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From medieval Cairo to modern Masdar City: lessons learned through a comparative study

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Today, researchers of Arab urban centres will observe a few differences between Arab and Western cities. The Arab city is now westernized; this quality cannot protect it from the hot dominant climate, and obscures the architectural heritage acquired over centuries. Traditional Arab-Islamic urbanism has been ignored for decades, and Arab architects have been unwilling to revive traditional features or complying with the New Urbanism movement, which emerged in the early 1990s. This study reveals why the conventional urbanism of Arab-Islamic cities has been ignored, and investigates the potential of bringing it back to the modern metropolis by comparing medieval Cairo with contemporary Masdar City in Abu Dhabi. This paper will highlight the urban values inherited from the historic Arab-Islamic city, and the precautions that should be considered before reviving it. This research concludes that the traditional Arab city is rich with architectural and urban techniques that could be innovatively applied to contemporary municipalities. Present-day planners should learn from urban heritage, rather than dismissing it. When re-introducing old models, today's planners should focus on solving the paradox between the need for narrow, winding streets to maximize shade, and wide, straight streets to facilitate the movement of pedestrians and permeability. Architects should examine beforehand changes in sociocultural life based on feminism and concerns about public and private spaces.

Keywords: Arab-Islamic city; New Urbanism; medieval Cairo; Masdar City; traditional urbanism

1. Introduction

Since the late nineteenth century and the beginning of the twentieth century, the style of big Arab cities has become substantially westernized, especially Khedival Cairo, where Khedive Isma'il was once inspired by Haussmannian planning to create Cairo's former city centre. In the second half of the twentieth century, specifically in the 1970s when the price of fuel rose dramatically due to the oil crisis, many Arab governments acquired the funding to switch from traditional to modern Western urbanism. The continuum of urban heritage in the Middle East was broken; since then, the gap between using historic and modern techniques has grown ever wider in the wake of allegations by orientalist¹ that the Arab-Islamic city has little potential to develop a sustainable, contemporary design. Due to a loss of Arab identity, the urban transformation occurring in Arab cities has triggered chaos. People live in rootless, distorted municipalities that greedily consume energy, and cannot adapt to the weather and dominant culture.

This architectural, urban split drove this study, which investigates the prospects for traditional urbanism to regenerate a sustainable modern metropolis. Furthermore, if planners employ the concepts of traditional urbanism, they should identify and consider its most important aspects during the preparation and design process.

This paper uses medieval Cairo as a conventional framework and compares it with Masdar City in Abu Dhabi, a cutting-edge model. Masdar City is known as the eco-city of the Arab world. These two places were chosen because they are located in the Middle East, where settled peoples mostly share the same culture, religion, and climate. However, medieval Cairo was founded more than 1000 years ago, while Masdar City is very young, having been established in 2007. A comparison of the time lag between the two cities (the time between when the cities were founded) will determine the possibility of reusing the traditional tools of medieval Cairo. The difference in the two cities' ages will help identify which dynamic sociocultural issues to consider when reviving older architectural and planning tools, especially in the Middle East, which has undergone rapid social mobilization in the last 50 years. The most important factors of comparison revolve around city planning (such as land use, building height, the municipality's physical form, and network of roads) and architectural elements (such as courtyards and windcatchers).

This paper comprises two parts. The first explains why historic architectural and planning tools from ancient Arab-Islamic cities were abandoned, and why Western urbanism emerged instead. Different theories that argue

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against generalizing urban modernism pave the way towards comparison. In the latter part, the contrast between medieval Cairo and Masdar City investigates the potential of numerous theories that confront modernism, such as Neo-traditional Urbanism or New Urbanism (NU).² In another sense, can the traditional Arab-Islamic city inspire the contemporary one? This question will be answered through the contrast, and will measure historic influences on the prototypes of traditional tools, which say something about the sociocultural mobilization that occurred between medieval and modern times.

2. Roots of the problem: for whom were Arab cities planned?

This section will discuss Arab-Islamic cities in general and explain why the momentum of the Arab-Islamic city has stopped based on various examples.

2.1. Early cultural contact and immense wealth

Early cultural contact is only relevant to the capital of Egypt (Elshahed 2007). Cairo is considered the largest city in Africa and was founded during the Fatimid dynasty in the tenth century. The city's style is based on the traditional Arab-Islamic urbanism inspired by Islamic building standards. Conventional urbanism was dominant until the nineteenth century, when Egypt was going through a similar process as Europe due to the policies of Muhammad Ali, the governor of Egypt at the time. He promoted scholarships and cultural contact with European countries, notably France. In 1867, Muhammad Ali's grandson Khedive Isma'il, who is known as 'the father of modern Egypt' was fascinated by Haussmannian urban planning when he visited Paris during the World's Fair (Attia 2011). Figure 1

shows the transformation that occurred in Cairo before and after the nineteenth century. Khedive Isma'il reproduced the Paris model in a part of Cairo that was the eastern section of the city during the Fatimid dynasty; this same site was deemed the centre of Khedival Cairo. The wide boulevards, public gardens, large department stores and cafés which lined the streets of Khedival Cairo emulated the thoroughfares of Paris (Naaman 2011). The differences between medieval and Khedival Cairo are significant (UNESCO 2012). Khedive Isma'il wanted to impress foreign dignitaries visiting Egypt for the inauguration of the Suez Canal in 1869 (Naaman 2011). Khedive's plan for Cairo left a legacy of urban design in old Islamic Cairo. It was perhaps the first time in the Middle East that an urban disconnect occurred between the people and their built environment. Khedival Cairo was created for an elite class of Egyptians and foreigners. Yet for whom were Arab cities designed?

The region's immense wealth relates to the Gulf countries. After the oil crisis in October 1973 due to that year's Arab-Israeli war, the price of oil spiked dramatically (Alpanda and Peralta-Alva 2010; Stefanski 2014). Most Arab countries, especially those who belong to the Organization of Arab Petroleum Exporting Countries (OAPEC), found themselves with a large financial surplus (Awartani and Maghyereh 2013); they used it to change the old landscape and impose a modern, Western style (Rizzo 2014) as shown in Figure 2.

