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Investigation of Natural Ventilation in the Existing Buildings of Qasimabd, Hyderabad

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Abstract

Environment is one of the biggest concerns around the globe as it affects every aspect of our lives, including the buildings used for residential and commercial purposes. A majority of people spend about 90% of their time indoors. In residential buildings, the existence of natural ventilation is essential to ensure the comfort level of residents. Recently, greater significance has been accorded to natural ventilation in building codes and planning policies. Today, many planning policies provide guidelines that stipulate the need for adequate natural ventilation in residential buildings. This paper aimed to investigate the occupants' level of satisfaction with natural ventilation in residential buildings of Qasimabad, Hyderabad. Twenty (20) houses with a different opening design individuality were selected as sample for the current study. In terms of the occupants' level of satisfaction with natural ventilation, the majority was neither satisfied nor unsatisfied. Further investigation demonstrated that the level of satisfaction is significantly related to the size of the openings. This study explored the residents' satisfaction level using the questionnaire survey and case study methodology. Data was collected from the study area of Qasimabad in Hyderabad from 290 respondents. The results vouched for the implementation of building bye-laws in the designing of residential buildings in order to achieve the comfort level of their occupants.

Keywords: building bye-laws, natural ventilation, occupants, residential building, satisfaction level

Introduction

Maintaining the quality of life is impossible without good living conditions. The most important part of the lives of the inhabitants of a building is the prevalence of good living conditions. Everyone wants a comfortable and

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healthy home (Kleiven, 2003). Natural ventilation is an essential element in a building because it directly affects the occupants' level of satisfaction. The satisfaction of occupants depends upon the ventilation of building, such as through windows, corridors, and ducts. The lack of natural ventilation in the residential buildings of Hyderabad, Sindh is a common concern. Hyderabad was once famous for the use of wind catchers' technique to provide natural ventilation in the buildings. However, the modern design of residential buildings totally ignores this particular phenomenon. This is one of the biggest reasons of dissatisfaction in the occupants.

Qasimabad is a town in Pakistan's Sindh province, located on the western side of the Hyderabad city. Hyderabad has a hot and dry climate. Due to the hot and humid climate of Hyderabad, natural ventilation is an effective way to promote thermal comfort in residential buildings. The interior of the buildings remains uncomfortable due to the lack of open spaces and buffer zones around them. Windows in the outer walls without any provision of shades is another factor in raising the indoor temperature and humidity with direct exposure to the environment.

It has been observed that most residential buildings lack natural ventilation and it affects the occupants' satisfaction level with these buildings (Abd Wahabet al., 2019). Hence, the occupants need to spend a lot of money on mechanical ventilation in order to cool them. In general, there are several issues in the designing of the residential buildings of Qasimabad, such as lack of open spaces, insufficient size of windows, and poor ventilation in kitchen and bathrooms. Buildings are designed while ignoring the bye-laws of natural ventilation. One of the reasons may be that residential research has not been conducted targeting specific areas to identify the problems and the levels of user satisfaction, as well as to prevent any future problems. Anecdotal evidence suggested that sufficient provision of passive ventilation is being eliminated or not considered while designing houses in Qasimabad.

Therefore, this study focused on damages that occurred due to ignoring natural ventilation on the required scale. Thus, it is very important to maintain indoor natural ventilation, which affects the occupants' satisfaction level. The focus of this research is to inquire about the satisfaction level of residents about the provided natural ventilation in residential buildings against the provision of the bye-laws for natural ventilation in order to verify the gaps for future implementation.

Research Objective

The objective of this research was to investigate the satisfaction level of occupants with the residential buildings of Qasimabad, Hyderabad.

Scope and Limitations

The scope of research was limited to the residential buildings of Qasimabad, Hyderabad only. Two residential buildings were selected in Naqashllas (Phase II) and Abdullah Town to complete this focused study.

Figure 1

Location Map of Housing Areas/Schemes for Research at Qasimabad, Hyderabad



Figure 2

Naqash Villa Phase II



Figure 3

Abdullah Sport City



Literature Review

Natural ventilation is a basic element of building design. A residential building must be energy efficient and provide people with a comfortable environment. Existing bye-laws do not work properly in many parts of the city, where people have built houses without obtaining planning permission from the authorities. Due to the high cost of land, most building sites are built with very little natural light and low wind in order to maximize the covered area (Mahar, [2018](#)). Natural ventilation strategies include building orientation, as well as the sizing and placing of the openings (Aynsley, [2014](#); Mast, [2009](#)).

