Residents' Perception Of Meenware Design In Residential Buildings In Saudi Arabia

Alzahrani Mohammed, Roshida Abdul Majid, Badr Alsolami, Abdullah Karban

Abstract: 'Meenware' is a vertical shaft that is carefully implemented in buildings as a design solution to provide daylight and natural ventilation for internal spaces. In Saudi Arabia, Meenware is typically applied in apartment buildings to overcome issues associated with deep plan buildings and allow daylight, natural ventilation, and services. Residents may not accept the Meenware due to its disadvantages that have been noted in many apartment buildings. The objective of this study is to provide insights into the residents' perception of existing Meenware in apartment buildings. A survey questionnaire was carried out to gather their opinions about Meenware in their apartment buildings in Makkah. The data is collected from the residents of more than 50 apartments buildings. The results show that the majority of the respondents have negative feedback, which includes the perception of Meenware designs and its adverse impact on the building and residents. This paper highlights the need to re-think the current Meenware function and design guideline in light of the residents' desire for a quality indoor environment in apartment buildings.

Keywords: Meenware; vertical shaft; apartment buildings; Makkah

1. INTRODUCTION

Due to the oil industry, Saudi Arabia is experiencing continuous advancement across multiple sectors including the housing sector. New buildings have been constructed to meet the increasing demand for housing (Alrashed and Asif, 2014). Furthermore, Saudi Arabia has adjusted its housing policies to include different types of residential buildings including apartment buildings with a deep plan design. This type of building is most prevalent across all cities in Saudi Arabia. According to the General Authority for Statistics in Saudi Arabia, there were some 3,591,098 total households in 2018. The survey results showed that the leading type of housing was apartments (Figure 1). A leading concern in deep plan buildings is access to fresh air and daylight. These issues increase energy consumption caused by extensive artificial lighting and mechanical ventilation. One of the design solutions to overcome such issues is Meenware (vertical shaft). The Meenware is defined as a vertical shaft from the ground floor to the roof of a building without a roof (Ahadi et al., 2018; Padilla-Marcos et al., 2017; Nada and Said, 2017). It is typically used in multi-story residential buildings. The main functions of Meenware are to provide light and ventilation to the interior spaces that do not have a direct opening to the exterior environment (Freewan et al., 2014; Nada and Said, 2018; Yang et al., 2014). It could also be used to allow designers to increase building depth while maintaining the same amount of daylight (Council, 2007).

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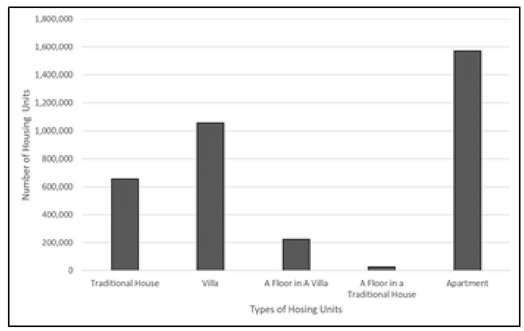

Figure 1. *Number of housing units by type of housing unit in 2018*

However, with considerable developments in the housing sector in Saudi Arabia, residents are concerned about the disadvantages of the Meenware in apartment buildings (Almgloth, 2017). This study provides insights into the residents' perception of existing Meenware in apartment buildings in Saudi Arabia.

1.1 Meenware (Vertical Shaft)

Meenware is a passive space that adapts to the climate, user needs, and building function dynamically. The term "passive" in architectural design describes the idea of self-protection on the part of users with respect to the environment to form a better level of indoor environmental comfort, or changes to space form, volume, or function to adjust a space's adaptability to the occupants' requirements (Dai et al., 2006; Guangming and Ding, 2005; Song et al., 2015). Freewan et al. (2014), Nada and Said (2018) and Yang et al. (2014) identified that the vertical shaft functions to provide daylight and natural ventilation to the interior spaces that do not have a direct opening to the exterior environment. It has many different names in different countries such as light well, light shaft, ventilation shaft, airshaft, and vertical shaft. There is a difference in the primary function of Meenware (Padilla-marcos et al., 2017; Prajongsan and Sharples, 2012; Yang et al., 2014; Nada and Said, 2017; Biddle et al., 2003). Historically, a Meenware was used in ancient civilisations, such as the Egyptians (figure 2) (The Citadel of Qaitbay in 1477) and at the Palace of Knossos on Minoan Crete (Figure 3). There are also instances of vertical shaft used by the Romans

(Bagnall and Frier, 2006).

