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PRJ 60403

Engineering Design and Innovation

Final Report of

Indoor Corner aircon Unit

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Contents

1.0 Introduction

1.1 Challenges

Challenges are unexpected or expected outcomes that could be faced by any consumers as well as producers which would bring negative effect. As air conditioners are nearly essential electrical appliances that are required by any buyers in this market, this would lead to increase in demand and usage of air conditioners. Excessive usage of air conditioners could lead to green-house effects and global warming as well [1]. As such, manufacturers are coming out with innovative ideas to produce eco-friendly air conditioners, that would reduce in energy consumption and limit the release of harmful chemical gas to the surrounding atmosphere. Air conditioner manufacturers is a rapidly growing industry in this era, with more and more household demand the needs for air conditioner due to the hot climate and tremendous amount of heat in Malaysia.

Besides, air conditioner in the market is limited to several models with the most popular category be it the ceiling mounted air conditioner (Figure 1) and the split wall mounted air conditioner (Figure 2). The ceiling mounted air conditioner, which is usually found in big office spaces or shopping malls, one is the split wall mounted air conditioner, which is commonly found in residential spaces. Both have its long and short-comings. Split wall mounted air conditioner has its limit, where the air direction or in other terms, the air flow could only be blown in a fixed or certain direction. This would in turn reduce the efficiency of the air conditioner. Therefore, the market was introduced with the ceiling mounted air conditioner, which could be blown in all four directions. On the bright side, lesser number of split wall mounted air conditioner could be use and replaced with only one ceiling mounted air conditioner. However, the price of the ceiling mounted air conditioner is relatively high compared to the common split wall mounted air conditioner and the energy consumption is also higher. This air conditioner is also not suitable for all residential household units as some units tend to have lower ceilings, which would result in over-consumption of energy and over-cooling.

Figure 1. Ceiling mounted air conditioner

Figure 2. Split wall mounted air conditioner

Other than that, the harmful chemical gases that are produced by the air conditioners are based on the refrigerants that the air conditioner manufacturers use. With the increasing of educated citizens and the rise in demand for environment friendly products, air conditioners that uses harmful refrigerants such as R22 are less likely to be purchased by customers. Accordingly, the R22 refrigerants was highly banned across the globe due to its damage towards the Mother earth. These refrigerants could lead to unwanted health issues as well as global warming with the thinning of our ozone layers.

1.2 Business Value

Therefore, to account with the challenges faced in the market, along came the idea of constructing a corner air conditioner to improve efficiency and with eco-friendly features. Several business values had been introduced with this corner air conditioner.

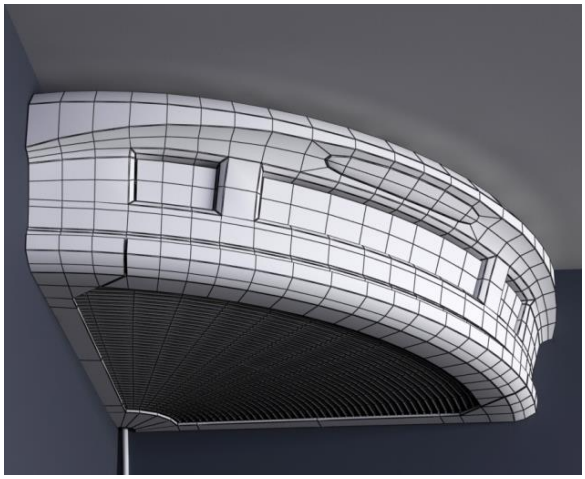


Figure 3. Corner air conditioner

i. Cost Savings (manufacturer)

Some savings could be experienced by the manufacturers. Some inner compartments are not required by the corner air conditioner, or if needed, lesser or smaller material would be used instead. For instance, the wall mounted air conditioners have motor swing attached to them which controls direction of airflow. This is associated with the air swing function that could be found on the remote control. In the corner air conditioner unit, this is not needed as the air flow could be blown in various direction, as shown in Figure 4. The motor swing would be roughly RM25 for one, and each wall mounted air conditioner requires two of it. Besides, with the reduction of material associated with a smaller sized indoor corner air conditioner, the cost would be lower. As manufacturer produces and sells in bulk, the cost savings would be larger in amount. Table 1 shows the cost comparison in between the wall mounted air conditioner and the corner air conditioner.

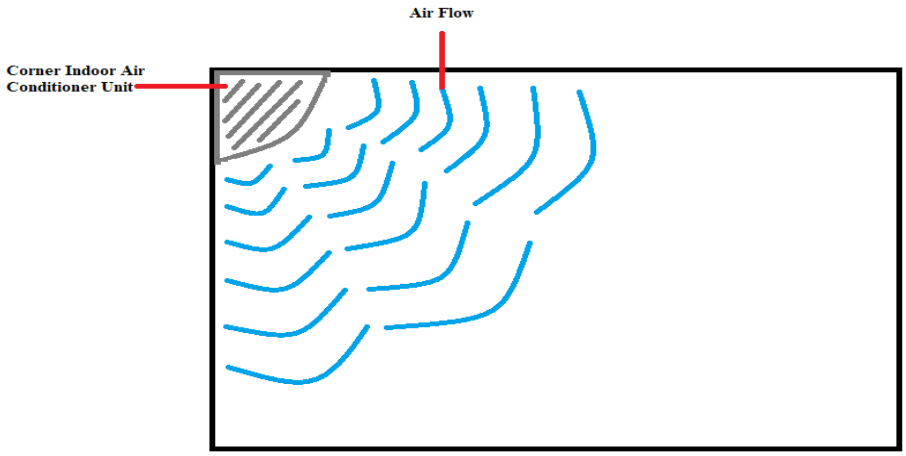


Figure 4. Air discharge from corner air conditioner unit

Figure 5. Blades that control airflow direction by motor swing.

