

Environmental Architecture: Courtyard as Element of Sustainable Energy Efficient Building Development

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Abstract: Global warming and Climate change are burning topics that the society cannot afford to play down on a sustainable ideas to reduce energy consumption. The salvage effect of temperature rise in the indoor thermal environments demand the utilization of strategies that will promote thermal comfort in our indoor environments. Buildings consume more energy now due to than in the past. This affects energy consumption in modern homes. The present high rate of energy without concern for the environmental and replacement calls for a review of passive and natural environmental ethics and practices. Environmental architecture is one that will provide comfortable indoor environment in response to energy consumption and reduction in greenhouse gases, a prelude to sustainable energy efficiency in buildings. This paper in view of the above, as a primer, reviewed courtyard as architectural element, then delved into its ability to assist in realization of sustainable energy efficient building development. It discussed ventilation, thermal comfort and lighting as ways courtyards contribute to sustainable energy efficient building development. The paper concluded that though courtyard is only one of the many passive design means in architecture for thermal comfort and energy efficiency, its addition into design will contribute in sustainable energy efficient development.

Key words: Architecture • Courtyard • Energy Efficient Building • Green World • Sustainable

INTRODUCTION

The need for sustainable built environment has created a consciousness for bioclimatic design. This is good a development for future. There have always been concern for sustainability in the issues of energy and greenhouse gas emissions resulting from the use of mechanically driven comforters known to be active means for ventilation. The stated problem created a demand for passive energy means in modifying indoor environments. High temperature has brought an increase in air-conditioners used to improve comfort and production in work places. This places very high premium on energy since buildings account for more than 40% of global energy consumption [1]. Air-conditioners take a lot of energy and create negative impact on the environment. [2].

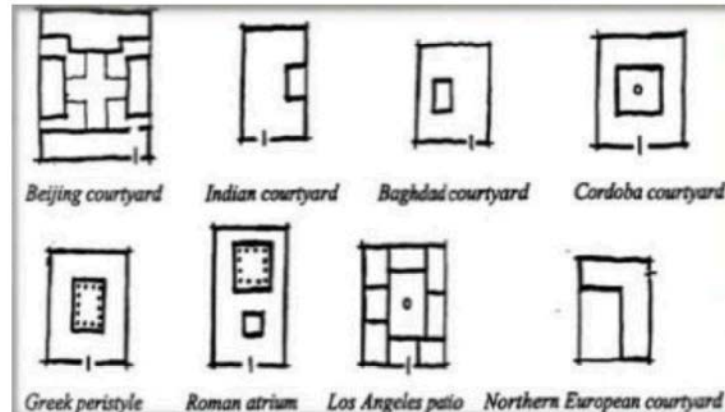
Courtyards are common elements in buildings all over the world which have been used by both ancient and contemporary architects as a typical and traditional building feature. Courtyard is defined as an open to sky area, enclosed by built spaces. Courtyard which were included as an architectural feature in ancient planning

and designing philosophies is gradually regaining popularity in spatial design with aim to reintroduce its open to sky built environment [3].

Architecturally, courtyards make perfect sense. They give the residents of a home private outdoor space, which is secure and suitable throughout the day. With its natural ventilation, a courtyard helps the house stay appropriately warm or cool without the need of air conditioners or heaters. In architecture, courtyards add design elements that creates connectivity between interior and exterior space [4].

The open air oasis, a rarity in dense cities, provides a multifunctional extension of living space ideal for entertaining, gardening, yoga and star gazing, right in the middle of a restless city. Unlike a yard, courtyard carved out in the center of a building provides a private tranquil space for homeowners, or buffered space for apartment dwellers in courtyard apartments [5].

Evolution of Courtyards: Ancient literature and Architecture emphasized the importance of the courtyard as a source of positive energy and vibrations in the center of the house. The courtyard has been a



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Fig. 1: Forms of Courtyard in different parts of the world.

recurring motif not only in residential architecture world over but in medieval churches and cloisters as well [6].

Courtyards have historically been used for many purposes including cooking, sleeping, playing, gardening and even places to keep animals. Before courtyards, open fires were kept burning in a central place within home, with only a small hole in the ceiling overhead to allow smoke to escape. Overtime, these small openings were enlarged and eventually led to the development of the centralized open courtyard we have today. Courtyard homes are employed in both temperate and tropical climates for thermal purposes [7].

Forms of Courtyard: Courtyard are defined primarily by size, shape, position and orientation. The degree of the enclosure also impacts the ambience created by the courtyard. These apart, the detailing of the courtyard should be in harmony with the architectural style adopted. Depending on the scale, some large courtyards have also included small to medium sized trees as soft landscape element. Effective lighting, ambience or mood, can also be incorporated for dramatic effect [8].

[9], noted courtyards as basic architectural structural frame which have undergone modifications to enable its suitability in resolving environmental features, arising from topography and site constraints. [10], classified courtyard into two basic types, the semi shut (three sided) and the completely encased (four or more sided).

