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# Problem Perceived in Residential House Regarding Air Cooled Split Unit Air-Conditioning

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**Abstract**: There are many ways to troubleshoot HVAC systems on the internet. However, there needs to be a standard just for air-cooled split unit air conditioning in Malaysia. The objective of this study is to determine the problem of the ACSU system in the residential area, to analyse the step of maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area and to evaluate the importance of steps for maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area. This research uses the questionnaire, pilot testing, snowball sampling, and RII analysis method. 18 respondents reply the questionnaire. They are the people that have 5-year experience or above in performing, repairing or maintaining air-cooled split unit air conditioning in the residential area in Malaysia. Under all the problems, the highest RII for the possible cause is 0.9500 (abnormal voltage), and the lowest RII for the possible cause is 0.7000 (faulty thermostat/room temperature sensor). The authors show the rank of the possible cause for the problem and the maintenance work step according to the possible cause. This study will benefit or be an excellent guide to those who repair or maintain the air-cooled split unit air conditioning in the residential area, especially the rookie in this sector. For further work based on this study, it needs to replicate this study in more experts to get the population of the expert and to replicate this study in more types of the HVAC system.

**Keywords**: ACSU, Maintenances work step, Guide for ACSU maintenance

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## 1. Introduction

HVAC is the short form for Heating, Ventilation and Air Conditioning. The HVAC systems in the residential area have many types, such as Heating and cooling systems, hybrid split systems and packaged heating and air [4]. An air-cooled split unit (ACSU) is one of the standard AC types used in residential. The air-cooled system is the system that removes the heat from the unit through the way that pushes it into the air [2]. Split unit air conditioning is a conditioner with two separate units: an indoor unit and an outdoor unit.

### 2.1 problem statement

The overall demand for using the air conditioner in Malaysia increased from 2012 (871000 units) to 2018 (100200 units) due to the increased atmospheric temperature [3]. However, many ways to do the troubleshooting on the internet, but there needs to be a standard just for air-cooled split unit air conditioning in Malaysia. It will increase the difficulty level of maintenance work, especially for those who just graduated or the rookie in this sector. Ignoring the problem will increase the cost of operation and other bad results, like the whole ACSU system being down.

### 2.2 Objective

The authors show the objective of this study in the following:

- To determine the problem of the ACSU system in the residential area
- To analyse the step of maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area.
- To evaluate the importance of steps for maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area.

### 2.3 Scope and Delimitation

Documents from several ACSU manufacturers have summarised the cause and the step of maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area.

The respondents reply to questionnaires. The respondents have 5-year experience and above in performing, repairing or maintaining air-cooled split unit air conditioning in the residential area in Malaysia. The authors show the importance of troubleshooting the air-cooled split unit air conditioning in the residential area in this study.

The actual place where to conduct this study is in peninsular Malaysia. The duration of the conduct is 3 weeks, from 3 December 2022 to 23 December 2022. The authors use this duration because The vocational trainer finishes the pilot testing finishes when 2 December 2022. There is no limit to the number of respondents because the sampling method for this study is the snowball sampling method.

### 2.4 Significance of the study/contributions

The Heating, Ventilation and Air Conditioning (HVAC) system is an important part of thermal comfort in Malaysia. A poor thermal comfort environment might lead the building users to have some problems like fatigue, attention distraction, headache, lack of concentration, dizziness, decrease in manual dexterity distracted and others [1].

The HVAC system provides indoor comfort for a building, but if the HVAC system is well functioning. Troubleshooting, repair and maintenance are significant for the HVAC system. The HVAC system with some problems will carry other issues like the electric bill increase, health problems and others. The people must recognize the HVAC system problem because it will only worsen if they solve

it as soon as possible. If they have good maintenance and management, The life span of the HVAC system increases.

This study will be an excellent guide to the people who repair or maintain the air-cooled split unit air conditioning in the residential area, especially the rookie in this sector.The contribution of this study is the empirical research contribution because this study provides knowledge through data collection, like the questionnaire [5].

## 2. Methods

### 2.1 Flowchart of this study

Figure 1 shows the flow chart of this study.