Kings and princes of Gulf countries have behaved like Khedive Isma'il in Egypt; they have adopted Western urbanism not to help their people, but to serve the foreigners and businessmen who invest in the Middle East, such as international oil companies. Arab leaders' desire to satisfy foreigners' needs to profit financially or promote themselves at the expense of their citizens and heritage might

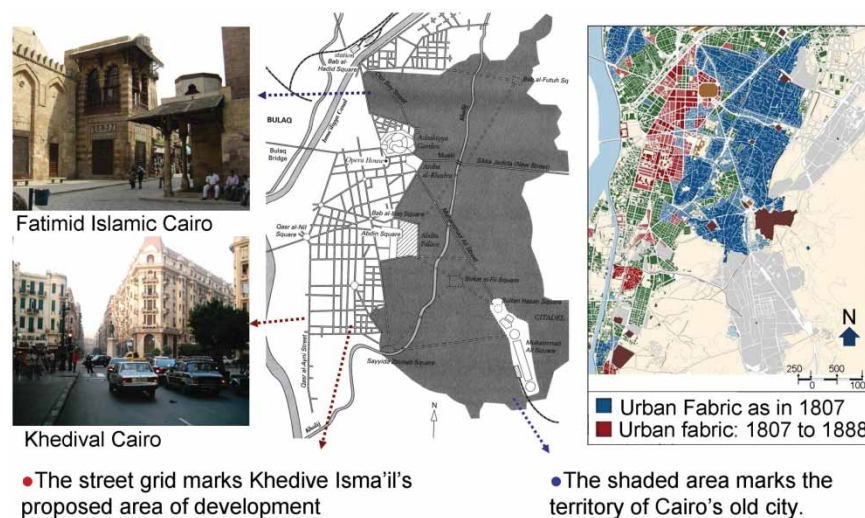


Figure 1. The transformation to Westernization; Cairo's urban fabric before and after the nineteenth century; the borders of Fatimid Cairo, with an organic urban structure and a grid showing Khedive Isma'il's Cairo.



Figure 2. The urban transformation from traditional to modern development in Qatar and the UAE. Tall glass towers have replaced low-rise buildings in a compact urban fabric.

be one reason behind the degradation of the current urban status. The United Arab Emirates (UAE) is a stark example of rapid post-industrial development (Radoine 2013). In 1986, Dubai suffered from a lack of sufficient infrastructure, especially regarding water, sewerage, and traffic; the spread of slums became problematic. However, some factors, such as the aspirations of Dubai's upper class for a better life, the services needed by international oil companies, and amenities needed by immigrants, prompted the royal family to import Western urban planning and implement exotic architectural styles (Melamid 1989). Yet again, the question arises: for whom were Arab cities designed?

2.2. Colonialism and orientalists

The rejection of local urbanism can be attributed to the colonial period, when Westerners defined non-Western styles and values as unworthy, especially regarding people from the East; they were thought of as savage, uncivilized, mysterious, and wicked (Blunt 2005) as Edward Said stated in his book 'Culture and Imperialism' (Said 1994). Orientalists generally found political cover for their allegations against oriental urbanism and the Arab-Islamic city in particular, which they considered chaotic and helpless, unable to transform into a contemporary metropolis.

Various orientalists have criticized the pattern of traditional Arab cities. In his book, 'Early Muslim Architecture', published in 1932, K.A.C. Creswell criticized Arab architecture. He argued that Arabia was parasitical

towards the monumental architecture of non-Arab nations (Creswell 1953), implicitly stating that Arabs and Muslims did not create their own architecture except for the simplest of buildings, but rather depended on other civilizations (King 1991).

In his work 'Cites Musulmanes d'Afrique du Nord', Roger Le Tourneau (1907–1971) criticizes the mysterious road network in Arab-Islamic cities; he added that for visitors, the meandering streets ending in cul-de-sacs make the city look like a maze (Burke III E 1972; Eickelman 1974). Tourneau's opinion was supported by G. Marcais, who commented on the labyrinthine characteristic found in the aerial images of historic Islamic cities. Marcais deemed irrational the medieval Islamic city's urban structure, with its many dead-end, winding, and narrow roads (Raymond 1994). Robert Brunschvig (1901–1990) adopted Marcais's view and attributed this organic pattern to the administrative system (Neglia 2008).

J. Sauvaget (1901–1950) attacked the Arab-Islamic city so aggressively that he regarded the medieval Islamic metropolis as the antithesis of urban order (Raymond 1994). De Panhol considered the twisting streets and chaotic arrangement to be an indirect, unfavourable influence of Islam (Landay 1971). The trend of ignoring Arab cultural heritage began with the publication of E. Gombrich's 'The Story of Art', in which he proclaimed the superiority of Western art over other forms, notably Eastern and Arab architecture (Hillenbrand 2003). Western scholars favoured the book, especially after the massive sales that followed the publication of the first copy in 1950.

Over time, the residents of the traditional Arab-Islamic city came to adopt the perspective of Western scholars – to reject the very place in which they lived. While most Arabs appear proud of their Islamic architectural heritage, the reality of Arab cities shows the dominance of Western architecture (Finster 1992). It is interesting to note that Saudis reject new developments that adhere to tradition, consider traditional patterns substandard, and accept buildings based on Western styles and technologies (Hakim and Rowe 1983).

Some Orientalists have inferred that the winding, tapered streets suggest that Islam is a 'religion of mess' (Bonine 1979). However, Von Grunebaum believes that the fully traditional Islamic city honours the aims of the mosque and Friday prayer (Winters 1977; Abu-Lughod 1987). For example, the orientation of streets in historic Iranian cities resulted from two elements: the need to respect the route from the palace to the mosque, and the need to position the mosque towards Mecca. However, a third opinion considers that the layout of the streets is due to environmental factors, such as the need to provide more shaded areas. It is worth mentioning that not all Islamic cities have an organic pattern, since some places such as Tabriz, Isfahan, Rezaieyeh, and Mashad in Iran have orthogonal grids that respond to the irrigation system,

rather than the direction of Mecca or climatic requirements (Bonine 1979). This shows that Islamic culture and norms are not the only factors that influence the traditional Arab city.

Orientalists' allegations have contributed to a cheapened image of the conventional Arab city. Arab planners ignored their heritage, particularly in urban planning and architecture. Creswell misunderstood Arab society and urbanism. Most Arab planners dismissed Arab-Islamic architectural heritage and adopted Western planning theories that were applied to a very different social structure, in comparison to the habitat for which they were originally designed. The results were disappointing on all levels, notably that of urbanism.

The modern cities built in the Arab region have failed to create a sustainable environment on the social, economic, and ecological levels. People have spoken out against the spectre of modernism and Western urbanism; some, such as Jacobs (1961) and Lynch (1960), have raised their voices in North America in support of NU. Some of these perspectives are presented in the next section.

