COMPETENCIES FRAMEWORK FOR TECHNICAL EXECUTOR HEATING, VENTILATING AND AIR CONDITIONING (HVAC) MAINTENANCE OF OIL AND GAS INDUSTRY IN MALAYSIA

MOHD SYAFIQ SYAZWAN BIN MUSTAFA

A thesis submitted in
fulfilment of the requirement for the award of the
Doctor of Philosophy

Faculty of Engineering Technology
Universiti Tun Hussein Onn Malaysia

SEPTEMBER 2023

Alhamdulillah, gratitude is extended to the almighty God because of His abundant grace, this thesis can be completed.

Throughout the journey of preparing a copy of this thesis, there were indeed many obstacles and challenges that sometimes weakened and broke my spirit and only to Him was the place to complain.

To beloved father, Hj. Mustafa bin Idris and the beloved mother Hjh. Hashimah binti Nani that always pray for the success of their children.

To my beloved wife, Noor Aqsa Nadeea binti Mat Isa and children, Umar and Sara who are always patient and give encouragement that strengthens this spirit.

Thank you for your prayers and support, the respected supervisor, Ts. Dr. Fatimah binti Mohamed Yusop, Associate Prof. Sr Ts. Dr. Mohammad Ashraf bin Abdul Rahman and Dr. Anies Faziehan binti Zakaria. Thank you so much for all your help and guidance and I cannot forget all the friends who always help and support.

May all the efforts and services that are poured in receive the grace of Allah SWT.

ACKNOWLEDGEMENT

Alhamdulillah, all praise and thanks to Allah SWT. Greetings to the noble Prophet Muhammad S.A.W. I am grateful to Allah SWT because with HIS grace, I was able to complete this Doctor of Philosophy thesis.

I extend my utmost gratitude to everyone who contributed to the success of this thesis, with special recognition given to the main supervisor, Ts. Dr. Fatimah binti Mohamed Yusop, and co-supervisors Associate Prof. Sr Ts. Dr. Mohammad Ashraf bin Abdul Rahman and Dr. Anies Faziehan binti Zakaria. Their invaluable guidance and support were instrumental in ensuring the successful completion of this Doctor of Philosophy research. I would also like to express my sincere appreciation to all those involved, including the esteemed panel of experts, who generously offered their time and expertise to help make this research a triumph.

I wish to express my profound gratitude to my beloved family, whose unwavering support has been instrumental in the successful completion of this thesis. I extend my sincerest appreciation to my friends as well, for their invaluable encouragement, assistance and insightful contributions, which have played a pivotal role in the achievement of this academic endeavor. Furthermore, I extend my thanks to all the individuals and entities who have directly or indirectly contributed to the triumph of this thesis. Your dedicated efforts and contributions are deeply cherished, and I fervently pray that all our endeavors find blessings from Allah SWT.

ABSTRACT

Heating, ventilating and air conditioning (HVAC) is one of the critical mechanical systems which needs careful maintenance in the oil and gas (O&G) industry. However, there are no guidelines to define and measure the competencies of the personnel who execute the HVAC maintenance in O&G industry, specifically in Malaysia. The objective of this research is to develop a competency instrument and framework for the HVAC maintenance technical executor in the O&G industry in Malaysia. A total of 18 constructs with 127 sub-constructs in technical skills, 3 constructs with 36 sub-constructs in non-technical skills and 4 constructs with 15 sub-constructs in core personality have been identified through literature review. Delphi method has been used for instrument competency development. It consisted of three rounds of data collection to obtain the consensus from 17 expert panels. The developed instrument was distributed to 158 respondents using cluster sampling based on 4 regions. The Winsteps Software V.3.69.1.11 was used for analysis and the results identified 19 constructs with 115 sub-constructs in technical skills, 3 constructs with 30 sub-constructs in non-technical skills and 4 constructs with 18 sub-constructs in core personality. Next, the competency framework was developed using principal component (PCA), which showed the raw variance explained by measures (empirical) as 55%, 58.8% and 61.3% (>40%), unexplained variance in 1st contrast as 5.9%, 5.2% and 3.3% (<10%) and eigenvalue of 2.7, 2.4 and 2.3 (<3) for technical skills, non-technical skills and core personality respectively. The results of this study have the potential to contribute significantly to the existing body of knowledge as well as offer valuable insights and guidance to employees seeking career advancement in the role of HVAC maintenance executors in the Malaysian O&G industry. Moreover, O&G HVAC maintenance organisations can leverage these findings to identify competency gaps among their employees and implement targeted training programs.

ABSTRAK

Pemanasan, ventilasi dan penyamanan udara (HVAC) adalah salah satu sistem mekanikal yang kritikal dan perlu diselenggara di dalam industri minyak dan gas (O&G). Walaubagaimanapun, tiada garis panduan bagi menentukan dan mengukur kecekapan pelaksana penyelenggaraan HVAC di dalam industri O&G khususnya di Malaysia. Objektif kajian adalah untuk membangunkan instrumen dan kerangka kompetensi untuk pelaksana teknikal penyelenggaraan HVAC dalam industri O&G Malaysia. Sebanyak 18 konstruk dengan 127 sub-konstruk bagi kemahiran teknikal, 3 konstruk dengan 36 sub-konstruk dalam kemahiran bukan teknikal dan 4 konstruk dengan 15 sub-konstruk dalam personaliti teras melalui kajian literatur. Kaedah Delphi digunakan untuk pembangunan kompetensi instrumen melalui tiga pusingan untuk mendapatkan konsensus daripada 17 panel pakar. Instrumen yang dibangunkan telah diedarkan kepada 158 responden menggunakan pensampelan kelompok berdasarkan 4 wilayah. Hasil analisis melalui Perisian Winsteps V.3.69.1.11 telah mengenalpasti 19 konstruk dengan 115 sub-konstruk dalam kemahiran teknikal, 3 konstruk dengan 30 sub-konstruk dalam kemahiran bukan teknikal dan 4 konstruk dengan 18 sub-konstruk dalam personaliti teras. Seterusnya, kerangka kompetensi telah dibangunkan menggunakan analisis komponen utama (PCA), yang menunjukkan bahawa varians mentah dijelaskan dengan ukuran (empirikal) 55%, 58.8% dan 61.3% (>40%), Varian tidak dapat dijelaskan dalam kontras pertama 5.9 %, 5.2% dan 3.3% (<10%) dan nilai eigen 2.7, 2.4 dan 2.3 (<3) masing-masing untuk kemahiran teknikal, kemahiran bukan teknikal dan personaliti teras. Hasil kajian ini berpotensi memberi sumbangan besar kepada badan pengetahuan sedia ada serta menawarkan pandangan dan panduan yang berharga kepada pekerja yang mencari kemajuan kerjaya dalam peranan pelaksana penyelenggaraan HVAC dalam industri O&G Malaysia. Selain itu, organisasi penyelenggaraan O&G HVAC boleh memanfaatkan penemuan ini untuk mengenal pasti jurang kompetensi di kalangan pekerja mereka dan melaksanakan program latihan yang disasarkan.

CONTENTS

TITLE			**i**
DECLARATION			**ii**
DEDICATION			**iii**
ACKNOWLEDGEMENT			**iv**
ABSTRACT			**v**
ABSTRAK			**vi**
CONTENTS			**vii**
LIST OF FIGURES			**xii**
LIST OF TABLES			**xiv**
LIST OF SYMBOLS AND ABBREVIATIONS			**xix**
LIST OF APPENDICES			**xxi**
CHAPTER 1	**INTRODUCTION**		**1**
	1.1	Overview	1
	1.2	Background of the problem	4
	1.3	Problem statement	7
	1.4	Research questions	12
	1.5	Research objectives	13
	1.6	Study outcomes	13
	1.7	Significance of the study	13

1.7.1 HVAC technical executor profession in O&G industry 14
1.7.2 Human resource management 14
1.7.3 Maintenance management 14
1.7.4 Oil and gas industry 15
1.8 Scope of the study 15
1.9 Conceptual framework 16
1.10 Summary 17
CHAPTER 2 LITERATURE REVIEW 18
2.1 Introduction 18
2.2 Oil and gas industry overview 18
2.3 Competencies 21
2.3.1 Technical competencies 23
2.3.2 Non-technical competencies 24
2.3.3 Core personality 27
2.4 Related competencies in HVAC maintenance 28
2.5 Maintenance profession 50
2.6 Competency model 51
2.6.1 Significance of competency model 54
2.6.2 Methodology for developing competency model 55
2.7 Competency measurement and assessment 56
2.7.1 Self-assessment measures 57
2.8 Rasch measurement model 57
2.9 The Iceberg Model 59

	2.10	Summary	60
CHAPTER 3	**METHODOLOGY**		**61**
	3.1	Introduction	61
	3.2	Research design	61
	3.3	Competencies identification	64
		3.3.1 Inter-rater reliability Fleiss' Kappa	64
	3.4	Competencies instrument	65
		3.4.1 Delphi Method (DM)	66
		3.4.2 Selection of expert in Delphi Method	66
		3.4.3 Delphi Method number of experts	67
		3.4.4 Implementation of Delphi Method	68
		3.4.5 Process of analysis in Delphi Method	70
	3.5	Competency measurement instrument	71
		3.5.1 Self-assessment competency measurement	72
		3.5.2 Development of instrument competencies	72
		3.5.3 Translation and back translation	73
		3.5.4 Stage of instrument testing	73
		3.5.5 Rasch Model analysis	74
		3.5.6 Profiling	75
		3.5.7 Framework	76
	3.6	Location	77
	3.7	Research sample	77
	3.8	Reliability and validity	78

