Medinas: From Vernacular to Smart Sustainable Cities and Buildings

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Cities are the most prominent agile and resilient complex systems that evolved over time and space. Many of them survived for centuries, some for more than two millennia, like the **Medinas** of the MENA region, and they are still thriving. They survived many natural and human-made hazards and crises not to mention fundamental cultural and economic changes. Urbanists and sociologists believe that the key to a sustainable agile city is the existence and living of a community with its inhabitants and users. When the community vanishes, and the communal societal spirit disappears, it is only a matter of time before a city begins to decline and potentially fully disappears or mutates. A gradual disintegration of various infrastructure systems and services leads to crime rise, poverty, deficient educational and health systems, and a growing social divisions and inequalities.

While the medina, being the sustainable agile city, is formed and considered as the matrix; the courtyard house or smart home, can be seen as the component-cell. The principles and concepts of smart sustainable cities and structures were adopted in the domestic architectural design for many years and centuries. In fact, these concepts and passive devices of traditional domestic units were developed as a solution to socio-cultural, economic and environmental parameters. In the past and before the invention of electrical energy, housing units were designed and built in the MENA region; mainly based on the use of passive vernacular architecture. In Qatar for example, wind-catchers, courtyards, small openings, lengthy vertical lattices, thick mud-baked bricks walls, have been adopted in vernacular domestic units and housing patterns (Al-Hinai, Batty & Probert, 1993).

Opting for other design strategies other that the design guidelines and devices of the domestic traditional housing units flourished in those regions since the oil boom of the 1970s, with great influences from the Western modern architecture. New modern architecture forms such as detached houses are designed and built using wide glazed facades and other active devices. These new design strategies are largely used nowadays in the MENA region. While showing modernity and technological advances, these structures consume high amount of energy and endanger natural environment. The switch in design strategies happened despite the negative impact caused by these “foreign” strategies on uses and habits of local indigenous populations. This caused dramatic increase in energy and water demands. Such houses and design strategies combined with high-income owners/developers and reduced electricity and water fees lead to astronomic energy and water consumption figures coupled with high negative impact on the natural and built environment.

Figure 01: The vibrant vernacular Suq Waqif in Doha (Fadli, 2019).

The development of Smart Sustainable cities through the use and applications of disruptive technologies developed further with the advent of the 4th Industrial Revolution. Building Information Modeling (BIM), Virtual Reality (VR), Machine Learning (ML) and Artificial Intelligence (AI) and other means of 21st Century technology disrupted and provided a high-speed fast-forward move for the way we design our buildings and cities. Computational methods and generative parametric design allow better understanding and optimized applications of parallel interactions integrating several factors to achieve better results. The flexibility of computer programs, plugins and apps also makes it possible to integrate a wide variety of stakeholders in planning and design processes simultaneously and diachronically, thereby respond to people's needs and aspirations through real-time collaboration.

In this perspective, the "Smart Home" concept has been developing over the past few decades. It has been introduced in few different terms such as "Domotica"1 (Domotics) (Berlo & Vermijs, 1993); (Berlo, 1994); (Recuero, 1999), "Smart Home" (Lutolf, 1992), "Internet of Things" (IoT), and "Smart Living" (Fadli et al, 2015). Of course, there are numerous features towards having a "Smart Home" including but not limited to indoor air quality, energy efficiency, lighting, security, safety, comfort, entertainment, and accessibility. Moreover, software and hardware are widely diverse when it comes to each of these features. It is noteworthy to mention that apart from architecture and related design themes, several other disciplines such as automation, networking and optimization, mobile computing, Internet of Things (IoT) are integrated (Solaimani, Keijzer-Broers, & Bouwman, 2015). The pioneering launch of "Smart Home" concept dates back to early 1980s, when the American Association of House Builder introduced this new term for the very first time (Chan, Esteve, Escriba, & Campo, 2008). "Smart Home" is interpreted differently by different sectors and disciplines. As such, in healthcare, "Smart Home" is a preventive care place where occupants' or patients' health is monitored and assistance is provided for those in need (Demiris, et al., 2004). In another domain, construction, "Smart Home" is a place where residents could enjoy the technology and features installed can be controlled automatically in buildings (Hu, Wei, & Cong, 2013).

Figure 02: Typical Khaleeji home, located in Doha, Qatar is used for experimental study. Image courtesy of MZ & Partners (2017).