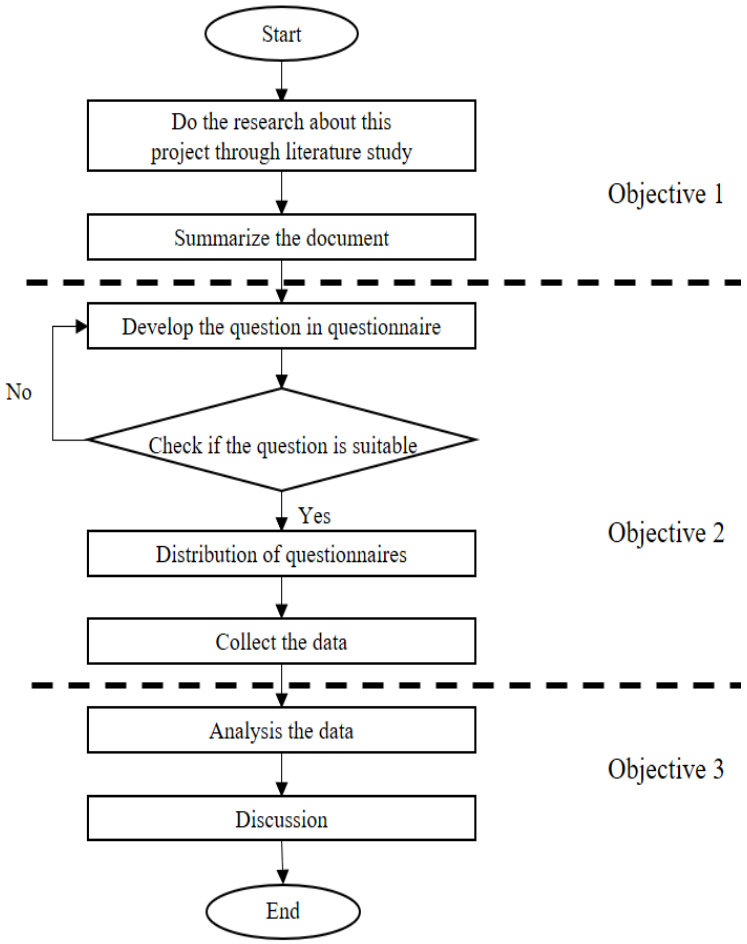


**Figure 1: The flow chart for the methodology**

### 2.2 Data Collection

The method for collecting the data in this study is snowball sampling. The reason for using this method is that it is difficult to identify the population. The population is the number of people with five years or above experience in performing, repairing or maintaining air-cooled split unit air conditioning in the residential area in Malaysia. This method is a non-probability sampling method. This method will start with one or more participants, continue with the participants' recommendations and end when reaching the target [6]. The respondent is the people that have experience of more than 5 years and above to perform, repair or maintain air-cooled split unit air conditioning in the residential area in Malaysia.

### 2.3 RII analysis

The method for analysing the data in this study is RII analysis. The equation of the RII analysis shows below.

$$RII = \frac{\Sigma W}{AN}$$

Where,

W = Weighting given to each factor by the respondent
A = The highest weight in the research
N = Total number of respondents

## 3. Results and Discussion

The results and discussion section presents data and analysis of this study.

### 3.1 Results and analysis

#### 3.1.1 Part A

##### 3.1.1.1 Gender

The gender of all respondents is male. The pie chart of the data shows in Figure 2.

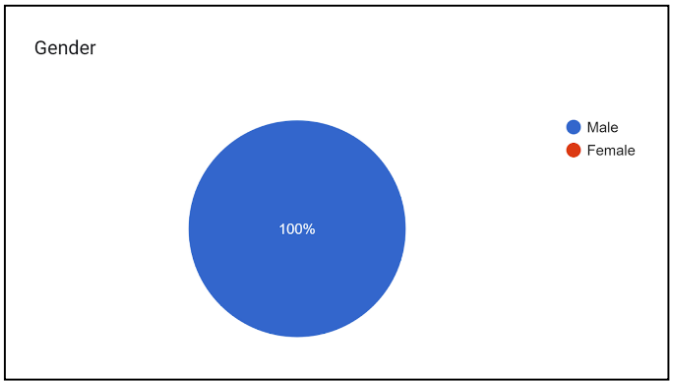


**Figure 2: Gender**

##### 3.1.1.2 Age

33.3 % of the respondents are between 31 years old and 35 years old. 30% of the respondents are between 36 years old and 40 years old. 16.7 % of the respondents are above 46 years old. The highest range of age for the respondents is between 36 years old and 40 years old. The pie chart of the data shows in Figure 3.

