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ADAPTATION AND AWARENESS OF PASSIVE DESIGN STRATEGIES IN CONTEMPORARY HOUSES OF LAHORE, PAKISTAN

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ABSTRACT

Passive strategies help us to achieve sustainable and environment-friendly, low-impact designs and solutions. Adaptation of these depends on climatic constraints and specific use, for instance, ventilation and natural lighting. To achieve a low carbon economy, mitigation approaches are incorporated worldwide where thermal comfort is achieved without using active means. These techniques can be adopted in all climates around the world, with respect to ventilation, orientation, thermal mass, shading devices, daylighting, etc. To cater to the challenges of climate change, mitigation approaches are being incorporated worldwide in the architecture industry to reduce reliance on active means. Their application not only improves health and well-being but is also energy efficient regarding electricity consumption and provides economic benefits for the users. The application of passive design is well-seen in commercial and residential projects. To understand the prospects of passive strategies, the research is carried out to identify current awareness and adaptation potential among architects and their clients in the residential sector of Lahore, Pakistan. The research survey has been done in the form of a questionnaire designed to analyze the application of passive design strategies by architects, awareness among their clients in contemporary residential architecture of Lahore, Pakistan. The research findings show that architects are well aware and positively use these strategies, however there is a gap in the awareness of clients. Most clients preferred active means, while a few clients were inclined towards passive means. The need to make clients more aware of the benefits of these strategies was a highlighted outcome.

Keywords: Passive design, passive strategies, energy efficient, sustainable, contemporary, residential, architecture.

INTRODUCTION

Passive design adaptation in building envelopes is among subjects discussed globally along discourses on climate change and related emerging theories. It addresses factors like greenhouse emissions and evident temperature discrepancies. Passive strategies encourage using natural sources and move towards sustainable and environment-friendly solutions. The benefits of the applications are a high level of comfort to the occupants and the provision of healthy living situations both in residential and commercial projects. Its awareness and adaptation are topics of consideration in changing world scenarios. Although, passive design strategies are not widely observed in residential buildings of Lahore, a prominent city major of Pakistan, the objective of this research is to investigate the reasons for their limited use. A questionnaire survey was conducted among practicing architects to investigate their point of view regarding the use of passive strategies and to study the demand of clients, in the context of Lahore city. Firstly, various form strategies including the orientation and building shape with respect to sun and wind directions, building materials, and addition of landscaping and water bodies were studied. Second, factors including daylighting, sun shading, screening and filtering devices, additional cavity walls, use of basements and courtyards were also studied in designing of projects.

The results of the study display that most architects are willing to adopt passive strategies while most clients are little aware of their benefits. Most of the clients are stuck to specific strategies and do not take risks to adopt others. They rather prefer to opt for trendy facade house designs.

RESEARCH METHODOLOGY

The mixed method research began with a literature review from books, websites, and was followed by an online questionnaire survey. Lahore is selected as the focus of this study as it experiences a broad range of climatic conditions, from very hot summers to cold winters. This makes the city a potential area to study that how buildings can be designed to naturally cope with this range. Additionally, many well-known architects have designed contemporary residential designs in Lahore, providing significant examples to analyze how they have used passive design techniques. Selected residences are analyzed considering the climatic conditions and corresponding use of passive strategies studied by conducting a virtual survey with a structured quantitative questionnaire. To propagate the survey among architects, the snowball sampling technique was used. 60 practicing architects responded and their data was used to frame this research. To augment the research, two design firms of practicing architects in Lahore shared their house design drawings. Their analysis illustrates the professional practice being carried out to address the passive strategies. The discussion brings together the essential findings to derive the conclusions. (Figure1)

LITERATURE REVIEW

The passive design addresses climate change which is a matter of extreme importance worldwide where several theories are emerging and under discussion (Saeed et al., 2013). Research shows that the factors of greenhouse emissions due to fossil fuels are resulting in evident effects on temperature variations and proposes a dire need for architects to design energy-efficient buildings (Saeed et al., 2013), where climate responsive strategies should be adopted to achieve sustainable solutions (Figure 2). It means that to get sustainable results, natural resources should be utilized rather than active means of energy resources. This also promotes healthy living conditions and economic benefits.

Passive design strategies encourage the use of natural sources in particular climates for lighting, heating, and cooling, considering various techniques to provide human comfort and well-being and sustainable solutions to the users. It is the domain of environmental design where comfort is achieved through various measures to attain the maximum benefit of natural means and non-reliance on artificial energy resources (Altan et al., 2016).

Passive strategies adaptation benefits

Passive strategies are considered to be modest and low cost as it takes the benefits of the available potential land opportunities of the site. Developed countries have sufficiently established the guidelines for the use of passive design for the builder to take benefit. Like in the United States of America, where passive solar adaptation and the use of passive strategies that enhance the internal comfort with use sunlight is in practice considered energy efficient according to the climate, advanced guidelines are available (Building & Associates, n.d.).