The placement and size of the opening area are very important for windward and leeward airflow because air flows from the windward side to the leeward side (preferably to a negative pressure point). Having smaller inlet holes than outlet openings increases the airflow speed. This general principle can be used to achieve the desired levels of user comfort in buildings using natural air (Arfaei, [2019](#); Leopoldo et al., [2007](#)). The design of a building should be based on natural ventilation. The amount of air intake depends on the size and location of the openings. Daytime opening design admits sunshine, airflow, and cross-ventilation. For cross-ventilation, windows should be openable with inlets of a similar size on opposite walls for cross-ventilation to work properly (Kalz & Pfafferott, [2014](#); Tantasavasdi et al., [2001](#)).

Power crisis has had a profound effect on people's daily lives and they look for alternative and less expensive ways to deal with it. Residents are generally dissatisfied with the comfort and warmth of their homes. There is a shortage of housing laws at the provincial and local levels. In many parts of the city, the existing bye-laws are not effectively implemented. People can construct a house without obtaining planning authorization from the local government because of the lack of control of City Development Authority (QDA). Due to the high cost of land, residents try to cover a large part of the residential plot, leaving few and insufficient holes for natural light and ventilation (Mahar, [2018](#); Nguyen et al., [2011](#)).

Methodology

The methodology adopted for conducting this research includes literature survey further complemented by questionnaire survey. The sample size was

calculated by using Taro Yamane Method, which is suitable for conducting these types of surveys.

Research Population

The population of two areas of Qasimabad, Hyderabad (Abdullah Sport City and Naqash Villa Phase 2) was targeted in this research. According to the population census 2020, the population of Qasimabad is 336,000. Approximately, 70-75% of this population lives in contemporary buildings. The population of the two targeted areas of Qasimabad was 1300 in 2021.

Taro Yamane Method

The Taro Yamane method for determining the sample size was formulated by Taro Yamane in 1967. Below are the mathematical illusions for the Taro Yamane formula. $n=N/(1+Ne^2)$ where n = sample size, N = population under study, e = margin of issues. As per formula: the study population of the two selected areas of Qasimabad is 1300 is and the margin of issues which is selected is 5%.

Applying Yamane Method

$$n=1300/(1+1300(0.05)^2)$$

$$n=1300/(1+1300 \times 0.0025)$$

$$n=1300 /1+3.25$$

$$n=1300/4.25$$

$$n= 300$$

Results and Discussion

The three selected house typologies are given below to formulate the results of the survey.

House # 01: 200 sqyd

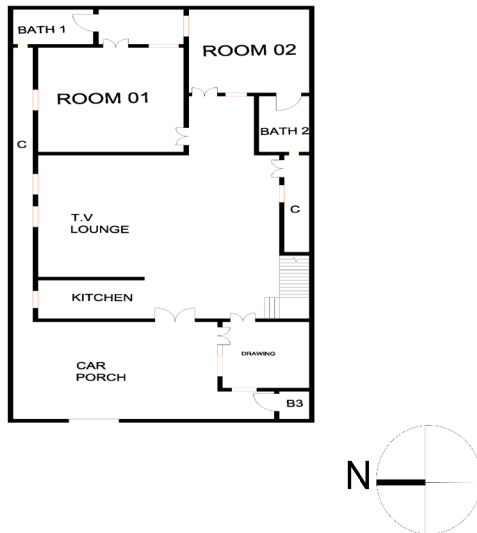
House # 02: 120 sqyd

House # 03: 200 sqyd

Existing House Plans of the Study Site

Figure 4

House Plan (1) 200sqyd(30'x60')



Schedule of House Area (200 SQYD)

Table 1

House Dimensions

No	Sizes	Window 1	Window 2	Doors	Ventilator	Corridor
R1	14'-0"x15'-0"	3'-0"x5'-0"		2'-6"x7'-6"		2'-0"
R2	12'-0"x13'-0"	3'-0"x5'-0"		2'-6"x7'-6"		
TV Lounge	17'-0"x23'-0"	3'-0"x5'-0"	2'-6"x5'-0"	4'-0"x7'-6"		
Drawing Room	13'-0"x18'-0"	3'-0"x5'-0"		2'-6"x7'-6"		
Bath 1	8'-0"x5'-0"			2'-6"x7'-6"	2'-0"x2'-0"	
Bath 2	5'-0"x8'-0"			2'-6"x7'-6"	2'-0"x2'-0"	
Kitchen	5'-0"x11'-0"		2'-6"x5'-0"			

