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Chapter

Wind Catcher: A Lost Architectural Heritage with Timeless Passive Attributes

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Abstract

Wind Catcher is prominently known as a passive cooling device in buildings, especially in hot humid, and hot dry regions. In metropolitan cities of Pakistan, the wind catcher is seen as a lost heritage of the past. Campaigns to revive the wind catcher as a cooling and air displacement device are surfacing amongst the global communities. The chapter aims to address the social paradigm of wind catchers in the past and present and discusses its prospects for the highly polluted cities of Lahore and Karachi with a focus on the landscape. Using digital ethnography, the responses toward wind catchers in non-residential buildings were observed via blogs and videos. A total of 1386 nodes were coded from 54 sources in Nvivo for thematic classification based on a deductive approach of Past, Present, and Future. The chapter suggests the implication of wind catcher revival in the buildings of Lahore and Karachi as an effective wind ventilation solution for indoor air pollution, infiltration, thermal comfort, and cultural identity.

Keywords: wind catcher, ventilation, chimney, passive cooling, heritage, digital ethnography

1. Introduction

Recent statistics from global networking organizations have identified air pollution as the world’s biggest threat to humanity due to its enormous burden on the environment, economy, and health sector. The metropolitan cities are housed to 3.5 billion population, alarmingly doubled by 2030 [1]. It requires flexibility for the global agenda of the United Nations, Sustainable Development Goals (SDGs) adopted by many countries including Pakistan. From 1990 to 2019 onward, a high concentration of PM 2.5 outdoor air quality index has been reported in the cities of Lahore and Karachi, Pakistan [2]. There is an alarming need to control the level of outdoor air pollution, which is 7–10 times greater than the requirements set by WHO [2, 3]. Increased dependency on fossil fuels, inefficient energy practices, burning of agricultural waste, and vehicular emissions have increased the air pollution level. The Pakistan government is focusing on 2030 air pollution control measures with the help of advanced control technologies [4] and building stakeholders have a social and moral responsibility to address the issue at hand. The rising concerns of outdoor
and indoor pollution coupled with the fact that people are spending more than 90% of their time indoors, lead to serious health concerns amongst building occupants [5]. The indoor air is highly contaminated and polluted due to furnishings, lack of ventilation, and choice of heating, and cooling modes [6]. With this, there is also an increased dependence on air conditioning [7], and air purification technologies for ventilation [8].

The street-level passive ventilation methods where openings such as doors and windows are used for the exchange of air [9]. But these methods although passive and sustainable but are not able to function and circulate clean air inside the building. This is because of the densely populated, closely packed new construction in Asian metropolitan cities of China, India, and Pakistan [10]. That is why the existing outdoor micro-climate is not healthy and clean to circulate within the buildings. Whereas studies published in countries such as the UK [11], Iran [12], and Malaysia [13] prove that the high-level passive ventilation method such as wind catchers, towers, or scoops are one of the ways to circulate the high level less polluted air to inside. The ventilation method has been demonstrated in existing commercial buildings in Ahmedabad India, Tucson, Arizona, Seville, Spain [14] Riyadh, KSA [15, 16].

2. Wind catcher revival

Yasmeen Lari featured the role of traditional technologies that are low carbon and have distinctive climate features, representing the local tradition and culture [17]. These features of vernacular architecture have not been recognized by the academicians and architects equally, thereby lead to decay or not being in original use in current circumstances. Besides the existence of less energy-intensive architectural features such as wind chimney, their role, presence in ancient times, current adaptability issues, and diminishing value in a modern, contemporary low-rise building is not known.