Figure 2. *Lightwell in the Citadel of Qaitbay in Alexandria, Egypt.*

In New York City, in 1885, they were using vertical shaft in Jewish immigrant apartment buildings to increase the number of rooms to accommodate the largest number of people as possible for natural ventilation and daylight (Figure 3) (Biddle et al., 2003).

1.1.2 The Function of Meenware in Buildings

1- Providing Natural Ventilation

Various researchers have studied natural ventilation with an emphasis on how to induce the phenomenon through different methods in order to achieve thermal comfort. One of the most conventional methods is the use of a ventilation shaft, a concept that works similar to a chimney effect (Wang and Lei, 2018; Asadi et al., 2016; Zhai et al., 2005; Gan and Riffat, 1998). It is typically a vertical space which acts as a passage facilitates the circulation of air between interior spaces of buildings and the exterior surroundings (A.-S. Yang et al., 2014). The use of a ventilation shaft is perhaps more significant in what is called 'single-sided' buildings, especially residential units (Prajongsan and Sharples, 2012). This includes even in high-rise residential buildings, where natural ventilation and thermal comfort were found to be enhanced. They have proven effective in increasing air velocities within interior spaces, a factor that extends thermal comfort for indoor space occupants.

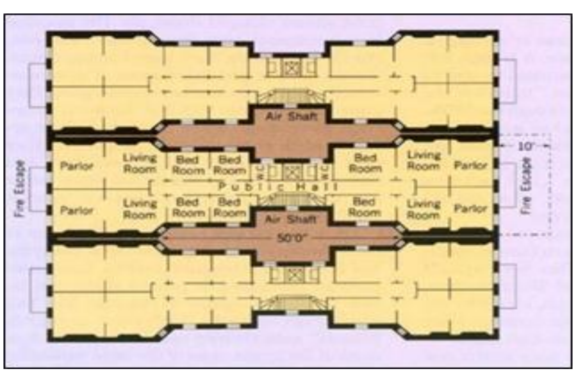

Figure 3*. First-floor plan of an apartment building in New York 1885*

Yang et al. (2014) also studied the effectiveness of using a built-in central ventilation shaft (CVS) for ventilating office spaces in a public building. They used the CFD simulation procedure to predict the aeration flow behaviour within the spaces. They also measured the interior air velocity and temperatures of 16 different positions on three different floors inside the main building. The most significant part of their findings was that ventilation shafts are effective in interior ventilation. They also validated the simulation software, in addition to asserting that the simulation procedure was a useful analysis tool for designers to improve the natural ventilation of buildings at the design stage. In their case studies research, Meiss and Padilla-marcos (2017) submitted that such a shaft inhibits the free circulation of air, although they attributed the inhibition to the influence of a building's geometry. Hence, the ventilation shaft as an architectural element could be said to have some negative impacts on the quality of the air in a building depending on the building's design. In other words, as long as the geometry is designed appropriately in relation to the ventilation shaft, it would enhance interior air circulation by letting in clean air and removing foul air. Through their analysis, Padilla-marcos et al. (2017) submitted that, for a shaft to yield efficient results regarding interior natural ventilation, it has to be up to 12 metres high. Some proffered reasons for that are factors like the surrounding urban environment around the building and the building design, which interfere with the ability of the shaft exchange process. Their submission was supported because the shaft height is very low, the exhaust effect inside it is weak, and reduces rapidly (Zhong et al., 2011). Some researcher argued that height alone cannot be the efficiency determining factor for a ventilation shaft. Saleem et al. (2016) strongly implied that, to improve a shaft's performance, which they called solar chimney, other parameters needed to be taken into account, such as the width and inclination angle. They concluded that, for ventilation shaft researches to be more meaningful, the various parameters need to be studied cumulatively to define the optimal design.

