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GREEN TECHNOLOGY APPLICATIONS: THE AWARENESS OF AIR VENTILATOR EFFECT TOWARDS RESIDENTIAL INDOOR AIR QUALITY

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ABSTRACT

This study explores the usage of air ventilator as one of the green technology applications at the residential areas. The stale air never goes out through the openings and entrances through which the wind enters the housing, thus it known as indoor pollutant emissions. Nowadays, a lot of residential health problems related to respiratory diseases are amplified for examples asthma, bronchitis, hay fever, and emphysema. Most all of these diseases are coming from the residential stale air. Thus, this study intends to explore the residential awareness of maintaining a good indoor air quality in their houses, respiratory problematic and the impact of air ventilators. Qualitative approach with convenience sampling becomes backbone of the study. Data are gathered through semi-structured interviews with thirty respondents and some pictures are also taken. Each interview session is lasting not more than 1 ½ hours and recorded with a digital recorder. The transcriptions of interviews were mailed to them right after three days. Among the significant results from the study are; 76% of respondents claimed the prices of the device are inexpensive, and 73% claimed their family members of asthma attacks are reduced as well as the allergic symptoms. The study is planned to further up to include major cities to see it implications.

Keywords: *Air Ventilator, Awareness, Health, Residential.*

1.0 INTRODUCTION

Green Technology is applying for any term of natural applications of science, knowledge and technology towards two ways; improving the relationship between human technology involvement and the impact to the environmental and natural resources (ITToolBox, 2008). One of the green technology applications is an air ventilator which can be installed on the roof. The device is an effective ways to reduce the indoor air quality (AIQ) containments related to asthma/allergic diseases. A study conducted in America suggested the improving of environments in buildings mainly IAQ of administration offices may result medical economic benefits of US$5 to US$75 billion annually (Jonathan and John, 2003).

In line with the Malaysia's desire to make Green Technology as a key pillar for the government to ensure the current environmental and natural resources can be preserved for future use for generations to generations (Goh, 2012). Thus, the study is exploring one of the green technology applications which are the air ventilators for enhancing the IAQ residential. The whole-house ventilation is one of the process that supplying fresh air to a living space and exhausting stale air, either by natural or mechanical means in order to maintain an acceptable level of air quality. The purpose of air ventilation is to provide fresh (or at least outdoor) air for comfort and to ensure healthy IAQ by reducing contaminants such as molds, fungus, bacteria and air odor. The unit of air ventilator can be seen in Figure 1.

Figure 1: Air Ventilator

Historically, people have ventilated their buildings to provide a source control for both combustion products and objectionable odors (Sherman, 2004). A daily human activity such as cooking, bathing, breathing, and maintaining house is including some plants which bring some kind of air indoor pollutants (including excessive levels of water vapor) into the home. Additionally, building materials and furnishing can become other contributors to increase the level of contribution into indoor pollution throughout the gassing of chemicals used in their manufacture. Based on the works of Sherman and Matson (2002), the current ways of

residential construction have created tighter and energy-saving building envelopes that create a potential for under-ventilation (Russell, *et al.,* 2005).

Natural ventilation is the process of supplying and removing air through an indoor space without using mechanical systems. It refers to the flow of external air to an indoor space as a result of pressure or temperatures differences. There are two types of natural ventilation occurring in residential and buildings; wind driven ventilation and buoyancy-driven ventilation. The strong of air blows is the main mechanism of wind driven ventilation (refer to figure 2). Figure 2 illustrates the Malays-house in Malaysia in the era of 1940s-1980s. The house is detached from the ground at least 1m by pillars and many holes are made under the roof that easily ventilated by natural air or wind from the surrounding areas.

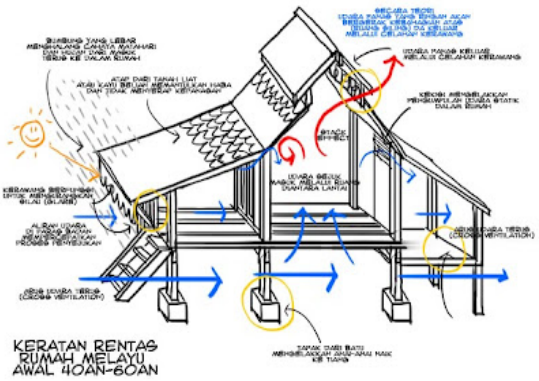

Figure 2: Wind-Driven Ventilation

And the second is the buoyancy-driven ventilation which is occurs as a result of the directional buoyancy force that results from temperature differences between the interior and exterior (refer to figure 3).