Countries such as Iran [18], Brazil [19], Malaysia [20], China [21], Jorden [22], Algeria [23], and many others are using wind catchers (WCA) as effective air change devices for thermal comfort and Indoor Air Quality (IAQ). The commercial use of wind catchers has gone through subsequent development by combining it with various techniques [24, 25]. The existing design of the wind catchers covers the transitional aspects of past and present. However, the future development of wind catcher design is still of great debate for academicians and researchers. It is due to the novice problem of high-level outdoor pollution, extreme challenges of indoor pollution, and the dynamic need of users for achieving personal comfort within the space. Also, there is a gap in utilizing wind catchers as a passive strategy while comparing Pakistan and the international context. The existing low-rise colonial buildings of Lahore have high-level ventilation strategies such as ventilators and wind catchers [26]/chimneys [27] to bring a high level of less polluted air to the interior and ventilate it within the buildings. Buildings such as the Governor House, The University of Punjab, the Old Campus, the Railway Barrack headquarter, and many other have wind chimneys that represent culture and are used to serve in both the climate of summer and winter [28]. Similarly, the wind catchers of Hyderabad have been well known for their unique character (Figures 1–4) [29].

The chapter is an attempt to explore the people's experience from a perspective of wind catcher revivalism. The academicians, scientists, or the public who have an interest in such ancient old tech have convinced people through various communication
Platforms. The blogs have been written by people from different cultures and are included within the research to cover the viewpoint of wind catcher origin, development, and challenges in various regions. This is to materialize the role of social networking platforms such as blogs and videos, whose obligational role is not clear. Blogs and videos are the most enriched sources that have the potential to analyze the sustainable contribution of wind catcher technology. The existing academic literature widely covers information regarding wind catcher development in which environmental and economic aspects are discussed in terms of eco-friendly, less intensive, low carbon footprint, passive design natural, free energy, and low cost highlighted [20, 22]. Still, the social factor concerning sustainability has not been touched so this chapter will...
consider social opinion through qualitative analysis. Additionally, the content analysis will cover people's experiences and reveal a greater insight into wind catchers, the three-phase development of the Past, Present, and Future.

3. Methodology “Digital Ethnography”

Digital Ethnography (DE) is a method that shares the insights of people through various digital mediums to marginalize the voice of people [32]. DE is chosen to evaluate the existing blogs and videos, which have emerged as an expression for wind catchers in various regional contexts. Existing blogs and videos specify the WCA development from classical to modern, and futuristic approaches in buildings for various regions including Pakistan. DE helps in synchronizing and analyzing WCA information reported by different bloggers. The DE was conducted with keyword searches such as 'wind catcher', 'scoops', 'WCA in Iran, Hyderabad, Pakistan', 'Monodraught', 'WCA technologies', 'WCA for thermal comfort', 'WCA types', and 'ventilation through WCA'. DE helps us to identify 33 blogs and 21 videos and transcripts from the search and scrutinize the relatable content in terms of replication and duplication. To extract meaningful information and trend spotting within the wind catcher, the scripts and transcripts were processed in the Nvivo version 11.

Figure 5 shows the five key step that has been applied to get the descriptive and analytical themes explored in terms of Past, Present, and Future. The raw data of measuring unit (a) consist of blogs and transcripts information, processed through Nvivo. The reference info is linked to themes and children's codes were developed as the text was coded accordingly and an auto summarizes theoretical framework was generated as a condensed meaning unit (b). The 19 children's codes are aggregated into 6 parental codes. The children's code of geography aggregated from (region, climate, history), IAQ (pollutants, standards, air change), thermal comfort (techniques, temperature, humidity), ventilation (ventilation type and standards), wind catcher type (classical, modern, reminisce), wind catcher (definition, types, characteristics, function). The coded sources help to extract information, analyze it, and categorized it in terms of past, present, and future intercessions. The different sections of the framework were coded again (c), and the information was grouped and categorized (d). Afterward, each section of summarized information was further grouped for manifest and latent analysis (e). A total of 1386 initial codes have been developed.
as shown in Table 1. The codes and themes have been generated from the deductive approach to achieve more reliable results [27]. The manifest analysis was done while reading through the transcripts of videos and blogs whereas the latent analysis was performed to summarize them in three key themes Past, Present, and Future. As part of the manifest analysis, some original saying that reflects the essence of information and personal experiences of people have also been reported in the text directly [27]. The main themes have been ranked according to the level of Past initiatives, Present situations, and future scenarios, in line with the objective of the chapter.