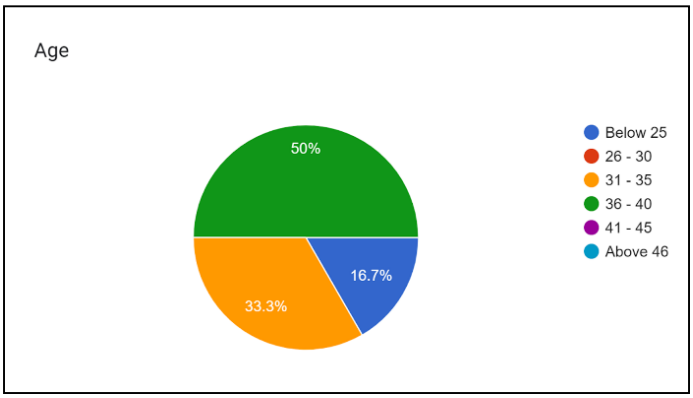


**Figure 3: Age**

### 3.1.1.3 Race

The race of all respondents is Malays. The pie chart of the data shows in Figure 4.

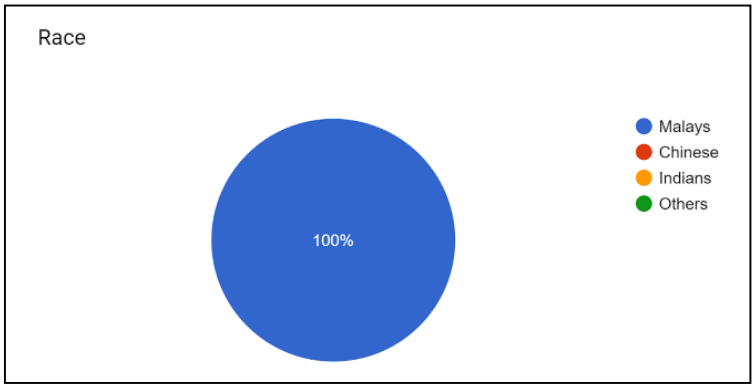


**Figure 4: Race**

### 3.1.1.4 Year of working

16.7 % of the respondents have work experience which is between 5 years and 10 years. 66.7% of the respondents have work experience which is 11 years and 15 years. 16.7 % of the respondents have work experience which is 16 years and 20 years. The highest range of working year for the respondents is between 11 years and 15 years. The pie chart of the data shows in Figure 5.

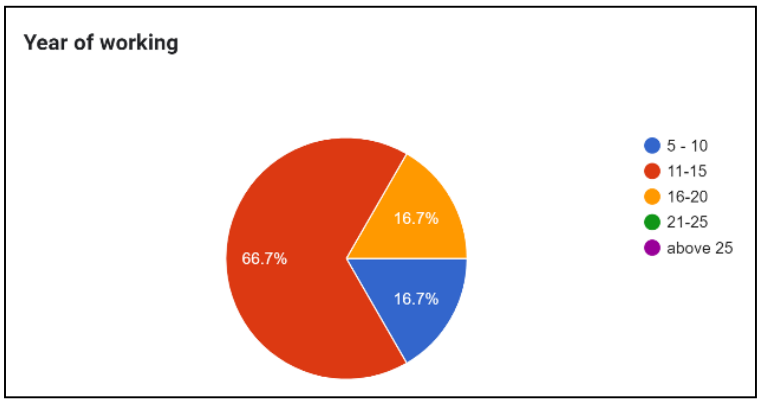


**Figure 5: Year of working**

### 3.1.1.5 Institution/Company

33.3 % of the respondents are form Vertiv (M) Sdn Bhd. 16.7 % of the respondents are form Extechpro. 16.7 % of the respondents are form Lestari Global Sdn Bhd. 16.7 % of the respondents are form HVAC Reliability. 16.7 % of the respondents are form NW Teguh Abadi Sdn Bhd. The Most of respondents are form Vertiv (M) Sdn Bhd.