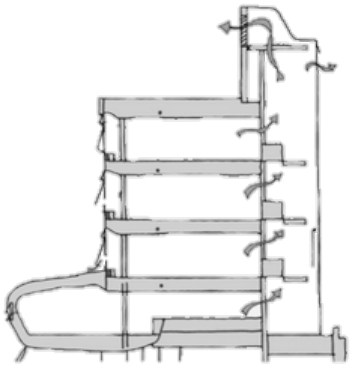

Figure 3: Buoyancy-Driven Ventilation

A whole house ventilation system delivers outdoor air IAQ. Besides the Natural Air Ventilation (NAV), there are varieties of ventilation system types including: exhaust-only, supply-only, balanced and balanced with heat-or energy-recovery. Any of these may be in continuous operation or operate intermittently, the may be single-port or multi-port, or the system may be integrated into an existing Heating, Ventilation, and Air-Conditioning (HVAC) system. Therefore, all these mechanical ventilation strategies provided more uniform ventilation rates than natural ventilation.

A continuous whole-house exhaust system provides ventilation by using a single-point or multi-point central fan to remove air from the building. Supply air enters the building in an uncontrolled manner and may be pulled in from relatively undesirable areas such as garages, musty basement or dusty attics (Barely, 2002). In the case of radon, researchers have found that exhaust systems may actually increase the indoor levels of contaminants (Bonnefous, Gadgil, and Fisk, 1992). Besides that, heat recovery can be added to exhaust systems. Passively, the building envelope can provide some heat recovery (Walker and Sherman, 2003), and is also partially effective at removing ozone.

Air pollution in Malaysia, particularly the haze episode, has a strong relationship with the existence of hot spots observed from satellite image from the Sumatra Island, Indonesia. Generally, the causes of air pollution in areas can be attributed to two sources; domestic sources and external sources. However, the most significant local sources including motor vehicles, landfills, power and industrial plants and agricultural sites (Liping and Hien, 2007). Apart from that, it also increase concentration of pollutants due to weak scattering process air may have negative impacts on human health in particular (Williamson 1973). Air ventilator also can help curb this problem. Therefore in line with the government initiatives, the use of air in the ventilator today's society should be given more emphasis to every household and buildings can receive healthy and fresh air especially residential areas near to the industrial areas.

2.0 LITERATURE REVIEW

Literature review is likely a manuscript written by people to consider the critical point of current knowledge including practical findings as well as theoretical and methodological contribution to a particular subject. It is crucial phase in the research process by reviewing the work of researchers in the past (Dellinger and Leech, 2007). Literature reviews can considered as secondary sources as well as it can be interpreted as a review of an abstract accomplishment.

Developing a literature review can be gained by references of journals, articles, relevant reports, books, internet, related databases, library catalogues, interviewing and so on. The information then will be re-infused to develop a report of this project. Furthermore, in this study, it is emphasized on the awareness of air ventilators effects towards residential indoor air quality (IAQ). It is about the effects of air ventilator use in any residential home that using it. This aspect is focused on respiratory problematic like asthma (Richardson *et. al.*, 2005) and the impact of air ventilators as overall such as maintenance cost. The study also tries to get some information on how the air ventilator's roles in addressing the problem of polluted IAQ in each respondent's house. One of the study in United States confirmed that potential annual savings and productivity gains are from the effect of good IAQ are US$6 to US$14 billion from the respiratory disease, US$1 to US$4 billion from reduced allergies and asthma, US$10 to US$30 billion from reduced sick building syndrome symptoms, and US$20 to US$160 billion direct improvements in worker performance that are unrelated to health condition (William, 2000).

Historically people have ventilated buildings to provide a control for Lingo combustion on products and objectionable odors (Sherman, 2004). Lately more studies have shown recent results of air ventilator impacts from the residential construction, and energy-saving building development. For an example, the first Malaysian Green Building accredited by Green Building Index (GBI) and Green Energy Office (GEO) is the Diamond Building at Precinct 2, Putrajaya (refer to figure 4). This building is the first LEED Platinum Building ever built in Malaysia and involved in the project of IAQ with Nano Titanium Dioxide (tio2). It is use to maintain the best IAQ by continuously reducing the Volatile Organic Compounds (VOCs).