In the hot-dry region of Indonesia, an experimental approach was carried out to study the effect of courtyard design on energy efficiency. The research indicated that indoor temperature was lower by 4.9 – 7.3 C than outdoor temperature, thus illustrating that use of courtyard in contemporary houses was a feasible means to achieve cooling effect through full-day ventilation system (Nugroho, 2020).

Research by Udo Dietrich (2019) conducted in Brazil, compared contemporary and traditional houses with passive strategies. Through practical survey and simulations, the research concluded that passive measures as significantly valid solutions to protect against solar heat transfer.

An energy-efficient building design assures maximum comfort level to the occupants in performance and the designed activities. It reduces the usage of non-renewable

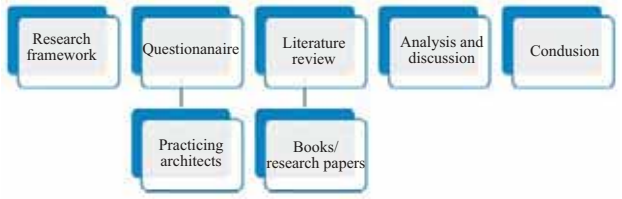


Figure-1: Methodological Framework.

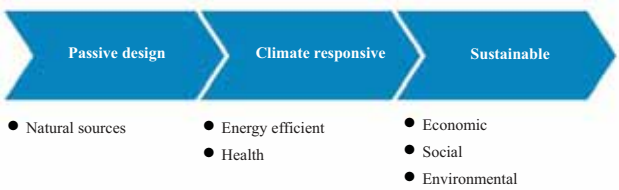


Figure-2: Sustainable Design Through Passive Strategies.

energy and considers the factors of energy cost. The socio-economic and environment-friendly design of the buildings should be considered to get sustainable solutions. This is conceivable with the low energy usage, providing a suitable indoor environment and resulting in good health. Eminent researchers showed that use of energy-efficient means in the designing of buildings have produced sustainable results and have effective results on human health and wellbeing. Naturally ventilated spaces considering the orientation and shape of the building, in comparison to other enclosed spaces, have proven to have given higher satisfaction levels for human health conditions (Sherali, 2014).

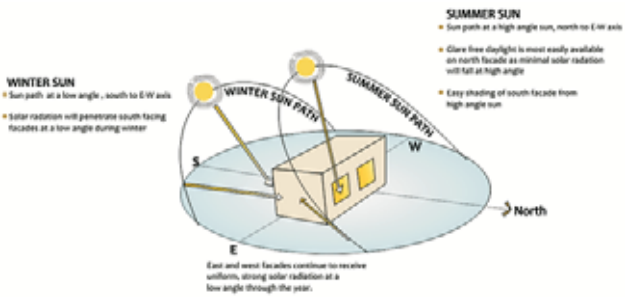
In the context of Lahore city, traditional house designs within the Walled City area were based on passive strategies with no use of air conditioning while contemporary houses are inseparable from air conditioners. These have become part of the contemporary lifestyle (Malik et al., n.d.). This study aims to fill the reseach gap, on how the client's demands and their view of buildings effect the use and design of passive strategies.

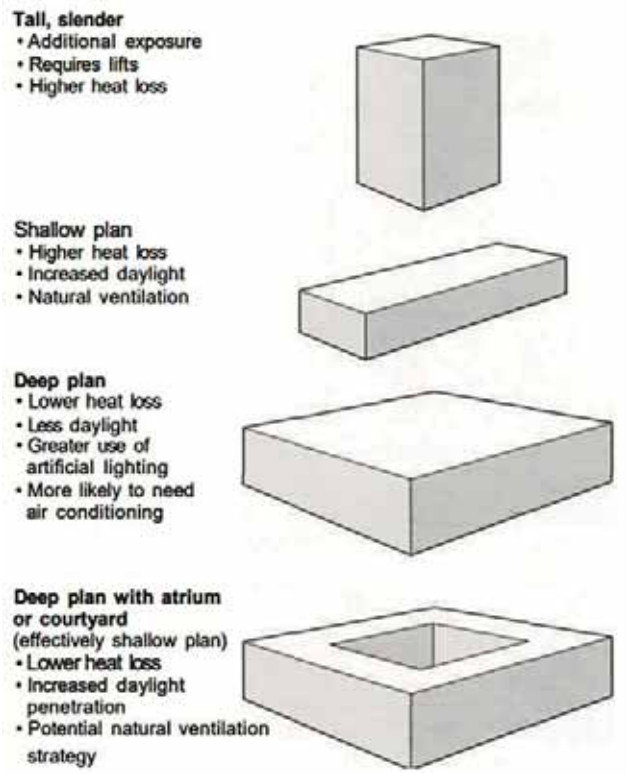
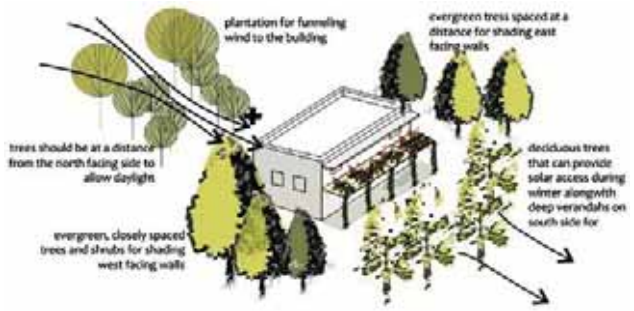
Passive house design