### 3.1.2 Part B

### 3.1.2.1 Result of Part B

Under the problem ‘unit will not start', the highest RII for the possible cause is 0.9167 (power failure), and the lowest RII for the possible cause is 0.7833 (safety device opens). Under the problem ‘compressor will not start but fans run', the highest RII for the possible cause is 0.8833 (shorted or broken wires), and the lowest RII for the possible cause is 0.8333 (faulty thermostat/room temperature sensor). Under the problem ‘compressor (outdoor) fan will not start’, the highest RII for the possible cause is 0.8704 (faulty magnetic contactor for fan), and the lowest RII for the possible cause is 0.8667 (faulty thermostat/room temperature sensor). Under the problem ‘evaporator (indoor) fan will not start’,

the highest RII for the possible cause is 0.9444 (faulty magnetic contactor for fan), and the lowest RII for the possible cause is 0.8500 (shorted or grounded fan motor). Under the problem that is 'evaporator (outdoor) fan will not start', the highest RII for the possible cause is 0.8833 (shorted or broken wires), and the lowest RII for the possible cause is 0.8250 (faulty thermostat/room temperature sensor). Under the problem 'unit runs, but shortly stops', the highest RII for the possible cause is 0.8800 (faulty magnetic contactor for compressor), and the lowest RII for the possible cause is 0.8500 (shortage of refrigerant). Under the problem 'compressor short-cycles due to overload', the highest RII for the possible cause is 0.9083 (faulty magnetic contactor for compressor), and the lowest RII for the possible cause is 0.8278 (overcharge of refrigerant). Under the problem 'high discharge pressure', the highest RII for the possible cause is 0.9000 (space load too high), and the lowest RII for the possible cause is 0.8711 (improper condenser unit operation). Under the problem 'low discharge pressure', the highest RII for the possible cause is 0.9000 (space load too high), and the lowest RII for the possible cause is 0.7000 (faulty thermostat/room temperature sensor). Under the problem 'high suction pressure', the highest RII for the possible cause is 0.9222 (clogged liquid filter drier), and the lowest RII for the possible cause is 0.8000 (shortage of refrigerant). Under the problem 'low suction pressure', the highest RII for the possible cause is 0.9111 (shortage of refrigerant), and the lowest RII for the possible cause is 0.9000 (expansion valve obstructed). Under the problem 'not cool', the highest RII for the possible cause is 0.9500 (abnormal voltage), and the lowest RII for the possible cause is 0.8333 (faulty thermostat/room temperature sensor). Under the problem 'insufficient cooling', the highest RII for the possible cause is 0.9111 (short cycling of condensing air), and the lowest RII for the possible cause is 0.8667 (restricted liquid line). Under the problem 'too cool', the highest, and the lowest RII for the possible cause is 0.8533 (faulty thermostat/room temperature sensor). Under the problem 'noisy operation', the highest RII for the possible cause is 0.8861 (loosen or faulty element), and the lowest RII for the possible cause is 0.8167 (overcharge of refrigerant). Under the problem that is 'horizontal louver cannot revolve', the highest RII for the possible cause is 0.8833 (shorted or broken wires), and the lowest RII for the possible cause is 0.8800 (shorted or grounded compressor). Under the problem 'no remote operation', the highest, and the lowest RII for the possible cause is 0.9000 (faulty or improper use remote). Under the problem 'smell bad or strange', the highest, and the lowest RII for the possible cause is 0.9000 (dirty component). Table 1 has shown the summary of the result.

**Table 1: Summary of the result**

| Problem | NO | Possible cause of the problem | Item | RII | Rank |
|---|---|---|---|---|---|
| Unit will not start | 1 | Power failure | 4 | 91.67% | 1 |
| | 2 | Shorted or broken wires | 4 | 89.17% | 3 |
| | 3 | Blown fuse or varistor | 4 | 89.17% | 2 |
| | 4 | Faulty transformer | 2 | 88.33% | 4 |
| | 5 | Safety device opens | 2 | 78.33% | 5 |
| Compressor will not start but fans run | 1 | Compressor stuck | 3 | 78.15% | 6 |
| | 2 | Shorted or broken wires | 4 | 88.33% | 1 |
| | 3 | Faulty thermostat / room temperature sensor | 4 | 83.33% | 5 |
| | 4 | Shorted or open capacitor | 3 | 87.78% | 2 |
| | 5 | Faulty magnetic contactor for fan | 3 | 85.93% | 4 |
| | 6 | Shorted or grounded compressor | 4 | 86.67% | 3 |
| Compressor (outdoor) fan will not start | 1 | Shorted or broken wires | 4 | 86.94% | 2 |
| | 2 | Faulty thermostat / room temperature sensor | 4 | 86.67% | 3 |
| | 3 | Faulty magnetic contactor for fan | 2 | 87.04% | 1 |
| Evaporator (indoor) fan will not start | 1 | Shorted or broken wires | 4 | 91.67% | 2 |
| | 2 | Shorted or open capacitor | 3 | 88.89% | 3 |
| | 3 | Faulty magnetic contactor for fan | 3 | 94.44% | 1 |
| | 4 | Shorted or grounded fan motor | 4 | 85.00% | 4 |
| Condenser (Outdoor) fan will not start | 1 | Shorted or broken wires | 4 | 88.33% | 1 |
| | 2 | Faulty thermostat / room temperature sensor | 4 | 82.50% | 5 |
| | 3 | Shorted or open capacitor | 3 | 84.44% | 4 |