Parts	*Unit*	*Wall mounted AC/unit price*	*Corner AC/ unit price*
Evaporator	1	RM150	RM100
Motor Swing	2	RM50	-
Blower Wheel	1	RM100	RM50
Control Circuit Box	1	RM180	RM180
Casing	1	RM30	RM30
Evaporator Fan Motor	1	RM100	RM100
Total		RM610	RM460

Table 1. Cost comparison between two air conditioners

ii. Cost savings (consumer)

By implementing a corner air conditioner, consumers could reduce the usage of one split wall mounted air conditioner, as well as substituting ceiling mounted air conditioner with the corner air conditioner. Besides, for consumers who prefers a smaller size air conditioner, or who lives in a small space as small as 10 metres squared, a half horsepower performance is more than enough. However, in the Malaysia market, there are no 0.5 horsepower air conditioners. The corner air conditioners are cheaper than the normal air conditioners and is perfectly catered for small rooms to minimize electricity usage.

Furthermore, copper pipe is required upon installation of air conditioners. Copper pipes and pipe insulators are needed to connect the air conditioners to the main socket. A corner air conditioner would require roughly 20% lesser in length of both copper pipe and pipe insulator than what was normally required (3 metres). Consumers could pay less installation fees along with the shorter usage of materials.

Length of installation pipe for typical air conditioner = 3 metre copper + 3 metre pipe insulator

= *RM60* + *RM45*

= *RM105*

Length of installation pipe for corner air conditioner = 2.4 metre copper + 2.4 metre pipe insulator

= *RM*48 + *RM36*

= *RM*84

Cost savings (20% less in length) per aircon unit = *RM*105 - *RM*84

= *RM*21

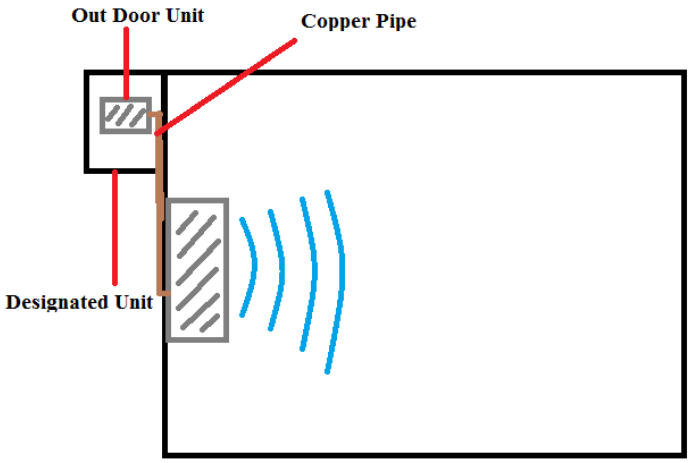


Figure 6. Copper wire required for wall mounted aircon

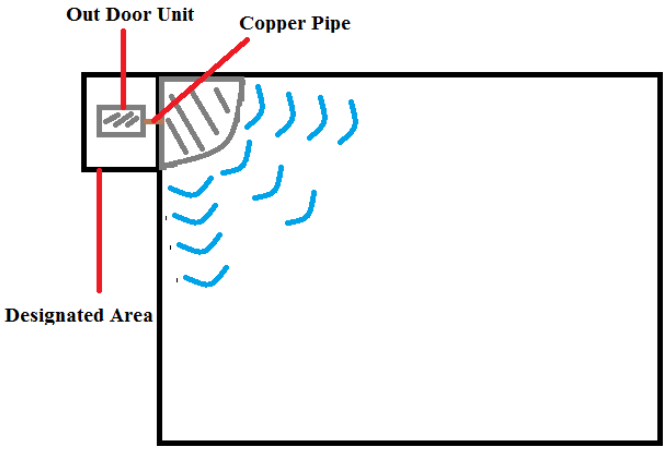


Figure 7. Copper wire for corner air conditioner

iii. Efficiency Performance

Moreover, return air plays and important role in determining the efficiency of performance of an air conditioner. Normally, the return air would be sucked back on the top of the air conditioner shown in Figure 8. Air conditioners would be placed near the top of the ceiling, with merely few centimetres away, limiting the air to be sucked back into the air conditioner due to the narrow spacing. For the corner air conditioner, the suction system would be built at the bottom of the air conditioner, which in turn maximize the amount of return air being sucked back as it is exposed to a wider space. A highly efficient air conditioner could save electricity as well.