Figure 5

House Plan (2) 120sqyd(23'x45')

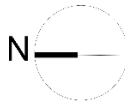
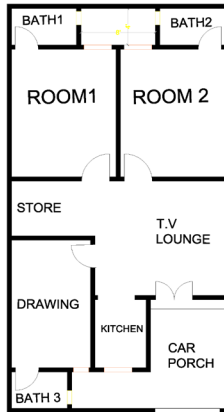


Table 2

House Dimensions

No	Sizes	Window 1	Doors	Ventilator	Corridor
R1	12'-0"x14'-0"	3'-0"x5'-0"	3'-0"x7'-6"		2'-6"
R2	12'-0"x13'-0"	3'-0"x5'-0"	3'-0"x7'-6"		
TV Lounge	14'-6"x12'-6"	3'-0"x5'-0"			
Drawing Room	14'-0"x8'-0"	3'-0"x5'-0"	3'-0"x7'-6"		
Bath 1	7'-0"x4'-0"		3'-0"x7'-6"	2'-0"x2'-0"	
Bath 2	4'-0"x6'-0"		3'-0"x7'-6"	2'-0"x2'-0"	
Kitchen	6'-0"x8'-0"				

Figure 6

House Plan (3)200SQYD

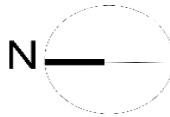
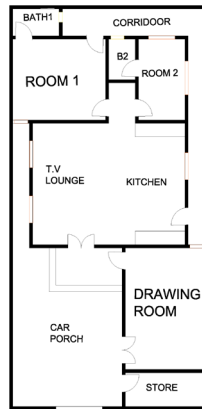


Table 3

House Dimensions

No	Sizes	Window 1	Doors	Ventilator	Corridor
R1	14'-0"x12'-0"	3'-0"x5'-0"	3'-6"x7'-6"		2'-6"
R2	7'-0"x12'-0"	3'-0"x5'-0"	3'-6"x7'-6"		
TV Lounge	18'-0"x14'-0"	3'-0"x5'-0"			
Drawing Room	12'-0"x18'-0"	3'-0"x5'-0"	3'-0"x7'-6"		
Bath 1	7'-0"x4'-0"		3'-0"x7'-6"	2'-0"x2'-0"	
Bath 2	4'-0"x6'-0"		3'-0"x7'-6"	2'-0"x2'-0"	
Kitchen	18'-0"x7'-0"				

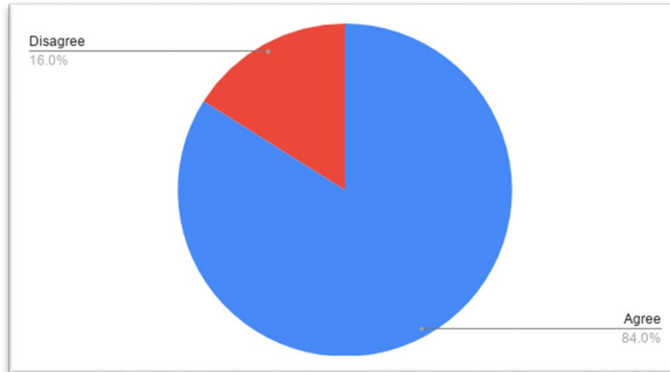
Data of Questionnaire

Some of the responses of the questionnaire are described below in order to provide an overall overview of the situation in the selected areas.

Is there proper ventilation in your building?

Figure 7

Response of Proper Natural Ventilation in your Building

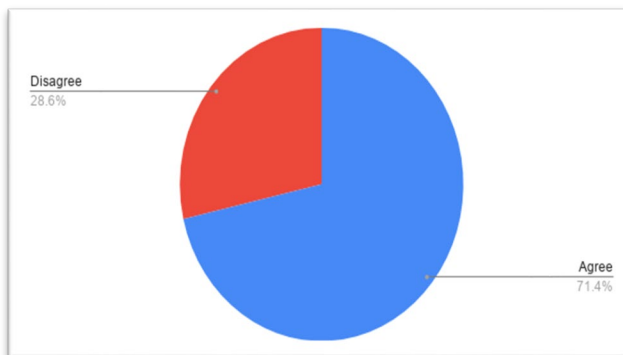


When the residents were inquired about the existence of proper natural ventilation in their building, 84% of them gave a positive response. Whereas, 16% disagreed with the said statement.