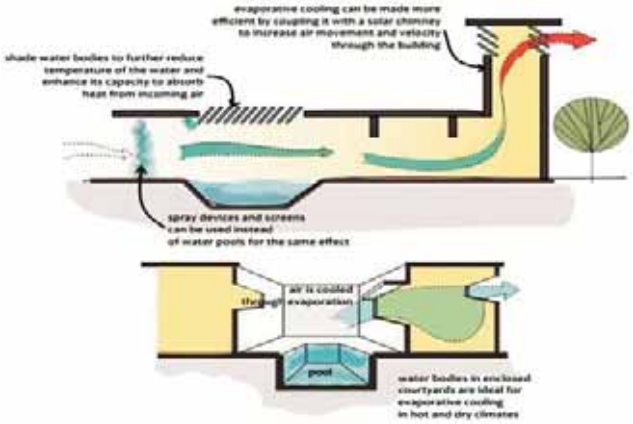
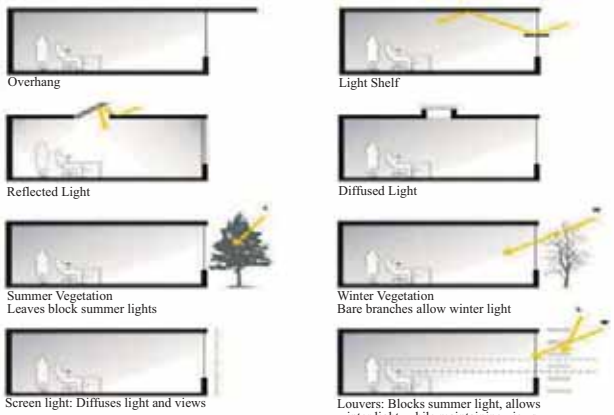
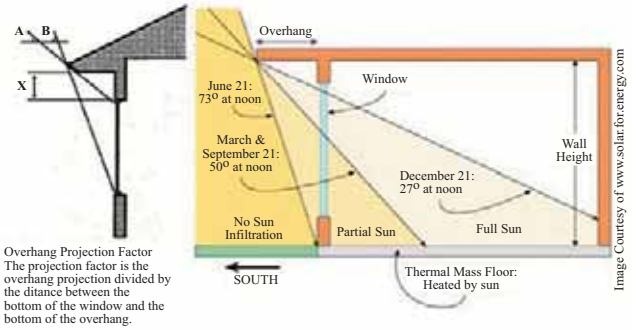
Passive house design principles revolve around the coordination of energy-related components to formulate design concepts and ultimate functions. The results are mostly taken into the building envelope by simple geometries fulfilling the passive requisite either heating or cooling depending on the requirement of site. Ultimately ensuring the appropriate level of comfort for the users (Gonzalo and Vallentin, 2014).

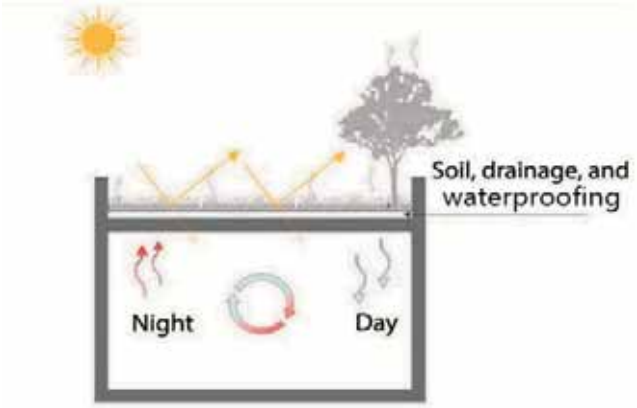
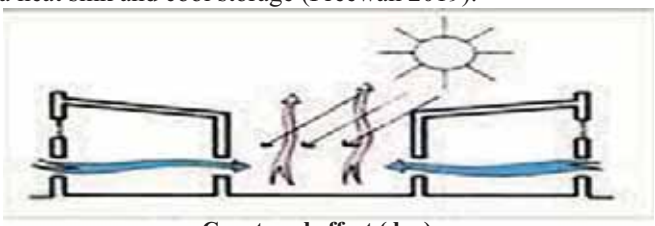
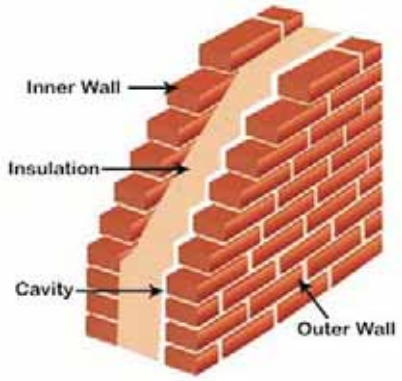
The building envelope contributes significantly in achieving thermal comfort through solar shading and orientation, controlling solar heat gains. Proper remodification, strategies and techniques application lower energy cost and promote sustainability (Mujahid et al., 2022). Moreover, to make good use of the wind in hot, tropical climates, courtyard, wind towers, and cross ventilation are considered where the desired comfort level is achieved in the buildings through stack effects (Malik, 2020). The following table outlines the academic and experimental approaches with examples identifying with different passive design strategies.