3. Voices against modern urbanism: can traditional urbanism be a solution?

John Nolen (1869–1937) suggested a traditional civic design to remedy the sprawl dilemma (Nolen 1912). Nolen's work guided Andres Duany and Elizabeth Plater-Zyber (Duany, Plater-Zyberk, and Speck 2010), who encouraged traditional town planning over the urban modern trend. NU theorists have resurrected Nolen's concept (Stephenson 2002). Some movements advocate for a return to conventional urban life to tackle the problems resulting from sprawl, which have worsened since the 1920s (Falconer, Newman, and Giles-Corti 2010). These tendencies suggest that traditional urbanism is a panacea (Talen 2001). Herbert Muschamp, who worked as a pundit for the *New York Times*, described NU as the most important movement in America since the Cold War (Alshuwaikhat 1999; Bohl 2000).

According to the NU official website, the movement is based on a range of principles: walkability, connectivity, diversity and mixed land use, mixed housing, quality architecture, traditional neighbourhood structure, increased density, green transport, and sustainability with quality of life (Wey and Hsu 2014). According to NU, such concepts prevailed in city planning before modernism (Newman and Kenworthy 1989; Saleh 2002). The American city of Irvine and the National Taiping University District in Taiwan are good examples of NU or Neo-traditional Planning (Wey and Hsu 2014).

In Japan, a similar movement has developed: *Machizukuri*, in which various Japanese features have been adopted from classic towns, such as mixed use with adequate facilities, public transportation, and narrow,

meandering walking paths that reduce the speed of vehicles (Sharifi and Murayama 2013).

Lynch (1960) was against modernism. Jacobs (1961) also criticized normative or orthodox planning in her popular book, 'The Death and Life of Great American Cities', in which she attacked modern urbanism, calling for mixed land use, smaller blocks, diversity of use, and more concentrated density (Hassan, Lee, and Yoo 2014; Jacobs 1961; Talen 2001). The following section will compare medieval Cairo with Masdar City, and will attempt to answer the aforementioned question 'For whom were Arab cities designed?' in addition to a new one: 'Can traditional urbanism be a solution?'

4. Medieval Cairo and Masdar City: a comparative case study

The Fatimids founded Cairo, Egypt's present-day capital, north of Fustat (the former capital) when Muslims conquered the country in the tenth century. Gawhar Alsaqalli (Fatimid leader: 928–992) established Fatimid Cairo in 969 AD. The medieval metropolis flourished during the Ayyubid and Mamluk dynasties. Masdar City (with a latitude of 24°28'N and a longitude of 54°22'E) is considered one of the world's few models (Elchalakani, Aly, and Abu-Aisheh 2013; Grêt-Regamey et al. 2013; Reiche 2010; Sgouridis and Kennedy 2010) that attempts to be a zero-carbon eco-city (Nader 2009; Whitehead 2003). Figure 3 shows the location of Fatimid Cairo and Masdar City in the Middle East. Masdar City lies in a hot dry zone, where the average maximum temperature exceeds 40°C (Grêt-Regamey et al. 2013). It is expected that Masdar City will be finished in 2025 (Arthur 2012; Masdarconnect 2013).

The following approach explores the differences between the Arab-Islamic city in medieval Cairo (64–1800) and its counterpart in Masdar City (2008–2015) in the UAE. Through this comparison, we can determine the degree to which the British architectural firm Foster and Partners, headed by Norman Foster, has considered architectural heritage while planning Masdar City. Today, the major motive for designing a sustainable city is to reap environmental benefits. The comparative approach focuses on five aspects of planning: city shape and orientation of



Figure 3. The locations of medieval Cairo and Masdar City in the Middle East.

streets, urban pattern, diversity of land use, height of buildings, and architectural techniques such as windcatchers and courtyards.

4.1. City shape and orientation of streets in medieval Cairo and Masdar City

4.1.1. In medieval Cairo

Al-Maqrizi, a well-known historian of the fifteenth century, said that the Fatimids planned Cairo in the shape of a complete square (Alsayyed 1999). Figure 4(a) shows the layout of Cairo during the Fatimid period, when the city was surrounded by a high wall that followed the square's four edges, each edge having two gates in the beginning. The streets in medieval Cairo might have been angled in the direction of the Kaaba in Mecca (Bonine 1979). Figure 4(b) shows that most streets were positioned on a southeast–northwest axis and a south–north axis to maximize the flow of cool air from the north and northwest, in addition to increasing the shade provided by buildings, which block solar radiation during the day.

4.1.2. Masdar City

Masdar City's grid provides shade at the street level throughout the day, minimizes thermal gain on building walls, and facilitates the flow of cool breezes throughout the city. Figure 5 shows the layout, comprises two squares;

the grid's dominant orientation lies on a southeast–northwest axis.

4.2. The urban patterns in medieval Cairo and Masdar City

4.2.1. Medieval Cairo

Medieval Cairo is a compact hierarchy of narrow, winding streets that contribute to the city's aesthetics. Fatimid Cairo had originally an area of 143 ha (Al-Sayyad 1981). According to Warner (2006), about 40,000 people were residing in this area. Therefore, the population density is roughly 280 persons per hectare. The minor streets were so narrow (2–3 m), whereas the major ones were ranging between 6 and 7 m (Al-Sayyad 1981). The urban pattern of this historic city offers perspectives on various pathways as shown in Figure 6. The dense arrangement includes the tapered, zigzagging roads around Al-Mu'izz Street in the centre of Fatimid Cairo. Cullen (1961) and Appleyard, Lynch, and Myer (1965) promoted this structure later on. A large number of these roads are dead-end, which helps residents to monitor their neighbourhoods. Furthermore, the dead-ends create semi-public or semi-private spaces that allow children to play under the close watch of their mothers while retaining the social privacy needed in an Arab Muslim community. The superblock theory, developed in 1920 by Henry Wright and Clarence Stein, was inspired by cul-de-sacs, which distinguish the Islamic city.