	3.9	Ethical consideration	79
	3.10	Summary	80
CHAPTER 4	**RESULT AND DISCUSSION**		**81**
	4.1	Introduction	81
	4.2	Findings for research Question 1: What are the constructs and sub-constructs required for the HVAC maintenance technical executors in the O&G industry?	82
		4.2.1 Inter-rater reliability for constructs and sub-constructs of HVAC maintenance executors in O&G industry from document analysis	84
	4.3	Findings for research Question 2: What is the reliable instrument with essential validity evidence to measure the competencies of HVAC maintenance technical executors in the O&G industry?	85
		4.3.1 Delphi first round	86
		4.3.2 Delphi second round	89
		4.3.3 Delphi third round	91
		4.3.4 Discussion on instrument development	98
	4.4	Findings for research Question 3: What is the competency framework for HVAC maintenance technical executors in the O&G industry?	100

		4.4.1 Preliminary instrument testing	100
		4.4.2 Actual instrument testing	123
	4.5	Summary	150
		4.5.1 Principal components analysis (PCA) for instrument items	151
		4.5.2 Discussion of competencies framework development	153
CHAPTER 5	**CONCLUSION AND RECOMMENDATION**		**157**
	5.1	Introduction	157
	5.2	Conclusion	157
	5.3	Contribution of study	158
	5.4	Recommendations	159
	REFERENCES		**160**
	LIST OF PUBLICATIONS		**180**
	VITA		**336**

LIST OF FIGURES

1.1	HVAC schematic diagram in O&G industry (Yang et al. 2014)	3
1.2	Structure of Malaysia Occupational Skills Qualification (NOSS, 2012)	8
1.3	The study's conceptual framework (Spenser & Spencer, 1993)	16
2.1	Three main streams and global value chains in O&G sector (P. Joshi et al. 2017)	19
2.2	Primary energy consumption of fuel in Malaysia for 2018 (Kumar and Stern, 2020)	19
2.3	Generic skills for the New Economy (Kearns, 2001)	25
2.4	Top 10 employability skills (Sarfaz et al., 2018)	26
2.5	Competence Model by Spencer and Spencer (1993)	60
3.1	Research Methodology Outline	63
4.1	Structure organization of this chapter	82
4.2	Summary of the Delphi method for instrument development	99
4.3	Category probability curve at five-point scale (12345) for preliminary instrument testing	108
4.4	Item-person wright map for the preliminary instrument testing	112
4.5	Category probability curve at 5-point scale (12345) for actual instrument	131
4.6	Item-person wright map for the actual instrument testing	136

4.7	Item-person map in competencies profiling for actual instrument	140
4.8	Competencies framework for HVAC maintenance technical executors in O&G industry in Malaysia	156

LIST OF TABLES

1.1	Hazardous area classification (BS 60079-10-12021)	2
1.2	Summary of fire and explosion accident in O&G industry	5
1.3	Requirement of manpower for HVAC maintenance (Onshore and Offshore) for Company A	6
1.4	Requirement of Manpower for HVAC Maintenance (Offshore) for Company B	6
1.5	Requirement of Manpower for HVAC Maintenance (Onshore) for Company C	6
1.6	Sub-Sector (HVAC)	9
1.7	Interpretation of mean score	9
1.8	HVAC systems and their maintenance in O&G industry	10
1.9	Competencies of technical executors for HVAC maintenance in O&G industry	11
1.10	Framework, model and instrument measurement of competency for HVAC maintenance technical executor in O&G industry	12
2.1	Definition of competency	22
2.2	Cluster of threshold and distinguishing competencies	23
2.3	Demand for skills in 2018 and 2022	27
2.4	NOSS sub sector HVAC	29
2.5	SCS Air conditioning and refrigeration engineering branch 32	

2.6	Scottish Vocational Qualification (SVQs) in Heating and Ventilating and Refrigeration and Air Conditioning	35
2.7	NZQF Heating, Ventilating, and Air Conditioning (Mechanical Services)	37
2.8	Vocational Education and Training (VET) in Australia	39
2.9	Performance Criteria OPITO Global Training Standards Maintenance	42
2.10	Knowledge Criteria OPITO Global Training Standards Maintenance	44
2.11	Scope Criteria OPITO Global Training Standards Maintenance	48
2.12	Comparison of traditional job analysis and competency modeling (Sanchez & Levine, 2009)	53
2.13	Literatures on competency modelling for job position in specific sectors	53
3.1	Fleiss' Kappa Agreement Scale	65
3.2	Expert panel criteria	67
3.3	Relation between error reductions and panel size	68
3.4	Comparison of Delphi techniques in previous studies 69	
3.5	Criteria for Delphi expert consensus and action	71
3.6	The scale for self-reflections measurement	72
3.7	Criteria to determine the reliability and validity of items	75
3.8	Sample size according to Rasch model measurement analysis	75
3.9	Distribution of sampling according to region and company	78
3.10	Summary of reliability and validity procedure	79
3.11	Summary of the research	80
4.1	Fleiss' kappa coefficient value index for sub-constructs	84

4.2	Distribution of expert panels for Delphi method	86
4.3	Distribution of expert panel experience	86
4.4	Sub-constructs rejected in first round of DM	87
4.5	Sub-constructs to be monitored and re-evaluated to the second round of DM	88
4.6	New constructs and sub-constructs proposed by experts	89
4.7	New constructs and sub-constructs proposed by experts in second round of DM	90
4.8	Sub-constructs rejected in second round of DM	90
4.9	Technical skills in third round of DM	91
4.10	Non-technical skills in 3rd round of DM	97
4.11	Core personality in 3rd round of DM	98
4.12	Respondent's demographic profile for preliminary instrument testing	101
4.13	Person and item reliability and separation index for preliminary instrument testing	102
4.14	Item and person reliability and separation index for each construct in preliminary instrument	102
4.15	Polarity of items for preliminary instrument testing	103
4.16	Item fit for technical skills construct for preliminary instrument testing	104
4.17	Item fit for non-technical skills construct for preliminary instrument testing	105
4.18	Item fit for core personality construct for preliminary instrument testing	106
4.19	Standardized residual correlations for preliminary instrument testing	107
4.20	Observed average at 5-point scale (12345) for preliminary instrument testing	108
4.21	DIF analysis of position in preliminary instrument items	109
4.22	Item difficulty level for preliminary instrument testing	110

4.23	Item difficulty and person response levels for preliminary instrument testing	110
4.24	Indicators of performance levels for preliminary instrument	113
4.25	Item measure order for preliminary instrument testing 114	
4.26	The items maintained and dropped in preliminary instrument	116
4.27	Summary of maintained and dropped items in preliminary instrument	123
4.28	Respondents' demographic profile in actual instrument	124
4.29	Person and item reliability and separation index for actual instrument	124
4.30	Item and person reliability and separation index for each construct in actual instrument	125
4.31	Polarity of technical skills construct for actual instrument testing	126
4.32	Polarity of non-technical skills construct for actual instrument testing	127
4.33	Polarity of core personality construct for actual instrument testing	127
4.34	Item fit for technical skills constructs for actual instrument testing	128
4.35	Item fit for non-technical skills constructs for actual instrument testing	129
4.36	Item fit for core personality constructs for actual instrument testing	130
4.37	Standardized residual correlations for actual instrument testing	130
4.38	Observed average at five-point scale (12345) for actual instrument	132
4.39	DIF Analysis of position for HVAC items (Actual instrument testing)	133

4.40	Item difficulty level for actual instrument testing	133
4.41	Item difficulty and person response levels for actual instrument testing	134
4.42	Indicators of performance levels for actual instrument	137
4.43	Item measure order for actual instrument	137
4.44	Background of junior technician group (above person mean)	141
4.45	Background of supervisor group (below person mean) 141	
4.46	Finalized items for actual instrument testing	142
4.47	Summary of finalized items for actual instrument	149
4.48	Summary of improvement for preliminary and actual instrument	149
4.49	PCA for technical skills construct	151
4.50	PCA for non-technical skills construct	152
4.51	PCA for core personality construct	152
4.52	Summary of PCA for actual instrument	153

LIST OF SYMBOLS AND ABBREVIATIONS

κ	-	*Fleiss' Kappa coefficient*
DM	-	*Delphi method*
IQR	-	*Interquartile range*
O&G	-	*Oil and Gas*
HVAC	-	*Heating ventilating and air conditioning*
E&P	-	*Exploration and production*
LQ	-	*Living quarters*
H_2S	-	*Hydrogen sulphide*
BOSIET	-	*Basic offshore safety induction and emergency training*
OGSP	-	*Oil and gas safety passport*
JHA	-	*Job hazard analysis*
PTW	-	*Permit to work*
SKM	-	*Malaysia skills certification*
MOSQ	-	*Malaysia Occupational Skills Qualification*
PETRONAS	-	*Petroleum Nasional Berhad*
MITI	-	*Ministry of International Trade and Industry*
MDTCC	-	*Ministry of Domestic Trade, Co-Operatives and Consumerism*
PCA	-	*Principal component analysis*
MBOT	-	*Malaysian Board of Technologist*
BEM	-	*Board of Engineer Malaysia*
IR 4.0	-	*Industrial Revolution 4.0*
NOSS	-	*National Occupational Skill Standard*
SCS	-	*Specification of competency standard (SCS)*
SVQs	-	*Scottish Vocational Qualification*
NOS	-	*National Occupational Standard*
NZQF	-	*New Zealand Qualification Frameworks*
VET	-	*Vocational Education and Training*