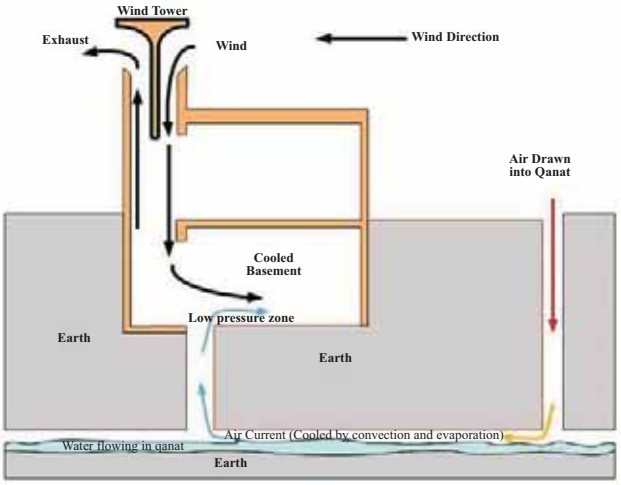
Table-1: Potential Passive Strategies for House Designs.

Strategies	Description	Benefit
Orientation	Orientation is defined as the placement of the building according to the direction of the sun and prevailing winds. The orientation of the building directs the size and location of the opeinings (Altan et al., 2016).  ***Figure-3:*** Building Orientation.	The building should be oriented to maximize winter sun and minimize summer sun (Jones 2004). North-facing windows benefit the most as they suffer the least solar gain. East-west facing is not recommended as they face the direct sun while south windows allow both direct and diffuse radiations (Jones 2004).
Materials	Environment-friendly materials are chosen according to the climatic conditions of the site. While choosing the materials, three properties of color, insulation, and assembly type should be considered, as these properties play a role in heat gain and loss (Altan et al., 2016).	The amount of heat and loss is also affected by the color of the finishing material (Altan et al., 2016).

Strategies	Description	Benefit
Building Shape	The shape of the building, its length, width, and height plays a major role in defining the building's thermal capacity and visual comfort (Altan et al., 2016).  ***Figure-4:*** Building Shape (Jones 2004).	Building block designs can influence wind flow, heat gain & loss, and natural ventilation achieved inside the building.
Landscaping	The use of landscaping helps to enhance or reduce the effect of microclimatic conditions on site. Designing soft and hard landscapes will affect the efficiency of the building. Trees and shrubs play a vital role in directing wind flow, providing shade, and acting as noise barriers (Altan et al., 2016).  ***Figure-5:*** Landscaping (Songa 2021).	Deciduous trees and vines help to reduce the solar heat and glare in reflected light from neighboring structures, water, or ground finishes (Jones, 2004).

Strategies	Description	Benefit
Water bodies	Water bodies are adapted to dry and hot climates. Using waterbodies for temperature reduction is a common method. With the process of evaporation, it gives a cooling effect.  ***Figure-6:*** Waterbodies work as evaporation (Songa, 2021).	Waterbodies help to cool the surrounding space by the removal of latent heat, thus providing cooling.
Daylighting	Daylighting is one of the most used passive strategies. It directs the location and size of the windows and shading devices, which helps to integrate daylight into the building (Jones 2004).  ***Figure-7:*** Daylighting (Ediael, et al., 2019).	If daylighting is designed according to the sun's path while considering its surroundings, it reduces the running cost and internal heat gains. This will also reduce the need for mechanical air conditioning. Daylight allows the natural light to penetrate up to 6 meters inside the window (Altan et al., 2016).
Shading/Louvers	Generally, horizontal shades work better in north and south orientations while vertical shades work better in east and west directions. While the combination of both will be required for harsh sun (Altan et al., 2016).  ***Figure-8:*** Shading (Associates 2016).	Shading is used to reduce heat gains during day and night temperatures. Shading devices do not allow the direct sun to penetrate but rather receive diffuse sun light (Altan et al., 2016).

