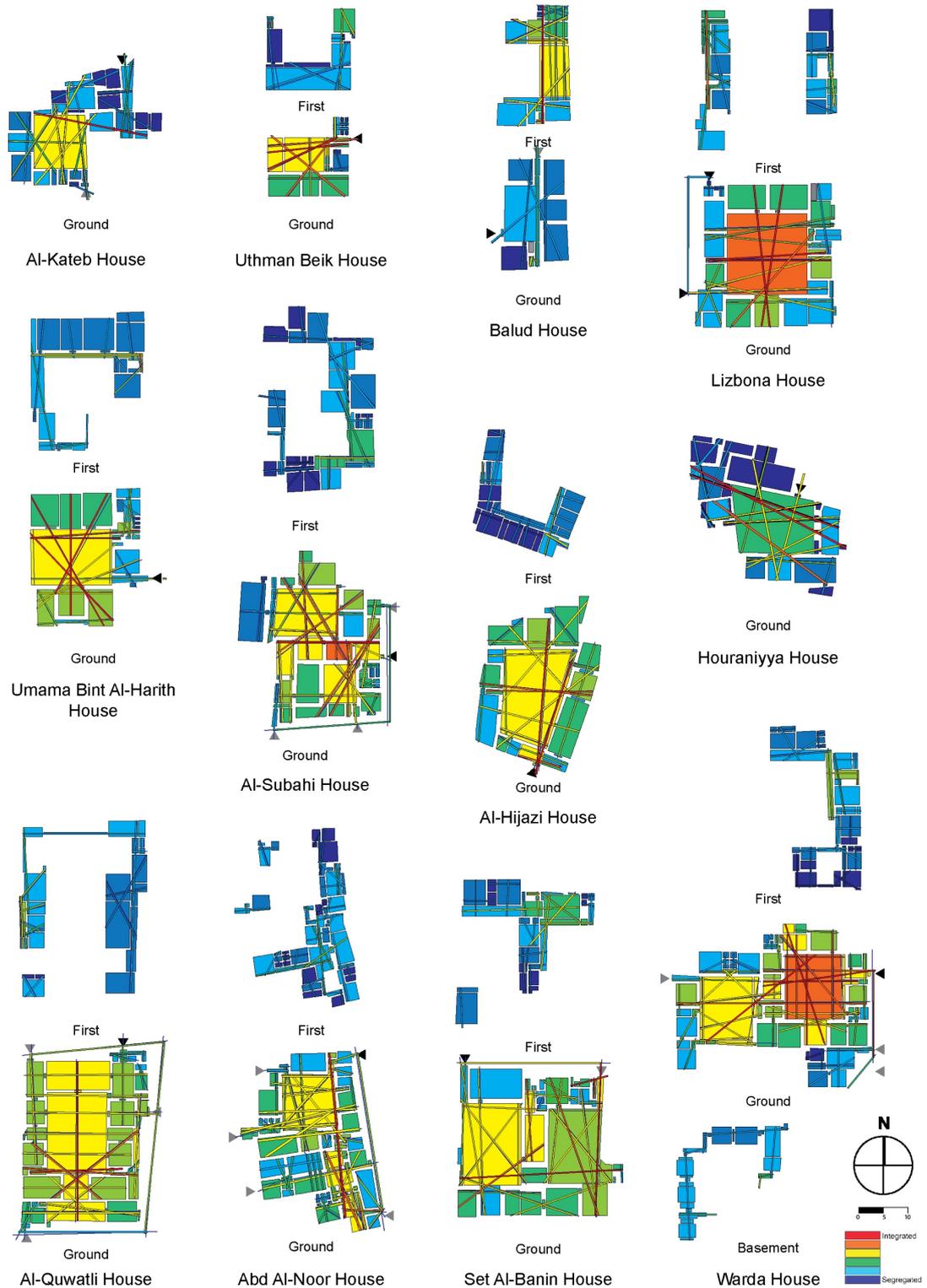
Figure 10: Pattern of global integration (radius=n) in the combined axial/convex model for the Syrian courtyard houses of the sample (Source: Authors).

The room for the female majlis was straightforward in only eight houses of the sample.

Nonetheless, the mean global integration values for the main entry (1.24) and female majlis space (1.23) are also spatially equivalent. Finally, the mean global integration values for the bedrooms

(1.09) and kitchen (1.08) form a domestic subset associated with privacy and service in the more isolated spaces of the spatial layout.