Figure 8. Return Air for wall mounted air conditioner

iv. Environmental-friendly

The corner air conditioner would use an eco-friendly refrigerant, which is newly introduced in the market, known as R410A to replace the initial R22 harmful refrigerant. a

2.0 Analysis of Design Thinking Technique

2.1 Observation

Observation is one of the efficient ways to inspire new ideas and understand the needs and demand of consumers. During the brainstorming stage, an idea of building an indoor corner air-conditioner unit came through.

The residential type of apartment and studio is growing up and on demand exponentially in Malaysia nowadays. The apartment and studio are merged to small family. The apartment and studio type of residential normally have at least one small room with the area of approximately $10m^2$. The normal household 1 horsepower aircon unit is the lowest horsepower aircon unit is available in the market (Malaysia). Where the 1 horsepower aircon unit can cooled a $20m^2$ room where this specification of the aircon unit is where more than enough for a small room with the area approximately $10m^2$. [2]

Table 1:suitable Horsepower for the area

Area to be cooled (sq.m.)	Capacity Needed	
	(kilojoules per hour)	Estimated HP Rating
17	8,440	3/4
20	9,496	1.0
22	10,550	1.0
26	12,661	1.5
30	14,771	1.5
38	18,991	2.0
44	22,156	2.0
50	24,266	2.5
64	31,625	3.0
72	35,872	3.0

The shadowing technique is applied where me myself is currently staying in a room which is smaller than $10m^2$ of an apartment unit. The aircon that installed in the room is an 1 horsepower aircon unit where it is the lowest horsepower that available in the market. A 1 horsepower aircon is actually not necessary for a small room as the horsepower is way high or even doubling the needs. The selling price of an 1 horsepower aircon unit is approximately RM1000. Besides, the efficiency of cooling a small room by the normal 1 horsepower aircon

unit is yet to be optimized where the air is discharging from the aircon unit from only one direction.

In term of space saving, the 1 horsepower aircon unit is slightly huge for a small room and causing a little wasting in space. Besides, the return air for the normal 1 horsepower aircon unit is sucked from the top of the aircon unit, therefore a gap must be spaced out for the returning air. The spaced-out gap is kind of wasting of space for the room. The six hats thinking method was applied in here too.

Blue Hats	**What is the issue?** There's no any aircon in the market that is can fit a small room with approximately area of $10m^2$ perfectly according to the performance. **What is the root cause?** The lowest horsepower aircon that can be found in the market is 1 horsepower where it is more than enough for a small room. It causes the user to pay more to install a higher performance but not paying lesser to get a suitable performance of aircon. **What is the solution?** By building a half horsepower with a better air flow to cool down a small room efficiently.
Red Hats	**Do we like it emotionally?** The outer look of the aircon unit is inspired by the corner holder or corner table that hung on the wall. Space saving can be found from this idea.
White Hats	**Why is this better compare to the current technology?** The corner aircon is a potential product where all the aircons that can be found in the market are selling approximately RM1000 in average for a 1 horsepower. Where the corner aircon is a half horsepower aircon and the raw materials needed to build the corner aircon is lower than the usual one. By doing so, user can get a corner aircon easily by a cheaper price compare to the usual one where the performance is just perfect for a small room. Where

	apartments and studios are demanding and growing up exponentially as discussed in the observation.
Yellow Hats	**Why is this a good idea?** The corner aircon has three fixed air discharge where it can cold down the small room efficiently and with an affordable price that user can get. And the performance of the corner aircon is suitable for a small room as the corner aircon can cool approximately area of $10m^2$room.
Black Hats	**Why is this a bad idea?** Not a bad idea as the corner aircon can discharge air in three directions which can improve the efficiency of cooling the small room.
Green Hats	**Think outside the box?** The service circuit board can be easily access and the corner aircon have a suction of return air from bottom where it can save space as the usual aircon need to leave a gap for return air from the top of the unit which means the ceiling and the aircon must leave a gap.

2.2 Understand

In order to further enhance the understanding towards the demands of the market, several meetings and discussions were held with the respective person in charge in Daikin headquarters Malaysia. It is found that there is a lack of smaller size air conditioners, or air conditioners that utilizes lower energy in our market currently. The minimum that one could go, even for a small space is a 1 horsepower air conditioner, which consumes larger electricity than a half horsepower air conditioner.

Besides, in term of user's perspective, the user must afford a 1 horsepower aircon for their small room due to the 1 horsepower is the minimal horsepower that the user can find. The root cause of the aircon manufacturer not manufacturing a half horsepower is about the manufacturing cost and the efficiency of the half horsepower. And the half horsepower aircon is only suitable for room which is smaller than area of $10m^2$. The apartments and studios weren't on demand in the pass 10 years in Malaysia and landed houses will be the first choice for the majority people. The people would prefer the landed

house is because the landed house is usually bigger, and the number of family are usually a lot in the pass 10 years and this what made them prefer the landed house. Recently, started from a few years ago, apartments and studios are on demand and being popular and even had become the first choice for the citizen in Malaysia. The reason of the apartments and studio growing exponentially and is demanded from the people is because of the safety problem where the apartment usually have fenced with security and the family nowadays are having less children and don't need a large unit to stay in. The rooms in the apartment have at least one small room ($10m^2$) in term of the average size of the apartment unit of 1000 square feet.