| | | | | | |
|---|---|---|---|---|---|
| | 4 | Faulty magnetic contactor for fan | 3 | 86.67% | 3 |
| | 5 | Shorted or grounded fan motor | 4 | 86.94% | 2 |

**Table 1: Summary of the result (continued)**

| | | | | | |
|---|---|---|---|---|---|
| Unit runs, but shortly stops | 1 | Shortage of refrigerant | 2 | 85.00% | 4 |
| | 2 | Restricted liquid | 3 | 85.93% | 2 |
| | 3 | Overcharge of refrigerant | 4 | 85.83% | 3 |
| | 4 | Faulty magnetic contactor for compressor | 5 | 88.00% | 1 |
| Compressor short-cycles due to overload | 1 | Shortage of refrigerant | 2 | 88.33% | 2 |
| | 2 | Overcharge of refrigerant | 4 | 82.78% | 3 |
| | 3 | Faulty magnetic contactor for compressor | 4 | 90.83% | 1 |
| High discharge pressure | 1 | Space load too high | 2 | 90.00% | 1 |
| | 2 | Improper condenser unit operation | 5 | 87.11% | 3 |
| | 3 | Fan wrong rotation | 4 | 87.50% | 2 |
| Low discharge pressure | 1 | Improper condenser unit operation | 4 | 84.17% | 5 |
| | 2 | Excessive condenser air flow | 3 | 87.78% | 3 |
| | 3 | Shortage of refrigerant | 2 | 81.67% | 6 |
| | 4 | Space load too high | 3 | 90.00% | 1 |
| | 5 | Faulty thermostat / room temperature sensor | 4 | 70.00% | 7 |
| | 6 | Overcharged refrigerant | 4 | 87.22% | 4 |
| | 7 | Excessive opening of thermostatic expansion valve | 3 | 88.89% | 2 |
| High suction pressure | 1 | Clogged liquid filter drier | 2 | 92.22% | 1 |
| | 2 | Shortage of refrigerant | 2 | 80.00% | 9 |
| | 3 | Restricted liquid line | 3 | 84.44% | 8 |
| | 4 | Faulty thermostat / room temperature sensor | 5 | 84.67% | 7 |
| | 5 | Wrong motor rotation | 4 | 90.28% | 4 |
| | 6 | Supply air short cycling | 3 | 92.22% | 2 |
| | 7 | Inadequate opening of thermos valve | 3 | 86.67% | 6 |
| | 8 | Clogged expansion valve | 2 | 90.00% | 5 |
| | 9 | Clogged air filter | 2 | 91.67% | 3 |
| Low suction pressure | 1 | Shortage of refrigerant | 2 | 91.11% | 1 |
| | 2 | Restricted liquid line | 3 | 91.11% | 2 |
| | 3 | Faulty element | 3 | 90.37% | 3 |
| | 4 | Expansion valve obstructed | 2 | 90.00% | 4 |
| Not cool | 1 | Defective sensor | 4 | 86.39% | 7 |
| | 2 | Open interlock circuit | 5 | 86.67% | 5 |
| | 3 | Defective operation switch | 6 | 88.33% | 2 |
| | 4 | Faulty fan bearing | 2 | 88.33% | 3 |
| | 5 | Compressor-motor malfunction | 2 | 86.67% | 6 |
| | 6 | Single phasing | 3 | 85.56% | 9 |
| | 7 | Shorted components | 4 | 85.83% | 8 |
| | 8 | Faulty thermostat / room temperature sensor | 5 | 83.33% | 11 |
| | 9 | Wrong phase | 4 | 85.00% | 10 |
| | 10 | Abnormal voltage | 4 | 95.00% | 1 |
| | 11 | Incorrect wiring | 5 | 87.11% | 4 |
| Insufficient cooling | 1 | Short cycling of condensing air | 2 | 91.11% | 1 |
| | 2 | Insufficient system | 5 | 88.00% | 4 |
| | 3 | Shortage of refrigerant | 2 | 87.22% | 5 |
| | 4 | Restricted liquid line | 3 | 86.67% | 6 |
| | 5 | Heavy load condition | 2 | 90.00% | 3 |