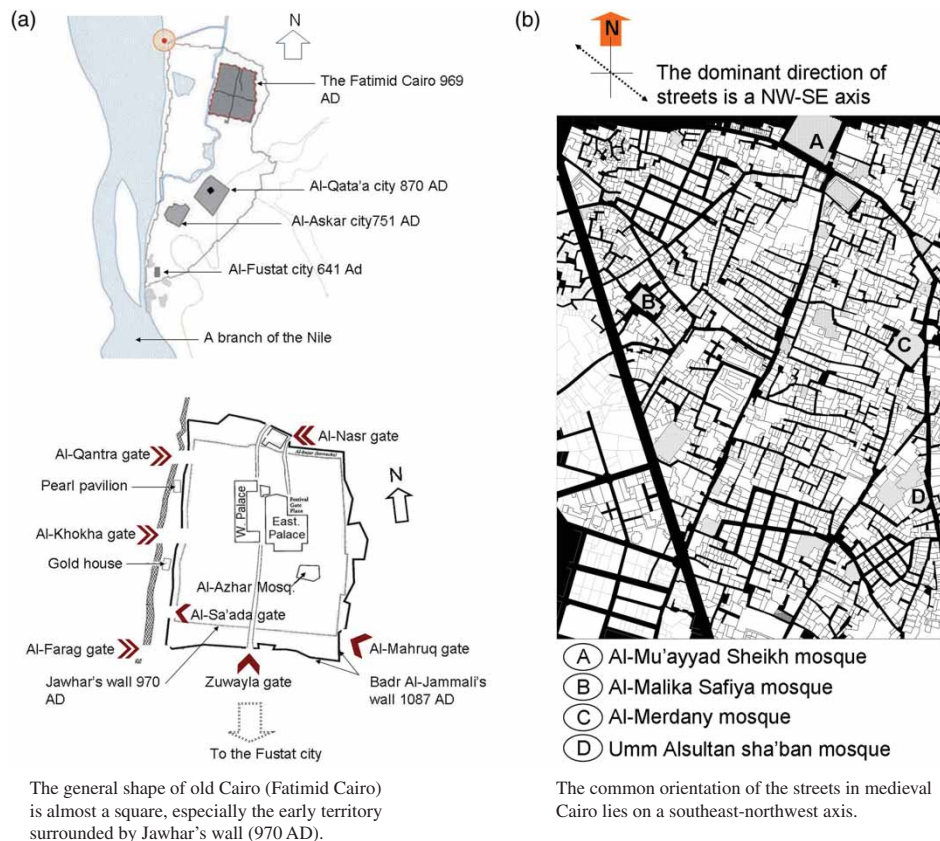


Figure 4. (a) Fatimid Cairo has a square layout. (b) The dominant orientation of the streets lies on a southeast–northwest axis.

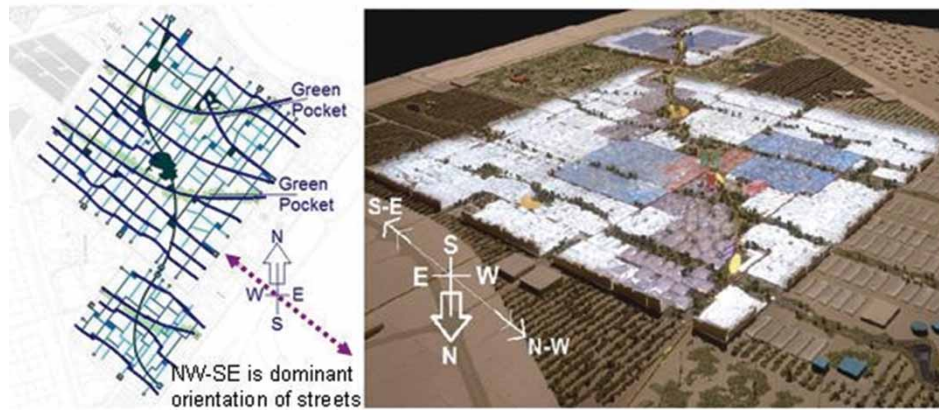


Figure 5. Masdar City consists of two squares. The first is big and the second is small. The dominant orientation of the streets lies on a southeast–northwest axis.

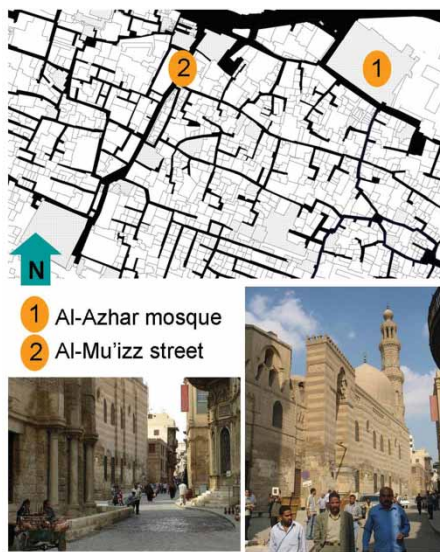


Figure 6. The urban pattern in the neighbourhood of Al-Azhar Mosque and Al-Mu'izz Street, where the dense city structure involves winding, narrow, and dead-end streets.

4.2.2. Masdar City

Masdar City was planned as a compact metropolis with low-rise buildings and a relatively high density (130–160 people per hectare). Because it is a modern city planned at the start of the twenty-first century according to current requirements, the streets are configured in a grid with a limitation on width (14 m as a maximum for main streets and 8.5 m for secondary streets). Masdar City's streets are narrow compared to their counterparts in other modern municipalities. Although the streets were arranged as straight paths at the ground level, the cantilevered, undulating facades from the first floor to the roof echo the twisting thoroughfares of Islamic cities. Photovoltaic solar panels are conspicuously placed over the roof to provide shade down below, as shown in Figure 7.

4.3. Windcatchers in medieval Cairo and Masdar City

4.3.1. Medieval Cairo

Wind towers or windcatchers (*malqaf* in Arabic) capture the preferable, cooler, upper layer of air and force it to pass through the tower shaft, supplying indoor spaces with cross-ventilation (Roaf 1990). Due to Islamic Cairo's tightly packed form, ancient Arab architects were forced to invent a technique to cool the courtyard. Figure 8 shows the traditional technique for ensuring an active ventilation process throughout indoor areas.

4.3.2. Masdar City

Masdar City is in a region with little wind. In response, the city's designers employed supersized windcatchers in public squares, rather than private and indoor spaces, so that the wind tower would have a greater effect on more actively used areas. The large urban square at the base of the wind tower is home to cafes and other retail outlets, with seating extending into the open plaza for use in pleasant weather. Figure 9 illustrates the supersized windcatcher's thermal performance in public urban space, which depends on new technologies. The sensible landscaping offers shade and numerous services such as a gym, prayer room, organic grocery store, and bank are located on or near the square to provide recreational and social spaces. A raised platform beneath the windcatcher serves as a performance stage (Masdarconnect 2013).