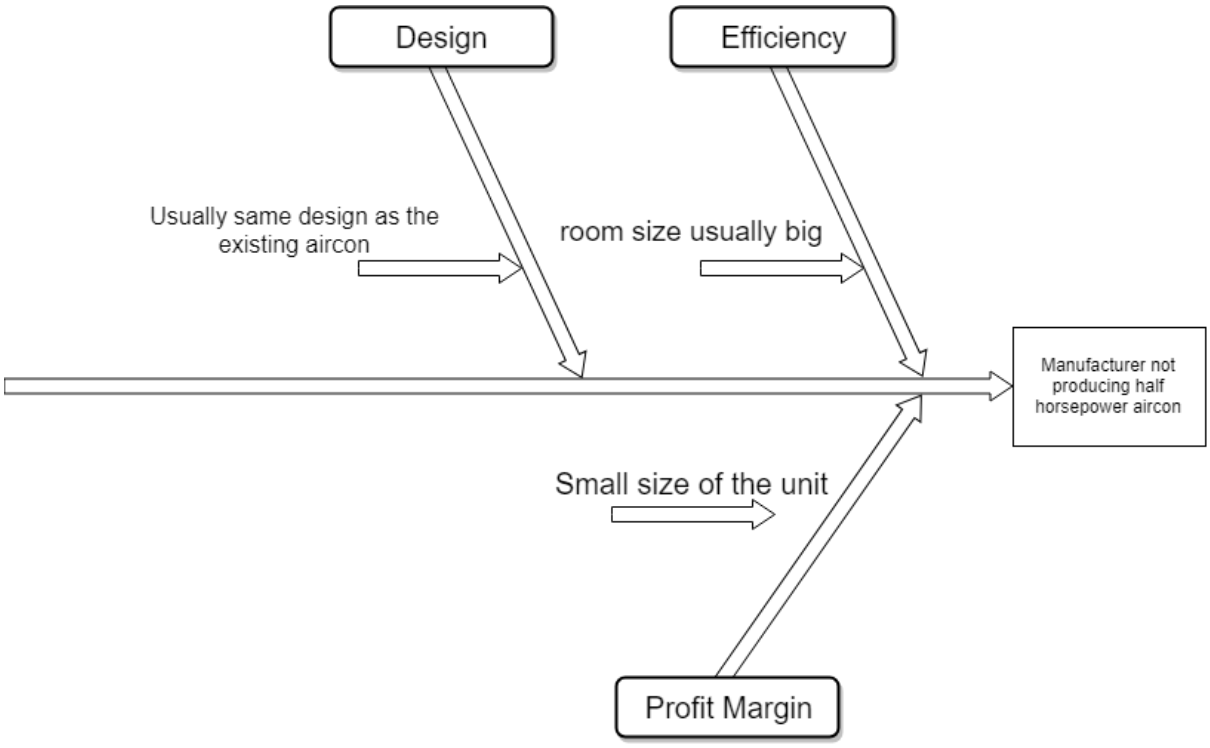


Figure 1: Ishikawa Diagram

The Ishikawa Diagram is a diagram helped to identify the root cause and the effect during the brainstorming stage. The Ishikawa Diagram helps to categorise all the challenges and the root causes into each column and allow the team to solve and see the problems easily.

Based on the Ishikawa diagram above, the first category is the profit margin. After consulting the DAIKIN supervisor of the project, we got to know that the profit margin is the main concern of not manufacturing the half horsepower, this is because the unit will be small, and the efficiency is not good as compared with 1 horsepower. Where it linked with the efficiency that the performance of half horsepower aircon unit is suitable for small rooms. All the users in the pass 10-year time preferred bigger house and rooms and therefore the demand

of half horsepower is low, and the profit margin became lower as well. The design of the half horsepower in the pass was in rectangular shape where is similar to the normal 1 horsepower aircon. The are only one air discharge therefore, the duration to cool a room take times.

2.3 Ideate

After all the challenges and the root causes have been determined, it will proceed will the Ideate stage. In this stage, Trimming and random entries are utilised to inspire ideas to overcome or resolve the challenges and the root causes.

Trimming

Trimming method is removing some parts which is not necessary from an existing product and come out with a new product or idea, but the functionality is still remained. By applying trimming methods, the normal aircon unit has been disassembled to observe all the components in it. The trimming part will be happened at the motor swing, the motor swing will be removed from the existing aircon. the function of the motor swing is to diverse the discharge air into different angle to cool down the room faster. By removing the motor swing, the design of the corner aircon can diverse the air flow without the motor swing due to the design of it. The corner aircon will have three fixed air discharge where this can replace the motor swing.

Figure 2: the air direct blade

Figure 3: concept of corner aircon

Random Entry

Random Entry method is to choose something or stuff from the surrounding and focus on all the structures or the functionality of the object. By doing so, we can find out something that is useful to improvise and merge into the current idea or create new idea. By applying Random Entry method, corner hanging shelf was being observed. The corner hanging shelf was built to allow user to put stuff on it therefore the functionality is not related to the project. Whereas the structure of the corner hanging shelf is the part that must be focus on. The structure of the corner hanging shelf can fully utilise the spaces of the room and it saved spaces too. Therefore, a corner structure had pooped up to merge into aircon and finally come out with the idea of corner aircon. Besides, the return air of the corner aircon is sucked from the bottom which is inspired by the existing ceiling mounted aircon. These two ideas combined and the corner aircon is presented.