Strategies	Description	Benefit
Roof garden	Roof gardening is the strategy that ceases solar radiation to reach the building below (Shrikant Pandey 2012).  **Roof garden** ***Figure-9:*** Roof Garden Strategy (Gou and Zhonghua 2018).	Roof garden helps to reduce the stormwater run-off, heat island effect, and CO2 from the atmosphere and maximizes the cooling effect of the building .
Courtyard	Courtyard strategy works to enhance microclimate and act as a heat sink and cool storage (Freewan 2019).  **Courtyard effect (day)**  **Courtyard effect (Night)** ***Figure-10:*** Courtyard Effect (Park, 2015).	Buildings with internal courtyards are solutions for hot climates to provide inner space with cool air and daylight (Freewan 2019).
Cavity Wall	It is the technique of creating a cavity (insulation) between two separate walls. This simple technique helps to work building efficiently.  ***Figure-11:*** Cavity Wall (Patel 2019).	Cavity wall works as a thermal insulator, and sound insulator, does not permit moisture content to penetrate, reduces weight on the foundation, prevent efflorescence, and are cheaper than a solid wall (The Constructor n.d.).

Strategies	Description	Benefit
Basement	At a depth of a few meters, the temperature of the Earth is below ambient temperature, which allows it to serve as a heat sink for basement rooms. The temperature of the Earth is constant, near to comfort zone, which makes this strategy applicable for different climates.  ***Figure-12:*** Cooled Basement.	The basement works best in hot arid climates. This strategy is useful for direct and functional responses. It provides cooler temperatures in summer. As the rooms are connected with Earth, it decreases the heat exchange with the outside temperature (Ahmadreza, 2015).

Analysis and Discussion

Contemporary house designing among architects of Lahore is showing up with a share of innovative experimentation and implementation of the latest technologies including passive strategies and techniques. Among many of the contemporary leading firms in Lahore, two examples have been studied in the research to get an idea of design practices regarding passive strategies. One of these is the architectural firm named, Galleria Design, working on concepts of passive strategies. With the analytical study of some of projects of Galleria design shows that architects have considered courtyard, cross ventilation, and roof garden to minimize the dense climate of Lahore while designing thier projects. With the creative use of such strategies in contemporary houses, clients are now inclined towards passive design techniques (Figure 13).

Another example of residential design is courtesy of Kaswa Design Services shows use of open patios in design and provision of cavity walls (Figure 14).

After reviewing the latest contemporary house design of leading firms, it is evident that clients are now informed and interested to adopt passive design solutions to mitigate the intense heat of Lahore. However, there is still a noticeable gap in their optimal use.

A survey was conducted of experienced architects in the field (Fig.15). The survey questionnaire was based on the idea of awareness of passive strategies among architects and demand of their clients. Identifying strategies that are observed to work better in Lahore's climate, the survey investigated their adaptation and architects' and clients' awareness and perceptions about using these strategies.

Passive design strategies adaptation in Lahore

On average, 35.7% of Lahore's practicing architects are familiar with the term passive design strategies. The graph bars from 1-5 show the lowest to highest scale according to awareness about passive strategies (Figure 16)

According to a survey most of the architects consider passive strategies while designing a contemporary house (refer to Figure 17).

While several architects are working on passive design strategies, the gap in the actual use of passive strategies is noticeable (Figure 18). Architects who are aware of these

