



Elements of Competency for Facility Engineers in The Field of Refrigeration and Air Conditioning

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Abstract: The challenge for institutions of higher learning today is to provide the human capital that this industry desperately needs. Past studies have shown that most graduates of local institutions of higher learning do not have the necessary work skills and competencies in the market and there seems to be mismatch in the preparation of graduates for the local job market. This study aims to explore the elements of competency that a facility engineer should have in the field of air conditioning and air conditioning. This study was done to provide a comprehensive overview of the elements of competency that need to be presented to the Facility Engineers in order to help the graduates of the Refrigeration and Air Conditioning Technology course at Universiti Tun Hussein Onn Malaysia (UTHM) to be better prepared for the occupational environment. This study used the Modified Delphi Technique approach for the purpose of obtaining expert approval on constructs in questionnaire instruments as well as using literature survey study through analysis documents. The research instrument used was a set of questionnaires prepared to obtain evaluation from experts. The data were processed by using Statistical Package for the Social Sciences (SPSS) software to obtain the mean score, median and Interquartile Range (IQR) for each item. The findings of the literature review through document analysis produced ten elements and 64 items. Meanwhile, the findings of the modified Delphi study produced the competence of Facility Engineers which has 10 elements and 62 items. Finally, the findings from this study are expected to open further discussion space and can help those involved in improvement to further enhance the quality of graduates in particular creating a skilled workforce according to industry demand.

Keywords: Competency, facilities engineer, Modified Delphi Technique, HVAC

1. Introduction

The main objective of an academic program in an educational institution is to produce knowledgeable and skilled students in line with the demands and requirements of the industry. Bilateral ties between educational institutions with the industry, especially the private sector, should be intensified to open up broader training opportunities in critical areas in the effort to produce highly skilled scholarship graduates (Adib, 2019). In the context of graduates' success, educational institutions face great challenges that are not merely to deliver knowledge but roles in applying value-added skills such as marketability skills in every human capital product produced. As such, the transformation of technical and vocational education continues to be strengthened to pursue the creation of first-class human capital.

In today's world, graduates need to have competence and job skills for them to be competitive in the job market. Having a high degree alone does not guarantee one's job. The frequent terms of competence are a group of knowledge,

skills, and attitudes related to one's duties and their work performance is measured in accordance with the established standards (Che Kob et al., 2018). TVET failure in the preparation of competent students will affect the job market. This situation is referred to as a mismatch, the curriculum aspect does not lead to industry requirements. Incompatibility is a situation where the level and type of skill available do not meet the job market requirements. In general, the incompatibility is divided into the mismatch of qualifying and skills and knowledge mismatch (Mohd Zuhdi et al., 2017). TVET is to enable students to learn how to make a job in a standard set that has been determined by experts in the field. The main results of vocational education are skills and the measurement of skill levels are based on competence (Lucas, Spencer, & Claxton, 2012).

The refrigeration and air conditioning sectors in the country are increasingly emerging as the government planned to achieve the goal of making Malaysia a fully developing country, it is a responsibility by the community to enhance efforts, especially students in preparing themselves in the field of employment through the knowledge and skills learned. However, there are also many graduates today who fail to get jobs in the industry due to their failure to meet employers' needs. This question arises based on the fact of the unemployment of university graduates in engineering, accountants, and other professionals is quite high today while they have had a very wide employment opportunity (Ministry of Higher Education, 2015).

Various studies have been made in connection with roles and competencies such as the Information Systems (Skulmoski and Hartman, 2010), Project Manager (Derus et al. 2015), and Facilities Management (Warren and Heng, 2005). These studies show that all areas of employment are studying roles and competencies. It turns out, that roles and competencies are a very important need in all areas of employment for an organization to achieve the prescribed performance. However, there is still no competence standard for the degree of masters that lead to professional professions such as engineers. This is important in providing guidance to the university in drafting and developing a curriculum in line with the employer's will. The lack of input from the industry in curriculum development has caused a gap between the skills required by the industry with TVET skills. As such, a study will be conducted to identify the competence elements of facility engineers in the field of refrigeration and air conditioning through analytical documents as well as identifying the competence elements of facility engineers in the field of cooling and air conditioning through expert confirmation modified Delphi.