Figure 4: hanging corner shelf

2.4 Prototype

After all the research and brainstorming are done, building a functioning prototype is to proof that the idea or the concept is fit to the needs of the market. By starting to build a corner aircon, the external shape of the prototype will be in a pizza shape where this is the concept of it. The dimensions of the prototype based on the size of the evaporator (heat exchanger), the housing of the fan and the size of the motor fan.

The performance of the corner aircon must be half horse power, where one horsepower is equivalent to 10000BTU/Hr or total capacity of 2.93kW. Therefore, the corner aircon should have a total capacity of 1.465kW which is equivalent to 5000BTU/Hr. Firstly, designing the heat exchanger is necessary in order to obtain dimensions of the entire aircon unit. Using a software called, EVAPCOND, can analyse and design the heat exchanger to meet the requirement of 1.465kW total capacity. Besides, Sensible Heat Ratio (SHR) is taking into consideration where it may afford the comfort for the surrounding due to the humidity. The acceptable and good SHR fall between 0.7 to 0.8. Therefore, the design must get the total capacity of 1.465kW and the SHR within the range of 0.7 to 0.8.

By using the EVAPCOND do design and analysis the heat exchanger for many times, there's one results that is suitable for the corner aircon which meet all the requirements above. The heat exchanger consists of 2 rows of tubes with 4 tubes in each row. The tube length will be 345mm with the outer diameter of 7mm and the inner diameter of 6.6mm. The tube pitch will be 21mm and row pitch will be 12.7mm with the materials of copper and the inner surface

of the tubes will be smooth surface. The fin of the heat exchanger will have a pitch of 1.4mm and 0.1mm with the materials of aluminium and the Louver type.