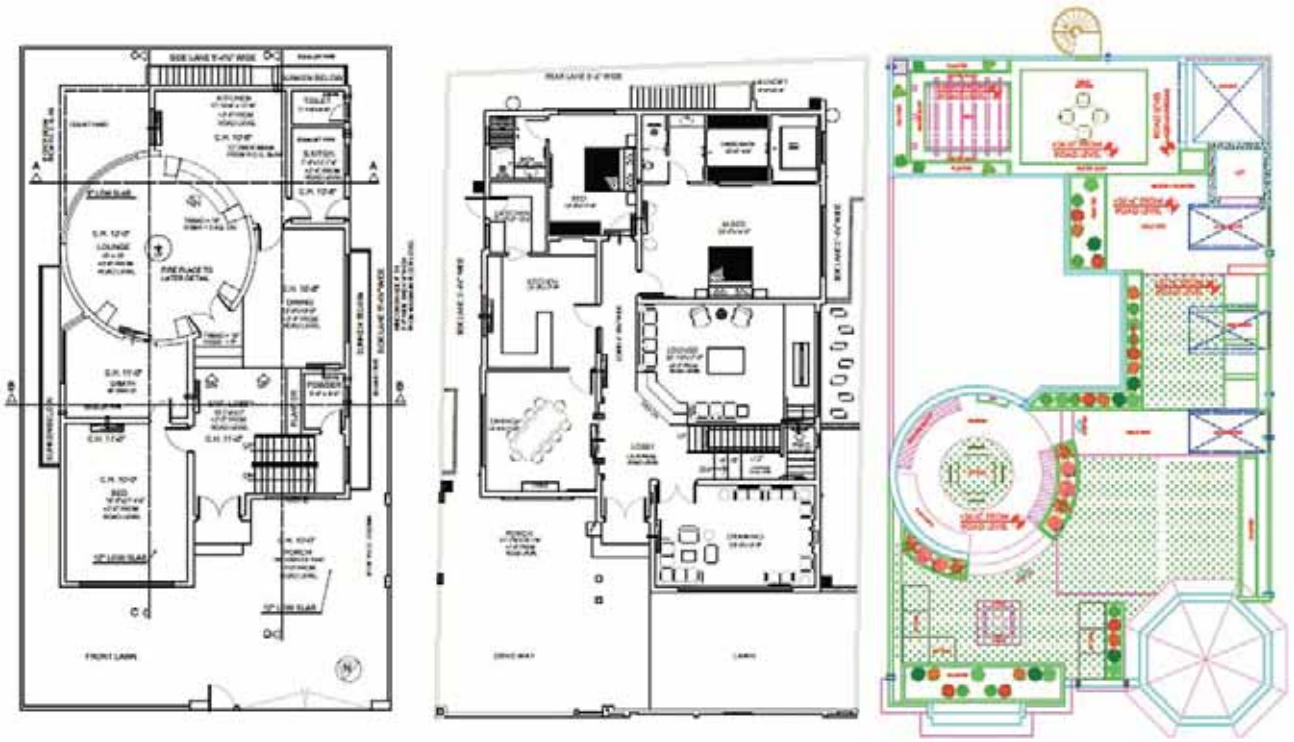


Figure-13: 4500 sq. ft. Area House Designs with Courtyard, Cross Ventilation, and Roof Garden Concepts. (Source: Galleria Design)

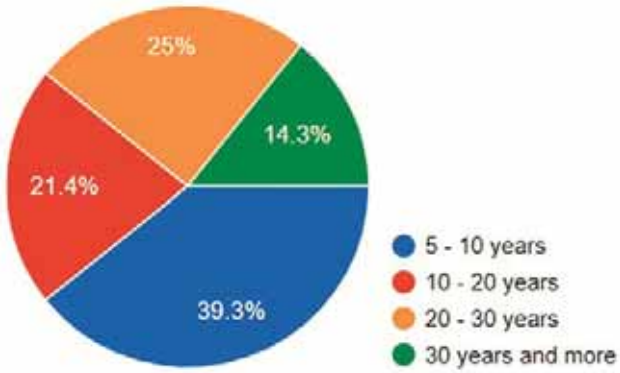


Figure-14: Field Experience.

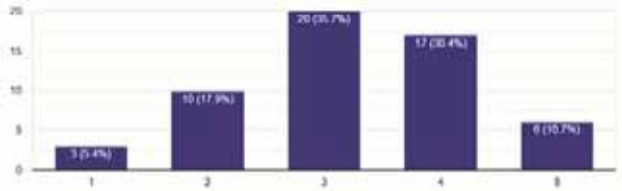


Figure-15: The Fame of Passive Design Strategies Among Practicing Architects of Lahore (1-5 Lowest to Highest).

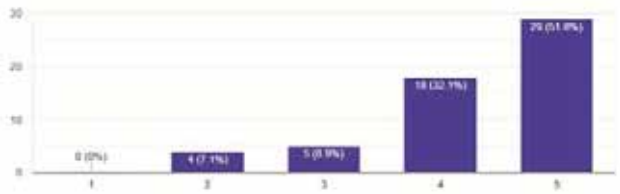


Figure-16: Adopting Passive Design Strategies While Designing a Contemparary House (1-5 Lowest to Highest).

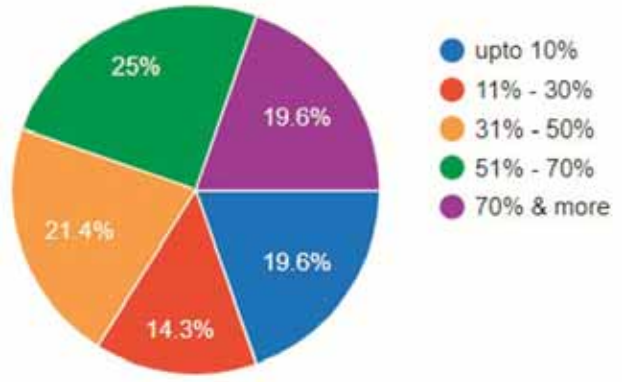


Figure-17: Percentage of Residential Projects based on Passive Strategies.

strategies, are not able to apply them in most of their projects. This is probably because of a lack of awareness among clients. According to the survey, 19.6% architects used passive strategies in only 10% of their projects, while another 19.6% architects have used passive strategies in more than 70% of their projects (Figure 19).