2. Methodology

The research methodology provides a guide to researchers so that research is made more organized and organized. According to Othman Mohamed (2001), the methodology is a systematic procedure incorporating the adaptation of research approaches and data analysis that is carried out with its own rules to ensure that the performance of research can be achieved well and perfectly. Each of the methods and measures to be used consists of several aspects among them are research design, population and sample of the study, study instrument, validity and reliability, data collection procedures, data analysis procedures, and operating framework

2.1 Research Design

This study uses the Modified Delphi Technique (MDT) for the purpose of obtaining expert consent on constructs in questionnaire instruments and using literature material surveys through analytical documents. This study uses Delphi techniques modified and performed in the second round until the agreement is reached. The formation of Delphi instruments has adopted a structured questionnaire by involving five experts in the field of engineering facilities in the refrigeration and air conditioning industry. Confirmation is done with experts in every two rounds of questionnaires to obtain items with high agreement among experts.

The literature review through analysis documents as the first round for Modified Delphi studies is used to measure the relevant variables. The purpose of this study is to explore the competence elements that need to be available at a facility engineer in the field of cooling and air conditioning to assist graduates of refrigeration and air conditioning technology programs to be more prepared for the work environment.

2.2 Population and Sample

The population in this study is trained and competent experts in the field of engineering facilities in the HVAC industry sector. The sample for this study will be selected based on the aim of the sample. Sampling is intended to refer to sampling procedures where a group of subjects with certain characteristics is selected as research respondents. Justification of researchers to take samples aimed at obtaining the data and information required, through the suitability of the characteristics or criteria that need to be available on the sample, before they are chosen as respondents. Five experts in related fields have been selected, based on their qualifications to evaluate and provide feedback, in connection with the criteria required for each selected item. The selected experts are (i) those whose individuals have the training, (ii) knowledge and experience, (iii) groups with experience of working 10 years as an engineer of facilities or professionals in the field of HVAC, (iv) experienced and responsible in areas of specialization of skills sector in Malaysia and knowledgeable in the field of HVAC. The industries that have been selected as a sample are from Boon

Wah Air Conditioning Engineering Sdn Bhd, Perkasa Marine Supply (M) Sdn Bhd, Imne Pro Solutions, Tenaga Nusantara Sdn Bhd, and Laubros Holdings (M) Sdn Bhd. The sample consists of various positions such as Senior Project Engineer, Branch Manager, Operating Manager, Executive Maintenance, and M & E Coordinator.

2.3 Research Instrument

To meet the objectives of the study, researchers use questionnaires to obtain data from respondents. This is because this survey form can facilitate the current researcher to make data collection and analyze data. According to Chua (2011), the questionnaire is a research instrument in the form of a set of questions consisting of certain items and respondents should provide feedback by marking the score at the end of the item provided. A set of questionnaires is provided for evaluation from experts. Modified Delphi studies use questionnaire instruments. According to Wiersma & Jurs (2009), in the Modified Delphi design, issues and questions are quite defined by the researcher. Therefore, the first round (interview) in the actual method of Delphi is not required. Distribution of questionnaires is done online via Google Form to all expert panels. There are three categories in the questionnaire, Part A, Section B, and Part C.

3. Results and Discussion

The researcher will discuss the formation of competency elements for facility engineers in the field of cooling and air conditioning through the three-round Modified Delphi method. The first round is an analysis of the document as a guideline in the formation of questionnaire items. In the second round and thirdly developed questionnaires were used in the Modified Delphi study. Overall, this chapter aims to answer the research question below:

- (i) What are the competence elements of the facility engineers in the field of cooling and air conditioning through analytical documents?
- (ii) What are the competence elements of the Facility Engineer in the field of cooling and air conditioning through expert confirmation modified Delphi?