Figure 6 shows a graphical distribution of various code references on the blog and video transcripts. The video content created the highest number of references in initial coding schemes. The regional and geographical characteristics identified the maximum number of references, followed by IAQ and thermal comfort, whereas landscape approaches and wind catcher challenges also significantly identified coded information from the blogs and video content analysis.
4. Result and discussion on the themes

The following section will generate a discussion according to synthesized themes, namely, past, present, and future. This section reviews the initiatives that have been taken in the past, and potentially adapted to the present. It can suggest a way forward for the future application of wind catcher revival and further development in Lahore and Karachi, Pakistan. An article published by ArchDaily [35] shows an excellent transition of WCA design to adapt to different regions, and climates, and carry on the tradition from past to present and future.

4.1 The past initiatives

A book named “Architecture without Architects” was published by Bernard Rudofsky, in which the contribution of passive ventilation through various methods such as stack, and the chimney effect [36] have been highlighted. The wind catcher varies according to the different geographical conditions and is designed to suit climatic conditions. The past initiatives cover the aspects of geographical suitability, regionalism, climate design, and the historic development of WCA.

4.1.1 History

Wind catchers have been debatable about their origin. One continuation of such claim is from Persia, where archeologists have discovered some 4000 BC wind catcher, which resembles a chimney with no ashes in the interior. The other is from the paintings of Pharaoh Nebamun’s residence, in Egypt in 1300 BC where the triangular structure proves its beginning in history (Figure 7). However, the traditions carried from the wind scoops of Iran almost around 2000 years ago, transferred to the nearby Gulf and Persian-influenced countries through the pearl trade route.

Arguably the Egyptian source is nontangible with speculation that only exists in drawings as inspiration from the nearby geographical site of Iran and Nasir Khusraw’s famous Persian poetry of the 5th century. Also, the Persians led to the surviving
examples in the Yazd city of wind towers (Figure 8). Furthermore, according to Dr. Abdel Moniem El-Shorbagy, the Arab conquest of Iran in the 7th Century helped to spread WCA to the Middle East and South Asia. So, both arguments support Iran as the birthplace and the spread of wind catchers to nearby countries. In terms of WCA revivalism, Iran shares an 805 km long border with Pakistan, providing an opportunity to revisit the cultural traditions of wind catchers. As seen in the past the pearl route helped to extend the architectural tradition from one region to the other areas, so now today, it can inspire architects of Pakistan to adapt and merge the old tech of wind catchers within new buildings. The tradition of wind towers has also been revived within India so various regions of Pakistan can also take some lessons from the past and today’s cultural adaptation to revive WCA in existing and newly constructed buildings.

4.1.2 Geography

Geographically WCA is suitable to low rise, less dense places with optimum wind speed in the regions. Other site conditions that are helpful for wind catchers to function are the best orientation, opening sizes, and solar protection. Yazd, the historic city of Iran known to us as the city of wind catchers have been declared a UNESCO World Heritage site in 2017 [38]. Another interesting dual tech of the old times was the use of WCA for air conditioning and refrigeration. They were used by the Persians to passively cool Khalistan palace, Tehran with water, wind, and desert ice.
In Sindh, Pakistan every house and many administrative buildings once have wind scoops. The Sindh scoops were unique in classification due to their shape and shutter function. Pakistani senior journalist and cultural analyst, Abid Ali Syed says “Photographs from the 1920s and 1930s of the Hyderabadi Skylines dotted with windcatchers serve as an archetype of a communal, synchronous climate responsive effort” [39] (Figure 11).

Now-a-day they are found in geographical locations of the Middle East, Dubai, Kuwait, Qatar, Bahrain, Jorden, Iraq, Afghanistan, Egypt, Spain, Pakistan, the UK, and some windy regions of the US, and Canada such as Toronto and Ottawa (Figure 9).