2- Provision of Natural Daylight

There are many interior spaces, especially in lower floors of multi-story buildings (Song et al., 2014) which have the problem of getting sufficient natural lighting in the daytime. This problem may arise as a result of a number of factors affecting daylighting. Saleem et al. (2016) enumerated some of them as the area and orientation of a building, type of glass used on a building, area of windows, shading, and external obstruction of a building. One of the ways of circumventing this problem is by using a light shaft. Baker and Steemers (2014) described the light shaft to be functioning like a courtyard having a large height to width ratio. Su et al. (2010) likened a light shaft's function to a light pipe or a medium-sized atrium. A light shaft is a natural lighting element which ascribes to the functional architectural need for proper penetration of daylight into deep interior spaces of buildings, especially in residential buildings (Ahadi et al., 2017)

1.1.3 Meenware types in apartment buildings in Saudi Arabia

Meenware has three different types based on its connection with the interior space and is used as follows:

1- Residential Meenware
It is for living rooms and bedrooms or other rooms that open onto the Meenware (figure 4).

2- Service Meenware
It is for the bathrooms, kitchens and stairs only (Figure 5).

3- Compared Meenware
It is for living rooms, bedrooms, bathrooms and kitchens (Figure 6).

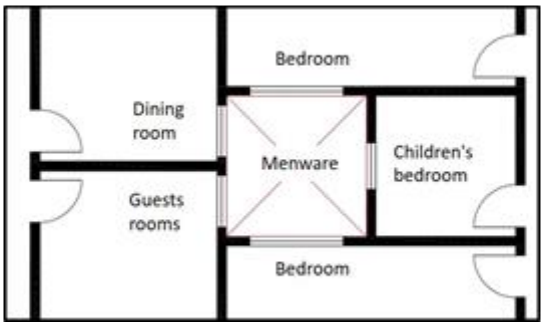

Figure 4: *Residential Meenware*

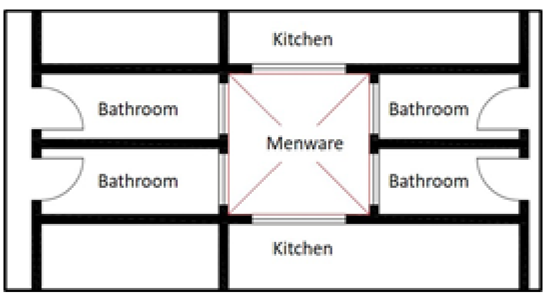

Figure 5: *Service Meenware*

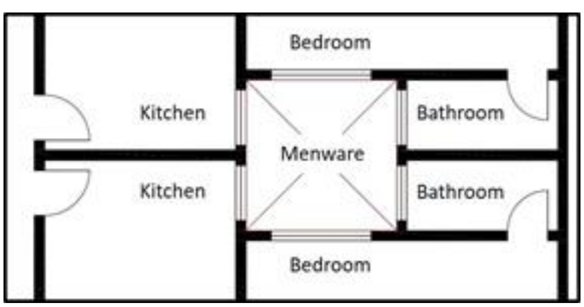

Figure 6: *Compared Meenware*

2. RESEARCH METHOD

Invitations to participate in the online survey were sent to more than 200 people living in Makkah. . The invitation to participate in the study contained a one-page description of the research and an invitation to complete the survey online. The first reminder was sent six days after the first invitation to all 180 non-respondents. The second reminder was sent 12 days after the first invitation to 160 randomly non-respondents. Of these, 50 completed the questionnaire online and the response rate was only 25% despite two reminders. The questions included in the questionnaire were selected in view of the objective of the study to gather residents' opinions about current Meenware in their residential buildings in Makkah. This will help define the current practices of Meenware and its impact on the spaces that are connected to it, which will lead to focusing on the issues that influence residents in apartments building in Makkah. The contents of the questionnaire were selected based on the review of the literature concerning light wells (Abedah, 2013; Farea et al., 2012).

The questionnaire was composed of three parts:

A. **Background questions:** socio-demographic questions regarding age and gender of the respondent and education and type of work of the respondent, questions regarding the current location.
B. **Questions regarding Meenware descriptions:** questions regarding the type of Meenware, the height of Meenware, type of roof, the entrance of Meenware.
C. **Questions regarding impacts of Meenware:** a question regarding the advantages of Meenware, a question regarding the disadvantages of Meenware.