3.1 Results

3.1.1 Modified Delphi's First-Round Analysis (Document Analysis)

In the early stages of Modified Delphi studies, literature surveys on documents related to competency elements have been made to form a questionnaire instrument item to be used in the second round of Delphi. The results of the literature survey (Boffardi, 1999; De Robles & Kramer, 2017; Carli Raffaele et al. 2020; Mathur, 2020; Thangavelu et al., 2017; Kumari et al., 2016; Tamošaitienė et al., 2021), have found ten major competence elements for facility engineers namely (i) Improving and operating water treatment on HVAC systems, (ii) Indoor air quality control & improvement/ testing & controlling Indoor Air Quality (IAQ), (iii) Monitoring and upgrading HVAC control systems, (iv) Planning, organizing & manage HVAC services to commercial buildings, (v) Apply HVAC safety, (vi) Plan, organize & manage chiller plant operations, (vii) Monitor, translate and prepare drafting in industry, (viii) Apply standard HVAC in building design & maintenance commercial, (ix) Installation of hybrid systems, and (x) Operate & control HVAC systems through hybrid systems.

3.1.2 Analysis Second-Round and Third-Round Modified Delphi

After exploring the competence elements and items through the analysis of the researcher document has built 64 questionnaire items, to answer the first study question. The questionnaire was distributed to 5 expert panels, where each expert was required to state their level of consent to the items submitted and the addition of new items was strongly encouraged if the expert wanted to do so. Furthermore, the feedback received was analyzed using a measure of centralized tendency to score mean, median and interquartile range (IQR). The results of the three-round Modified Delphi analysis of 10 elements and 62 questionnaire items were generated.

Table 1 - Result of 3 round Modified Delphi

No.	Element	No. of Item	Consent (High) (0-1)	Consent Agreement) (≥ 2)	(No
1	Improving and operating water treatment on HVAC systems	4	4	-	
2	Indoor air quality control & improvement/ testing & controlling Indoor Air Quality (IAQ)	4	4	-	
3	Monitoring and upgrading HVAC control systems	7	5	-	
4	Planning, organizing & manage HVAC services to commercial buildings	10	10		
5	Apply HVAC safety	6	6	4	

6	Plan, organize & manage chiller plant operations	9	6	2
7	Monitor, translate and prepare drafting in industry.	7	7	3
8	Apply standard HVAC in building design & maintenance commercial,	8	8	1
9	Installation of hybrid systems	4	4	-
10	Operate & control HVAC systems through hybrid systems.	5	5	-
Total		64	62	10

3.2 Discussions

Based on the literature review, all of the 10 key elements and 64 items of competence that had been found from document analysis are necessary in becoming a profession of a facilities engineer in the field of HVAC (CDC 2016; De Robles & Kramer, 2017; Carli Raffaele et al. 2020; Aghemo et al., 2012; Mathur, 2020). The discovery of these elements and indicators is a new discovery if all the elements and indicators are combined in a study. This is because according to the literature review, there is no study that applies to all the elements and indicators stated to be applied for the purpose of improvement to further improve the quality of graduates, especially to produce skilled manpower according to industry demand and improve student achievement and performance.

Meanwhile, for the second objective, based on consensus from the 5 experts, a total of 62 questionnaire items were built through the Modified Delphi study in the second and third rounds. The findings show that the first element of improving and operating water treatment on HVAC systems by 2 items has received a high level of agreement from the expert panel that is maintaining water quality for HVAC systems and implementing water treatment for HVAC systems. This is in line with the study of Nofirman Firdaus et al. (2016) that the issues of impurities, corrosion of tubes, and cooling towers are related to water quality. Water quality improves the driving force of the failure mode. Therefore, maintaining proper water quality through a water treatment program is the most important maintenance program. This action can control the rate of refrigerant deterioration. For a proper water treatment program, a specialist should be consulted. This clearly shows the presence of competency elements to improve and control water treatment on HVAC systems which can maintain water quality for HVAC systems. An addition, the findings of the study have found that the item of performing Indoor Air Quality (IAQ) test measurement under the element of indoor air quality control & improvement/ testing & controlling Indoor Air Quality (IAQ) has gained high agreement among experts as stated by The Centers for Disease Control and Prevention (CDC, 2016) states that “Building ventilation is one of the important factors influencing the relationship between the transmission of respiratory infections through the air and the health and productivity of workers”. Finding ways to improve indoor air quality in commercial buildings can lead to better health and better productivity by the workforce (De Robles & Kramer, 2017). However, based on the analysis of the study conducted some panel of experts disagreed that the item build Internet of Things (IOT) application in HVAC system and item upgrade Internet of Thing (IOT) application in HVAC system and was eliminated in the second round of modified delphi. This is not in line with the study of Ruano et al. (2018) who stated IoT will also reshape the HVAC industry, allow real-time monitoring through the use of smart sensors, enable remote diagnostics and predictive maintenance, real-time control, incorporate user choice, system adaptation for future situations, increase efficiency, and possibly replace Traditional Building Management System. Furthermore, the panel of experts has stated the justification for the items that have been dropped i.e. the experts think the items are not yet needed in the field of HVAC. This is because, the operation of the HVAC control system needs to be done manually because when the system starts operating, the user needs to check and monitor the system in good condition either visually or soundly. If it is found that the system is in poor condition or noises should be, the response to shut down immediately is faster than using IoT. Each item removal has been notified in advance to a panel of experts to obtain agreement and views on the importance of an item.