The Zion National Park Visitor Center in Utah (USA) has wind towers for the hot dry climate that works in combination with evaporative cooling pads to cool interior spaces. The Wind tower of Torrent Research Center Ahmedabad, India designed on the principle of Passive Downdraught Evaporative Cooling (PDEC) with annual energy and cost savings of 64 and 36% respectively. The labs achieved a comfortable temperature of 27 and 29°C on the ground and first floor in comparison to 38°C outside temperature with an air change rate of 6–9 m$^3$/hr. The PDEC system was effective most of the time of the year except during monsoon season which was managed with a ceiling fan. The wind catcher and scoops of the UK are at the forefront of creating the most innovative and prefabricated design, with environmental consideration of energy efficiency and low carbon emissions (Figure 10).

4.1.3 Climate

Daniel A. Barber explains in his book “Modern Architecture and Climate: Design before Air Conditioning” about the role of climate adaptive strategies in regionalism and its reflection in modern architecture to replace HVAC [40]
Climate plays a significant role in passive ventilation, as it requires consistent wind speed and challenges of seasonal and variable wind direction during the day. Other important climate parameters are dry bulb temperature and humidity. So, a wind catcher is an ancient accomplishment of engineering that uses wind energy and has the potential to replace HVAC. WCA has been adapted to various climates and geographical locations according to environmental attributes. They have shown great potential in hot dry, hot humid, and temperate climates, where occupants need air movement to deal with the hot weather. Wind scoops also work efficiently in the hot dry wind region of the Midwest United States. Iranian wind towers are suitable for the hot desert climate.

Today buildings are classified in various climate zones and are designed accordingly. The wind velocity, direction, turbulence, surroundings, seasonal variation, and diurnal changes will develop the flow pattern. The wind is not only distributed horizontally but also circulated in the vertical spatial division, bringing less polluted and strong wind at the higher level. Similarly, the design of the wind tower inlet is opposed to the solar direction to minimize the heat. The WCA suitability in summer and winter is necessary for the adaptability of a passive design strategy. The role of climate is pertinent as it will bring comfort through air circulation within the interior.

4.1.4 Regionalism

Wind catchers are used as vernacular architecture in ancient Egypt, Babylonians, Persian, and Arabs. According to regions, their local name is Persian Badgir or Shish Khan, which serve as temperature regulators and ventilation devices. In the Sindhi language, they are known as the ‘Manghan Jo Shahir’ (City of Wind Catchers). But this claim is very limited because the same is known to us for the Iranian city of Yazd, which truly represents the ancient past, well preserved for today, and a great inspiration for the future. Like the Iranian context, where Persian poetry praises the
function, beauty, and social setting of WCA, the Sindhi Jiji also explains its social contextual use as a communication window (gossip) between two houses, to borrow and exchange items [41].

In an international context, WCA has been explored in various technical aspects of calculating wind dynamics from exterior to interior. But in Pakistan, they have not been acknowledged by the academic community except for a few architects Yasmeen Lari, Kaleemullah Lashari, and Anila Naeem have highlighted their importance in vernacular practices. The conservational drawing of WCA (Mangh) developed by Abdullah Qadir Baksh Shaikh conveys its use, esthetic, and social presence [41]. In ancient times, WCAs were present in Hirabad, Matiari, Halla, Sujawal, Thatta, Kotri, Gjaro, Jati, Gujo, and Bathoro to make use of rooftop ventilation.

The blogs also show the expression of people’s love and intimacy about the use of ancient WCA. The blogs quote information from the elderly experience who have enjoyed the WCA cool breeze of the Indus, a sole air conditioning mechanism. The blogs also talk about the dilemma of eliminating the use of catchers in present times due to several reasons such as a power station being built in the city of Hyderabad. As time went on, people stop acknowledging the true essence of WCAs presence, and the lack of adaptability to newly raised problems and issues of climate change and air pollution. The old pictures (Figure 11) of the Hyderabad wind catcher shared through online social media platforms interestingly catch the eye of architects, historians, and environmentalists as free energy tech of ancient times that has great potential to convince stakeholders for the present and future.

“What I found was that windcatchers do still exist—even though they are very rare—and in my opinion, they are ready for a comeback.” [31].

