

SDR

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Making Facility Management more intelligent and efficient.

System
Definition
Review

Revision record			
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1.0	07.03.16	Arshad Shakil, Badis Madani, Håkon Hedlund, Zhili Shao	
2.0	11.04.16	Badis Madani, Håkon Hedlund, Zhili Shao	More detail about different solutions and preferred solution choosing process.

Contents

1. Identification of design concepts	3
1.1 Panel Control.....	3
1.2 Remote Control	3
1.3 App Control.....	3
2. Selection of preferred design concept	4
2.1 Criteria.....	4
2.2 Pugh matrix	4
2.3 AHP matrix	5
2.4 Preferred design concept	7

1. Identification of design concepts

For the concepts of HVAC control system, we identified the possible methods can be used by users, based on our stakeholder requirements and some criteria, we choose three the most important ones as our potential solutions: Penal Control, App Control, Remote Control.

1.1 Panel Control

In this concept, a control panel will be used as the way for users to access the HVAC control system. Users can set the value of temperature, humidity, CO2 level they prefer through this panel. Sensors, which are assembled in one specific closed space like office or classroom, will collect the indoor environment data and translate them to the controller inside the panel. After calculating the regulation data and sensor data, the adjusting data will be created and translated to actuators like motors, valves, and dampers of HVAC system to change the indoor environment.

1.2 Remote Control

Remote Control solution is similar with panel control, it contains a remote controller and a receiver box like a TV remote control system. Users can use the remote controller to send regulation date to the receiver box. The receiver box should contain a microprocessor to calculate the data from user and sensors, then send the result to actuators to change the indoor temperature, humidity, and CO2 level.

1.3 App Control

Compared with the previous solution, App Control solution use the latest high technology and have different system structure with them. All sensors and actuators will be connected to a centralized server, this server will also provide access for mobile app or website app. Users will input the regulation data through the app, then the server will receive the data and calculate with data from sensors. After calculation, the result will send to actuators to change the indoor environment.

2. Selection of preferred design concept

2.1 Criteria

Based on the stakeholders' requirements and references of former projects, we decided crucial criteria for our design concepts:

Initial cost - Cost of implementation and deployment of the solution

Life cycle cost - maintenance, electrical cost, etc. on lifetime

Easiness of use - Is solution user-friendly

Easiness of installing - is it easy to install the solution to the exist HVAC system

2.2 Pugh matrix

The Pugh matrix gives a general suggestion to the preferred design concept.

	Solutions		
Criteria	Panel	App	Remote Control
Initial cost	-	s	-
Life-cycle cost	+	-	s
Easiness of use	+	s	+
Easiness of installing	-	s	-
$\Sigma+$	2	0	1
$\Sigma-$	2	1	2
Σs	0	3	1
<p>“+” represents performance better than required</p> <p>“-” represents performance lower than required</p> <p>“s” represents performance as required</p>			

Table 3.2.1 Pugh matrix evaluation

The NovoFM team members worked together on rating different solutions according to each criteria, by giving “+”, which represents better performance than required, “-” represents lower

performance than required and “s” if the performance as required. As seen from the Table 3.2.1, the selection method suggests panel as the best solution.

2.3 AHP matrix

Because of the difference in the importance of the criteria, the Pugh matrix is not enough for a well-evaluated concept selection. To be more certain it's the correct concept, an AHP matrix is used. The AHP matrix is included in an attachment to this document, and only the most important results will be showed in this part.

Criteria weights

	Initial cost	Life cycle cost	Easiness of use	Easiness of installing
Initial cost	1	0,2	0,2	1
Life-cycle cost	5	1	0,3333	5
Easiness of use	5	3	1	7
Easiness of installing	1	0,2	0,1429	1
	12	4,4	1,676190476	14

Table 3.3.1 Criteria weights

Initial cost

	Decimal Equivalents			Normalized Weights				
	Panel Control	App Control	Remote Control	Panel Control	App Control	Remote Control	Row	Average
Initial cost								
Panel Control	1,0000	0,2000	3,0000	0,1579	0,1429	0,3333	0,6341	0,2114
App Control	5,0000	1,0000	5,0000	0,7895	0,7143	0,5556	2,0593	0,6864
Remote Control	0,3333	0,2000	1,0000	0,0526	0,1429	0,1111	0,3066	0,1022
	6,3333	1,4000	9,0000	1,0000	1,0000	1,0000	3,0000	1,0000

Table 3.3.2 Initial cost

Life-cycle cost

	Decimal Equivalents			Normalized Weights			Row	Average
Life-cycle cost	Panel Control	App Control	Remote Control	Panel Control	App Control	Remote Control		
Panel Control	1,0000	0,2000	3,0000	0,1579	0,1304	0,4286	0,7169	0,2390
App Control	5,0000	1,0000	3,0000	0,7895	0,6522	0,4286	1,8702	0,6234
Remote Control	0,3333	0,3333	1,0000	0,0526	0,2174	0,1429	0,4129	0,1376
	6,3333	1,5333	7,0000	1,0000	1,0000	1,0000	3,0000	1,0000

Table 3.3.3 Life-cycle cost

Easiness of use

	Decimal Equivalents			Normalized Weights			Row	Average
Easiness of use	Panel Control	App Control	Remote Control	Panel Control	App Control	Remote Control		
Panel Control	1,0000	5,0000	3,0000	0,6522	0,4545	0,7143	1,8210	0,6070
App Control	0,2000	1,0000	0,2000	0,1304	0,0909	0,0476	0,2690	0,0897
Remote Control	0,3333	5,0000	1,0000	0,2174	0,4545	0,2381	0,9100	0,3033
	1,5333	11,0000	4,2000	1,0000	1,0000	1,0000	3,0000	1,0000

Table 3.3.4 Easiness of use

Easiness of installing

	Decimal Equivalents			Normalized Weights				
Easiness of installing	Panel Control	App Control	Remote Control	Panel Control	App Control	Remote Control	Row	Average
Panel Control	1,0000	0,2000	1,0000	0,1429	0,1429	0,1429	0,4286	0,1429
App Control	5,0000	1,0000	5,0000	0,7143	0,7143	0,7143	2,1429	0,7143
Remote Control	1,0000	0,2000	1,0000	0,1429	0,1429	0,1429	0,4286	0,1429
	7,0000	1,4000	7,0000	1,0000	1,0000	1,0000	3,000	1,0000

Table 3.3.5 Easiness of installing

Final result

	Initial cost	Life cycle cost	Easiness of use	Easiness of installing	Alternative Weighted Evaluation
Criteria Weights	0,0799	0,3000	0,5488	0,0714	
Design Concepts					
Panel Control	0,2114	0,2390	0,6070	0,1429	0,4319
App Control	0,6864	0,6234	0,0897	0,7143	0,3420
Remote Control	0,1022	0,1376	0,3033	0,1429	0,2261

Table 3.3.6 Final result

This evaluation shows panel as the most preferred solution. It had a consistency ratio of 0,063377. This is below 0,1 so the evaluation has been consistent.

2.4 Preferred design concept

Both the Pugh and AHP matrix points out panel as the best solution. This was also the most preferred solution of the users as shown in the survey analysis. So the preferred design concept



System Definition Review

will be Panel Control solution for our project, more details about this design concept is stated at the Identification of Design Concepts part.