4.4. Courtyards in medieval Cairo and Masdar City

4.4.1. Medieval Cairo

Courtyards characterize the buildings of medieval Cairo and act as a thermal regulator (Hassan and Lee 2014). Homes in Islamic Cairo often encompass two courtyards: a large one and a small one; cool air moves from the small courtyard towards the large one during the day. Circulation is important for thermal comfort in these dry, hot climates

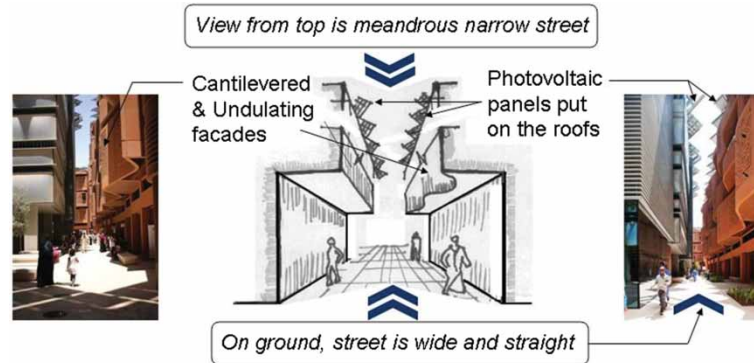


Figure 7. The streets have been designed as wide and straight on the ground. If we look from a bird's eye view towards the streets, we would find them twisting and narrow due to prominent cantilevers, undulating facades and photovoltaic panels fixed on the roofs. The Masdar planners achieved shaded areas without compromising the movement of pedestrians or light motorized vehicles.

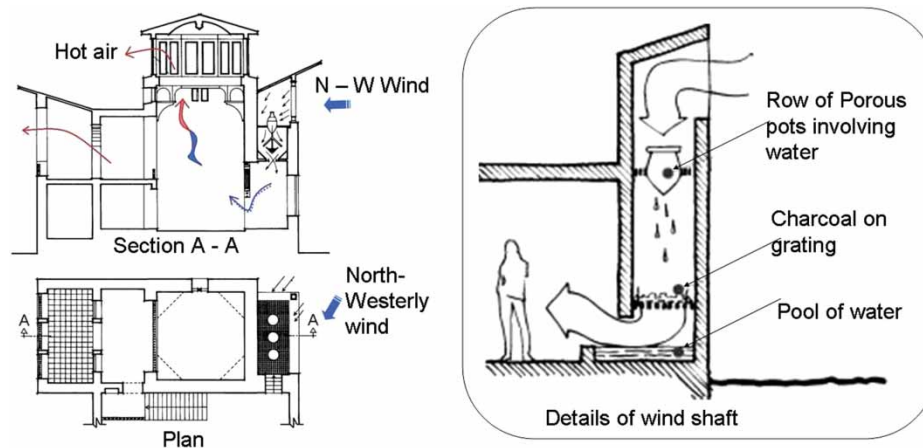


Figure 8. A traditional windcatcher is based on a simple technique. Porous pots of water convert dry air into humid air, and charcoal on a grating increases the flow of air into indoor spaces. Here, windcatchers were only used to affect the inside of buildings.

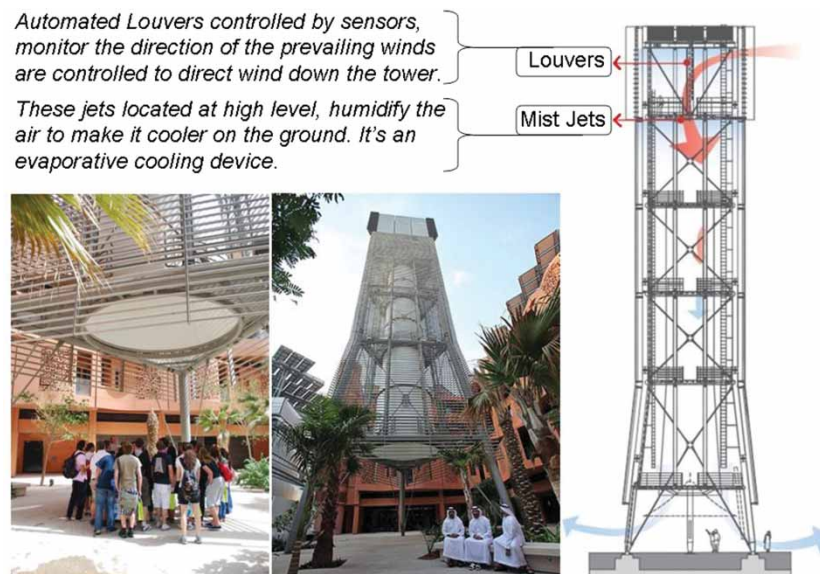


Figure 9. The windcatcher in Masdar City involves complex technology to control the orientation of the wind and the quality of the air. Windcatchers are used in public spaces alongside buildings.

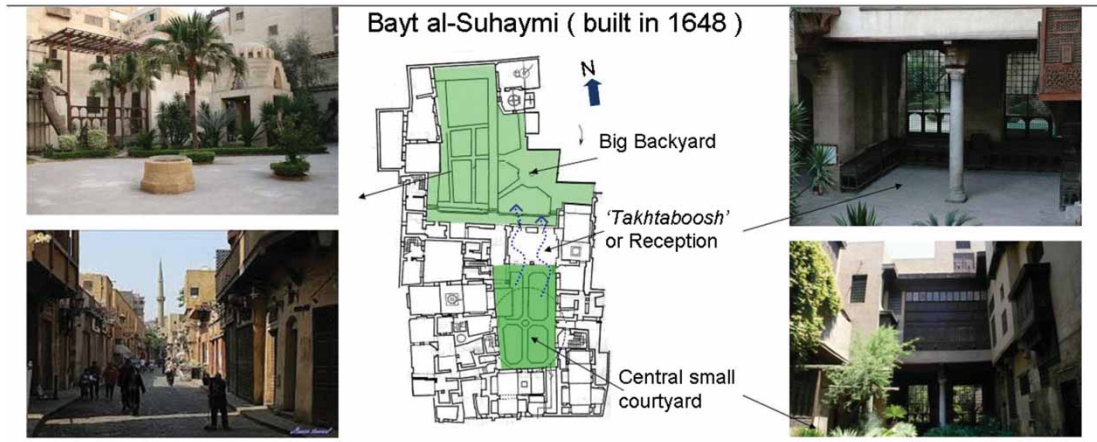


Figure 10. The courtyard is a substantial part of the Arab-Islamic house. Integration between small and big courtyards in Bayt Al-Suhaymi provides a thermal comfort zone through cross-ventilation.

because people can adjust the temperature, especially when sweating. Figure 10 shows how cool air moves from a small courtyard to a large one, then passes from the reception area (*takhtaboosh* in Arabic) to the inner space of Bayt Al-Suhaymi ('House of Suhaymi'), a museum in Cairo that is a house from Ottoman times. Courtyards are a centre for family activities; the fountain, greenery, and privacy make it preferable for women and children (Ratti, Raydan, and Steemers 2003; Roaf 1990). Arab planners showed particular insight using climate control techniques to create the private sphere, where people spend most of their time.