“I read that windcatchers had been replaced by air conditioning, but surely something this widespread couldn’t have completely disappeared in just a few decades, could it?” [31]
4.1.4.1 Implications

Wind Catchers were built with a sustainable approach, place-making, a reflection of social connectivity amongst people, and valuing climate design. They can be revived as a lost cultural heritage that represents symbolism due to their resemblance with Sindhi poetry, and a point of women's socialization. So, understanding the true social, environmental, and economic essence of old wind catcher design may help stakeholders to revive the tradition in various regions of Pakistan. Dr. Susan Roaf [26] advocated the wind catcher's unique design in various regions including Iran and Pakistan and their relative adaptive measure to achieve increased comfort zone in naturally ventilated buildings of Lahore and Karachi that can be revived according to new needs. The high-level ventilation openings provide a solution to indoor air pollution. So, it is suggested that existing closed openings either be made functional again in terms of using it for ventilation or introducing a wind catcher.

4.2 The present situation

Buildings were built in the past and present to protect the people from the harsh climate. Today the WCA appears to be a successful adaptable tech that has great potential to resonate in many countries of the world. The contemporary architecture of Lahore and Karachi can be relooked at adapting existing designs such as prefabrication, solar-powered, and new WCA forms according to wind direction, and speed. The analysis also proves that Lahore and Karachi as metropolitan hubs provide huge potential to use commercial WCA and save energy, fewer GHG emissions, and greater carbon savings within the low-rise buildings. This will help to address the issue of climate change and the energy crisis. Architects and historians are more hopeful about the potential application of this old tech even today. In the present day, the maintenance and use of ancient wind catchers and towers are of great challenge. Along the side, their continuous use in rehabilitated and newly constructed commercial buildings is of great interest to Lahore and Karachi.

The wind catcher heads, openings, and columns are the different parts that functionally control the air quality too, and play a role in achieving comfort. In addition, the wind catcher is climatically controlled for varying wind directions with a rotatable head and personalized comfort within the room can be achieved. The IAQ can also be improved with the help of providing a solar chimney, another variation of stack ventilation within the building. In many places, wind catchers have been used in combination with other passive methods. So, in Lahore and Karachi, the same concept can be used with natural ventilation systems e.g., a combination of the clerestory, wind tower, zenithal openings, and wind exhausts will help to improve the IAQ. The wind catcher can be built with sustainable materials, thermal regulators such as brick, clay cover, wood, medium density board, or sandwiched insulation to provide a time lag between interior and exterior. The landscape design in connection with nature will bring a new life to indoor workplaces for a healthy environment. Amongst the common strategies of green building are the green roof and green facade that acts as a thermal regulator for building in many regions. So, it is suggested to provide wind catchers as an initiative of using in green approach in the recent and existing construction of Lahore and Karachi.
4.2.1 Air conditioning issues

The world population has risen to 9.7 billion with 68% urban migration and stakeholders are relying on HVAC causing the urban heat island effect. The human need for a climatically controlled atmosphere within the building makes us less adaptive to passive solutions and design strategies. The natural landscape is converted to construct the buildings, leading to heat accumulation and temperature rise in urban areas. International Energy Agency (IEA) statistics for various countries have shown that there is an annual stock sale increase in the cooling consumption of both residential and commercial buildings [42]. Air conditioning has become one of the key components of a commercial building. The comfortable temperature in HVAC building range between 20 and 26°C rather than adaptable to a more flexible range of being adaptable on the wider temperature range. Environmental pollution has increased due to the release of various Noxious, Sulfur accumulation and other Green House Gases (GHG). The unsustainable practices of suggesting comfort based on air conditioning (AC) have created a dilemma for passive architecture. At one time the whole city skyline was filled with WCAs which are now replaced with rooftop split units and there will be a need for a system for replacing those AC along with its air handling units and pipes on large scale. These AC are expensive and unreliable due to grid electricity shortages in many developing countries. Building’s cooling need requires greater dependence on electricity and HVAC technologies to manage the long duration of summer. The aftereffects of air conditioning pose serious environmental concerns to the people who work indoors and suffer from sick building syndrome.