Passive Strategies Preference among Architects of Lahore

Building orientation is the most commonly used strategy by architects in residential projects to channel wind and optimum natural light. Among other well-utilized strategies are use of daylighting, environmentally friendly materials and finishes, landscaping, shading, use of shadows and courtyards (Figure 19).

Given Lahore's climatic conditions, the most workable strategies preferred by architects are orientation of building, use of materials, landscaping, daylighting, shading, and cavity wall. Although, basements are now allowed in residential societies and work best for hot summers and cold winters of Lahore, the use of the basement as a passive strategy is comparatively low. Similarly, waterbodies and building shapes are the lowest on the list of preferences. This is due to the use of large spaces and the high initial cost of these strategies, which makes them less workable (Figure 20).

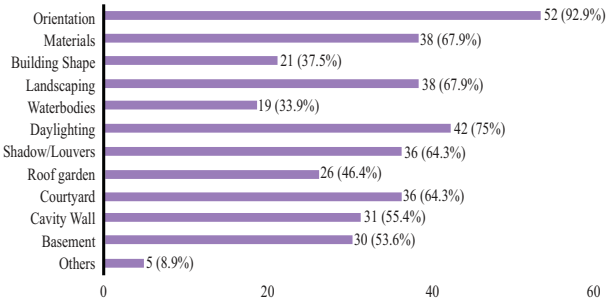


Figure-18: Familiar Passive Strategies Among Architects.

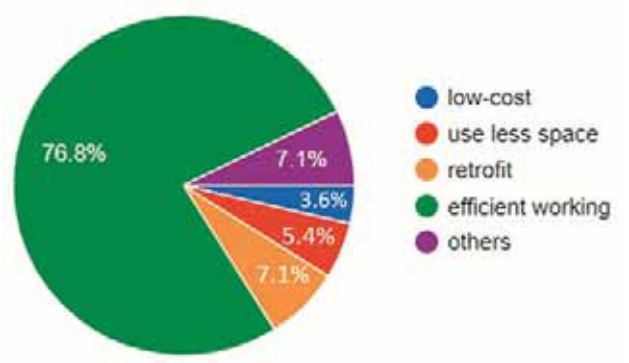


Figure-20: Preference of Specific Strategy by the Architects.

It is clear from the pie chart that most architects prefer passive strategies due to their efficient working, while cost is the least consideration among architects when choosing the appropriate strategy (Figure 21).

Client Concentration on Passive Strategies

By contrast, survey results revealed that clients have greater preference for active means of ventilation. Social status, comfort parameters and norms are subjected to this, along with perhaps a lack of awareness of efficient passive strategies among clients (Figure 22).

Questions asking architects' opinion about clients brought out the sheer lack of motivation (46.4 percent) for adopting passive strategies, while 37.5% mentioned that clients were neutral about application of passive strategies (Figure 23).

While clients are familiar with passive strategies such as orientation, landscaping, daylighting, and use of basement, the most preferred strategies included orientation, landscaping, use of daylighting, louvers for shadow and cavity walls.

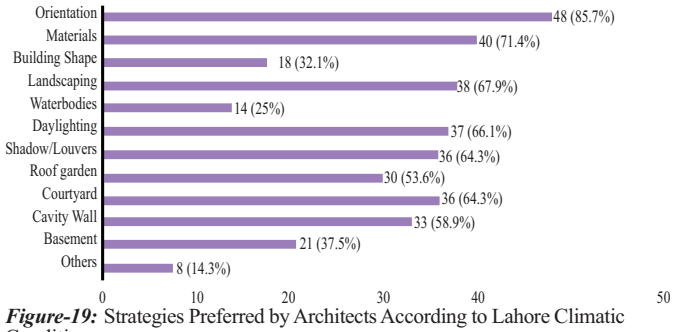


Figure-19: Strategies Preferred by Architects According to Lahore Climatic Conditions.

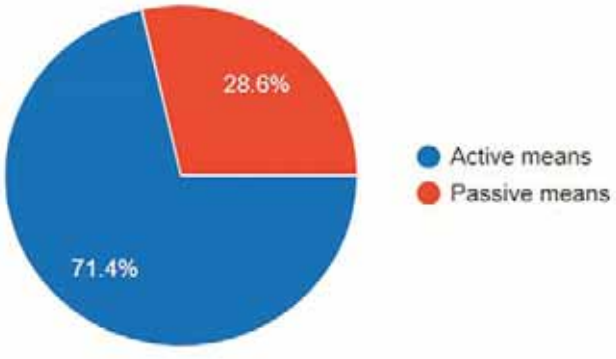


Figure-21: Client's Focus on the Ventilation System.