4.4.2. Masdar City

In Masdar City, courtyards also regulate thermal performance in hot zones, providing cool air and shade to the surrounding areas, creating assorted spaces of air density that encourage ventilation, and a private environment, further shaping a social, secure area for residents to meet and converse outdoors. The planners created the courtyards based on the arrangement of buildings in the urban design, and included them inside buildings in the architectural design. Figure 11 shows the framework of Masdar City with its embedded courtyards, revealing the rich pattern of positive and negative space.

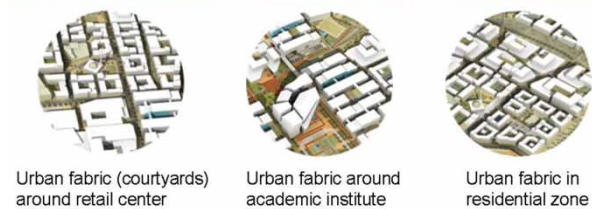


Figure 11. Courtyards are an important element in Masdar City's urban fabric. Most buildings include them. The urban syntax is also based on the courtyards' configuration.

4.5. Diversity of land use and building height in medieval Cairo and Masdar City

4.5.1. Medieval Cairo

The population density of medieval Cairo was 50,000 people per km². Classic Islamic cities encouraged high-density urbanism, especially in the Middle East (Winters 1977). When Ibn Khaldon, a polymath geographer, visited Cairo in 1384, he was fascinated with its crowded streets, markets, and built environment, naming the city the 'mother of the world'. Frescobaldi, an Italian historian, affirmed in 1384 that while the population of Cairo was greater

than Tuscany's, one street in Cairo housed more people than the entire city of Florence. During the reign of Al-Naser (1285–1341), Cairo's population increased by half a million, and was equal to that of China's largest cities (Williams 1984). These commentaries stress the vitality of Cairo during Fatimids and Mamluks times. Islamic Cairo had a mixed-use pattern 1000 years ago. Figure 12(a) shows part of the city where commercial, artisanal, religious, residential, and educational purposes can be seen incorporated into one area (education took place in the mosques). In most cases, people used the ground floor for commercial or professional use, whereas the first, second,

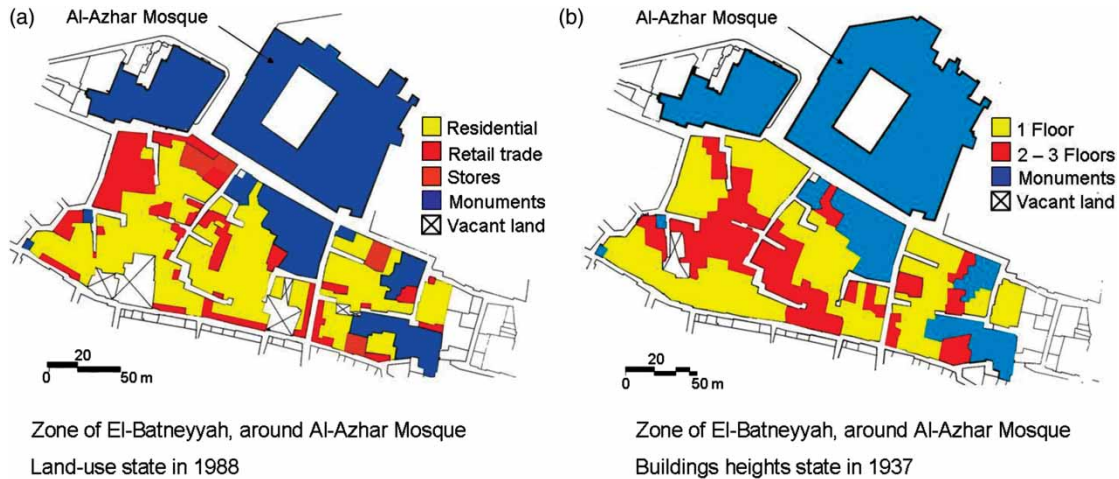


Figure 12. Fatimid Cairo was designed based on the variety of land uses and building heights. The zone of Al-Azhar Mosque, in the centre of Fatimid Cairo, is still diverse.

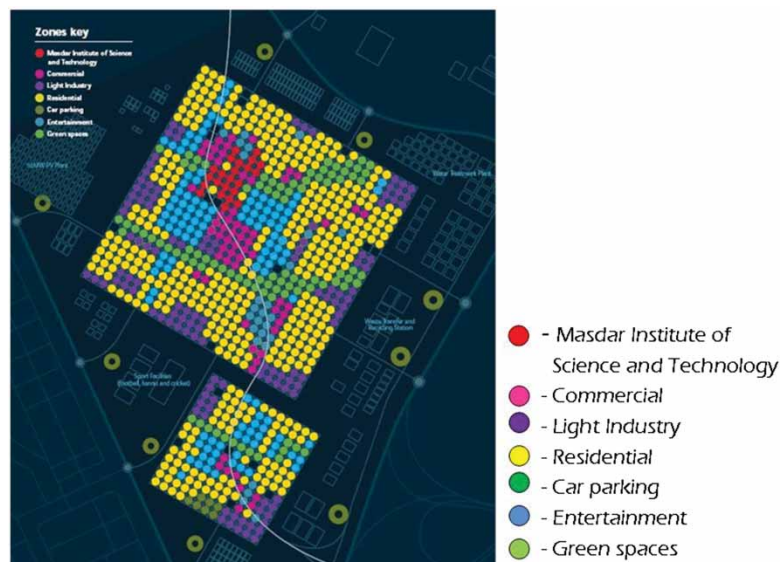


Figure 13. The design of Masdar City is based on mixed land use.

and third floors were used as homes. In 1243, Ibn Sa'id, a well-known historian, described Cairo as a crowded metropolis with relatively tall buildings and narrow, winding streets (Alsayyad 1999). Although most buildings in Islamic Cairo range from 2 to 4 floors, the population density is higher than average. Only a dense layout can provide low-rise buildings and high density while having using less energy for transportation. Figure 12(b) shows building height in the core of Fatimid Cairo, where buildings with three floors were considered tall alongside the large size of each family.

4.5.2. Masdar City

While new planning theories are based on land-use zoning, Masdar City's architects depended more on diversity,

merging together residential, commercial, educational, industrial, and entertainment functions in one area. Figure 13 shows Masdar City's mixed uses, where educational, commercial, light industry, residential, and entertainment purposes can be seen in the same sector.