Figure 4: The Diamond Building, Putrajaya

The scope of the study is to collect the data from potential respondents which are the owner of residential with installed air ventilators on their roof. The study will covers only two small cities in Kubang Pasu areas which is; Changloon and Jitra, Kedah.

2.1 Air Ventilator Background

In the middle Ages, people began to realize that air in a building could somehow transmit disease among people in crowded rooms. Homes and small buildings were heated with open fires in fireplaces. Smoke often spilled into the room and poisoned the air. King Charles I of England in 1600 decreed that no building should be built with a ceiling height of less than 10 ft. (3 m), and that windows had to be higher than they were wide. The objective was to improve smoke removal. "Ventilate" comes from the Latin word for "To Fan, "the action of causing air to move.

It was one thing to find out the minimum volume of fresh air needed to maintain comfortable indoor conditions, but quite another to find how to deliver it to the ventilated areas. This required mechanical ventilation and placed responsibility for system design and construction on the engineers. Although the first fan was built in circa 1500 by Leonardo Da Vinci as a water-driven fan to ventilate the bedroom of his patron's wife, the real development of this industry did not start until the 19th century. Before that, ventilation was natural and controlled by the building's orientation and placement of windows to catch the prevailing breezes. High ceilings and large open central staircases with ventilated domes provided some assistance to gravity and Mother Nature. Natural ventilation is the process of supplying and removing air through an indoor space without using mechanical systems. It refers to the flow of external air to an indoor space as a result of pressure or temperatures differences (Fitzgerald, *et al.*, 2011). There are two types of natural ventilation occurring in buildings; wind driven ventilation and buoyancy-driven ventilation. While wind is the main mechanism of wind driven ventilation, buoyancy-driven ventilation occurs as a result of the directional buoyancy force that results from temperature differences between the interior and exterior (Linden, 1999). There are two fundamental approaches to designing for natural air ventilator that will be effective in most Victorian situation, cross ventilation uses air pressure differentials caused by wind and stack ventilation which uses the increased buoyancy of air as it warms up.

Billings (1893) which is a physician, believed that CO2 was an accurate measure of impurity emissions from the human body. He calculated that 50 cfm of ventilating air would be needed to keep the room CO2 level to 550

ppm if the exhaled respiration was limited to a concentration of 200 ppm. Some people believed that 10 cfm (4.7 L/s) of air ventilation was sufficient Janssen (1986). However, based on work by Leaderer and Cain (1983) and Thayer (1982) found that 15 cfm (7.5 L/s) of outdoor air per occupant was sufficiently enough to reduce the concentration of tobacco smoke to a level acceptable to the 80% of the population today's reduced smoking rate.

On the other hand, health condition for the house residents is depending to the IAQ. According to The American College of Allergists states that 50% of illnesses are caused or aggravated by poor IAQ illnesses such as such as colds and flu, allergies and asthma. The warm and bad odor air condition also attracts to the development of dusts, pollen, mold, bacteria and viruses, including the VOCs and other airborne pollutants where they are have its place (April-Aire, 2013).

2.2 Types of Air Ventilator

Ventilator is divided in to two types, namely natural and mechanical ventilation. Referring to earlier results has indicated that the natural ventilation is the process of supplying and removing air through an indoor space without using mechanical systems. It does also refer to the flow of external air to an indoor space as a result of pressure or temperatures differences. At the moment, there are two types of natural ventilation occurring in buildings; wind driven ventilation and buoyancy-driven ventilation. The wind is the main mechanism for the wind driven ventilation, while the buoyancy-driven ventilation occurs as a result of the directional buoyancy force that results from temperature differences between the interior and exterior (Linden and Hunt, 2004).

3.0 METHODOLOGY

Methodology is usually a guideline system for a solving particular problem. The guideline is accompanied by specific components such as phases, tasks, methods, techniques and tools. The guideline also provides a systematic method that used in achieving the goals and objectives of the study. Purposely this study uses a qualitative method where three components are triangulated; face-to-face semi-structured interviews, photos and observation. Since the study is exploratory purposes, the qualitative method is appropriate to gather an in-depth understanding of human behavior (awareness) and the reasons that govern such behavior. The study is focused on small samples or respondents where the observation is taking a first place. Researchers must drive through a few places especially in residential places in Changloon and Jitra. The study provides a guideline for the selection of respondents which is convenience sampling. A convenience sample is basically one in which the researcher uses any subjects that are available to participate in the research study. As one of the criteria, the respondents must have installed the air ventilators on their roof. This study successfully gathered 30 respondents; they are 18 respondents from Taman Mutiara Indah, Taman Aman, Taman Tengku Maheran and Taman Tunku Sarina, Jitra and others 12 respondents from Taman Teja, Taman Pertama, Taman Resak and Taman Meranti, Changloon.