The rectangular and square forms are the most commonly adopted for courtyard in buildings even though, there is no particular form is considered most suitable [11]. Most courtyards in residential buildings are

rectangular or square. Circular, curvilinear and other forms may evolve. Courtyard form can be adapted to by using eco-friendly aspects such as scenery, site limitations and building orientation, to generate new shapes such as; U, L, T or Y [12, 13].

Courtyards form can be fully enclosed, semi-enclosed or in some cases even two sided [14]. The application of these forms is not limited to residential buildings, but may extend to other forms of buildings.

Scholars have conducted studies on courtyard design concepts. The studies made it clear that the forms could be manipulated to provide microclimate modifier to the built environment. For instance, the courtyard form was found to be a key design requirement in a study on the rectangular courtyard form and its impact on the eco-friendly performance in the tropical region [15].

Functions of Courtyard: In architectural design, the courtyard has been put into use for many years particularly in housing design. Its application is justified due to its numerous benefits. In recent times, scholars have made known their opinion on the benefits of the courtyard in order to explain its relevance in buildings. These benefits include; architectural benefits, social benefits, climatic benefits, cultural benefits, economic benefits and the religious benefits [16].

Courtyards were frequently used as meeting area, for specific functions such as gardening, cooking, working, playing, sleeping, or even in some cases as places to keep animals [17].

The use of courtyard for functions may depend on its location in the building (this may vary due to culture). [18], noted the importance of the location of courtyards to

be significant choice and made known his opinion on having the courtyard located in central sites within the urban fabric or building, surrounded by arcades and colonnades, paved, landscaped with water bodies, various plants, shade and light. They both believe our social life, life expectations and health may be affected positively. [19] continued that the courtyard can be used as a place for facilitating the healing process due to its natural healing environment. The courtyard also contributes in a major way by modifying the climatic setting and thereby inducing mental and physiological sensation of its end users.

Benefits of Courtyard in Architecture: Architecturally, courtyards make perfect sense. They give the residents of a home a private outdoor space, which is secure and usable throughout the day. With its natural ventilation, a courtyard helps the house stay appropriately warm or cool without the need for heaters and air conditioners.

In a warm climate, a courtyard can bring down the house's temperature, saving on energy bills. Several courtyards also include natural cooling elements as a part of their design like a fountain, a basin, an artificial waterfall, thick external walls and double-glazed windows.

Interior courtyards are very much in vogue today for the above reasons. They provide an aesthetic means of spending time with nature in the midst of a busy schedule. And the best part is that courtyards work with any style of home - modern or traditional.

So from growing an indoor garden to creating a serene corner in a crash and burn busy lifestyle, interior courtyards can do so much to enrich life. Here are some more advantages you can enjoy.

With daylight, every room that opens into the courtyard gets its dose of sunlight during the day, helping you with energy savings.

The benefits of being exposed to this optimum quantity of sunlight are well known, as well as the creation of natural refreshing environment.

The inclusion of courtyards into low buildings and houses has many benefits which [20], stated as follows:

Psycho-Social Benefits: The courtyard provides a sense of enclosure and privacy to the residents of the house.

Cultural Benefits: The courtyard is used as a cultural element which separates the public and private spaces within the house. The inner court is more restricted to the family and is usually a protected outdoor space enjoyed by the females of the house in full privacy [21].

Energy Benefits: Courtyards have been generally referred to as a "microclimate modifier" in the house due to their ability to mitigate high temperatures, channel breezes and adjust the degree of humidity [22].

Architectural Benefits: Courtyards generally function as a Centre in buildings and houses, connecting the different areas and functions.

Symbolic - Religious Benefits: The courtyard is both symbolical and religiously significant. The open to sky, yet enclosed space within the surrounding walls of a house has been considered the central focus of interest in the house [23].

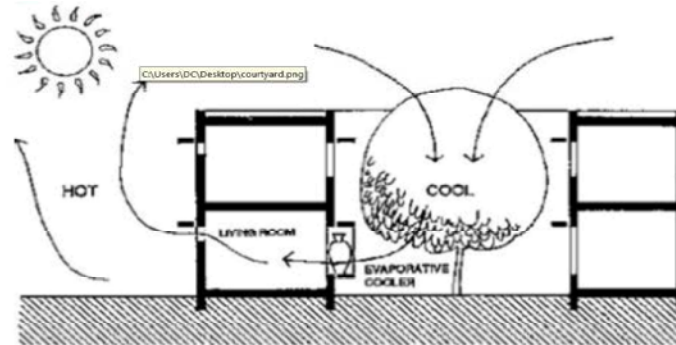
Economic Benefits: Some financial benefits are closely associated with courtyard form and construction. Courtyard house designs show efficiency in land use, as they do not require a conventional yard for outdoor space. Especially when adjoin courtyard houses share walls, the cost of both construction and maintenance is significantly reduced [24].