PSFs	-	*Performance shaping factors*
RMM	-	*Rasch measurement model*
IRT	-	*Item Response Theory*
ASHRAE	-	*American Society of Heating, Refrigerating and Air conditioning Engineers*
TVET	-	*Technical and vocational education and training*
H	-	*Number of Person or Item Strata*
G	-	*Separation index of item or person*
OGST	-	*OPITO Global Training Standard*
AHU	-	*Air handling unit*
PT-MEA CORR	-	*Point Measure Correlation*
MNSQ	-	*Mean Square*
DIF	-	*Differential Item Functioning*

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A(i)	Matrix Frequency from document analysis	181
A(ii)	Sources used for frequency matrix	187
B	Inter-rater Reliability Form (Fleiss' Kappa)	188
C(i)	Delphi 1st Round	201
C(ii)	Delphi 2nd Round	224
C(iii)	Delphi 3rd Round	245
D(i)	Instrument Preliminary I	265
D(ii)	Instrument Actual II	292
E	Winsteps Rasch Analysis	317

CHAPTER 1

INTRODUCTION

1.1 Overview

Malaysia is the 14th largest natural gas producer and the 25th largest crude oil reserve in the world (Baradari *et al.*, 2021). Owing to the availability of domestic hydrocarbons, Malaysia will become a major petrochemical exporter in the ASEAN region, resulting in a natural boost for oil and gas development (Malaysian Investment Development Authority). As a strategic position on key shipping lanes, Malaysia has the advantage of becoming a major player in the Asian business and management industry. The oil and gas (O&G) industry is responsible for the global processes of exploration, extraction, refining, transportation and marketing (Ikwunze *et al.*, 2016) of petroleum products. According to the market division, the O&G sector consists of three major streams and a value chain in each stream (Gardas *et al.*, 2019). The upstream distribution system consists of the exploration and production (E&P) of hydrocarbons, which can be either oil or gas, or a combination of the two, and is typically referred to as offshore. The midstream distribution system consists of pipelines and tankers that transport crude oil to refinery plants, while the downstream stage includes refining, marketing, wholesaling and retailing. These three streams are a series of linked and sequential tasks designed to transform crude oil and gas into consumable, high-quality products for global marketing.

As O&G industry is capital-intensive, the offshore and onshore plants should be operated with high reliability and availability, as downtime due to system failure has a major effect on the production activity and the degree of safety (Hwang *et al.*, 2018). All operations in the O&G industry need to be carried out with high reliability and availability, to sustain the upstream and downstream business of O&G industry. Various machinery and equipment including heavy machinery need to be employed

and utilized to create a good operation in the O&G business. All equipment mechanical, pneumatic, hydraulic system and electrical generation equipment must be effectively maintained in order to achieve the daily target production with the lowest possible maintenance cost (Olose, 2016). Maintenance includes inspection, maintenance and repair task to ensure the procedure and operation of equipment at minimum possible cost under good and safe conditions. These activities entail technical and administrative actions such as planned, scheduled and team mobilisation, in order to efficiently deliver the maintenance activities. Maintenance benefits can be classified as, ensuring the plant's design life, plant durability, environmental protection, cost effectiveness and effective resources (Abdelnaser *et al.*, 2016). Furthermore, the effectiveness of maintenance can be assessed by looking at related equipment, costs, maintenance tasks and customer satisfaction (Syan & Ramsoobag, 2016). The maintenance strategies within the O&G industry often exhibit parallels with those found in other heavy industries. This observation holds true despite the notable levels of hazard, risk, and safety requirements entailed by the processes and operations in the O&G industry. Hazardous areas are classified based on risk explosion, and safety precaution towards electrical components become priority and important. A hazardous area is one in which an explosive gas atmosphere is present or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment (BS EN IEC 60079-10-1:2021). Table 1.1 shows the hazardous area classification according to zone.

Table 1.1: Hazardous area classification (BS 60079-10-1:2021)

Hazardous area	Description
Zone 0	Area in which an explosive gas atmosphere is present continuously or for long periods or frequently
Zone 1	Area in which an explosive gas atmosphere is likely to occur periodically or occasionally in normal operation
Zone 2	Area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exist for a short period only

HVAC system is a combination of mechanical and electrical systems that need to be maintained in the O&G industry. Air cooled condensing unit (ACCU), air cooled chiller (ACC) and air cooled split unit (ACSU) are widely used in the O&G industry, especially in the offshore platform due to the limitation of fresh water sources. ACCU and ACC are connected with the fan coil unit (FCU) or air handling unit (AHU) to

supply cooled air into the space. An additional pressurised fan is needed to pressurise fresh air into the AHU (Figure 1.1).

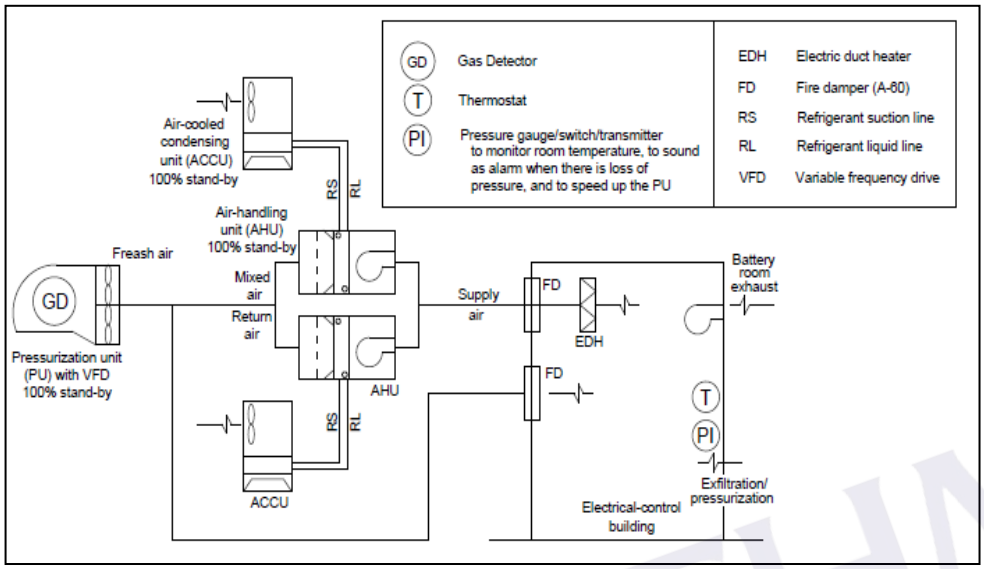

Figure 1.1: Schematic diagram of HVAC in O&G industry (Yang *et al.*, 2014)

A comfortable and healthy indoor environment is provided for occupants through the utilisation of HVAC system. Positive room pressure is required in the offshore platform's living quarters (LQ) to prevent toxic or hazardous gases such as hydrogen sulphide (H_2S) from entering the area. High concentrations can cause health hazards such as shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death. Effects can occur within a few breaths, possibly a single breath (United States Department of Labor). HVAC systems are also necessary to supply cool air to the rooms containing sensitive electrical equipment, such as battery rooms, radio equipment rooms, switchgear rooms and central control rooms. Malfunction of the sensitivity equipment caused by a hot environment to sensitive electrical equipment can result in an electrical failure and cause the production offshore platform to shut down. The effect of unexpected shutdown will incur huge losses for the O&G industry (Yang *et al.*, 2014).

In this context, the quality of maintenance seems to be related to the competencies of the personnel who perform the maintenance tasks. Commonly, all maintenance tasks will be executed by the executor team which may have skilled as well as semi-skilled workers. Competence refers to the combination of awareness, knowledge, skill and attitude that an individual must possess to meet the performance

standard required and to be capable to perform a specified job (Garavan T. & McGuire D., 2001). The team is led by the supervisor for HVAC maintenance task, who communicates the progress of maintenance work to the platform's regular operator. It is very much required that the executor team is highly competent to carry out all the HVAC maintenance task at the offshore platform and onshore. Incompetence of executor team in performing the HVAC maintenance task may affect the organisation's performance and hence, could impact the maintenance cost due to repetitive failure, failure in detecting unwanted failure and mistake (Au-Yong *et al.*, 2014).

1.2 Background of the problem

A pro-business policy has been implemented to create a vibrant ecosystem by offering competitive rates and skilled labour to ensure sustainable and successful upstream and downstream business in the O&G industry. To date, the group responsible for the extraction of natural gas and crude oil has employed the most people (18,630), with a percentage of 50.7%. 18,146 people (49.3%) have been involved in the group that supports the extraction of natural gas and petroleum. (Department of Statistical Malaysia 2018). A significant portion of skilled labour is needed in the O&G industry's various engineering disciplines, including support activities. The need of the hour is that the workforce is required to competitively upgrade knowledge, skills, abilities and attitude.

Competencies of skilled and semi-skilled manpower become subjective due to different interpretations and have no consistency across different fields of the O&G industry (Puteh *et al.*, 2016). In terms of skilled and semi-skilled labour in the O&G industry, much of the literature focuses on exploration and production (E&P) skills such as geoscience, petroleum, reservoir engineering and corrosion engineering, regardless of the support activities. (Al-Daihani *et al.*, 2016; Lau, 2017; Morshed, 2014; Fattahi, 2003). Support activities should be highlighted because, they greatly aid in preserving optimal operation in the O&G sector, particularly in offshore platforms. HVAC maintenance activities are classified as support activities, and manpower competency is very important, as there are various approaches to task execution, particularly those involving strict safety requirements and in hazardous areas. HVAC

REFERENCES

Abd-El-Fattah, S.M., Al-Sinani, Y., El Shourbagi, S. & Fakhroo, H.A. (2014). Using Rasch Analysis to Examine the Arabic Version of the Perceived Physical Ability Scale for Children. *Australian Journal of Educational & Developmental Psychology, 14*, pp. 29-44.