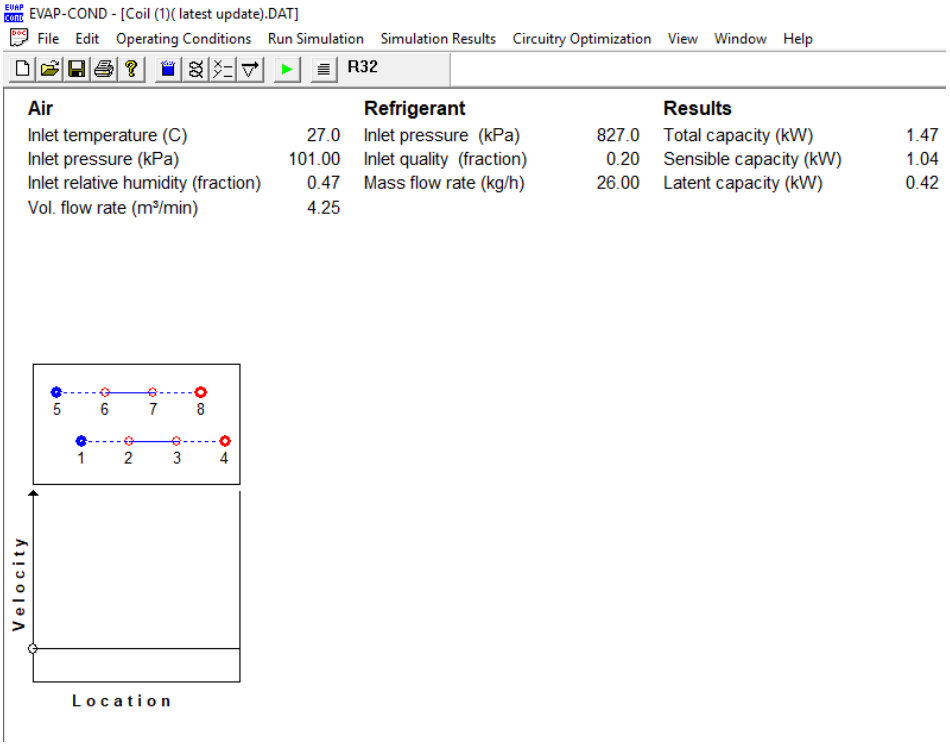


Figure 5: Results of the EVAPCOND

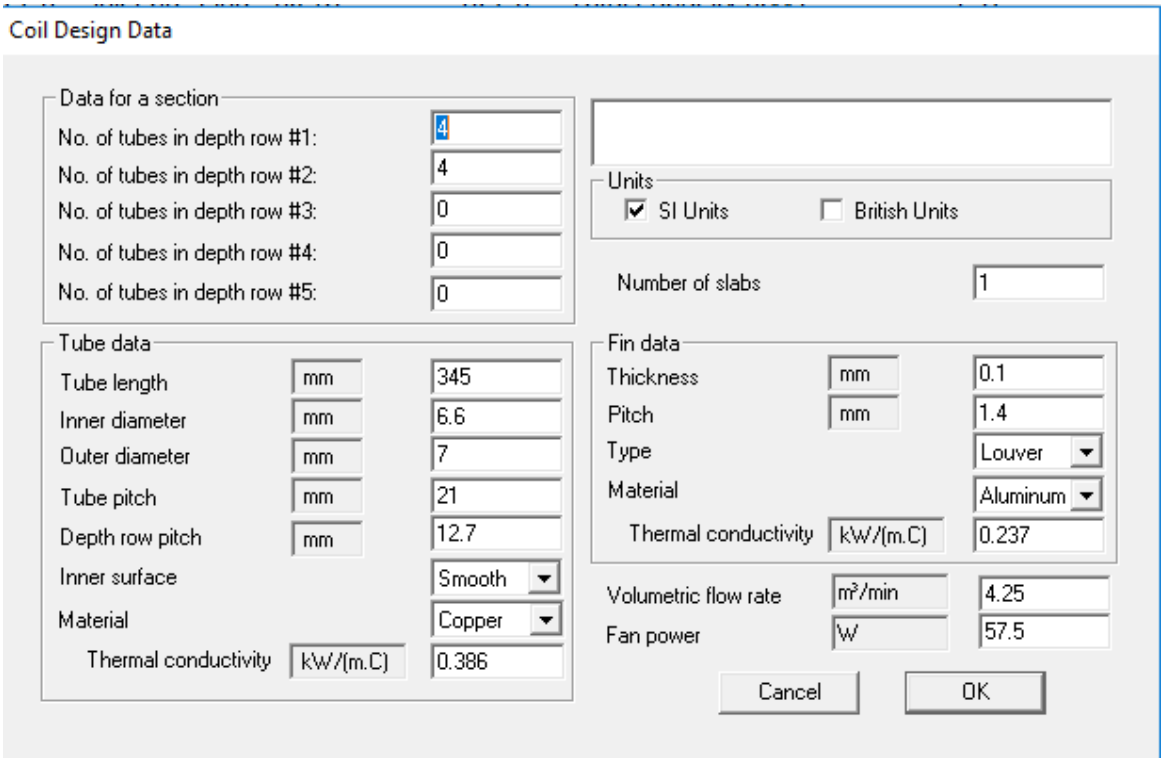
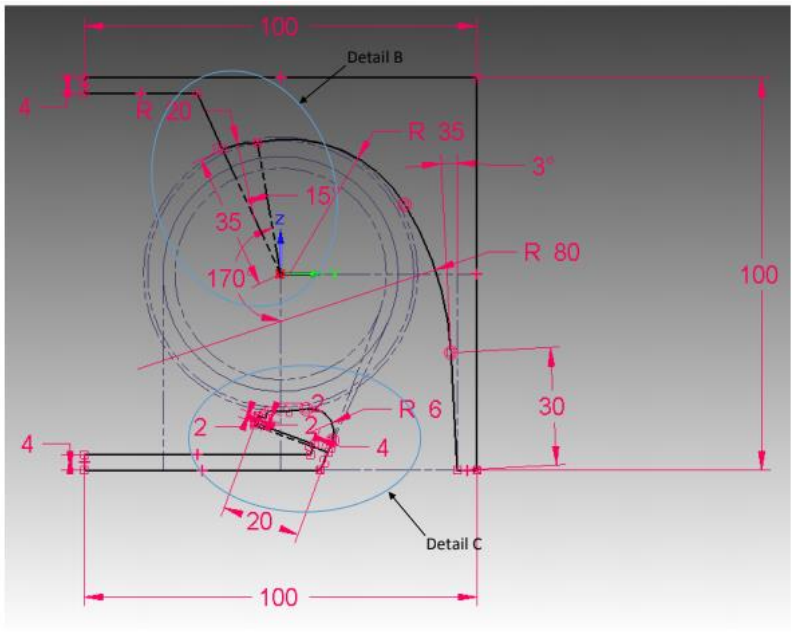


Figure 6: Coil design

After obtaining all the data and dimensions, the heat exchanger design will be passed to DAIKIN and they will be fabricating the heat exchanger according to the design. After collected all the dimensions, the design of the casing of the aircon unit will be started and design according to the dimensions. A housing for the motor fan will be constructed by using Solidworks and 3D printing. The functionality of the housing is to maximize the discharge air and the design will be constructed according to the figure below.



The casing of the corner aircon unit will be built with Perspex and all the sizing of the Perspex need to be precise and therefore the Perspex will be cut by using lasercutter which is available in the lab. Bolts and nut are used to screw and lock everything in place. After the casing was constructed, insulator must be installed into the inner surface of the casing to prevent condensation happened. Drain pad will be built to prevent water dripping from the aircon unit to user.

3.0Project Review

3.1 Project Cost

Table 2: Project cost

No.	Parts	Description	Vendor	Unit price (RM)	Quantity	Total
1	Evaporator Coils and Radiator		DAIKIN	100	1	DAIKIN
2	Motor Swing		qqonline trading	25	1	25
3	Blower Wheel	Metal	University Lab	50	1	DAIKIN
4	Control Circuit Box		DAIKIN	180	1	DAIKIN
5	Casing	3D print	University Lab	30	1	LAB
6	Evaporator Fan Motor	230V	Gain City Parts	100	1	DAIKIN
7	Copper pipe	5metres	Gain City Parts	100	1	100
8	R32 refrigerant	refrigerant	DAIKIN	DAIKIN	DAIKIN	DAIKIN
					TOTAL	125

The budget for this project is RM300 which is sponsored by the Taylor's University. All the core components will be fully sponsored by DAIKIN and the components that DAIKIN sponsored are a Evaporator Coil and Radiator (Heat Exchanger), a Metal Blower Wheel, a control circuit box, a Evaporator Fan Motor. The rest of the components will have to bought from vendors or get from the lab. Then 5 metres copper pipe was bought from the Gain City Parts with the price of RM100 and the Motor swing was bought from qqonline trading with the price of RM25. The casing of the corner aircon was 3D printed in the lab. Therefore, there's RM175 of the budget left for the project.