3. RESULTS AND DISCUSSION

3.1. Response rate

Since the response rate was only 25%, and a non-respondent analysis was not performed, the responses cannot be consideredas representative for the residents in Makkah due to potential of selection bias. Nevertheless, they carry essential information regarding Meenware, and its impacts on residents and the buildings in Saudi Arabia, of which data is meagre.The highest response rate was among residents living in apartment buildings. According to the participants' locations, the buildings were distributed in more than 6 residential neighbourhoods as shown in Figure 7.

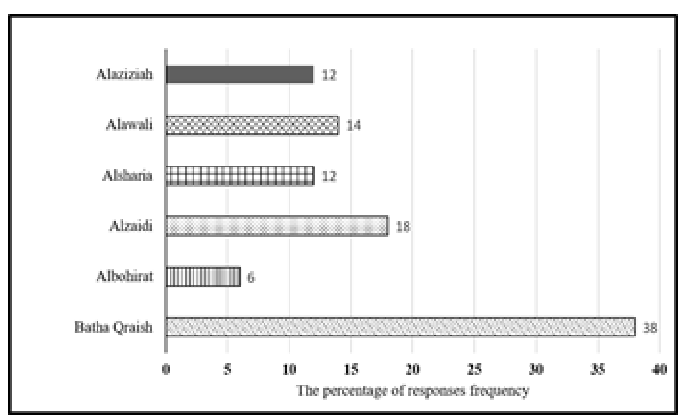

Figure 7: *The distribution of buildings were in six residential neighbourhoods participating in the study*

3.2. Meenware Descriptions

The findings revealed that the compared Meenware dominated the Meenware types by 55.9% as compared to 32.6% services Meenware and 11.6% for residential Meenware (Figure 8). While, the respondents' views on the height of Meenwares showed that the height was three levels (around 9 metres) by 63.85%, 23.45% for four levels (12 metres) and 12.7% for five levels (15 metres).

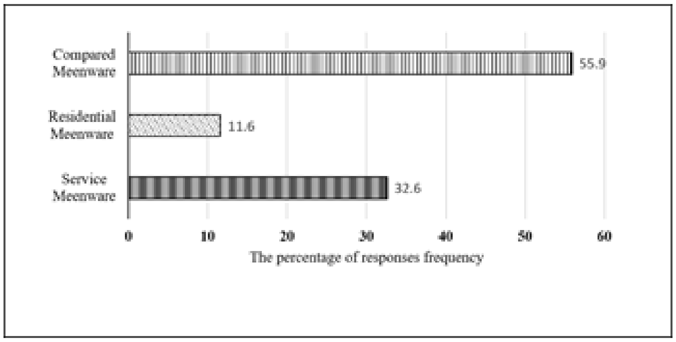

***Figure 8**: Different types of Meenware*

Regarding the entrance of the Meenware, 61% of Meenwares had entrances, and 53% of entrances were doors dedicated to entering the Meenware, and 47% were using the windows inside the apartments to enter the Meenware. Concerning Meenware roofs, 63.3% of respondents answered that Meenwares are open to the sky and 36.7% reported Meenwares had closed roofs. 69% of roofs were steel grill, 17% aluminium grill and 14% corrugated metal sheet. Among the respondents who reported having closed roofs, the most frequently mentioned reasons are presented in Figure 9.

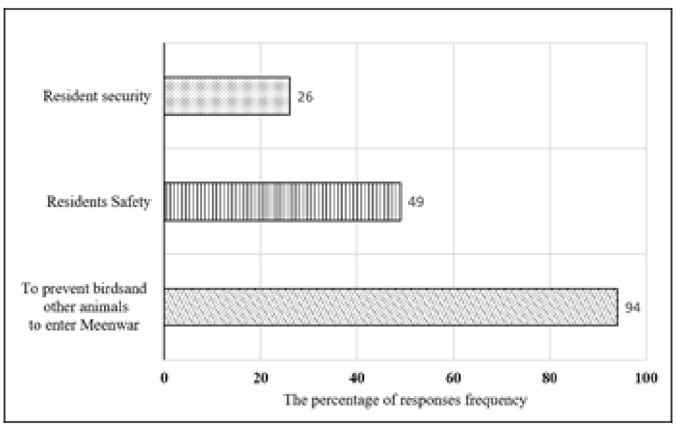

***Figure 9:** Reasons to close the roofs of Meenwares*

These figures represent the current function of the Meenware. They highlight that the Meenware function is not utilised to improve the indoor environment quality.