Abdullah, A.H. & Sentosa, I. (2012). Human Resource Competency Models: Changing Evolutionary Trends. *Interdisciplinary Journal of Research in Business, 1(11)*, pp. 11-25.

Abdullah, A.H., Raja Musa, R.M.F. & Ali, J. (2011). The Development of Human Resource Practitioner Competency Model Perceived by Malaysian Human Resource Practitioners and Consultants: A Structural Equation Modeling (SEM) Approach. *International Journal of Business and Management, 6(11)*, 240-255.

Affero, I., & Razali, H. (2012). The Basis of Supervisory Practice for Vocational Education and Training. *Prosiding Seminar Pendidikan Pasca Ijazah ke-2 dalam PTV*. Malaysia: Universiti Tun Hussein Onn Malaysia, 18-29.

Ahadzie, D.K., Proverbs, D.G., & Olomolaiye, P.O. (2008). Towards Developing Competency-Based Measures for Construction Project Managers: Should contextual behaviours be distinguished from task behaviours? *International Journal of Project Management, 26(6)*, pp. 631-645.

Al-Qadhi, A., & Abdullah, A. (2021). Impact of Intensive Training and Quality Assessment on Core Competency of Oil and Gas Employees in Yemen Petroleum Companies Fall Under Competency Framework. *International Journal of Academic Research in Business and Social Sciences, 11(4)*, 750–770.

Amy Irwin, Siouxsie Taylor, Erika Laugerud & Dave Roberts (2016) Investigating Non-Technical Skills in Scottish and English Aircraft Maintenance Teams Using a Mixed Methodology of Interviews and a Questionnaire, *The International Journal of Aviation Psychology*, *26*:*3-4*, 105-119.

doi: 10.1080/10508414.2017.1319734

Apple, M. T. (2013). Using Rasch analysis to create and evaluate a measurement instrument for foreign language classroom speaking nnxiety. *Japan Association for Language Teaching (JALT), 35(1),* 5-28.

Arias D. & Tucker J. (2002). Proactive Safety management. *SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production*, Kuala Lumpur, Malaysia: Society of Petroleum Engineers.

Arnold, I., & Randall, R. (2010). *Work Psychology,* 5. Aufl. Essex: Pearson. Arthur

Au-Yong C. P., Ali A. S. & Ahmad F. (2014) Optimising Maintenance Cost Performance with Skilled Technicians. *Structural Survey, 32(3),* pp238-245.

Au-Yong, C. P., Ali, A. S., & Ahmad, F. (2014). Improving Occupants' Satisfaction with Effective Maintenance Management of HVAC System in Office Buildings. *Automation in Construction, 43* ,31-37.
doi: http://dx.doi.org/10.1016/j.autcon.2014.03.013.

Azmi, A. N., Kamin, Y., Noordin, M. K., & Nasir, A. N. M. (2020). Non-Technical Skill Level of Electrical Engineering Undergraduates Using the Rasch Measurement Model. *International Journal of Psychosocial Rehabilitation, 24(5).* ISSN: 1475-7192, 5388-5403.

Baghaei, P. (2008). The Rasch model as a construct validation tool. *Rash Mesurement Transactions, 22 (1955),* 1145-1162.
https://doi.org/10.1017/CBO9781107415324.004

Balan, S., Zainudin, Z. N., & Ab Jalil, H. (2021). Understanding and Readiness in Facing IR 4.0 Future Skills Transformation among UPM Trainee Counsellors. *Asian Social Science*, *17*(11), 1-69.

Barry Jon Bauer, Tracey M. Richardson, James W. Marion Jr (2014). *Int. Journal of Engineering Research and Applications* ISSN: 2248-9622, Vol. 4, Issue 4(Version 1), 269-273.

Bashook, P. G. (2005). Best practices for assessing competence and performance of the behavioral Health workforce. *Administration and Policy in Mental Health and Mental Health Services Research, 32(5-6),* 563–592.

Benayoune, A. (2022). Future skills in industry 4.0 era: Empirical evidence from oil and gas companies. *Academy Strategic Management Journal, 21(S6),* 1-14.

Bhaskar B. Gardas, Rakesh D. Raut & Balkrishna Narkhede (2019). Determinants Of Sustainable Supply Chain Management: A Case Study from The Oil and Gas *Supply Chain. Sustainable Production and Consumption, 17*. https://doi.org/10.1016/j.spc.2018.11.005.

Bhatawdekar, S., & Bhatawdekar, K. (2012). Competency and Competency Matrix. *Pune, India*: *Prodcons Group*.

Bobby Naemi, Jacob Seybert, Steven Robbins & Patrick Kyllonen (2014). Examining the WorkFORCE™ Assessment for Job Fit and Core Capabilities of FACETS™. *ETS Research Report Series 2014(2)*.

Bond, T. & Fox, C. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences (2nd)*. Mahwah, NJ: LEA.

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal, 9(2),* 27-40.

Boyatzis, R. E. (1982). *The Competent Manager: A Model for Effective Performance*. Wiley

Boyatzis, R. E. (1998). *Transforming Qualitative Information: Thematic Analysis and Code Development, 1st Edition.* SAGE Publications.

Boyatzis, R. E. (2008). Competencies in the 21st century. *Journal of Management Development, 27(1),* 5-12. doi:10.1108/02621710810840730

Boyatzis, R. E., Goleman, D., & Rhee, K. (2000). Clustering Competence in Emotional Intelligence: Insights from the Emotional Competencies Inventory. *Consortium for Research on Emotional Intelligence in Organizations,* 343-362.

British Standard BS 60079-10-1:2015, Explosive Atmospheres, Part 10-1: Classification of Area - Explosive Gas Atmosphere.

Burn, R. B. (1995). Introduction to Research Methods. Melbourne: Long man.

Campion, M. A., Fink, A. A., Ruggeberg, B. J., Carr, L., Phillips, G. M., & Odman, R. B. (2011). Doing competencies well: best practices in competency modeling. *Personnel Psychology, 64(1),* 225-262.

Cathleen Stasz (2001). Assessing Skills for Work: Two Perspective. *Oxford Economic Paper 3*, 385-405.

Chouhan, V. S., & Srivastava, S. (2014). Understanding competencies and competency modelling-A literature survey. *IOSR Journal of Business and management*, *16*(1), 14-22.

Chua Yan Piaw (2006). *Kaedah Penyelidikan. Kuala Lumpur.* McGraw-Hill.

Chung, R., & Wu, C. (2011). The identification of personnel director' s competency profile through the use of the job competence assessment method. *African Journal of Business Management, 5(2)*, 405-415.

Chung-Herrera, E. L. (2003). Grooming Future Hospitality Leaders: A Competencies Model. *Cornell Hotel and Restaurant Administration Quarterly, 41(1)*, 17-25.

Chung-Herrera, E. L. (2003). Grooming Future Hospitality Leaders: A Competencies Model. *Cornell Hotel and Restaurant Administration Quarterly, 41(1)*, 17-25.

Cohen, L., Manion, L. M., & Morrison, K. (2005). *Research Methods in Education (6th Edition)*. Routledge.

Cohen, R. J., & Swerdlik, M. E. (2002). *Psychological testing and assessment: An introduction to tests and measurement*. McGraw-Hill.

Coltman, T., Devinney, T. M., Midgley, D. F., & Venaik, S. (2008). Formative versus reflective measurement models: Two applications of formative measurement. *Journal of Business Research, 61(12)*, 1250-1262.

Crawford, L. (2005). Senior Management Perceptions of Project Management Competence. *International Journal of Project Management, 23(1)*, 7-16.

Creed, P. A., Conlon, E. G., & Dhaliwal, K. (2013). Revisiting the Academic Hardiness Scale. *Journal of Career Assessment, 21*, 537-554.

Creswell, J. W. (2012). Educational Research: *Planning, Conducting, and Evaluating Quantitative and Qualitative Research*, 4th edition, Merrill.

Cripe, J. (2011). Superior performers produce superior results. Workitect, Inc., 1-4.

Curnow, C. (2005). Competency Modeling & Job Analysis. ICF International, 1-8.

Curtis, K. R., & Cowee, M. W. (2009). Direct marketing local food to chefs: Chef preferences and perceived obstacles. *Journal of food distribution research, 40(856-2016-57832)*, 26-36.

D. Priyanta, M. B. Zaman, Semin (2021). The Development of a Risk-Based Maintenance Flowchart to Select the Correct Methodology to Develop Maintenance Strategies of Oil And Gas Equipment. *The 5th International Conference on Marine Technology (SENTA 2020)*. IOP Conf. Series: Materials Science and Engineering 1052 (2021) 012042.

Dadgar, E., Janati, A., Tabrizi, J. S., & Asghari-jafarabadi, M. (2012). Iranian Expert Opinion About Necessary Criteria for Hospitals Management Performance Assessments. *Health promotion perspectives*, 2(2), 223-230.

Dainty, A. M. J., Cheng, M-I., & Moore, D. R. (2010). A competency-based performance model for construction project managers. *Construction Management and Economic*, 22(8), 877-886.

Dalkey, N. C. (1975). IV. B. Toward a Theory of Group Estimation. *The Delphi method: Techniques and applications*, 236.

Dalkey, N. C., & Rourke, D. L. (1971). Experimental Assessment of Delphi Procedures with Group Value Judgments.

Dalkey, N., & Helmer, O. (1951). The use of expert for the estimation of bombing requirements: A project Delphi experiment. Santa Monica, CA:

Daniel Kuok Ho Tang, Fereshteh Leiliabadi, Ezutah Udoncy Olugu, Siti Zawiah binti Md Dawal (2017), Factors Affecting Safety of Processes in The Malaysian Oil and Gas Industry, *Safety Science 92*, 44-52.