Based on interview guidelines which have been modified from past research, the study comes out with three main objectives and six sub-objectives. All the interviews done within a week (4 days in Jitra and 3 days in Changloon) and each respondent conversation are digitally recorded and have been transcribed within three days. Each respondent is emailed with a record of the interview's transcription. No other extra information is obtained. Some photos regarding air ventilators are also gathered as well as researchers' observation.

The study also uses secondary sources such as journals, articles, and website that available become necessary tools in determining the research's objectives and to develop the interview guide. As overall, figure 5 shows the flow plan of the study in data collection process including the data analysis section.

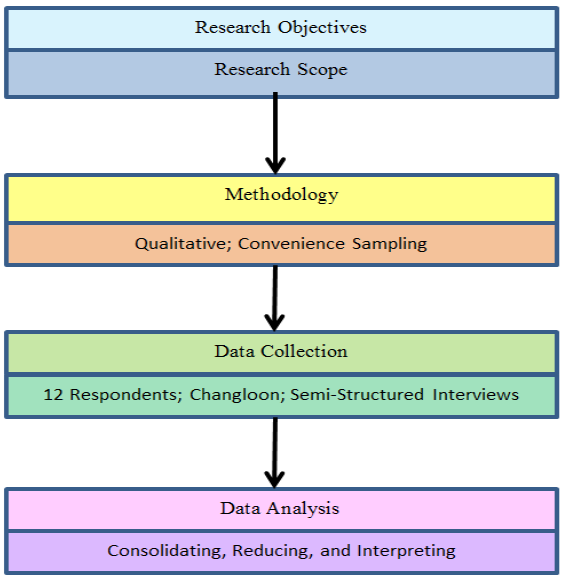

Figure 5: Process of Data Collection

4.0 FINDINGS

Data analysis is the process of making sense out of the data. These data may involve consolidating, reducing,

and interpreting what people have said and what the researcher has seen and read it. There are three types of data that are collected from 30 respondents who involved in the interviews. Firstly, the primary data is collected from the conversations which are digitally recorded. Each conversation is lasting between 45 minutes and up to 1 and 15 minutes. Secondly, pictures or photos of the house owners including the air ventilators are taken by a digital camera. And thirdly, a few medical records from some individual in the families also are collected. However the medical records are not be revealed at any publications. Table 1 shows the details about the 18 respondents in Jitra.

Table 1: Jitra Respondents' Details

Respondents	Type of House	No. Air Ventilator	No. Members in Family
Fadzillah S.	Single Semi-D	4	5
Mohd A.J.	Single Terrace	2	3
Kumar S.Y.	Double Semi-D	3	7
Noratul A.	Single Terrace	4	3
Mawariyah.	Single Terrace	2	4
Jamal. N	Double Semi-D	2	5
Siti Asmah	Single Semi-D	1	3
Woon A.T.	Double Semi-D	2	7
Afiza H.D	Double Semi-D	3	6
Daniel A.K	Single Semi-D	2	5
Abdullah A.	Double Semi-D	2	4
Roslan R.	Double Terrace	4	7
Hambali S.	Double Semi-D	2	3
Ikhmal K.	Double Terrace	2	4
Khalid S.	Double Terrace	4	3
Rohani T.	Double Terrace	2	4
Choong AC.	Double Semi-D	2	5
Siva Kumar	Double Terrace	4	6

Table 3 provides information on 12 respondents' background at several residential areas in Changloon.

Table 2: Changloon Respondents' Details

Respondents	Type of House	No. Air Ventilator	No. Members in Family
Hj. Fauzi	Single Semi-D	2	5
Mazlan J.	Single Terrace	2	3
Rohaiza R.	Double Semi-D	3	7
Nor Hanisah	Single Terrace	1	3
Rusliza D.	Single Terrace	4	6
Akhmal S.	Double Semi-D	2	5
Nursyakila	Single Semi-D	1	3
Hussin J.	Double Semi-D	2	7
Afza Aziz	Bungalow	3	6
Firdaus A.	Single Semi-D	2	5
Rozainie H.	Double Semi-D	2	4
Wahidah A.	Single Terrace	4	6

Table 3 shows the overall result which can be categorized into four sections; the initial cost, care (maintenance), benefits (reduce dusks, heat and odor, feel of fresh air and circulation) and health condition. These four categories are scaled into three indicator; (1) good, (2) medium and (3) low.