4.2.2 Pollutants and air change

Various exterior and indoor sources significantly contribute to the level of indoor pollution such as CO₂, Volatile Organic Compound (VOC), which makes it difficult for people to breathe and affect their cognitive performance. The indoor environment is prone to emissions from indoor furnishings. As Martin W Liddament tells in his book A Guide to Energy Efficient Ventilation:

"Many systems operate in ‘blending’ mode to dilute pollutants, while others operate in ‘displacement’ mode to remove pollutants without mixing. The pollutants most often found in work and home environments are so-called VOCs, or “volatile organic compounds” [43]."

Carbon dioxide (CO₂) is a byproduct of human respiration and Indoor Air Quality (IAQ) can be improved with air change in a particular space through a wind catcher. Building requires thermal comfort as well as optimally good IAQ by reducing the level of CO₂ and maintaining internal temperature. Low carbon use within the room will reduce the level of CO₂ and help to achieve the required healthy and productive environment. Some countries are highly polluted and an additional layer of filter or screens in the inlet is required to clean the incoming air. According to Leonard Woolley, the wind catcher technology also advances in providing an air shaft to accelerate air within the building. The highly dusty zones also can be well treated with a tall wind catcher that brings cooler, stronger, and less dusty winds. The collected dust can be dumped at the bottom and can be further cleaned with meshing or indoor plants. Such a solution is highly suggestable in areas prone to insect-borne illnesses that require air filtration. The new Urban Development Company (EDU)
headquarters in Medellin, is built with a prefabricated solar chimney to replace cool air with warm air in the indoor workplace [44]. The Northern Link, Stockholm Sweden ventilation tower was constructed at the tunnel to tackle the highly polluted zones to divert pollution. Wind scoops are structures that are applicable in a dry but windy location with a minimum pollution rate. The availability of various filters in wind scoops also further clean the air and removes dust particles. There is a certain limitation with the design of existing scoops that rely on the outdoor air properties and in that case the outdoor air needs to process through a medium to achieve a significantly good level of ventilation.

4.2.3 Thermal comfort

Another noticeable feature of wind catcher buildings is thermal comfort, and its requirement depends on the climate condition of a particular area. “Pottinger wrote in 1815 and it’s because the climate is so bad that to occupy buildings in that climate you have to have air movement for comfort” [45]. In dry conditions of hot-arid climates, adiabatic humidification will increase the moisture of the air to manage thermal comfort. This can be done with the help of evaporative cooling of sprayed pad system, tubes of lightweight fabric 1.4 meters in diameter, and a mist fan. The use of a ceiling fan will accelerate the process of natural ventilation and cooling process. The fan has a fog nozzle that produces a very fine mist, that helps to quickly evaporate the water and the air passes with high velocity at low temperature. Thermal comfort within the building is achieved with the help of wind pressure differences in a windy region, otherwise through temperature differences in less windy places. Comfort is achieved when air passes over the body and heat transfer between the body and the surrounding environment takes place with the help of convection, radiation, and conduction. At the same time, body tends to adapt to different personal factors in its natural environment. People of Tehran and Baghdad are comfortable at temperatures of 37 and 38°C in summer using various adaptive methods. The use of different mechanisms such as changing postures, open and close of opening depends on the seasonal requirement, and the use of blinds and curtains are chosen by people to keep themselves thermally safe, and neutral, and maintain a core body temperature. The groundwater heat exchanging pipes play a significant role in combination with solar chimneys and then channel within the room and air exhaust either to the other end of the tower or window. The interesting feature of WCA design is to bring air/wind directly to the place where occupants sit and can enjoy the breeze sometimes directly above it. The comfort in the WCA building can be controlled through materials like mud brick as an Egyptian architect Hassan Fathy talks about it. The material acts as a thermal insulator or thermal lag to protect against the unusual loss of heat. Persians also made Yakhchals through thermally sustainable mortar consisting of clay, lime, sand, egg whites goat hair, and ash. Similarly, the towers are being effectively used in combination with the radiant panels, Trombe wall, and solar heated system.