Delbecq A.L., Van de Ven A.H., & Gustafson D.H. (1975). *Group Techniques for Program Planning: A Guide to Nominal and Delphi Processes*. Scott, Foresman and Co., Glenview, IL.

Department of Statistical Malaysia (Annual Aconomic Statistics 2018 Mining of Petroleum and Natural Gas) (www.dosm.gov.my)

Desmond Eseoghene Ighravwe & Sunday Ayoola Oke (2019). An Integrated Approach of SWARA and Fuzzy COPRAS for Maintenance Technicians' Selection Factors Ranking. *International Journal of System Assurance Engineering and Management, 10(6)*:1615-1626. https://doi.org/10.1007/s13198-019-00912-8.

Dubois D. (1998). *Competency-based HR Management*. Black Well Publishing.

Duckhee Chae, Hyunlye Kim, Jae Yong Yoo, Jina Lee. (2019). Agreement on Core Components of an E-Learning Cultural Competence Program for Public Health Workers in South Korea: A Delphi Study. *Asian Nursing Research 13(3)*, 184-191.

Eisa Gadi Al-Daihani, Arun Kumar Nandi, Maqhim Bender Matar & Syed Mohammad Raza (2015). Competency Based New Hires Roadmap; A Case Study of Kuwait Oil Company. *International Petroleum Technology Conference (IPTC).*

Eisa Hadi Al-Daihani, Marzouk Al-Otaibi, Juan Pablo Valdivieso and Arun Kumar Nandi (2016). Drilling Competency Model, A Case Study an Upstream Oil & Gas Company. *IADC/SPE Asia Pacific Drilling Technology Conference*.

Elijah Onoriode Olose (2016). Effective Maintenance and Reliability Program in the Production of Crude Oil and Natural Gas. *International Journal of Scientific & Engineering Research, Volume 7(2)*, 2229-5518.

Elmendorf, D. C., & Song, L. (2015). Developing indicators for a classroom observation tool on pedagogy and technology integration: A Delphi study. *Computers in the Schools, 32(1),* 1-19. https://doi.org/10.1080/07380569.2014.96 7620.

Elwerfalli, A.A., Khan, M.K. & J. Munive, E. (2018). A New Methodology for Improving TAM Scheduling in Oil and Gas Plants. *IAENG Transactions on Engineering Sciences, Vol. 2*. pp. 104-117.

Ewing, M. T., Salzberger, T., & Sinkovics, R. R. (2005). An alternate approach to assessing cross-cultural measurement equivalence in advertising research. *Journal of Advertising, 34(1),* 17-36.

Fadilah Puteh, Maniam Kalianan and Nafis Alam (2016). Employee Core Competencies and organizational excellence: An Interpretative Analysis. *Australian Journal of Business and Economic Studies, Vol. 2, No. 1.*

Faherty, V. (1979). Continuing social work education: Results of a Delphi survey. *Journal of Education for Social Work, 15(1),* 12-19.

Faizah, A. G., Megat Aman Zahari, M. Z., Shaharuddin, M. S., Mohamed Sharif, M., Mohd Ismail, M., Adibah, A. L., Azian, A. A., & Fatin Faseha, A. W. (2014).

Fatemeh Baradari, Zulkifli Mohd Nopiah, Sabirin bin Ja'afar, W.S.A. & Wan Dahalan (2021). Critical Risk Factors of Joint Venture Projects in the Oil and Gas Industry. *Jurnal Kejuruteraan 33(3),* 447-460.

Fattahi, B., Murer, A. S., & Myers, G. A. (2003, May). Technical competencies for geoscience professionals. *In SPE Western Regional Meeting* (pp. SPE-83471). SPE.

Fisher, W., Jr. (1992). Reliability, Separation, Strata Statistics. *Rasch Measurement Transactions, 6(3),* 238.

Fleiss, J. L. (1971). Measuring nominal scale agreement among many raters. *Psychological bulletin, 76(5),* 378.

Förster, B., & von der Gracht, H. (2014). Assessing Delphi panel composition for strategic foresight - A comparison of panels based on company - Internal and external participants. *Technological Forecasting and Social Change, 84,* 215-229.

França, J.E.M., Hollnagel, E., dos Santos (2021). Analysing human factors and non-technical skills in offshore drilling operations using FRAM (functional resonance analysis method). *Cogn Tech Work 23*, 553-566.

Garavan T. & McGuire D. (2001). Competencies & Workplace Learning: Some Reflections on the Rhetoric & the Reality, *Journal of Workplace Learning 13(4)*, 144-164.

Gaspar Robert (2012). A Study on the Perception of Human Resource Executives On Competency Mapping for the Superior Results. *International Journal of Social Science Tomorrow, 1(8)*.

Getha-taylor, H., Hummert, R., Nalbandian, J., & Silvia, C. (2012). Competency Model Design and Assessment: Findings and Future Directions. *Journal of Public Affairs Education, 19(1)*, 141-171.

Getrude C. Ah Gang, Shazia Iqbal Hashmi & Chua Bee Seok (2020). Perceiving The Importance of Job-Related Skills in The 4th Industrial Revolution Era From The Perspectives Of Graduates And Employers. *International Journal of Advanced Science and Technology 29 (11)*, 702-713

Gilbert, T. (1996). Human competence. Silver Spring, MD: *International Society for Performance Improvement*.

Gillian Strudwick, Lynn M. Naglec, Alicia Morgand, Margaret Ann Kennedye, Leanne M. Currief, Brian Loa & Peggy Whiteg (2019). *International Journal of Medical Informatics, 129*, 211–218.

Gossler, T., Sigala, I. F., Wakolbinger, T., & Buber, R. (2019). Applying the Delphi method to determine best practices for outsourcing logistics in disaster relief. *Journal of Humanitarian Logistics and Supply Chain Management, 9*(3), 438-474. doi: 10.1108/JHLSCM-06-2018-0044

Green, K. E., & Frantom, C. G. (2002). Survey development and validation with the Rasch Model. *In International Conference on Questionnaire Development, Evaluation and Testing, Charleston, SC*, 1-42.

Grosse, M.E. & Wright, B.D. (1986) Setting, evaluating, and maintaining certification standards with the Rasch model. *Evaluation and the Health Professions, 9*, 267-285.

Guest, D. E. (2011). Human resource management and performance: a review and research agenda. *The International Journal of Human Resource Management (March 2014)*, 37–41. doi:10.1080/095851997341630

Gurvinder Kaur Gurcharan Singh & Sharan Kaur Garib Singh (2008). Malaysia Graduates Employability Skills. *Unitar E-Journal, 4(1).*

H.J. Hwanga, J.H. Lee, J.S. Hwang & H.B. Jun (2018). A study of the development of a condition-based maintenance system for an LNG FPSO. *Ocean Engineering 164*, 604-615, https://doi.org/10.1016/j.oceaneng.2018.07.004.

Haridoss, S. (2017). Health and safety hazards management in oil and gas industry. *Int. J. Eng. Res, 6,* 1058-1061.

Hasson, F., & Keeney, S. (2011). Enhancing rigour in the Delphi technique research. *Technological Forecasting and Social Change, 78(9),* 1695-1704.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of advanced nursing, 32(4),* 1008-1015.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of advanced nursing, 32(4),* 1008-1015.

Hazinah K. Mammi and Norafida Ithnin (2012). Competency based Education (CBE) for IT Security: Towards Bridging the Gap. Preparation Of Papers for The *International Journal of Engineering Pedagogy, (2)4.*

Heather Getha-Taylor, Raymond Hummert, John Nalbandian & Chris Silvia (2013). Competency Model Design and Assessment: Findings and Future Directions, *Journal of Public Affairs Education 19, (1),* 141-171.
doi: 10.1080/15236803.2013.12001724

Heiko, A. (2012). Consensus measurement in Delphi studies: review and implications for future quality assurance. *Technological forecasting and social change, 79(8),* 1525-1536.

Heslin, P. A. (2005). Conceptualizing and evaluating career success. *Journal of Organizational behavior, 26(2),* 113-136.

Hogg B. (1989). Realizing the Potential of Your Employees through Assessment and Development. London: Tata- McGraw-Hill Training Series

Hon Chung Lau (2017). Competency Development for the Next Generation of Petroleum Engineer. *Abu Dhabi International Petroleum Exhibition & Conference.*

Hornby, D and Thomas, R (1989). Towards a Better Standard of Management. *Personnel Management, January, 21(1),* 52-55.

Horng Jeou-Shyan, Hsu Hsuan, Liu Chih-Hsing, Lin Lin, Tsai Chang-Yen (2011). Competency analysis of top managers in the Taiwanese hotel industry. *International Journal of Hospitality Management, 30(4)*, 1044-1054.

Ismail, A. A., & Hassan, R. (2019). Technical Competencies in Digital Technology Towards Industrial Revolution 4.0. *Journal of Technical Education and Training, 11(3)*.

Ismail, A., Kasman, Z., Sumarwati, S., Nur Yunus, F.A. & A. Samad N. (2019). The Development of Job Competency for Skilled Technical Worker towards Green Technology. *International Journal of Geomate, 17(59)*, 216-221.

Isra Sarfraz, Diana Rajendran, Chandana Hewege, and Mohan Dass Mohan (2018). An exploration of global employability skills: a systematic research review. *International Journal of Work Organisation and Emotion, 9(1),* 63-88.

Izatul Hamimi Abdul Razak, Shahrul Kamaruddin & Ishak Abdul Azid (2011). Implementation of the Workforce Competency Model for assessing maintenance worker's performance. *International Journal of Productivity and Quality Management, 7(4)*.