Is there proper natural ventilation of the room of your building (Room 1)?

Figure 8

Response of Proper Natural Ventilation in Room 1 of your Building

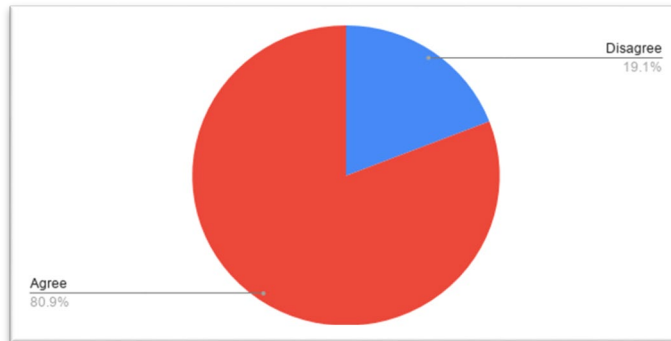


When the residents were inquired about the existence of proper natural ventilation in room 1 of their building, 71.4% of them gave a positive response. Whereas, 28.6% disagreed with the said statement.

Is there proper natural ventilation of bath / toilet of your building (Bath 1)?

Figure 9

Response of Proper Natural Ventilation of Bath/Toilet 1 of your Building

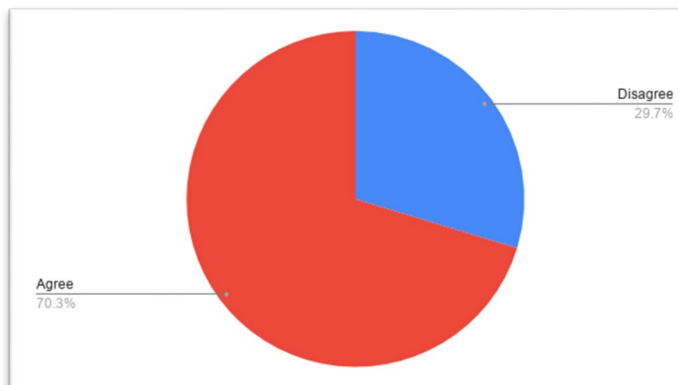


When the residents were inquired about the proper passive ventilation of bath / toilet 1 of their building, 80.9% of them gave a positive response. Whereas, 19.1% disagreed with the said statement.

Is there proper natural ventilation in your kitchen?

Figure 10

Response of Proper Natural Ventilation in your Kitchen

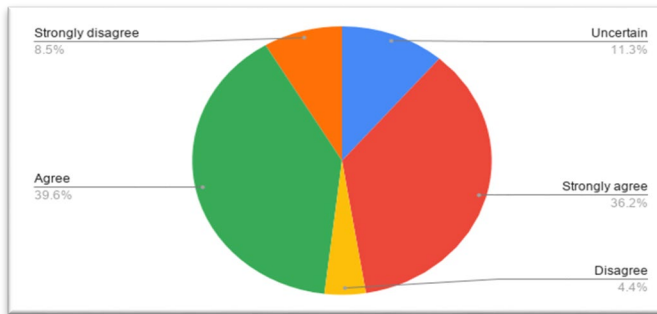


When the residents were inquired about proper natural ventilation in their kitchen, 70.3% of them gave a positive response. Whereas, 29.7% disagreed with the said statement.

Are you satisfied by the size and location of the windows of your building?

Figure 11

Response of are you Satisfied by the Size and Location of the Windows of your Building

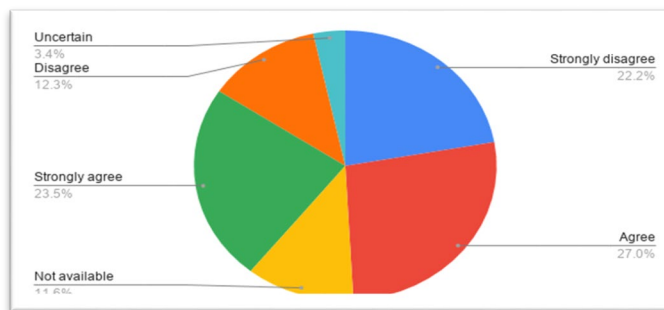


When the residents were inquired about their satisfaction with the size and location of the windows of their building, 75.8% of them agreed, 12.5% disagreed, and 11.3% gave a neutral response to the question.