3.3. Positive and Negatives Impacts of Meenwares

In recording the positives aspects (Figure 10) and advantages of the Meenwares from the respondents' point of view, the findings show that the most common response was installing water and sewer pipes inside the Meenware with 58.8%. The second most frequent response was that Meenwares were used to install air conditioning units with 54.9%. In terms of providing buildings with natural ventilation, it recorded the third-highest response with 49%, followed by building daylight with 29.4%, and a space for storage with 6%.

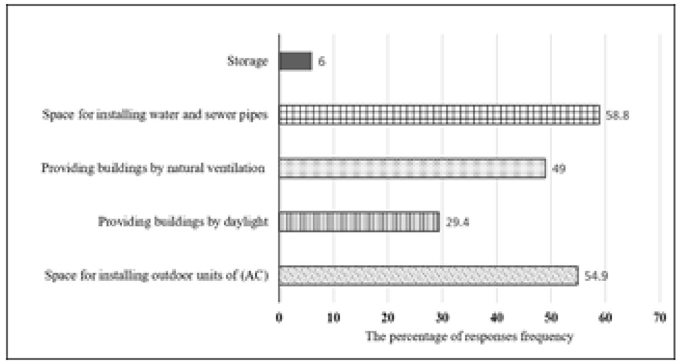

***Figure 10:** Advantages of Meenwares*

In recording the negative aspects (Figure 11) of the Meenware, the most common response was the bad smells with 32%, which emanated from the bathrooms and kitchens that opened onto the Meenwares. The second negative aspect was the temperature with 22%. Many reasons caused the increase in temperature such as air conditioning, closing the bottoms of Meenwares followed by dust and air pollution (17%). Interestingly, the minimal privacy (in acoustic and visual) and unused spaces of the Meenware came last with 6% each. The small sizes of Meenwares was a leading reason for not using Meenwares and caused the voices of neighbours to travel throughout the apartment block.In addition, the small size of Meenwares means that windows were close to each other, which allowed neighbours to see into other apartments.

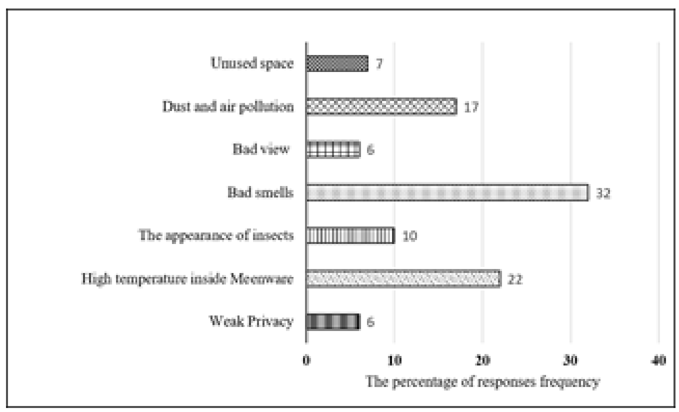

***Figure 11:** Negatives of Meenwares*

These findings highlight the current issues of the Meenware from the perspectives of building users. It seems that the Meenware concept that was discussed in the literature to aid in overcoming the issue of weakness in providing natural light and air in central spaces in deep plan buildings has caused numerous adverse issues that affect the Meenware and the spaces connected to it. In addition, the findings highlight that the current function of Meenware is not utilised to improve the indoor environment quality.

4. CONCLUSION

The findings suggest that the existing Meenware is a negative design element in the building design, particularly in deep plan and low-rise apartment buildings. In general, the design and layout of the Meenware seem to influence the respondents' experience and affect their levels of acceptance of it. This study recommends investigating the impact of different designs of the Meenware on indoor environment quality that affect residents and the performance of a building. Furthermore, it is possible to consider the impact of the Meenware on thermal comfort, air indoor quality, acoustic comfort and visual comfort.

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