| | | | | | |
|---|---|---|---|---|---|
| | 6 | Poor choices of capacity | 2 | 90.56% | 2 |
| Too cool | 1 | Faulty thermostat / room temperature sensor | 5 | 85.33% | 1 |

**Table 1: Summary of the result (continued)**

| | | | | | |
|---|---|---|---|---|---|
| Noisy operation | 1 | Overcharge of refrigerant | 4 | 81.67% | 2 |
| | 2 | Loosen or Faulty element | 4 | 88.61% | 1 |
| Horizontal louver cannot revolve | 1 | Shorted or broken wires | 4 | 88.33% | 1 |
| | 2 | Shorted or grounded compressor | 5 | 88.00% | 2 |
| No remote operation | 1 | Faulty or Improper use remote | 5 | 90.00% | 1 |
| Smell bad or strange | 2 | Dirty component | 2 | 90.00% | 1 |

## 3.2 Discussions

The author calculated the results using the RII analysis and the rank in the chart that is Figure 6.

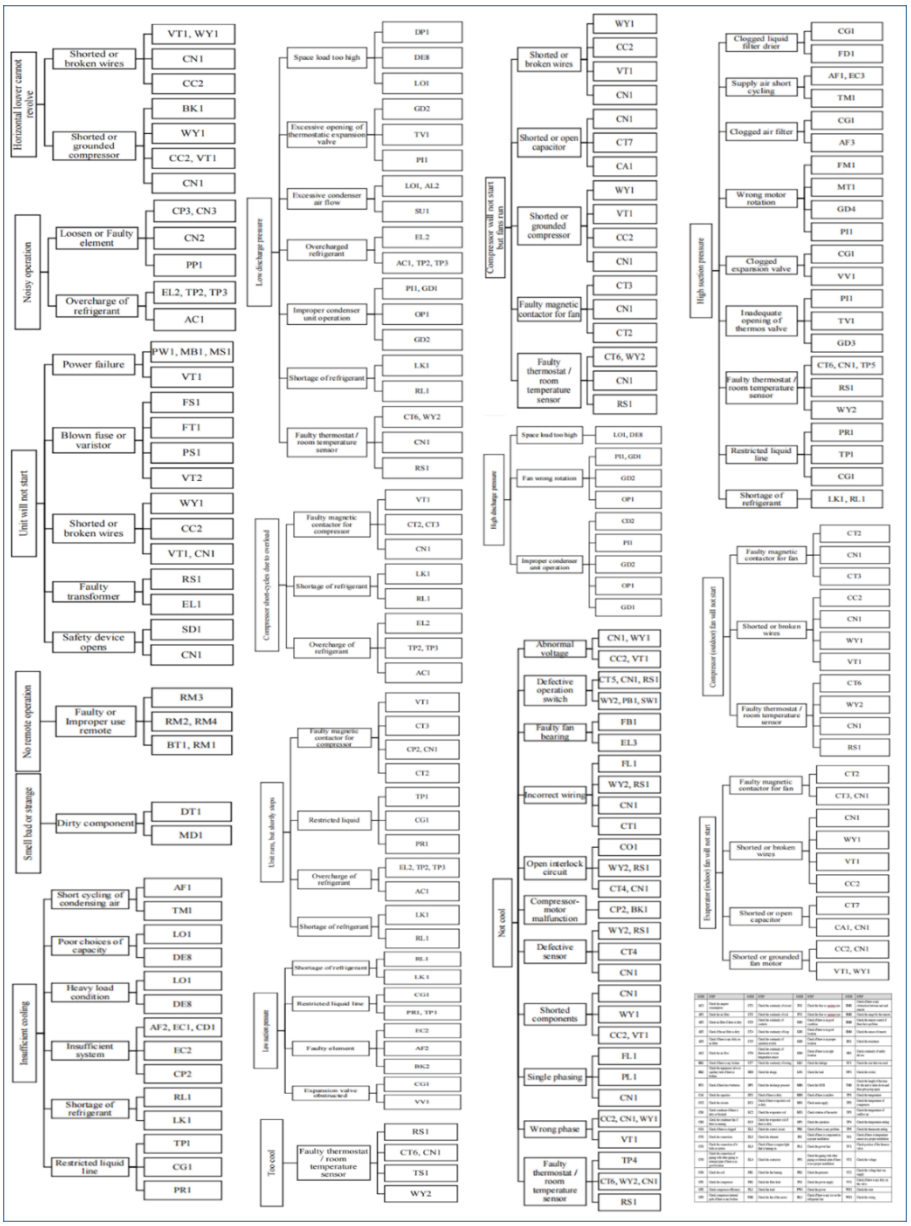


**Figure 6: Rank of the result**

The authors arrange the chart using the rank. The rank is from highest RII to lowest RII. The first column of the chart is the problems. The second column of the chart is the possible cause that places with the rank. The third column of the chart is the maintenance work step which the authors arrange using the rank. The authors use the code to represent the maintenance work steps. The list of the maintenance work steps with code can refer in Appendix A. Figure 6 also show the list of the maintenance work steps with code beside the chart.

The chart for the rank of the maintenance works steps can let people know the step easily. This study will benefit or be an excellent guide to those who repair or maintain the air-cooled split unit air conditioning in the residential area, especially the rookie in this sector. For example, If the air conditioning has the problem 'not cool', they can find the chart for 'too cool' that is like figure 7 shows. After seeing the chart, they can start the 1st maintenance work step for the 1st of the possible cause. If they still cannot find the real reason, they can move on next, which is the 2nd maintenance work step for the 1st of the possible cause.