3.2 Project Timeline

WBS Code	TASK	WEEK/DATE													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Understand and Observe**														
1.1	**Research**														
1.1.1	Identify challenge														
1.1.2	Study Marketability														
1.1.3	Identify the system of A/C														
1.2	**Plan**														
1.2.1	Breakdown the information obtained														
1.2.2	Identify the causes of problems														
1.2.3	Find out the solution for the problems														
1.2.4	Calculate estimated BV of proposed solution														
2	**Ideate**														
2.1	**Design Drawing**														
2.1.1	Identify the system in the prototype														
2.1.2	Detailed sketch														
2.1.3	Labelling the specification of design														
3	**Prototype**														
3.1	**Budget Management**														
3.1.1	Survey on the quality and the price for the raw materials														
3.1.2	Purchase materials														
3.2	**Construction**														
3.2.1	**Heat Exchange System**														
3.2.1.1	Construct the evaporator														
3.2.2	**Control System**														

3.2.2.1	Construct the circuit of on/off system														
3.2.2.2	Construct the circuit of connection between outdoor and indoor unit														
3.2.3	**Air Discharge System**														
3.2.3.1	Construct the outlet of air discharge														
3.2.3.2	Construct the blower blade														
3.3	**Integration**														
3.3.1	Finalized Design														
3.3.2	Integrate the system														
3.4	**Testing**														
3.4.1	Testing for the functionality														
3.4.2	Testing for the air discharge														
3.4.3	Testing for the reliability														
4	**Enhancement and Improvement**														
4.1	Enhance the efficiency														
4.2	Reduce the cost to minimal														
4.3	Improvement on the aesthetic														

For the first four weeks, the project was kept with the schedule with no delay where the challenges and the aircon system had been identified, the marketability and the demand of corner aircon had been studied as well. All the root causes had been determined and BV were identified.

For the ideate stage, it had been delayed being started at week 6 due to the software of designing the heat exchanger. The software took time to learn and had to arrange time to drop by DAIKIN to learn the software. After learning the software, there are some issues noticed by

DAIKIN about the heat exchange and eventually took time to modify therefore the design stage ended at week 10.

After the design of the heat exchanger had been approved by the DAIKIN, the dimensions obtained to construct the prototype. The budget management took a week of time. The control system will all be done by DAIKIN in week 12 and 13 where all the circuit connecting will be done at that time. The heat exchanger (evaporator) will be constructed by DAIKIN in week11. The blower blade was sponsored by DAIKIN therefore the blower blade did not 3D print. After the ideate stage, the integration stage was kept with the time flow of ideate stage. Therefore, the ideate and integrate stage was ended on week12. The testing was conducted on week13 and the corner aircon was tested by DAIKIN technicians. After the testing had been done in the early week13, Enhancement and improvement took place. Improving the aesthetic of the corner aircon and the obtain the best direction of the air flow where the air direct can be changed due to the design.

3.3 Current Status of the Prototype

The current status of the project is 90% completed. The corner air conditioner unit had been mounted on the wall. During the installation and refrigerant charging, an error had been found and the air conditioner system could not be completed fully and efficiently. If there is any occurrence of error, the entire aircon system cannot be run. Hence, the technician suggested to charge the refrigerant and run a test without a circuit board to see whether the entire components in the aircon is working fine. After running the test, all the components are working fine fortunately. A new circuit board is needed to replace to previous circuit board in order to re-run the test.

3.5 Economic Viability & Environment Sustainability

The indoor corner aircon unit is overall economically viable. There are minority components that are not economically viable. Talking from the outer layer of the corner aircon in the current design stage, the outer layer is built with the combination of Perspex and 3D printing. Perspex is a very cheap accessible materials and easily to be found. There are certain parts of the corner aircon is built with 3D printing which is available in the lab to construct specify dimensions. Where the cost of using the 3D printing is lower compared with the manufacturing and is easily accessible. The purpose of corner aircon is to reduce the materials usage according to the needs of the household or market but having a greater efficiency. This

help to reduce the manufacturing costs and meets the need of the household or market where they don't need a 1 horsepower aircon in a small room but a corner aircon unit. but reducing the horsepower of the unit, the sizing of the unit is reducing indirectly as well. This simply means that the materials usage can be lower and the user able to save the budget of not buying a 1 horsepower aircon but a half horsepower corner aircon unit which is just enough for a small room.