The paper having listed the benefits of courtyard in buildings to include, Psycho- Social, Cultural, Architectural, Symbolic- Religious, Economic and Energy, discussed Energy as the benefit to embrace for the attainment of "Sustainable Energy Development".

Courtyard as Means for Sustainable Energy Efficient Buildings: Courtyards were developed mainly in response to climatic requirements. The residents of such climates utilized the courtyard to serve as a collector of cool air at night and a source of shade in the daytime [25].

Courtyards are not new concepts in architecture, rather it is one of the oldest forms of residential dwelling development in history of man having been used by many urban and medieval civilizations. Courtyards are believed to be able to improve the natural ventilation performance of buildings [26]. They are transitional zones which improve thermal comfort conditions by modifying the microclimate around the building and by enhancing the airflow in the building [2]. One of the objectives of courtyard is to introduce the outdoor into the heart of the buildings core, as well as optimize the climate source.

Passive design strategies are aimed towards sustainable energy efficiency in buildings. Energy efficient buildings, afford indoor thermal comfort and prolonged application of it brings about sustainable built environment. Application of courtyards in buildings can contribute meaningfully towards achieving passive buildings with high energy efficiency [5].



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Fig. 2: Showing use of courtyard for Ventilation, Thermal Comfort and Lighting.

[11, 12], underscored passive and low energy architecture as strong design strategy to bring cooling into buildings. [6] affirmed that employing passive measures reduces the much dependency on active measures to energy use in buildings. Dependency on active energy sources Akande argued is because most residents have experienced constant thermal performance failures resulting from high indoor temperature. He concluded that courtyards remain one of the ideal elements to mitigate environmental issues resulting from high temperature, ventilation, thermal discomfort and poor indoor air quality. Which have continually become a disturbing impact of global warming and climate change.

[9] opined that courtyard is microclimate modifier, in dwellings due to its capability to moderate high temperature, channel wind and regulate the amount of dampness, hence courtyard remains good passive strategy for attainment of Passive and LowEnergy Architecture(PLEA), cannot be overlooked.

Natural Ventilation in Courtyards: [14] identified major effect of the courtyard to be the ability to provide better ventilation to building's interior by having the space for exchange of air between indoor and outdoor environments. The effectiveness of the courtyard in providing ventilation is because it makes use of both stack and wind forces to generate airflows through the room spaces adjoining to the building well. During summer, the stack force can be inactive while the walls act like the chimney for venting warm air out through roof openings.

Thermal Comfort: Thermal comfort is defined by American Society of Heating, Refrigeration and Air - conditioning Engineers (ASHRAE, 2004) as the condition of mind which expresses satisfaction with the thermal

environment. ASHRAE (2004) went further to quantifying a comfortable thermal environment as one in which 80% of the sedentary or partly active people in it accept to be thermally comfortable.

There are six main factors considered when defining thermal comfort conditions. There are, air temperature, radiant temperature, air speed, humidity, metabolic rate and clothing (ASHRAE, 2004). Thermal comfort indicator are generally based on prediction of percentage dissatisfied (PPD) and predicted mean value (PMV). PMV is an index that predicts the mean value of the votes of a large group of persons on seven thermal sensation scales while PPD is an index that establishes a quantity prediction of the percentage of thermally dissatisfied people determined from PMV (ASHRAE, 2004).

Indoor thermal discomfort results from increase in temperature and a solution may be to increase air flow through ventilation [7]. Ventilation defined by [23] as the replacement of used air by fresh one could be enhanced in buildings with courtyard because of the enablement to achieve window openings in opposite directions, usually referred to as cross ventilation. This indeed provide for less usage of active energy means and saves energy which incrementally build sustainable energy environment.

Natural Lighting: Buildings in general and commercial buildings in specific, the use of artificial lighting is considered a key problem that can lead to bankruptcy in energy. As it affects cooling and heating loads requirements of the building (Department of Energy, 2004). [8] noted energy consumption by artificial lighting to amount to 25%-40% of total energy consumption hence the call for courtyards to not only cool the house but also provide natural lighting during the day time and minimize lighting loads.

RECOMMENDATIONS AND CONCLUSION

The paper brought more realities to the use of courtyard in architecture. It in brief stated the use of courtyards in buildings in history and unveiling its types, functions and benefits in architecture, among which is the energy benefit. Courtyards are extensively used for ventilation, thermal comfort and lighting and in the improvement of indoor air quality which depends on airflow.

The paper recommended that architects be ahead in the race to employing the use of courtyards in their new schemes, especially as it provides safe outdoor environment, enclosed by the building, which assists in checking the excesses of felt indoor thermal discomfort. The paper concluded that, though courtyards in buildings development is just one of the many passive design measures, but its benefits are far too many.

The paper is of the opinion that the practice, will join the other many passive measure in enhancing the development of energy efficient buildings.

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