Table 3: Impacts of Air Ventilators

Respondents	Cost	Care	Benefit	Health
Fadzillah S.	3	1	1	1
Mohd A.J.	2	2	2	2
Kumar S.Y.	3	2	1	1
Noratul A.	3	1	1	1
Mawariyah.	3	1	1	1
Jamal. N	2	1	2	1
Siti Asmah	3	2	1	2
Woon A.T.	3	1	1	2
Afiza H.D	2	2	1	1
Daniel A.K	3	1	1	1
Abdullah A.	2	1	2	1
Roslan R.	3	2	1	1
Hambali S.	2	1	2	2
Ikhmal K.	3	1	1	1
Khalid S.	3	2	2	1
Rohani T.	3	1	1	1
Choong AC.	3	1	1	2
Siva Kumar	3	2	2	1
Hj. Fauzi A.	3	2	1	1
Mazlan J.	3	1	1	2
Rohaiza R.	3	2	1	2
Hanizah Y.	3	2	1	1
Rusliza D.	3	1	1	2
Akhmal S.	3	2	1	1
Nursyakila	2	1	2	2
Hussin J.	3	1	1	1
Afza Aziz	2	1	1	2
Firdaus A.	3	1	1	2
Rozainie H.	3	1	2	1
Wahidah A.	3	1	1	1

4.1 Cost

Most of the respondents are concerned about the cost if they wanted to use the air ventilator as long as possible. 14 residents are quite new which approximately a year uses of those air ventilators. Ten residents are considered used more than three years. The other six residents have been used the air ventilators for at least eight years. In 2006, the cost for each air ventilator is about RM1200 each and currently in 2013; the price has dropped to RM500 each for the middle size. Therefore, many owners who are aware of the air ventilator potential will installed the another units on their roof. From the study shows that 76% of the respondents are suggested the price of ordinary air ventilators are inexpensive. The prices of the devices are reasonable for long term usage. Presently, residents have a lot of

choices where there are many companies have the business locally with international brands and warranty.

4.2 Care (Maintenance)

Air ventilators have at least 5 to 10 years of maintenance free. From the study, there are 63% of respondents suggested that they have never touched the device for at least 6-year. Most of them said that the cost of air ventilators is no longer a concern because they already got what it should be delivered; air circulation, fresh air, reduce heat and temperature, reduce dusts and reduce costs for medication especially for asthmatic children.

4.3 Benefits

According to Environmental Protection Agency (U.S E.P.A) the sources of indoor pollutant are releases gases or contaminants into the air quality problems in homes. Others, it has been associated with indoor source emissions and it has associated with increasing number for the health conditions. Therefore, one way to reduce the air contamination with inexpensive ways is to use the air ventilators. The device is working by free air flow from outside and inside the house. The operations cost is totally free because it not using the electricity at all. Among the benefits gathered from the device are; free care and maintenance up to 5-year, no electricity – saves money, a possible way to make the house 'breath', exchange bad air with fresh and cleaner outdoor air.

One of the respondents said: "*The device is working with no sound at all and no noise pollution! One more that I noticed is … the heat condition in my room is reduced and also, the air-conditioning 'cool' the room slightly faster than before! Maybe the warm air in my room is sucking out faster by the air ventilators! Thus it saves so much time and money too!"*

4.4 Health

Ventilating is a process of changing the air in any space to provide high IAQ. Most importantly, the exchange of air will help to; control the temperature, replenish O_2, remove moisture, odors, toxic smoke, airborne bacteria and CO_2. As a result, the rooms or the building will have a fresh air condition with unpleasant smell and lower level of VOCs. Past studies have shown how the low air ventilation in the buildings will lead to occupant to have Sick Building Syndrome (SBS) symptoms (William *et al.,* 2009). The same effect will occur to house residents, a study shows that children in houses with low ventilation rates have more allergic or respiratory symptoms compared to children in houses with high ventilation rates (Mark and Garvin, 2009). From the study, 73% of the respondents claimed that their families' health conditions are better than previous. This study also confirmed by providing some testimonial from the respondents.