The entire corner aircon unit and the system are environmentally sustainable. The corner aircon unit is using the refrigerant R32 to run the entire aircon system. The R32 is a latest and the best environmental-friendly refrigerant as compared to the traditional refrigerant R410a which is harmful to the ozone layer. According to the research that has been done by the Australian Air-conditioning and Refrigeration Equipment Manufacturers' Association of Australia (AREMA), they proved that the R32 refrigerant is not extremely flammable and not a highly toxic gas which resulting the user to get cancer as compared to R410a refrigerant. [3] Perspex, or as known as Acrylic plastic, it is durable and water proof which is easily accessible, and it is environment friendly. The Perspex id used to build the outer layer of the corner aircon, it's recyclable and reusable and it's a non-toxic product which never against or impact on the environment. [4] Besides, the parts that 3D printed, are printed with a renewable biodegradable thermoplastic which called Polylactic Acid (PLA). It can be decomposed by bacteria therefore it is not harmful to the environment. The Polylactic Acid material is a durable materials which having a high yield strength.

3.6 Risk Assessment

Category	Risk	
	Low Risk	High Risk
1. If the user simply disassembles aircon unit	copper pipe that connected between the outdoor unit and indoor unit maybe damaged and need to replace a new one	fatally electrical shock
2. If the user did not arrange maintenance	Dust that stuck in the evaporator will be affect the efficiency of the aircon	leaking of R32 refrigerant which will causes user to suffer from Emphysema

3. If user careless	bacteria grow on the wet filter and affected the user's environment	User may plug into a higher voltage socket and burn the motor and compressor of the entire unit

The table above shows the risk of the corner aircon with the category of High risk and Low risk which referred to the Risk Assessment Matrix. The risks that have been foresee if user is careless, simply disassemble the aircon unit and did not arrange for maintenance.

There will be a User's guidebook comes along with the corner aircon which guide the user to use or operate the electronics in a proper way. The guidebook will be stated clearly to acknowledge the user strictly do not disassembles the aircon unit without any professional knowledge and skills. If the user did not study the guidebook or insist to disassemble without any professional knowledge and skills, the user might damage the copper pipe which connecting between the outdoor and the indoor unit aircon. If the copper pipe is minor damaged, it will just affect the efficiency of the aircon where this is considered as a low severity risk where the copper pipe can be replaced and does not harm the user. Besides, if the copper pipe is serious damaged, it will lead to the leaking of refrigerant. The refrigerant will be harmful to the user if the refrigerant is being breath-in. If the copper pipe is serious damaged, the user will know as the refrigerant is visible and it will leak with "peeping" sound if it's leaking, therefore the user shouldn't be breathing in too much of the refrigerant and causes too serious harmful to the user. So, it will be fall in the medium severity risk. Other than that, if the user disassembles the aircon unit when the unit is still plugged in with current flowing through, the user may have chances to get fatally electrical shocked when the user touches the copper wire which connected to the circuit board. This is threatening the life of the user, therefore it will be fall in the high severity risk.

Secondly, if the user did not arrange maintenance for a long period of time, the performance or the efficiency of the aircon will be affected due to the large amount of dust stuck in the evaporator. However, arranging maintenance to clean up the evaporator with proper way can be settled, therefore it will be a low severity risk. Besides, if the aircon unit has not been operated any maintenance for a long period of time, the copper pipe that connected to the indoor aircon unit will be loosen by any chances and lead to the leakage of refrigerant. The refrigerant is odourless where it is harmful to human being. If the user did not notice the leakage

of refrigerant and has been breath-in the refrigerant for the long period of time, the user might suffer the Emphysema. This will be fall in the high severity risk. [5]

The third category of risk that has been foreseen is the reckless usage of the aircon. If the user put back the filter with wet condition after cleaning the filter with water or wet cloth without drying it first, the humidity is perfect for the bacteria to grow and it may affect the user's environment or even the health of the user. However, the user just needs to dry the filter before putting it back, therefore it is a low severity risk. Besides, the user might accidentally plug in the aircon unit into a higher voltage socket and lead to the failure of the motor and the compressor. Where the compressor and the motor are the most expensive components in the aircon unit and it might even catch on fire if it's too serious. Therefore, this is a high severity risk. All the risk above will be unlikely to happened if the user follows exactly the guidebook.

3.7 Design Flaw & Improvements

A wired controller was installed into the indoor corner aircon unit. The wired controller will be mounted on the wall and resulting the user must approach to the wired controller when they want to switch on the aircon unit. Other than that, the indoor aircon unit motor fan in this design can only perform one speed. Therefore, the user cannot change the speed of the fan when they feel cold or hot to speed up or speed down the fan speed.

All these components that made the flaws of the design is all sponsored by DAIKIN for the first stage design. The current design of the indoor corner aircon unit is basically based on the sponsored items because of these are the core components. The corner aircon can be optimized to its maximum potential by having some improvements on it. First, a wireless controller can be installed to allow the user to switch on the aircon unit from where they initially at and do not need to walk to the wired controller which is not convenient. Besides, the motor fan can be replaced by 3 speed motor fan where it can performs three levels of different speed to allow the user adjusts the speed of the fan according to their preference. Last but not least, the aesthetic of the corner aircon can be improved by having a nice outer casing as the current design is using Perspex due to the limitation of resources. The corner aircon unit can be improvised to come out with more version with some advanced features to meet the needs of the households or even industries. The concept of corner aircon will be the needs of every houses in the future with all the improvements.

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