5. The influence of time on the revitalization process

The comparison shows that Masdar City's architects took inspiration from traditional Arab city planning. While indigenous urban design combines numerous strategies to address the desert climate, it is also characterized by relatively low overall energy consumption due to its high population density and compact features, typical of traditional Arab cities. These cities are also socially diverse; people live and work in the same context, with lively

Table 1. Comparison between medieval Cairo and Masdar City, demonstrating the revival of traditional Islamic architecture techniques.

Tool	Medieval Islamic Cairo	Masdar City	Degree of congruence
1. City's shape	Original shape is almost square	Clear square shape	Completely congruent
2. Orientation of streets	Most streets are positioned on a SE–NW axis	Most streets lie on a SE–NW axis	Completely congruent
3. Windcatcher	Used as a passive technique to direct cool, fresh air into indoor spaces	Used to provide public plazas with cool, fresh air	Masdar City's planners transmitted this technique from the private sphere into the public one
4. Courtyard	Embedded in the home as an active social spot linked with the natural environment	The courtyard is part of a building's interior and affects urban planning in public spaces	Masdar City's planners focused on public spaces by creating courtyards
5. The pattern of streets	The main street, which is wide and slightly twisting, is called <i>al-kasabah</i> , but most streets are narrow and meandering, ending in cul-de-sacs	The road network has a hierarchical pattern, and streets are divided into three widths: the central artery is 25 m, main streets are a maximum of 14 m, and secondary streets are 8.5 m	Masdar City planners considered the modern requirements of motorized mobility and designed slightly wider, straight streets to facilitate the movement of vehicles
6. Diversity and mixed use	Buildings have multiple uses in addition to high densities and different heights	Masdar City has mixed-use buildings where educational, commercial, and residential buildings are found in the same zone	Completely congruent

and enjoyable public spaces. Table 1 shows that Masdar City's planners drew on the architectural heritage of old Arab-Islamic cities in the Middle East.

While Masdar City's planners revived some techniques from conventional Arab cities without changing them, they modified other mechanisms – such as wind towers, courtyards, and the layout of the streets – to be more compatible with modern requirements and lifestyles. The shape and orientation of roads and diverse uses were derived from medieval Cairo and directly applied to Masdar City with no changes.

5.1. Reviving the windcatcher

Fatimid Cairo was founded more than thousand years ago. At the time, the city served the Islamic community, which was significantly more focused on private spaces (homes) than public ones (such as plazas and streets). In addition, except for the plaza at the mosque or the market, Muslims rarely stopped to talk in the narrow, winding streets because Islamic traditions encourage men to keep their eyes away from women while passing them in the streets. Nowadays, the Islamic lifestyle has changed, with more women participating in public life and working outside the home, increased access to entertainment, and a more active lifestyle. People now spend less time at home than they did before. Masdar City planners focused on the importance of public spaces more than architects of traditional Islamic cities. They revived the traditional windcatcher used in Islamic homes in medieval times. Norman Foster employed the windcatcher as a landmark for the Masdar

Institute neighbourhood, where the LED lighting of the tower changes colour to let residents, students, professors, and visitors know whether they are using too much energy in Masdar Institute buildings or consuming it at an appropriate level. The wind tower captures upper level winds and directs them to the open-air public square at its base. Sensors at the top of the steel structure operate high-level louvers, which open in the direction of the prevailing winds and close in other directions, diverting wind down the tower. A polytetrafluoroethylene membrane carries the wind downward, while the mist generators at the top provide additional cooling of the air, as shown in Figure 9.

5.2. Reviving the street pattern

Medieval Cairo began a thousand years ago before the advent of motor vehicles; the twisting, narrow streets dominated the medieval layout due to the region's harsh climate. Nowadays, however, vehicles have become essential for daily life. Masdar City's architects faced a challenge where the width of the streets needed to increase to at least 8.5 m, and gradually to between 14 and 25 m depending on traffic. The task was to widen the streets while retaining a certain amount of shade. In short, the planners designed straight paths at least 8.5 m wide at the ground level, while the upper stories protruded in a cantilevered form. The cantilevered facades on the upper stories make the street narrower at the ground level. Moreover, converting the cantilevered wall to an undulating facade creates a meandering path that offers shade. Photovoltaic panels

were placed on the roof, projecting over the buildings to optimize shade in the streets, as shown in Figure 7.

6. Discussion

In response to the worsening urban status quo, Lewis Mumford emphasized the need to revive the missing pleasant qualities of traditional towns. He proposed the use of these features in modern urbanism (Stephenson 2002). Contemporary urban planning is considered systematic, where collector streets are located in the heart of the city. Postmodernist thoughts evolved into NU, which has been promoted in the USA to restore traditional values and achieve a balanced design (Saleh 2002). Raymond (1994) said that it would be wiser to use the techniques of the historic city, which are still valuable, rather than ignore them. In their reviews of G.R.D. King's book, 'The Historical Mosques of Saudi Arabia', Hillenbrand (1989) and Fehervari (1989) point out that conventional Islamic architecture can accommodate new perspectives regarding present-day architecture in the Arab world.

A. Rapoport stated in his book, 'House, Form and Culture', that the built environment does not directly result from physical forces; rather, it is a consequence of sociocultural factors (Rapoport 1969). In fact, the socio-cultural dimension is missing from modern Arab cities. Alshuwaikhat (1999) affirmed the need for public participation in the urban planning process, and the need to consider cultural heritage instead of adopting Western theories. Alshuwaikhat believes that residents' views change with time; thus, planning theories from the late nineteenth or early twentieth centuries are likely to be unsuitable today. The same criticism has been directed at architects of NU, who intend to superficially mimic the urban design of traditional Arab-Islamic towns without knowledge of modern, socio-economic factors (Southworth 1997).

Although the tenets of NU could contribute to a better life for city residents, Bohl (2000) suggested that it might not lead to a pleasant urban environment, especially if we ignore some issues such as social and technological factors. NU is not the only approach for creating a successful city fabric; it is one of many that need to be considered, depending on the development's location and the time in which it is built (Moore 2010). Neo-traditional Planning is criticized for its attempt to impose an idealized view of the past as if the landscape were a painting by Norman Rockwell (a renowned American painter, 1894–1978) – regardless of contemporary needs. The fast pace of modern life means that residents are often too busy to converse with each other; thus, NU does not consider today's 'time of place', a term coined by Lynch in his book 'What Time Is This Place?' (Lynch 1972). The term refers to the need to contextualize a place by respecting the time within which it functions. Lynch (1972) declared that good places not only tell us where we have been chronologically, but also

provide guidance on where we are now and where we are going (Ford 1999).