A respondent from Jitra said: "*Before we installed the air ventilators, which was 3 years ago, our children (3 boys and 1 daughter) were easily expose to cough, sneeze, hard breathing (asthma) and their skins are quite sensitive. Even myself, can easily find the dusts everywhere especially on the couches and tables. Then after we have them (air ventilators), the condition is slightly changed! We noticed that we are seldom brought our children to the clinics. Their asthmatic problem suddenly becomes easy to prevent and control. They are now can play without having a tight-breath anymore. Their skins look better now. The dusts also quite disappear too!"*

A respondent from Changloon said: "*On my roof right now at least has installed four air ventilators since two years ago! Why? Because after be influenced by a few neighbors that have same children condition as we are, like asthmatic, we decided to have them. And I noticed after a few months…not more than six months, my child's asthma condition becomes better and today, they can play around without taking a medicine anymore! Even their allergic to dusts also improved! The air condition in the house is quite better…no more bad smells and over-heating feelings!"*

Other few respondents also quoted the same results about the health conditions. Actually more than half (18 out of 30) of the respondents or 60% are influenced to install the air ventilators because of children health such as allergic to animals' hairs, dusts, coughing and asthmatics. Some respondents (parents) or 40% of them told us that their health condition likes migraine and fuzzy becomes slightly reduced. Besides that, they claimed the air ventilators have improved heat and temperature condition inside the house especially in the kitchen and bedrooms.

A few respondents (27%) expressed that they installed the devices because of relatives influenced (who have the same condition) claimed that their health are much better (after at least 5 to 7 months installed). On the other hand, the study found that the cost of purchasing a unit air ventilator is generally quite reasonable because it working for a long time period with a minimum of maintenance. We also did asking a few families who lived near to our respondents either they wanted to use the air ventilators. One of the neighbors said; "*Actually I heard a lot of good news about it, indeed! Perhaps I will install it maybe next few months! Yes, especially during the hot season – it will coming soon! Besides*

that I myself have asthmatic problem, perhaps it will help me a lot!"

The other neighbor claimed that; *"I also heard the same thing! But I more concerned about the electricity cost! With that thing, it works without electricity, so I assume it will reduce the air-conditioning operations! It sucking the hot air and refill it with cool air! That is my priority!"*

5.0 Limitation

Although this study was carefully prepared, we are still aware of its limitations. First, the study only uses two areas of place for data collection; Jitra and Changloon. Only two areas covered might not represent the majority of the respondents in Kedah state. Second, the respondents are gathered from the convenience sampling approach are also quite limited. It was because we have to do the survey by vehicle where we must find the house with air ventilators only. And third, the time for data collection is limited time which is 7-day. It would be better if it was done in a longer time with more respondents.

6.0 CONCLUSIONS

This study is carried out in Changloon and Jitra – two small cities in the northern Kedah. The purpose of the study is to explore; (i) The impact of air ventilator to house owners with four elements; cost, maintenance, benefits and health, and (ii) The awareness of house owners towards air ventilator functions and benefits. Qualitative approach with convenience sampling becomes the main source for data collection method. There are 30 respondents involved in the study coming from Jitra and Changloon areas. Most of them know that to create a good air circulation system for health is very important in the house. Furthermore, from the study, we know that residential have chosen the green concept by applying the green technology applications with low cost and low maintenance as well as to help the preservation of the earth's future. The residential also seems enjoyed with IAQ that minimizes the VOCs and also to feel the comfortable temperature (approximately 25 to 27 Celsius) inside the house. Therefore, we as a residential can have a good IAQ and a better health conditions in just a few steps by using the green technology. Besides that, these residential actually have contributed a little thing to the campaigns like Save the Earth and Stop Global Warming.

The future study should be carried out to explore more residents in other places in Malaysia especially in the big cities. Hopefully, by installing air ventilators, Malaysian citizen will be healthier and communities can breathe in the fresh air in the house all the time. Apart from the well in the hope that public awareness of the importance of the use of this ventilator is changed in terms of cost and health aspects. Overall, the use of a ventilator at home has a positive impact in the lives of consumers. Energy savings obtained, allowing for users of green concepts that have been brought in the life of today. The study of the impact in terms of health where wind- house diseases has been reduced. Ventilators also increase the quality of the air, polluted air can be filtered out and breathe before entering the house. The role of mass media and the government in ensuring the ventilator in use by every house in Malaysia is very important in providing information and exposure to the population about the importance of using a ventilator at home. It is also because of its relatively affordable cost and also benefits to be gained from saving a lot of energy in the home. Therefore, it is recommended that residential take advantage of the existence of Malaysia ventilator at their homes.

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