Jacky Chin, Herlina, Shu-Chiang Lin, Satria Fadil Persada, Choesnul Jaqin & Ilma Mufidah (2019). Preventive maintenance model for heating ventilation air conditioning in pharmacy manufacturing sector. *International Journal of System Assurance Engineering and Management*. doi: 10.1007/s13198-019-00923-5.

Jacobs, H. H. (1989). *Interdisciplinary Curriculum: Design and Implementation.* Association for Supervision and Curriculum Development, 1250 N. Pitt Street, Alexandria, VA 22314.

Jailani, M. Y., Wan Mohd Rashid, W. A., Noraini, K., & Wahid, R. (2010). Technical & Vocational Education & Training (TVET) from Malaysia Perspective. 2nd *International TT-TVET EU-ASIA-Link Project Meeting, VEDC Malang.*

Jimmy Kansal & Sandeep Singhal (2018). Development of a competency model for enhancing the organisational effectiveness in a knowledge-based organisation. *International Journal Indian Culture and Business Management, 16(3)*.

John Connor, Mark Butterworth, Karen Casey, Geoff Eddon, Jared Kapela, Chidinma Maduka & Moustafa Osman (2014). Evolution of The Nature and Application of Competence in The Learning and Development of Oil and Gas Industry Personnel. *International Petroleum Technology Conference.*

John Ojuola, Sherif Mostafa & Sherif Mohamed (2020). Investigating the Role of Leadership in Safety Outcomes within Oil and Gas Organisations. *Safety and Reliability*, ISSN: 0961-7353.

Johnson, C., Surlemont, B., Nicod, P., & Revaz, F. (2005). Behind the Stars a Concise *Typology of. Cornell Hotel and Restaurant Administration Quarterly, 46(170)*, 170-187. doi:10.1177/0010880405275115

Johnson, R. E., Rosen, C. C., & Djurdjevic, E. (2011). Assessing The Impact of Common Method Variance on Higher Order Multidimensional Constructs. *Journal of Applied Psychology. 96(4)*, 744-761. doi: 10.1037/a0021504.

Jr, W., Bennett Jr, W., Edens, P. S., & Bell, S. T. (2003). Effectiveness of training in organizations: a meta-analysis of design and evaluation features. *Journal of Applied psychology, 88(2)*, 234.

K. C. Ikwunze & H. U. Nwosu (2016). Developing Maintenance Model for Effective Oil and Gas Equipment Management: A Case Study. *International Journal of Advanced Academic Research Sciences, Technology & Engineering*, ISSN: 2488-9849 (2)5.

Kahirol Mohd Salleh, Nur Hidayah Khalid, Nor Lisa Sulaiman, Mimi Mohaffyza Mohamad, Lai Chee Sern (2015). Competency of Adult Learners in Learning. *Application of the Iceberg Competency Model, Procedia - Social and Behavioral Sciences, 204*, 326-334.

Kamaruzaman, M. F., Hamid, R., Mutalib, A. A., & Rasul, M. S. (2019). Comparison of Engineering Skills with IR 4.0 Skills. *International Journal of Online and Biomedical Engineering (iJOE), 15(10)*, 15-28.

Kamaruzzaman, S. N., Lou, E. C. W., Wong, P. F., Edwards, R., Hamzah, N., & Ghani, M. K. (2019). Development of a non-domestic building refurbishment scheme for Malaysia: A Delphi approach. *Energy, 167*, 804-818.

Kamis, A. & Talib, S. (2017). Development of Automotive Technology Competency Constructs by Modified Delphi Method. *International Journal of Engineering Research and Application, 7(12),* pp. 18-24.

Kansal, J. and Singhal, S. (2018). Development of a competency model for enhancing the organisational effectiveness in a knowledge-based organisation, *International Journal Indian Culture and Business Management, 16(3)*, 287-301.

Katarzyna Grzybowska & Anna Łupicka (2017). Key competencies for Industry 4.0. *Economics & Management Innovations, 1(1),* 250-253.

Kearns, P. (2001). *Generic Skills for the New Economy. Review of Research*. National Centre for Vocational Education Research, 252 Kensington Road, Leabrook, South Australia 5068, Australia.

Khairani, A. Z. (2017). Assessing Urban and Rural Teachers' Competencies in STEM Integrated Education in Malaysia. *MATEC Web of Conferences, 87,* 04004. https://doi.org/10.1051/matecconf/20178704004.

Klemp, G. O. (1980). Assessment of Occupational Competence. Washington DC: National Institute of Education.

Koehler, T. C., Bok, H., Westerman, M., & Jaarsma, D. (2019). Developing a competency framework for pharmacy technicians: perspectives from the field. *Research in Social and Administrative Pharmacy*, *15*(5), 514-520.

Konigova, M., Urbancova, H., & Fejfar, J. (2012). Identification of Managerial Competencies in Knowledge-based Organizations. *Journal of Competitiveness, 4(1),* 129-142.

Lambert, B., Plank, R. E., Reid, D. A., & Fleming, D. (2014). A Competency Model for Entry Level Business-to-Business Services Salespeople. *Services Marketing Quarterly, 35,* 84-103.

Le Deist, Françoise Delamare, Winterton & Jonathan (2005). What Is Competence? *Human Resource Development International, 8(1),*27 46. doi:10.1080/1367886042000338227.

Lee, Y.T. (2010). Exploring high performers' required competencies. *Expert Systems with Applications, 37(1),* 434–439. doi: 10.1016/j.eswa.2009.05.064.

Legendre, P. (2005). Species associations: the Kendall coefficient of concordance revisited. *Journal of Agricultural, Biological, and Environmental Statistics, 10(2),* 226-245.

Lerdal, A., Opheim, R., Gay, C. L., Moum, B., Fagermoen, M. S., & Kottorp, A. (2017). Psychometric limitations of the 13-item Sense of Coherence Scale assessed by Rasch analysis. *BMC Psychology, 5(1),* 18. https://doi.org/10.1186/s40359-017-0187-y

Leung, R., & Law, R. (2010). A review of personality research in the tourism and hospitality context. *Journal of Travel & Tourism Marketing, 27(5),* 439-459.

Linstone, H., & Turoff, M. (1975). The Delphi method: Techniques and applications. London, UK: Addison-Wesley.

Lotovskyi E, Teixeira AP, Guedes Soares C. (2020). Availability Analysis of An Offshore Oil and Gas Production System Subjected to Age-Based Preventive Maintenance by Petri Nets. *Maintenance and Reliability, 22 (4),* 627-637.

Lounsbury, J.W., Sundstrom, E.D., Gibson, L.W., Loveland, J.M. and Drost, A.W. (2016). Core Personality Traits of Managers. *Journal of Managerial Psychology, (31)2,* 434-450. https://doi.org/10.1108/JMP-03-2014-0092.

Lucia, A. D., & Lepsinger, R. (1999). The Art and Science of Competency Models: Pinpointing Critical Success Factors in Organizations, 1st Edition.

Lucian Cernusca and Cristina Dima (2007), Competency and Human Resource Management. *International journal of psychology, 2*.

Ludwig, L., & Starr, S. (2005). Library as place: results of a Delphi study. *Journal of Medical Library Association, 93(3),* 315-326.

Madar, A. R., & Buntat, Y. (2011). Elements of employability skills among students from Community Colleges Malaysia. *Journal of Technical, Vocational & Engineering Education, 4*, 1-11.

Maggie Kumar & Jonathan Stern (2020) Gas Industry Reform and the Evolution of a Competitive Gas Market in Malaysia. Oxford Institute for Energy Studies.

Mahlangu (Kubheka), S.R., & Govender, C. (2015). Management competencies required in the transition from a technician to a supervisor. *SA Journal of Human Resource Management 13(1).*

Mahmood, W.H.W., Rahman, M.N.A., Deros, B.M. and Mazli, H. (2011) Maintenance management system for upstream operations in oil and gas industry: a case study. *Int. J. Industrial and Systems Engineering, 9 (3),* 317-329.

Mak Met & Ibrahim Ali (2014). Investigating the Moderating Effect of Demographic Factors on the Relationship between Monetary Motivation and Employees' Job Satisfaction at Oil and Gas Offshore Production Facilities in Malaysia. *International Review of Management and Business Research. 3(2),* 788-818.

Mansfield, B. (2005). Practical Questions in Building Competency Models. Workitect.

Mariah Awang, Abdul Hakim Mohammad, Maimunah Sapri & Mohd Shahril Abdul Rahman (2014). Requisite Facilities Management Competencies for

Sustainable Development at Higher Education Institutions. *Journal of Sustainability Science and Management, 9(2)*, 71-89.

Marrelli, A. F., Tondora, J., & Hoge, M. a. (2005). Strategies for Developing Competency Models. *Administration and Policy in Mental Health and Mental Health Services Research, 32(5-6)*, 533-561.

Marrelli, A. F., Tondora, J., & Hoge, M. a. (2005). Strategies for Developing Competency Models. *Administration and Policy in Mental Health and Mental Health Services Research, 32(5-6)*, 533-561.

Maurer, T. J., Wrenn, K. a., Pierce, H. R., Tross, S. a., & Collins, W. C. (2003). Beliefs about improvability of career-relevant skills: relevance to job/task analysis, competency modelling, and learning orientation. *Journal of Organizational Behavior, 24(1)*, 107-131.

Maxwell Asumeng (2014). Managerial Competency Models: A Critical Review and Proposed Holistic-Domain Model. *Journal of Management Research, 2(4)*.