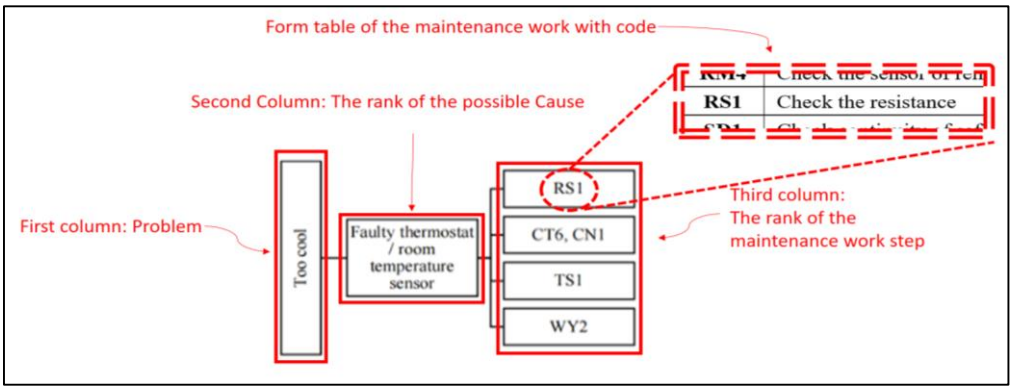


**Figure 7: Chart for 'too cool'**

The maintenance work step for the HVAC system is a categorise of electrical and mechanical engineering. Mechanical and electrical engineering includes manufacturing and repairing various electrical and electronic products. Mechanical and electrical systems are pretty important in this era. This study is critical because of Malaysia's rapid development of mechanical and electrical engineering. There will benefit a part of mechanical and electrical engineering [7].

## Conclusion

In conclusion, the authors achieve the objective. The objective of this study is to determine the problem of the ACSU system in the residential area, to analyse the step of maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area and to evaluate the importance of steps for maintenance work according to the possible cause for the problem of the air-cooled split unit (ACSU) air conditioners in the residential area.

The chart for the rank of the maintenance works steps can let people know the step easily. This study will benefit or be an excellent guide to those who repair or maintain the air-cooled split unit air conditioning in the residential area, especially the rookie in this sector. For example, the rookie is only a newcomer in this industry, and those have a few years of experience repairing or maintaining the air-cooled split unit air conditioning in the residential area. They can check the steps they should take.

The contribution of this study is the empirical research contribution because this study provides knowledge through data collection, like the questionnaire.