4.2.3.1 Implications

To celebrate the old traditional culture, and sensational space experience, the standalone wind catcher was built from recycled material at an exhibition and expos recently in Dubai [46, 47] (Figures 12 and 13). The site structure was objectively developed to gain people's confidence in the wind catcher tower, where they can experience wind ventilation. The use of local traditional materials, a climate-friendly
design that projects energy saving and struggles for climate justice and a sustainable common future. Such initiatives can be taken even today to build wind catcher tower models, at various exhibition places in Lahore and Karachi. Even educational institutes can build a model as part of raising awareness amongst the education communities. This will help to familiarize people with the need and use of wind catchers in their specific climate context. This proposal can pave the way for climate-conscious design, a celebration of old cultural identity, inspiring people at large, and its implementation in future times.

The only wind catcher example of revivalism is the Hyderabad district administration’s office (Figure 4) where architects are inspired by the old WCA traditions and want to revive them in commercial buildings. However, they can be made functional for climate-conscious design.

Wind catchers are predominantly used in the summer when more frequent air change is required. But their use in the winter season can also be suggested for air exchange on sunshine days. So, a wind catcher open and close pattern can be suggested to make it workable for all seasons.

4.3 The future scenario

Wind Catcher faces a lot of challenges regarding their development in various regions. Particularly, Lahore and Karachi are facing problems of pollution that require filtration of air in combination with evaporative or convective cooling in hot dry, and humid climates. Another biggest challenge is how they can be usable and adaptable to the changing need for human comfort and IAQ. Pakistan is a developing country where economic conditions are poor and building stakeholders have lost their confidence in the well-known passive design techniques. These cities experience long summer duration and high levels of polluted outdoor air quality in winter. The wind catcher revivalism should be done with state-of-the-art tech, employing green approaches in low-rise buildings.
4.3.1 Landscape approach

This section aims to look at the landscape-based micro-climate design for buildings. According to the World Economic Forum, the ancient wind catcher towers are a great inspiration to the Madrid outdoor wind garden to cool the city temperature by 4°C [48]. Another outdoor application of wind catcher in terms of landscape design is the spiral structure composed of ferns and mosses that catches the wind from the treetops/canopies and help to cool the nearby places. The most common methodology for building walls and roofs is green roofs and green walls. But the greenery also has some wind-friendly characteristics that attract or repel the wind for a cooling effect. For example, hedges, shrubs, and bushes reduce the air movement around the building and are suggested to be planted a minimum of 8 m away from the building. But the limitation changes for about 2 m on the leeward side of the building. Other cities such as Athens, and Bangkok have pocket parks and mangroves Eco-Park. The greenery not only cools the surrounding areas but also minimizes the level of surrounding pollution. There are ancient WCA where indoor plants along with mesh help to filter the clean air. However, the role of local and native plants is necessary that suit the climatic and geographical conditions of an area. The bio-climatic design of the green roof and facade acts as insulation for the city and encourages ventilation within and around the buildings. Farming Kindergarten and Vedana Restaurant, their native plants act as respiratory organs for air purification and maintaining a comfortable temperature for surroundings.

4.3.1.1 Implications

Presently, the blogs and videos do not discuss the immediate need and far-reaching impact of adopting the SDG 2030 agenda, for the design of passive buildings. This may be because of the reasons that such a platform is not aware of policymaking and driving a direct connection with the needful. But now and in the future to achieve the target set by sustainable communities and cities of Goal 11, the stakeholders will take into consideration the need for wind ventilation through wind catchers, increasing the impacts of a healthy environment within buildings. This will further help to bridge the gap of reducing indoor pollutants and sick building syndrome issues in line with the global agenda of SDG 2030.

