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Thermal comfort through the microclimates of the courtyard. A critical review of the middle-eastern courtyard house as a climatic response

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Abstract

The last few decades have seen a dramatic increase in using the mechanical means of air-cooling in the Middle East to provide thermal comfort that has caused high rates of energy consumption. This has drawn the attention of specialists who see the reuse of traditional prototype as a highly efficient strategy to confront this issue in contemporary architecture. An in-depth investigation is undertaken regarding this approach by this paper concentrating on thermal comfort through the microclimates of the courtyard to reveal its limitations and possibilities to make a fruitful contribution to contemporary architecture.

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1. Introduction

Twentieth century architecture of the Middle East is considered a prim consumer of energy, most of which is utilised for the provision of thermal comfort for occupants to enable them to survive the severe climatic conditions for which this region is renowned [1]. This is highly indicative of the lack of climatic rationale in architecture design

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in the region, an issue which has drawn the researchers' attention. In this context, traditional models are believed most researchers to offer key lessons about the best solutions to confront these concerns in contemporary applications [2-4]. As such, a number of authors believe the courtyard house of a highly suitable prototype that offers a comfortable internal environment in this climatic region [5-8]. Fathy [7] claimed that at night, this architectural system accomplishes a significant reduction in air temperature (10-20 C°). Moreover, Scudo [9] stated that this strategy did and still performs as a free cooling system and thus it should be incorporated in contemporary architecture. But is this true? Other researches have shown how unsuitable the courtyard is in terms of thermal comfort [10,11]. In a study of non-shaded patios, Etzion [10] found that, "In summer, most of the time the courtyard is warmer than the ambient air temperature near the house, day and night. In a few cases the temperature differences between the ambient air and the air inside the courtyard were as high as 7 °C." Apart from that, Dunham [12] pointed out that a comfortable internal environment can only be achieved by small courtyards. Furthermore, Al-Hemiddi & Megren Al-Saud [13] concluded that a remarkable cooling effect is attained when a courtyard includes a fountain and is covered during the day by a tent.

If this architectural system climatically accomplishes the inhabitants' needs, then there are a number of questions that must be addressed. Firstly, why is this space uninhabited most of the day except early in the morning? Secondly, what is the purpose of covering this space with a sheet during the day? Moreover, if the patio performs well environmentally in a temperate climate, does this mean that it can offer the same quality in a region that is characterized with extremely high temperatures most of the year? Furthermore, why have people resorted to air conditioning systems over the last decades rather than relying on traditional cooling strategies? Finally, what possibilities can the reemployment of the courtyard offer in a modern context as it has been used under different climatic and cultural factors?

Perhaps a lack of complete understanding of the patio's environmental role is because morphological and interventionist aspects are addressed alone. Based on the literature review, to undertake an in-depth investigation, both morphological and interventionist factors as well as behavioural aspects must be considered in this article as integral parts of an overarching strategy of climate adaptation. As a result, its limitations and the need for optimisation can be clearly revealed in order to make a fruitful contribution to contemporary architecture. In addition, the cultural context should also be addressed to discover the socio-cultural forces behind this strategy and their impact on its performance.

2. Forces behind the formation of the courtyard house

In-depth insight into the procedures or forces that decisively affect building morphology is necessary to understand the prevailing housing typologies in the Middle East, particularly the courtyard house. In spite of endeavours undertaken by a number of authors to more theoretically and deeply investigate the drivers that have shaped the courtyard house, most have identified Islam as the main determinant behind the built form [14-18].

In this context, a sense of privacy is believed to be the major factor behind the formation of the built environment, which can be seen when referring to the words of God Almighty in the Holy Quran [19]. After the revelation of those verses, builders began to accurately organise and orient rooms in a formula that provides vocal and visual comfort. Apparently, creating closed spaces for inhabitants to be entirely detached and isolated was not required to attain visual and vocal comfort inside their houses since that would give rise to psychological problems. Thereby, the process was made in parallel with the accomplishment of the logical connection with environmental components. Consequently, the introverted design was employed in configuring their shelters as El-Shorbagy [20] stated. Hence, the courtyard became the main space for daily life activities as it provides a limited visual axis between the inside and the outside [20]. The reality that the building form is informed by many factors is ignored by many arguments which place robust emphasis on just the single concept of achieving religious needs. Owing to the idea that the introverted focus through courtyards is an efficient strategy that makes a house proficiently adapted to social requirements, including religious values and thermal conditions, it is argued that this formula was adopted by people who followed Islam [15].

Nevertheless, relating the emergence and proliferation of the courtyard to Islamic architecture indicates a lack of rigour. According to Rapoport [21], "Courtyard houses, and separation of domains in general, are used in cultures which are both crowded and hierarchy." Rapoport [22] also stated that this tactic has been utilized throughout the

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