Over the last ten years, a sensitive raise happened in using, adopting sustainable design, related concepts, and principles (Fadli, 2014), (Bahrami et al., 2016). Several world leading institutions like the U.S. Green Building Council (USGBC) and the UK based Building Research Establishment Environmental Assessment Method (BREEAM) incited several countries, regions and governments to develop their own labelling and assessment systems (Attia, 2014), (Fadli, 2014). Energy (E) indicator is considered with Water (W), as one of the most important if not the most important indicator of these models and matrices. Many systems were developed and launched in the region such as Estidama Pearl system (UAE, 2009) and GSAS (initially QSAS) (Qatar 2010). The majority of these guidelines and models are performance based rather than focusing on the type of buildings and most importantly on the relationship between users and the spaces, and on how to innovate by developing integrated smart systems for sustainability. The lack of residential-specific green design guidelines proved that new research is highly timely and of high necessity and priority in Qatar and the region due to the harshness of the climate but also for social, economic and environmental reasons.

The passively designed entity targets to reach a minimum of half reduction of cooling load on a yearly basis as well as lowering down the electrical energy and water usage. The proposed house also aims to reduce investment costs by the fifth (Amato & Skelhorn, 2015). To-date, scarce and rare are those perceptive evidenced outcomes that have been mentioned and published (Fadli, 2016).

A smart home occupant can monitor and control the interface to feel the intelligent surrounding like 3D computer games. To the contrary agent-based monitoring (no occupant-machine inter-action), info insertion by occupants in a virtual place is gathered. Furthermore, Virtual Reality could be utilized to enhance the users' experience and let the user observes and feels for him/herself. This is considered as a user-oriented approach. V-PlaceSims presents a better understanding to users, which helps architects to find out about users' desires more clearly (Lertlakkhanakul, Choi, & Kim, 2008).

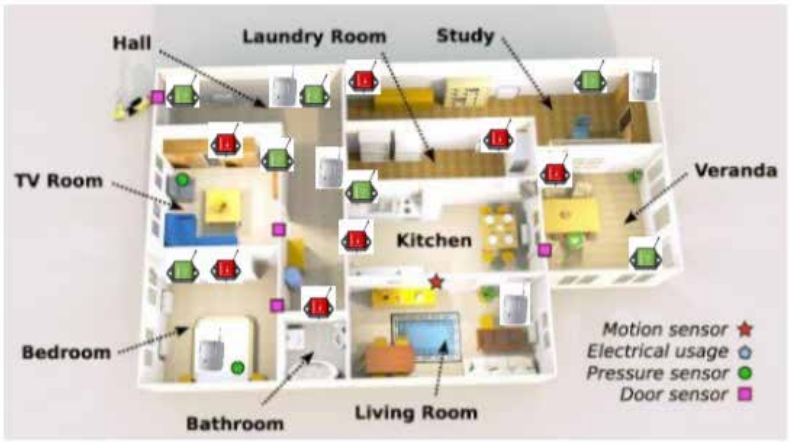

Figure 03: Sensors installation layout and configuration (Fadli et al., 2017).

This opinion essay targets and explores the major dimensions of sustainability based on its three-legged-impact model of socio-cultural (inc. health), economic and environmental aspects. On the socio-cultural dimension, it provides great insight in the way common users will be able to interact in a smart way with their homes, buildings, spaces, neighborhoods and cities at large. Moreover, they will constitute one single entity with complementary status. Home-Human correlation will work in both ways rather than human-home in one side. This will produce a chain of positive impact on the health, social-cultural and environmental aspects of the vernacular "bayt" transformed into smart sustainable homes in particular and interactive buildings in general. As per the health of users and the environment, the smart home app will provide ways of intelligent monitoring of indoor environment, which would positively influence users' health, comfort and wellbeing (AlFadala and Fadli, 2019). While economic patterns will be enhanced and a more efficient strategy adopted when it comes to energy and water consumption and recycling, hence proving economic and environmental positive effects to protect and safeguard both the natural and built environment (Fadli et al, 2014). The smart sustainable concept adopted into buildings, neighborhoods and cities will deliver the-state-of- the- art modern smart homes imbedded within the socio-cultural roots of the medina and its communities and society but also improving the health of its occupants and users as well as the economic and environmental patterns of the related natural and built environment.

The principles of smart sustainable design are being developed from research-lead design, where the knowledge is transmitted to students through the "students-centered pedagogical approach" and the interactive studio to definitely move towards practice through consultancy and Research, Development and Innovation.

From indigenous vernacular 'ingeniosity' to smart and sustainable, only the Medina and its buildings can make it through two millennia…and beyond!

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