The lack of landscape and scarce vegetation in the city of Hyderabad [49] also require espousing a vegetated wind catcher approach. This can be universally applied to all cities in the world that lack vegetation. In this way, it will help to balance the hard and landscape in terms of the built environment. The green vegetation approach needs to explore using numerical modeling in Computational Fluid Dynamics (CFD). The context or site-specific situation can be simulated for exploring the reduced impact of improving outdoor polluted air and circulation within the building. Another point of concern revealed in the qualitative analysis of sources is the selection of local vegetation.

Wind Catcher ventilation uses a sensational use of different senses that will give an enhanced indoor experience to the user. The WCA air can be felt on the skin in terms of thermal comfort, the indirect natural light can be treated for a visual connection with nature, and the aroma of air to remove the gaseous substance of various types also increases air quality and can be sensed through the nose. It will give an exciting experience of creating a quiet zone by making use of an acoustical design that is difficult to achieve in window ventilation. WCA design can provide personalized thermal, visual, and acoustical comfort to all users according to their dynamic needs.
5. The next step for wind catcher design

The WCA potentially suitable for future use in the buildings will have to face some contextual challenges that are highlighted through digital ethnographic analysis. Amongst the most competitive passive design techniques, the wind catcher's potential for ventilation needs to be realized. In metropolitan cities of many countries, air pollution has been critical and surpassed the level set by WHO. Due to the introduction of air inside the building, it's become critical to bring polluted and non-treated air to the channel within the building. Sometimes stack ventilation induces turbulence and fluctuation of wind inside the building, resulting in poor air movement. Wind Catcher arrangement is important, and flow needs to justify the fairer distribution of air inside. A common strategy is to place some of them in the wind direction and some places opposite. If the design of the wind catcher is not proper, it may cause a downdraft attack within the interior of the buildings. The airflow pattern and turbulence become critical in areas of a high and dense urban environment.

More recently, in some countries, the wind catchers have fallen, not maintained due to their non-usage in modern times. Yazd's City is a UNESCO heritage site because of its ancient, oldest known, and highest number of wind catchers, which survived today but losing their identity. Their existence as a historic piece, celebrating the regional architectural identity is more dominantly a driving factor. The wind catcher of Lahore and Karachi face the same situation of lost heritage and requires attention. It also challenges the maintenance of cultural identity by reducing the existing dichotomy between form and function.

6. Limitations of digital ethnographic studies

The study does not analyze finding from any WCA community on social networking sites such as Facebook, Instagram, and Twitter. However, people have uploaded some pictures on their accounts, followed by content sharing. Interestingly some images were found on architectural pages that support the vernacular architecture of Sindh, Pakistan. A few architects have also supported and advocated wind catcher images as part of a successful strategy in the past.

7. Conclusions

The research is an attempt to synthesize insights through blogs and videos. The content analysis of digital sources was accessed to determine the role of wind catchers as mediation and interposition of past, present, and future. It is hoped that findings from this study can inspire policymakers to revive the usage of wind catchers as a solution to Indoor Air Quality and Thermal Comfort in Pakistan. Both Karachi and Lahore are metropolitan cities with high populations, facing long hours of electricity shortages, and high levels of indoor/outdoor pollution. The recent design of wind catcher in various countries take air filtration into the consideration. The landscape design such as water bodies, moist mud, vegetation, and indoor air-purifying plants are the natural way of cleaning the air and achieving thermal comfort. The wind catcher can be revived in both regions of Lahore and Karachi on new lines of green catcher.
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Conflict of interest

The authors declare no conflict of interest.

Acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>WCA</td>
<td>Wind catcher</td>
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<tr>
<td>SDGs</td>
<td>Sustainable development goals</td>
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<td>DE</td>
<td>Digital ethnography</td>
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<td>AC</td>
<td>Air conditioning</td>
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<td>GHG</td>
<td>Green house gases</td>
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<tr>
<td>HVAC</td>
<td>Heating ventilation and air conditioning</td>
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<td>CO₂</td>
<td>Carbon dioxide</td>
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<td>IAQ</td>
<td>Indoor air quality</td>
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<td>TC</td>
<td>Thermal comfort</td>
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<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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