In addition, the results of the study also show that the element of planning, organizing & managing the operation of the chiller plant contains four items that get high agreement and approval, namely item (iv) identify problems on equipment for chiller operation, item (v) identify maintenance requirements for chiller operation, item (vi) handles the maintenance of the chiller system and item (vii) checks the temperature, pressure, fluid level and flow rate of the HVAC system. This finding coincides with the study of Thangavelu et al., (2017) that several operational strategies have been practiced in chiller plants to improve operational efficiency and reduce power consumption. This is in line with the findings of Firdaus et al. (2016) in his article investigating the deterioration of chiller performance in hotels. The results show that the performance of the chiller deteriorates over time. To restore chiller performance, maintenance actions must be taken. Through chiller performance monitoring, measurement and inspection, the main causes of chiller performance degradation can be identified. Besides that, the element of applying standard HVAC in the design & maintenance of commercial buildings contains one item that there is no agreement among the expert panel compared to the other seven items that have a moderate to high level of agreement, which is item (viii) compiling a checklist of building requirements and information. However, this item is still at an agreed level and is still being maintained. This finding is supported in a study conducted by Tamošaitienė et al., (2021) where in the field of commercial buildings, the core concept of repair and maintenance consists of several steps, including: a) the main identification of commercial

buildings, which aims to classify buildings according to their type; b) secondary design/average building service life; and c) the previous second step involves the following factors required for the evaluation of existing commercial buildings: i) Usability; ii) Ultimate limit states related to the structure, wear and tear and structural defects; iii) Life cycle energy parameters and building efficiency. The results of the data analysis of the second and third rounds of the modified Delphi study on hybrid system installation elements conducted on four items found that all experts agreed at a moderately high level. The items are (i) installing a hybrid system in an HVAC system, (ii) analyzing the design of a hybrid system, (iii) explaining the basic concept of a hybrid pneumatic system, and (iv) explaining the basic concept of a direct digital control system. It is in line with the findings of the study highlights that the use of hybrid machines has gained popularity in the advancement of high-performance control systems. Higher accuracy and better performance for predictive models of energy destruction and energy consumption used in heating, ventilation and air conditioning (HVAC) system control circuits can be very economical on an industrial scale to save energy (Ardabili et al., 2020) .

4. Conclusion

This study was conducted to provide a thorough overview of the competence elements that need to be present at facility engineers to assist graduates of refrigeration and air conditioning technology courses at Universiti Tun Hussein Onn Malaysia to be more prepared for the work environment. Furthermore, there are reviews and recommendations of improvements received by researchers during the evaluation and verification process by experts aimed at enhancing the quality of the study. Through the feedback received analyzed using a measure of centralized tendency to score mean, median, and interquartile range (IQR) for the second objective and question, the researcher found that the agreement among the five expert panels against the item in the second and third rounds was not much different. As for different numbers, most respondents agree. The consent among them against the item is fixed and unchanged at each round. Finally, the researcher hopes that findings from this study are expected to open further discussion space and can help those involved in improvement to further enhance the quality of graduates in particular creating a skilled workforce according to industry demand.

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