Clients prefer the above strategies because of their efficient working and consider the installation's cost effective and other minor factors (see figure 24).

FINDINGS

Out of 60 responses, 40% architects had experience of more than 30 years in their field. The first part of survey outlines adaptation of passive strategies among architects. Survey shows that while architects are much aware of benefits of adopting of such strategies but not all architects are able to use these in all of their projects. Only 19.6% of the architects have applied these strategies in more than 70% of their projects.

Considering the climate of Lahore and effective workability of the strategies, most architects preferred building orientation, shading, cavity wall, daylighting and landscaping in their projects. For study about clients demand, only 21% of architects believe that clients have basic knowledge of common passive strategies. Thus, 71% architects pointed that client demand for active ventilation over passive means.

CONCLUSION

This research contributes to existing body of knowledge by exploring the adaptation and awareness of passive design strategies in contemporary houses in Lahore. The research focuses on the current state of adaptation of passive strategies. By analyzing built residential designs, the research also points out practices being adopted in architectural projects. Findings from the study addresses an important gap between academic and practice knowledge, as it aims to highlight the level of awareness for use of passive strategies among clients. This research supports the hypothesis that there is a major need to impart and inculcate awareness among clients. By identifying the barrier, this study promotes the use of passive strategies in residential architecture of Lahore and similar climatic regions in the country.

The survey results depict the contrasting component of awareness and adaptation among clients and architects in contemporary residential architecture in Lahore, Pakistan. Most architects are knowledgable about the benefits of passive strategies and prefer to use these in residential projects. However, most of the client's knowledge is somewhat limited to adaptation of orientation and building shape and they prefer to use active means rather than passive and focus to have a trendy house design over adapting passive strategies. This also becomes the reason that only 20% of the architects have worked on more than 70% of

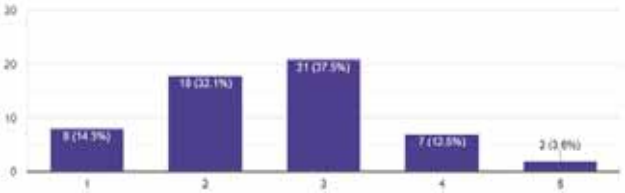


Figure-22: Client's Motivation for the Adaptation of Passive Strategies (1-5 Lowest to Highest Scale).

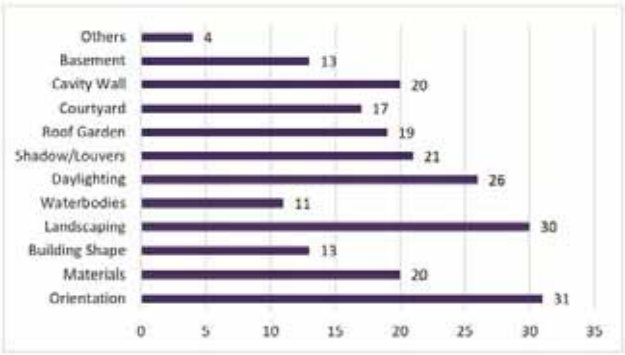


Figure-23: Familiar Strategies Among Clients.

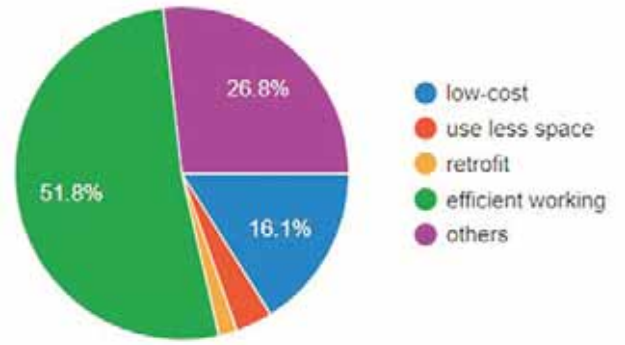


Figure-24: Reason for thePreference Above Strategies.

their projects with passive strategies. Among adapted strategies, building orientation is preferred by most architects for Lahore's climatic conditions. Other strategies used by architects are landscaping, daylighting, cavity wall, and the use of environment-friendly materials. According to the survey building shape and waterbodies are the least preferred strategies by architects. Although Lahore's hot and dry summers can work well for evaporation, however the addition of waterbodies would take up a large area and is comparatively costly, thus making it least preferable. This paper concludes that architects are aware of passive strategies and try to adopt them in their designs. With time, the relation of architects and clients are evolving in better terms. Now, while clients seem positive to adopt passive strategies due to the climatic condition of Lahore, but their knowledge and awareness of adaptation require endorsement to encourage

the acceptance of climate-responsive designs and sustainable environments.

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