7. Conclusion

In his classic early book, 'House, Form, and Culture', Rapoport (1969) said that the built form results from a sociocultural system where religion is one of the major cornerstones (41). Thus, it has been unwise for Arab planners and local governments to abandon traditional Arab urbanism, as they have done recently. Masdar City proves that the historic urban experience, developed over centuries, is still worth pursuing and learning from. The comparison between medieval Cairo and Masdar City revealed a number of lessons, as outlined below, that need to be considered when using NU to resurrect the past.

- (1) The study concluded that positioning the road network on a SE–NW axis increases shade in the streets and safeguards residents and homes from solar radiation. However, this is not enough to achieve total thermal comfort; the winding, narrow streets are also important in maximizing the amount of shade due to the constant sunlight. Today's designer must decide whether to imitate the exact tradition without taking modern requirements into account, or mimic the role of zigzagging streets in an innovative way that does not compromise current needs. Masdar City's planners addressed this problem by using a pioneering architectural solution, rather than simply copying the meandering streets. They designed upper stories to protrude over the first floor and form an undulating mass. Extra shade was provided by the photovoltaic panels that extend past the roof and over the street, as shown in Figure 7. Masdar City's planners increased the amount of shade in the street while providing beneficial cross-ventilation, maximizing cool wind from the north and northwest without compromising the movement of pedestrians.
- (2) The study also found that courtyards in traditional Arab homes and public spaces facilitate varied air pressure, which allows breezes to move from the cool zone of high-density air to the hot zone of low-density air. In many medieval Islamic buildings, the courtyard and windcatchers provide indoor spaces with cool air and cross-ventilation, as we have seen in Bayt Al-Suhaymi in Figure 10. Courtyards also achieve the required indoor privacy and safety for the Arab Muslim family. Masdar City's architects have improved the traditional windcatcher at the technical level, and revived it to provide private and public spaces alike with a cool environment; this encourages residents to gather and actively use squares, plazas, and public areas

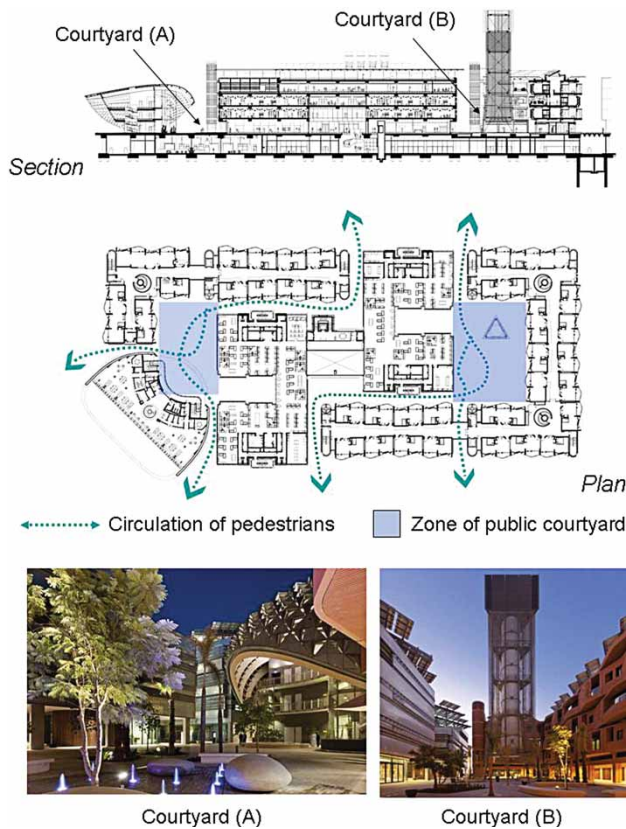


Figure 14. Public courtyards with landscaped elements and climate-adaptable tools facilitate social interaction and outdoor activities, a necessary part of modern life.

during the hot part of the day, as shown in Figures 9 and 14. Contemporary use of public space highlights the social changes that have occurred in Islamic communities, which modern planners need to take into account. In the historic Arab-Islamic city, design focused on indoor spaces; the residential unit was the city's most important element, where people spent most of their time. In contrast, in modern urban centres, such as Masdar City, men and women are much more used to leaving home for work and entertainment. Masdar City's architects used courtyards and windcatchers to provide comfortable thermal zones in outdoor public spaces, thus setting the stage for outdoor social activities.

This study shows how techniques of traditional urbanism acquired over centuries and residents' experience can assist modern planners in building sustainable cities that maintain residents' lifestyles, as well as connecting them to their heritage. However, as we have explained in this paper's previous sections, when architects begin reviving methods from traditional Arab-Islamic cities, they should consider two issues. The first is movement in the streets. Nowadays, driving in the streets has become faster and

more complex due to advances in transportation and communication, and the rapid increase of the urban population. The second matter is a feminist one regarding the sociocultural changes in Arab-Islamic communities, where women have become more involved in public life and outdoor activities. Thus, architects should carefully study local residents' technological and sociocultural needs before carrying out any new developments.

However, the sustainable design of Masdar City, known as one of the most eco-friendly cities in the world, has been shown to have included key characteristics of traditional Arab city form and detail as demonstrated in Cairo. This provides a rich mixture of passive techniques and cultural heritage.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. 'Orientalist' derives from 'orientalism' which refers more broadly to the study of countries and regions in 'the Orient'. During the period of colonial conquest, several European states set up institutions for dealing specifically with the Orient in trade and scientific study and by the nineteenth century, 'Oriental Studies' was a well-established discipline. (Haldrup and Koefoed 2009) Orientalists, who can be defined as those earlier scholars with knowledge of the languages and cultures of the Middle East and North Africa, were responsible for the concept of the Islamic city. The French Orientalists Georges Marcais, William Marcais, and Jean Sauvaget were prominent during the 1920s and 1930s (Bonine 2009). In this study, 'orientalists' means foreign (non-Arab) scholars with knowledge of Arab-Islamic cities.
2. NU or Neo-traditional Planning (Ellis 2002) is a movement that emerged significantly in 1993, against the modern urbanism. It has begun in North America and have spread to many other countries as a reaction against the suburban sprawl. The movement also advocates designing villages as a neighbourhood (Bridge 2009) encouraging walking, compactness, mixed land uses and high densities to avoid car dependency (Falconer et al. 2010) and provide quality of life. Therefore, the general aim of NU is inducing people to resort to the traditional urbanism and avoid the modern urbanism which ate the public spaces and offered inhuman urban developments, but through a contemporary perspective. NU 'calls for new design concepts to meet new situations. These include innovative ways to retrieve the mistakes of recent development; new regulations and policies to keep the old mistakes from recurring; visionary proposals for making older areas competitive again' (Barnett 1999, 7). In this study, the term of NU means the general aim of the movement more than its 27 principles per se.

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