Mayer, J.D., & Faber, M.A. (2010). Personal intelligence and resilience: recovery in the shadow of broken connections. In Reich, J.W., Zautra, A.J., & Hall, J.S. (Eds.), Handbook of adult resilience (pp. 94-111). New York, NY: The Guildford Press

Mcadams, D. P. & Pals, J. L. (2006). A New Big Five: Fundamental Principles for and Integrative Science of Personality. *American Psychologist 61(3),* 204-17

McClelland, D. C. (1973). Testing for competence rather than for intelligence. *American psychologist, 28(1)*, 1.

Md. Nasir, A.N., Ali, D.F. Noordin, M.K., & Nordin, M.S. (2011). Technical skills and non-technical skills: Predefinition concept. *Proc. of the IETEC'11 Conference. Kuala Lumpur, Malaysia: Taylor's University*. 1-17.

Medina, R. (2010). Upgrading yourself-technical and nontechnical competencies. Potentials, *IEEE, 29(1)*, 10-13.

Mehmet Sercan Uztosun (2018). Professional competences to teach English at primary schools in Turkey: a Delphi study. *European Journal of Teacher Education, 41(4),* 549-565.

Minghat, A.D., Yasin, R.M. & Udin, A. (2012). The Application of the Delphi Technique in Technical and Vocational Education in Malaysia. *International Proceedings of Economics Development and Research, 30(1)*, 259-264.

Mir Hadi Moazen Jamshidi, Amran Rasli & RorlindaYusof (2012). Essential Competencies for the Supervisors of Oil and Gas Industrial Companies. *Procedia - Social and Behavioral Sciences, 40*, 368 – 374.

Mohd F. Kamaruzaman, R Hamid, A A Mutalib, M S Rasul (2019). Comparison of Engineering Skills with IR 4.0 Skills. *International Journal of online and Biomedical Engineering, 15(10).*

Mohd Farhaan Shah, Two injured in explosion and fire at Pengerang O&G facility, 12th April 2019. The Star.

Mohd Z. Nor (2019). Developing a preliminary questionnaire for the faculty development programme needs of medical teachers using Delphi technique. *Journal of Taibah University Medical Sciences, 14(6)*, 495-501.

Morshed, A. (2014, March). Corrosion management and the widening competency gap. *In NACE CORROSION* (pp. NACE-2014). NACE.

Munirah, M. M., Libriati, Z., Nordin, Y., & Norhazilan, M. N. (2019). Prioritization of the human health and safety loss factor subject to offshore pipeline accidents. In *IOP Conference Series: Earth and Environmental Science*, *220(1)*. IOP Publishing.

Mustafa, M. S. S., Zakaria, A. F., Che'Om, S. S. Z., Yusop, F. M, Yunus, F. A. N., & Rahman, M. A. A. (2022). Predicting Job Satisfaction of Malaysian Mechanical Ventilation and Air Conditioning Maintenance Personnel in the Oil and Gas Sector. *Humanities and Social Sciences Letters, 10(3)*, 256-267.

Nasir, A. N. M., Ali, D. F., Noordin, M. K. B., & Nordin, M. S. B. (2011). Technical Skills and Non-Technical Skills: Predefinition Concept. *Proceedings of the IETEC'11 Conference*, Kuala Lumpur, Malaysia.

Ngu, K. M., Philip, N., & Sahlan, S. (2019). Proactive and Predictive Maintenance Strategies and Application for Instrumentation & Control in Oil & Gas Industry. *International Journal of Integrated Engineering, 11(4)*.

Nikbakht, M., Sayyah, A., & Zulkifli, N. (2010, September). Hazard identification and accident analysis on city gate station in natural gas industry. *In 2010 International Conference on Environmental Engineering and Applications*, 13-17. IEEE.

Nordhaug, O., & Gronhaug, K. (1994). Strategy and Competence in Firms. *European Management Journal, 10(4)*, 438-444.

Nordin, M. S., Nasir, A. N. M., Noordin, M. K., & Buntat, Y. (2013). Gap of proficiency for skilled workers and employer needs towards Non-technical Skills for electronic sector in Klang Valley, Malaysia. *Procedia-Social and Behavioral Sciences, 93*, 1473-1477.

Nordin, M. S., Nasir, A. N. M., Noordin, M. K., & Buntat, Y. (2013). Gap of proficiency for skilled workers and employer needs towards Non-technical Skills for electronic sector in Klang Valley, Malaysia. *Procedia-Social and Behavioral Sciences, 93*, 1473-1477.

Nornazira Suhairom, Aede Hatib Musta'amal, Nor Fadila Mohd Amin, Yusri Kamin & Nur Husna Abdul Wahid (2019). Quality culinary workforce competencies for sustainable career development among culinary professionals. *International Journal of Hospitality Management, 81*, 205-220.

NOSS, National Occupational Skills Standard Development Guidelines (2014). Department of Skills Development.

Nurhazirah Hashim, Nor Irvoni Mohd. Ishar, Wan Edura Wan Rashid & Mohd. Saidfudin Masodi (2015). Personality Traits, Work-Family Conflict and Job Satisfaction: Items Validity using Rasch Measurement Approach. *Procedia - Social and Behavioral Sciences 65*, 1013-1019.

Nurul Syuhadah Khusaini, Nor Hayati Saad, Nurul Hayati Abdul Halim, Salmiah Kasolang and Bulan Abdullah (2017). Engineering Education Final Examination Assessment using Rasch Model. *Pertanika Journal Social Sciences & Humanities, 25*, 403-412.

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & Management, 42(1)*, 15-29.

O'Neill, S., Scott, M., & Conboy, K. What's technology got to do With IT? A Dephi study on. *development*, *10*, 7-00.

Othman, I., Napiah, M., Nuruddin, M.F & Klufallah, M.M.A (2015), Effectiveness of Safety Management in Oil and Gas Project. *Applied Mechanics and Material, 815*, 429-433.

P. Joshi, L. Haghnegahdar, Z. Anika & M. Singh (2017). Supply Chain Innovations in the Oil and Gas Industry. *Proceedings of the 2017 Industrial and Systems Engineering Conference*.

Page C. and Wilson (1994). *Management Competencies in New Zealand. On the inside looking in Wellington*. Ministry of Commerce

Panayides, P., Gavrielides, M., Galatopoulos, C., & Gavriilidou, M. (2013). Using Rasch Measurement to Create a Quality of Sleep Scale for a Non-Clinical Sample Based on the Pittsburgh Sleep Quality Index (PSQI). *Europe's Journal of Psychology, 9(1),* 113-135.

Peltokangas, H. (2014). The Use of Personality Measures in Personnel Selection: The Person-Job Fit and Its Relationship to Leaders' Performance and Burnout. *American International Journal of Social Science, 3(4),* 185–193.

Pensavalle, C. A., & Solinas, G. (2013). The Rasch Model Analysis for Understanding Mathematics Proficiency - A Case Study: Senior High School Sardinian Students. *Creative Education, 4(12),* 767.

Petra Lietz (2010). Research into Questionnaire Design: A Summary of the Literature. *International Journal of Market Research, 52(2).*

Prastacos, G. P., Soderquist, K. E., & Vakola, M. (2005). A strategic forward-looking approach to competency modelling. *Strategic Leadership Review, 2(2),* 1-5.

Prieto, L., Alonso, J., & Lamarca, R. (2003). Classical test theory versus Rasch analysis for quality of life questionnaire reduction. *Health and quality of life outcomes, 1,* 1-13.

R.N.S. Murali, Six Hurt in Platform Baze, 15th December 2010. The Star.

Rachel L. Bissett, Michael S. H. Cheng, & Robert G. Brannan (2010). Qualitative Assessment of Culinary Science Competencies Defined by the Research Chefs Association. *Journal of Culinary Science & Technology, 7*, 285–293

Rahim M. S., Abdul Rahman M. A., Asnarulkhadi A. S., Azimi H., Sidek M. N., Zakaria K. (2007). Handbook on Social Skills and Social Values in Technical Education and Vacation Training, Kementerian Sumber Malaysia.

Rahmat, A. M., Adnan, A. H. M., & Mohtar, N. M. (2019). Industry 4.0 Skill sets and 'Career Readiness': Can MalaysianUniversity Students face the Future of Work? In MNNF Network (Ed.), *Proceedings of the International Invention, Innovative &Creative (InIIC) Conference*, Series 2/2019, 28-37.

Rand. Dalkey, N., & Helmer, O. (1963). An experimental application of the Delphi Method to the use of experts. *Management Science, 9,* 458-467.

Reader, T. W., & O'Connor, P. (2014). The Deepwater Horizon explosion: non-technical skills, safety culture, and system complexity. *Journal of Risk Research, 17*(3), 405-424. doi: 10.1080/13669877.2013.815652

Richard F. Fellows, Anita M. M. Liu (2009). Research Methods for Construction, 4th Edition.

Rizki ParahitaAnandi & Muhammad Azhar Zailaini (2019). Using Rasch Model to Assess Self-Assessment Speaking Skill Rubric for Non-Native Arabic Language Speakers. *Pertanika Journal Social Sciences & Humanities, 27 (3),* 1469-1480.

Rodney C. Vandeveer & Michael L. Menefee (2010). Human Behavior in Organizations, 2nd Edition.

Rodriguez, D., Patel, R., Bright, A., Gregory, D., & Gowing, M. K. (2002). Developing competency models to promote integrated human-resource practices. *Human Resource Management, 41*(3), 309–324. https://doi.org/10.1002/hrm.10043

Rothmann, I., & Cooper, C. (2008). Organizational and Work Psychology. Hodder Education (303)

Rothwell, W. J., & Graber, J. M. (2010). Competency-based training basics (ASTS Training Basics Series). *American Society for Training and Development. Danvers, MA: Copyright Clearance Center*.

