



RESEARCH ARTICLE

Traditional Iranian courtyards as microclimate modifiers by considering orientation, dimensions, and proportions



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Abstract

The effect of courtyards as microclimate modifiers on the sustainability of traditional houses in a region with BWks mesoclimate in Iran was explored. The principle behind traditional Iranian courtyards was investigated to identify the most influential physical-environmental characteristics that can effectively improve energy efficiency in contemporary residential buildings. A field study was performed to analyze various physical elements of six valuable traditional courtyard houses located in a region with BWks mesoclimate in Iran. These elements included the orientation, extension, rotation angle, dimensions, and proportions of enclosed and open spaces, as well as physical bodies (opaque walls), transparent surfaces (openings), and natural elements (water and soil). Results showed that most of the studied Iranian courtyards were particularly designed to enable orientation, dimension, and proportion to act as microclimate modifiers. All survey-based data were summarized and integrated to propose a physical-environmental design model for courtyards as a useful energy-efficient strategy for contemporary sustainable housing in a region with BWks mesoclimate. The proposed model can be generalized to all design cases located in areas with similar climatic conditions.

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1. Introduction

Sustainable design is the philosophy of designing physical objects, building environments, and services to comply with

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the principles of social, economic, and ecological sustainability. Sustainable designs require nonrenewable resources, have minimal impact to the environment, and connect people with the natural environment (McLennan, 2004). Most modern buildings are designed without adequate attention to environmental impacts. The history of architecture exhibits a positive correlation between the environment and traditional buildings, which have been designed with careful attention to climatic requirements and socio-cultural contexts. Traditional courtyard houses in the hot and dry region of Iran can also be considered successful climate-representative architecture that responds to many persistent environmental challenges. These houses use renewable solar and wind energies for passive heating and cooling to provide thermal comfort for their occupants. Traditional courtyard houses apply design principles such as compact urban fabrics, regular forms, optimal climatic orientations, dome-shaped roofs, high thermal capacity materials, courtyards as microclimate modifiers, and wind catchers as natural cooling systems (Figure 1).

The courtyard is one of the most important elements of traditional courtyard houses. The lexical root of the word “courtyard” was the word “Curtis,” with the Caucasian root, “Gherdh,” which means “fencing off.” The term was

derived from medieval documents. Thus, a courtyard is a closed area in a house or other structures that is a vast uncovered space surrounded by rooms on some sides (Mahdavinejad et al., 2013).

Central courtyards have cooler air temperature primarily in the area above the courtyard and during mornings. A courtyard operates as follows. The air in the courtyard becomes warmer as the day progresses toward nighttime. Cool air is stored in the courtyard in laminar layers and flows into the rooms surrounding the courtyard. Then, the temperature in the courtyard slowly increases in the morning, allowing the courtyard to remain cool until solar radiation falls directly onto it. Warm wind passes over the house during the day. This wind does not enter the courtyard and merely creates eddies inside it, unless baffles are installed to deflect airflow. This phenomenon can be explained by the thermal properties of air and the material used in constructing the courtyard. The thermal capacity of the air is extremely low, and thus, the temperature of the courtyard is too close to the temperature of its surrounding surfaces. At night, the walls and floor of the courtyard are cooled down by long waves of outgoing radiation. Therefore, the surface of the floor and walls of the courtyard will remain cool until the following morning. Hence, most parts



Figure 1 Environmental sustainability of traditional courtyard houses in the hot and dry climate of Iran: (a) compact urban layout of the structure of the Chupanan Desert town, Isfahan; (b) traditional courtyards as microclimate modifiers, Kashan; (c) narrow enclosed alleys provide shade during summers, Yazd; (d) traditional wind catchers as natural cooling systems, Yazd; and (e) roof dome windows provide natural light, Kashan (Soflaei, 2004).

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