The authors want to give some recommendations for future research. First, repeat this study with more experts. The number of experts that filled out the questionnaire in this study is 18. For who want to do this study in future can find as much as possible for the respondents. Second, try to get the

population of the respondents in future studies. In this study, the population is unknown. The authors cannot find out the number of people with 5 years of experience or above to perform, repair or maintain air-cooled split unit air conditioning in the residential area in Malaysia. Last, repeat this study with other types or more types of HVAC systems. This study only focused on ASCU air-conditioning. The people who want to further this study can do different types of HVAC systems or wide varieties in a study.

## Acknowledgement

The authors would like to thank the Department of Civil Engineering Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support.

## Appendix

The table of list of the maintenance work steps with code.

**THE MAINTENANCE WORK STEPS WITH CODE**

| CODE | STEP | CODE | STEP | CODE | STEP | CODE | STEP |
|---|---|---|---|---|---|---|---|
| **AC1** | Check the ampere consumption | **CT1** | Check the continuity of circuit | **FS1** | Check the fuse or varistor size | **RM1** | Check if there is any obstruction between unit and remote |
| **AF1** | Check the air filter | **CT2** | Check the continuity of coil | **FT1** | Check the fuse or varistor type | **RM2** | Check the range for the remote |
| **AF2** | Check air filter if there is dirty | **CT3** | Check the continuity of contacts | **GD1** | Check if there is in good condition | **RM3** | Check the remote control if there have problem |
| **AF2** | Check if the air filter is dirty | **CT4** | Check the continuity of loop | **GD2** | Check if there is in good location | **RM4** | Check the sensor of remote |
| **AF3** | Check if there is any dirty on air filter | **CT5** | Check the continuity of operation switch | **GD3** | Check if there is in proper location | **RS1** | Check the resistance |
| **AL2** | Check the air flow | **CT6** | Check the continuity of thermostat or room temperature sensor | **GD4** | Check if there is in right location | **SD1** | Check continuity of safety device |
| **BK1** | Check if there is any broken | **CT7** | Check the continuity of wiring | **LK1** | Check the leakage | **SU1** | Check the size that was used |
| **BK2** | Check the expansion valve or capillary tube if there is broken | **DE8** | Check the design | **LO1** | Check the load | **SW1** | Check the switch |
| **BT1** | Check if there have batteries | **DP1** | Check the discharge pressure | **MB1** | Check the MCB | **TM1** | Check the length of the time for the unit to shuts down and then gets going again. |
| **CA1** | Check the capacitor | **DT1** | Check if there is dirty | **MD1** | Check if there is mildew | **TP1** | Check the temperature |
| **CC2** | Check the circuits | **EC1** | Check if there evaporator coil is dirty | **MS1** | Check main supply | **TP2** | Check the temperature of compressor |
| **CD1** | Check condenser if there is dirty or blocked | **EC2** | Check the evaporator coil | **MT1** | Check rotation of the motor | **TP3** | Check the temperature of outflow air |
| **CD2** | Check the condenser fan if there is running | **EC3** | Check the evaporator coil if there is dirty | **OP1** | Check the operation | **TP4** | Check the temperature setting |
| **CG1** | Check if there is clogged | **EL1** | Check the control circuit | **PB1** | Check if there is any problem | **TP5** | Check the thermostat setting |
| **CN1** | Check the connection | **EL2** | Check the element | **PI1** | Check if there is component in a proper installation | **TS1** | Check if there is temperature sensor in a proper installation |
| **CN2** | Check the connection of it bolts or screws | **EL3** | Check if there is engine light that is turning on | **PL1** | Check the power line | **TV1** | Check position of the thermos valve. |
| **CN3** | Check the connection of piping with other piping or external plate if there is in good location | **EL4** | Check the contractor | **PP1** | Check the piping with other piping or external plate if there is in a proper installation | **VT1** | Check the voltage |
| **CO1** | Check the coil | **FB1** | Check the fan bearing | **PR1** | Check the pressure | **VT2** | Check the voltage that was supply |
| **CP1** | Check the compressor | **FD1** | Check the filter drier | **PS1** | Check the power supply | **VV1** | Check if there is any dirty on the valve |
| **CP2** | Check compressor efficiency | **FL1** | Check fan load | **PW1** | Check the power | **WY1** | Check the wire |
| **CP3** | Check compressor internal parts if there is any broken | **FM1** | Check the fan of the motor | **RL1** | Check if there is any ice on the refrigerant line | **WY2** | Check the wiring |

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