Rus, R. C., Yasin, R. M., & Rasul, M. S. (2014). From zero to hero: Becoming an employable knowledge worker (k-worker) in Malaysia. *TVED@ Asia*, *3*, 1-16.

Sabitha, M. (2005). Kaedah penyelidikan sains sosial. *Petaling Jaya, Selangor: Pearson Prentice Hall*.

Sanchez, J. I., & Levine, E. L. (2009). Human Resource Management Review What is (or should be) the difference between competency modeling and traditional job analysis ? *Human Resource Management Review, 19(2),* 53–63.

Schmidt, R., Lyytinen, K., Keil, M., & Cule, P. (2001). Identifying software project risks: An international Delphi study. *Journal of Management Information Systems, 17*, 5-36. https://doi.org/10.1080/07421 222.2001.11045662

Schmitt, N. (2014). Personality and cognitive ability as predictors of effective performance at work. *Annu. Rev. Organ. Psychol. Organ. Behav., 1*(1), 45-65.

Scholl, S. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational researcher, 32(5),* 19-25.

Sekaran, U. (2003). Research methods for business. Hoboken.

Shatina Saad, Zulkifli Mohamed Udin & Norlena Hasnan (2014). Dynamic Supply Chain Capabilities: A Case Study in Oil and Gas Industry. *International Journal Supply Chain Management, 3(2)*.

Sinead Keeney, Felicity Hasson & Hugh P. McKenna (2001), critical review of the Delphi technique as a researchmethodology for nursing. *International Journal of Nursing Studies, 38*, 195-200.

Sitthisak, O., Gilbert, L., & Davis, H. C. (2009). Transforming a competency model to parameterised questions in assessment. In *Web Information Systems and Technologies: 4th International Conference, WEBIST 2008, Funchal, Madeira, Portugal, May 4-7, 2008, Revised Selected Papers 4* (390-403). Springer Berlin Heidelberg.

Six Secrets: Searching for Self Success, Malaysia Technology Expo 2014.

Spencer, L. M., & Spencer, S. M. (1993*). Competence at Work: Models for Superior Performance*, 1st Edition. John Wiley & Sons. USA.

Stangor, C. (2011). *Research methods for the behavioral sciences*. Cengage Learning

Staškeviča, A. (2019). The Importance of Competency Model Development, *Acta Oeconomica Pragensia*, *27(2)*: 62-71.

Stephen Then, Five Hurt in Oil Drilling Platform Fire, 12th June 2012. The Star.

Stevens, G. W. (2013). A critical review of the science and practice of competency modeling. *Human Resource Development Review, 12(1)*, 86-107.

Strauss, A., and Corbin, J. M. (1997). Grounded theory in practice. Thousand Oaks: Sage.

Strauss, J. P., & Connerley, M. L. (2003). Demographics, personality, contact, and universal-diverse orientation: An exploratory examination. *Human Resource Management, 42*(2), 159-174. https://doi.org/10.1002/hrm.10074

Su, C.T., & Parham, L. D. (2002). Generating a valid questionnaire translation for cross-cultural use. *American Journal of Occupational Therapy, 56(5)*, 581-589.

Suhairom, N., Musta'amal, A. H., Mohd Amin, N. F., Nordin, M. K., & Ali, D. F. (2016). Quality indicators in the field of culinary professions in Malaysia – a method of developing competency profiling through self-assessment. *TVET@Asia, 7*, 1-22.

Sullivan, O. (1995). Demonstration of portfolios to assess competency of residents. *Advances in Health Sciences Education, 9(4)*, 309-323.

Syan, C. S., & Ramsoobag, G. G. (2016). Design of a Maintenance Optimisation Approach for Offshore Oil and Gas Production Systems. In *CAD/CAM, Robotics and Factories of the Future: Proceedings of the 28th International Conference on CARs & FoF 2016* (pp. 43-50). Springer India. https://doi.org/10.1007/978-81-322-2740-3_5

Tang, D. K. H., Dawal, S. Z. M., & Olugu, E. U. (2018). Actual safety performance of the Malaysian offshore oil platforms: Correlations between the leading and lagging indicators. *Journal of safety research, 66*, 9-19.

Vagias, W. M. (2006). Likert-type scale response anchors. *Clemson International Institute for Tourism & Research Development, Department of Parks, Recreation and Tourism Management. Clemson University*.

Wan Ahmad, W. S. (2007). To inculcate training culture amongst Malaysian industry through national dual training system (NDTS). *Retrieved February*, *20*(2012), 25-30.

Wayne F. Cascio & Herman Aguinis (2005). Test development and use: New twists on old questions., 44(3), 219–235 Cascio, W. F., & Aguinis, H. (2005). Test development and use: New twists on old questions. *Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management*, *44*(3), 219-235. doi:10.1002/hrm.20068

Woodman, S., Bearman, C., & Hayes, P. (2021). Understanding skill decay and skill maintenance in first responders. *The Australian Journal of Emergency Management, 36(4)*, 44-49.

Woods, S. K. (2011). Self-assessment. In A. Schwartz (Ed.). Assessment In Graduate Medical Education: A Primer for Pediatric Program Directors, Chapel Hill, *NC: American Board of Pediatrics,* 29-35.

Wright, B. D., & Grosse, M. (1993). How to set standards. *Rasch Measurement Transactions, 7(3)*, 315.

Wright, B. D., & Masters, G. N. (2002). Number of person or item strata. *Rasch Measurement Transactions, 16(3)*, 888.

Yaman, S. K., Abdullah, A. H., Mohammad, H., & Hassan, F. (2015). Technical competency of construction manager in Malaysian construction industry. *Applied mechanics and materials, 773*, 1053-1059.

Yang, Z., Pedersen, S., & Durdevic, P. (2014, August). Control of variable-speed pressurization fan for an offshore HVAC system. In *2014 IEEE International Conference on Mechatronics and Automation*, 458-463. IEEE.

Young, M., & Dulewicz, V. (2005). A model of command, leadership and management competency in the British Royal Navy. *Leadership & Organization Development Journal, 26(3)*, 228–241.

Yunus, F. A. N., Rahim, M. B., Razali, M. N., & Abdul Rahman, K. A. (2022). Elements of Competency for Facility Engineers in The Field of Refrigeration and Air Conditioning. *Online Journal for TVET Practitioners, 7(2)*, 38-43.

Yusof, H. M., Mustapha, R., Mohamad, S. A. M. S., & Bunian, M. S. (2012). Measurement model of employability skills using confirmatory factor analysis. *Procedia-Social and Behavioral Sciences, 56*, 348-356.

Zakaria, Z., & Som, H. M. (2001). *Analisis data menggunakan SPSS WINDOWS*. Penerbit Universiti Teknologi Malaysia (UTM).

Zhang, Q., & Zhang, T. (2015). Rasch Model: Status Quo & Prospect in China. *(PROMS) 2014 Conference Proceedings.*

LIST OF PUBLICATIONS

M M Syafiq Syazwan, Fatimah Yusop, Mohd Bekri Rahim, Kamarul Aini Mohd Sari, Nurdalila Saji and Norshuhaila Mohamed Sunar (2021) Needs Assessment for The Development of Competency Heating Ventilation and Air Conditioning (HVAC) Supervisor and Technician In Oil And Gas Industry Malaysia, AIP Conference Proceedings, 020043-1, ISBN:9780735441187. (Scopus-indexed)

Mohd Syafiq Syazwan Mustafa, Anies Faziehan Zakaria, Siti Shaidatul Zarifah Che Om, Fatimah Mohamed Yusop, Faizal Amin Nur Yunus & Mohammad Ashraf Abdul Rahman (2022). Predicting Job Satisfaction of Malaysian Mechanical Ventilation and Air Conditioning Maintenance Personnel in The Oil and Gas Sector, Humanities and Social Sciences Letters, Conscientia Beam, 7, 256, ISSN:23124318. (Scopus-indexed)

M. M. Syafiq Syazwan, F. Yusop, M. S. Saad, K. A. Mohd Sari, A. A. M. Damanhuri, N. N. Mat Hassan, A. R. Fahmi (2023). Identification of competency supervisor and technician heating ventilating and air conditioning (HVAC) maintenance in oil and gas industry Malaysia. AIP Conference Proceedings. 2544, 040029-1–040029-1, ISBN:9780735443228. (Scopus-indexed)

VITA

The author was born on December 25th, 1987, in Kuala Lumpur. He went to Sekolah Kebangsaan Wangsa Melawati and Sekolah Menengah Teknik Setapak Kuala Lumpur for his primary and secondary school respectively. He obtained his Diploma in Engineering Technology (Air conditioning and Refrigeration Technology) in 2008 and Bachelor's Degree in Engineering Technology (Air conditioning and Industrial Refrigeration Technology) in 2011 at Universiti Kuala Lumpur Malaysia France Institute (UniKL MFI). He further pursued his part time Master's Degree by research in Mechanical Engineering at Universiti Tun Hussein Onn Malaysia (UTHM) and graduated Master's Degree in Mechanical and Manufacturing Engineering in 2017. During this time, he pursues his Doctoral Philosophy in Engineering Technology under Faculty of Engineering Technology (FTK), UTHM. He worked as Maintenance Engineer specializing in heating, ventilation and air conditioning (HVAC) in oil and gas industry for 8 years. In 2019, he joined academic field and worked as Industrial Fellow in Department of Civil Engineering Technology, Faculty of Engineering Technology, UTHM. He has been teaching the related subject of Mechanical Engineering for the past 4 years and actively involved in research focusing on maintenance management, building services, indoor air quality (IAQ), thermal comfort and HVAC system. He is also a Professional Technologies (Ts.) under Malaysia Board of Technology (MBOT).