Are you satisfied by the duct system for ventilation (if available)?

Figure 12

Response of are you Satisfied by the Duct System for Ventilation (if Available)

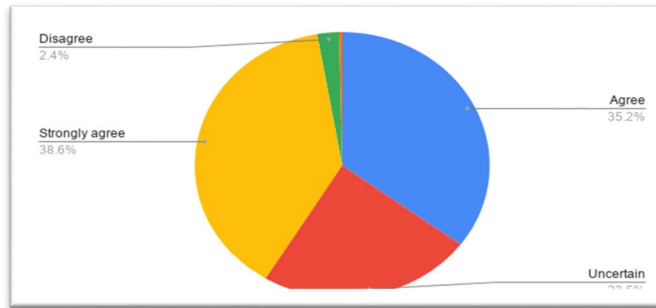


When the residents were inquired about their satisfaction regarding the duct system for ventilation (if available), 50.5% of them agreed with the said statement. Whereas, 34.5% disagreed and 11.6% did not answer this particular question.

Are you satisfied by the corridors/galleries for service ventilation?

Figure 13

Response of are you Satisfied by the Corridors/Galleries for Service Ventilation



When the residents were inquired about satisfaction with the corridors / galleries for service ventilation, 37.6% of them agreed with the said statement, 2.4% disagreed and 23.5% gave a neutral response.

The satisfaction level of the respondents is summarized in the Table 4 below.

Table 4

Response to the Question to Investigate the Satisfaction Level

S. No	Factors	Satisfied	Unsatisfied
01	Ventilation of building	84%	16%
02	Ventilation of bedroom 1	71%	29%
03	Ventilation of bedroom 2	53%	47%
04	Ventilation of bath / toilet 1	80%	20%
05	Ventilation of bath / toilet 2	69%	31%
06	Ventilation of kitchen	70%	30%
07	Ventilation of living area	85%	15%
08	Size and location of windows	75%	25%
09	Size and location of doors	80%	20%

S. No	Factors	Satisfied	Unsatisfied
10	Duct system for ventilation	50%	50%
11	Corridor / galleries for service ventilation	70%	30%
12	Ventilation of staircase	56%	44%
13	Width of corridor	70%	30%
14	Width of stairs	90%	10%
15	Ceiling height	85%	15%
16	Area of room 1	63%	37%
17	Area of room 2	79%	21%
18	Area of kitchen	70%	30%
19	Area of bath / toilet 1	56%	44%
20	Area of bath / toilet 2	75%	25%

Uncontrolled development in Qasimabad is consuming the open spaces that allow the free movement of air in and out of the buildings. It is evident from the above table that “ventilation of rooms” is not sufficient according to the room area. In some houses, duct ventilation is used in rooms, which is inadequate. According to the survey, 29% of residents were not satisfied with room ventilation. This is symptomatic of the fact that the current design practices are not following the bye-laws of ventilation as stated by Sindh Building Control Authority. The usual practice is the provision of ventilators in kitchen instead of a full window, which is not sufficient for the functioning of the kitchen. This is one of the main reasons of the dissatisfaction of the residents. The above table showed that 30% of residents were not satisfied with kitchen ventilation. The bye-laws suggested 15% minimum opening in the kitchen walls for reasonable ventilation. Similarly, detailed guidelines are present for living areas in residential buildings. The inappropriate provision of the openings leads to dissatisfaction of the residents. The duct system used for the ventilation of kitchen and bathrooms in vertical residential buildings is also fixed to 25sqft for two floor residential buildings in order to provide adequate ventilation. The results also showed the dissatisfaction of more than 40% residents in

two-floor buildings due to the lack of ventilation provision as per the bye-laws.

Conclusion

The research concluded that the implementation of bye-laws is mandatory to achieve an adequate level of satisfaction in the residents of Qasimabad, Hyderabad. The local development authority should not allow the execution of the buildings deviating from the bye-laws. A post- occupancy survey should be conducted immediately to further analyze the current scenario of illegal constructions. Adequate provision of open spaces should be mandatory to allow air movement in the buildings. Strict control on the provision of openings in residential buildings is the only solution to build habitable spaces that increase the satisfaction of the occupants.

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