Table 4: Table of global integration values for principal room functions of the Syrian courtyard houses in the sample (Source: Authors).

House/ Function	Uthman Beik	Al-Kateb	Al-Harith	Al-Subahi	Houra-niyya	Liz-bona	Balud	Al-Hijazi	Set Al-Banin	Abd Al-Noor	Al-Quwatli	Warda	Mean
E	1.20	1.40	1.15	1.25	1.70	0.95	1.19	1.41	1.10	1.27	1.15	1.10	**1.24**
C	1.65	2.68	1.82	1.41	3.02	2.19	0.89	1.69	1.40	1.94	1.65	1.02	**1.78**
I	1.27	1.53	1.46	1.55	2.08	1.60	0.73	1.26	1.12	1.35	1.60	1.01	**1.38**
Mm	1.25	1.42	1.22	1.76	1.79	1.41	0.62	1.24	1.07	1.26	1.43	1.18	**1.30**
Mf	1.25	-	-	0.86	2.30	1.51	0.73	-	-	1.44	0.62	1.16	**1.23**
K	0.91	1.19	1.15	0.94	1.14	1.24	0.97	1.17	1.65	0.81	1.23	0.61	**1.08**
L	1.61	1.72	1.41	1.03	2.08	1.27	0.73	1.86	1.26	1.23	1.17	1.44	**1.40**
B	1.05	1.46	0.99	0.98	1.71	1.09	0.91	0.73	0.98	1.10	1.20	0.87	**1.09**
Mean	**1.28**	**1.63**	**1.31**	**1.22**	**1.98**	**1.41**	**0.85**	**1.34**	**1.23**	**1.30**	**1.25**	**1.05**	**1.31**

KEY: E=entry; C=courtyard; I=iwan; Mm=Majlis(male); Mf=Majlis(female); K=kitchen; L=living room; B=bedrooms.

Table 5: House genotype based on rank ordering of the mean global integration value for specific room functions (left to right from most integrated or black through a greyscale range to the most segregated or white) in the twelve (12) traditional Syrian courtyard houses of the sample (Source: Authors).

C >	L =	I >	Mean =	M(m) >	E =	M(f) >	B =	K
1.78	1.40	1.38	**1.31**	1.30	1.24	1.23	1.09	1.08
Everyday Living				Hospitality			Privacy/Service	

6 LIMITATIONS AND FUTURE RESEARCH

Researchers were diligent about assigning room functions to the floor plans of the twelve traditional Syrian courtyard houses in this study based on the available information from Sakka (2018) and previous precedents in the literature. However, it is plausible that more details about these courtyard houses or site visits might lead to revisions to the assignments of room functions for the houses in the study. There are two interpretations for the emergence of a clear-cut house genotype in the analysis of this paper. First, it represents a validation of the researchers' choices for the assignment of the room functions. Alternatively, it is an artifact of researchers' biases in assigning the room functions. More information and additional research are necessary to clarify with absolute certainty whichever might be the case. There is also an opportunity for future research using Visibility Graph Analysis (VGA) to review how the architectural elements of these plans, such as colonnades and iwans. VGA might reveal how spatial layout plays a sophisticated role in shaping the visual experience of the houses for distinct types of users, such as visitors and inhabitants. Space syntax researchers at DAUP-CENG at QU intend to perform VGA at a future date precisely for this purpose.

7   CONCLUSIONS

The paper presented a study of form and function in a sample of twelve traditional courtyard houses of Old Damascus in Syria. The research deployed various representational techniques to understand better the formal and spatial logic of the houses in the sample. All the houses possessed evidence of structural aggregation in their architectural form. Due to their age and setting in one of the oldest continuous inhabited cities in the world, there was a straightforward articulation between hospitality and everyday living spaces on the ground floor and private and service rooms on the first floor. However, spatial nuances did appear in the relationship between everyday living spaces associated with the courtyards and iwans, hospitality spaces such as the male and female majlis related to the main entry, and private and service rooms such as the bedrooms and kitchen in the more spatially isolated portions of the houses. This spatial structure defined a clear-cut genotype in these traditional Syrian courtyard houses. The study's findings further added to our knowledge about the courtyard house prototype in the Middle East region.

ACKNOWLEDGEMENTS

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