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A Study On A Model To Improve The Competency Of The Operator Who Operates Water Boiler Or Boilers That Use Liquid As A Heat Carrier Under The Supervision Of The Ministry Of Industry

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Abstract

This study aimed to analyze the confirmatory factors of a study on a model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry. The sample group used in the quantitative research was 495 participants who attended the lecture in the course for the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry for the fiscal year 2019 to 2022 of the training center of Institute of Technology Development for Industry. The research instrument was a 5-level rating scale questionnaire based on the Likert method and relative model fit index by confirmatory factor analysis.

Research results revealed that that the participants who attended the lecture had an intention to develop the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry, as a whole, in a high level. Results of the confirmatory factor analysis showed that the structural equation model for the a study on a model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry was consistent with the empirical data (χ^2 = 176.332, df = 149, p = 0.063, χ^2/df = 1.183, GFI = 0.964, RMSEA = 0.019)

Keywords: Competency, Development Model, Water Boiler Operator

Introduction

The revised version of development guidelinelines in the 3-year government action plan (2020-2022) of the Department of Industrial Works, for the fiscal year 2021, aims to drive the manufacturing sector to be balanced, stable and sustainable. It also promotes and develops industries that are in line with the country's basic competency as the application of science, information technology and innovation will increase productivity, value and standards, as well as strengthen the competency of entrepreneurs and compete on the world arena. The development of supporting factors in terms of laws and regulations facilitating industrial business operations, managing and supervising industrial businesses including hazardous substances in production, environment, and safety in accordance with legal frameworks and international agreements, promotion and support of information and knowledge on machinery, production, environment, and safety Hazardous Substances, Energy and Social Responsibility aim to benefit industrial business development as well as developing organizational and personnel competencies (Department of Industrial Works, 2019).

Currently, there are about 5,000 boilers used in the industrial plants nationwide. The most common accident is an explosion, which causes serious damage to the lives and property of the plant and its neighboring residents. Notification of the ministry of industry on safety measures regarding water boiler or boilers that use liquid as a heat carrier, B.E. 2549 (2006), clause 15, stipulates that the plant using water

boiler or boilers that use liquid as a heat carrier must provide a controller for water boiler or boilers that use liquid as a heat carrier to be responsible for the use of the water boiler or boilers that use liquid as a heat carrier (Government Gazette, 2006). Therefore, safety in working with water boiler or boilers that use liquid as a heat carrier is essential for those involved, in particular, the controller of the water boiler or boilers that use liquid as a heat carrier, who is responsible to control daily operation, inspection and maintenance of water boiler or boilers that use liquid as a heat carrier, must be competent in the work of knowledge, skills and attributes for efficient operation (McClelland, 1973). However, based on the past training, some attendants were unable to pass the curriculum on " the operator who operates water boiler or boilers that use liquid as a heat carrier ". This may be due to many factors such as the curriculum, lecturers, the readiness of the attendants as well as incentives of establishments, etc.

The training center of Institute of Technology Development for Industry (ITDI), is a government agency in King Mongkut's University of Technology North Bangkok, with the mission to be a center for providing academic services to government agencies, industry, private sector, independent agency, public agencies and communities, creating a network of cooperation with government agencies, industry, private sector, independent agency, public agencies and communities in the country's economic development to increase the efficiency of organizational management with good governance, increasing the personnel competency of the agency to become professional with a vision to provide quality academic services that meet the needs of government agencies, industry, private sector, independent agency, public agencies and communities and can be self-reliant. In addition, it is an agency that has been registered as a training unit for "Course for the operator who operates water boiler or boilers that use liquid as a heat carrier " as per the notification of the ministry of industry on safety measures regarding water boiler or boilers that use liquid as a heat carrier, B.E. 2549 (2006), which has organized a large number training for people involved until now (2022). The agency has foreseen the importance of the aforementioned problems, therefore it has interest in studying a model to develop the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry to have knowledge and skills for working with safety in working with water boiler or boilers that use liquid as a heat carrier under government requirements accordingly.

Research's Objectives

1. To study key components factors in developing the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry.

2. To analyze the confirmatory factors of a model to develop the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry.

3. To prepare a manual to develop the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry.

Benefits.

1. The Training Center of Institute of Technology Development for Industry (ITDI) is a government agency in King Mongkut's University of Technology North Bangkok is aware of the significant components of the improvement of the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry to be used in the development of training courses, guidelinelines, and training methods of lecturer.

2. Relevant government agencies especially Department of Industrial Works, Ministry of Industry, is aware on the competency development of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry. The information obtained from this research can be used for policy purposes in order to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry to have the knowledge and skills that necessary for operations to comply with safety measures related to water boiler or boilers that use liquid as a heat carrier under government requirements.

Hypothesis. There are 3 main components of a model to develop the competency of the operator

who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry, namely, Knowledge, Skills, and Attributes where all main components are under the key component.

Materials and Methods

1. Population and sample

1.1 There were 7 informants in the in-dept interview, namely, knowledgeable and experienced professors in providing knowledge and Experienced lecturers in organizing training courses for the operator who operates water boiler or boilers that use liquid as a heat carrier who have qualifications as specified by the Department of Industrial Works.

1.2 There were 543 respondents of questionnaire, namely, participants who attended to a lecture on the topic related to the operator who operates water boiler or boilers that use liquid as a heat carrier with the qualifications specified by the Department of Industrial Works, Ministry of Industry organized by The Training Center of Institute of Technology Development for Industry (ITDI),

King Mongkut's University of Technology North Bangkok, Fiscal Year 2019 – 2022. The samples were defined from the entire population.

1.3 There were 15 experts in a Focus Group Discussion to create principles and concepts to be used in improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry, consisting of knowledgeable and experienced professors in providing knowledge and Experienced lecturers in organizing training courses for the operator who operates water boiler or boilers that use liquid as a heat carrier who have qualifications as specified by the Department of Industrial Works. Water boiler experts from government agencies, experts in human resource development and relevant academics.

2. Research Variables

2.1 Structural variables consisting of 3 components: Knowledge, Skills, and Attributes.

2.2 The indicative variables consisted of 1) the knowledge component consisting of 6 indicators, 2) the skill component consisted of 7 indicators, and 3) the attributes component consisting of 6 indicators.

3. Assessment of Research Tools

The research instruments were semi-structured interviews and one questionnaire developed as Likert's 5-scale rating method (Likert, 1932), namely, highest, high, moderate, low and lowest. The criterion for interpretation is the mean between 4.51 - 5.00 means highest, 3.51 - 4.50 means high, 2.51 - 3.50 means moderate, 1.51 - 2.50 means low and 1.00 - 1.50 means lowest (Spooren et al., 2007; Srisa-ard, 2010; Silpcharu, 2017), divided into 3 aspects: knowledge, skills and attributes with the Index of item objective congruence (IOC) between 0.80 - 1.00.

4. Data Collection

4.1 Conduct an in-depth interview about model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier from a sample of 7 people.

4.2 Conduct a survey using a questionnaire, data collection with a questionnaire and online collection (Google Form) from a sample of 543 sets and a total of 496 sets were responded which representing 91.34%.

4.3 Conduct a Focus Group Discussion participated by 15 knowledge and Experienced lecturers in organizing training courses for the operator who operates water boiler or boilers that use liquid as a heat carrier and related scholars to consider the suitability and feasibility of applying the model as well as the suitability of the manual for improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry, which the researcher has recorded and compiled the recommendation from experts to improve and modify in order to be more complete.

5. Data analysis

5.1 Analyze opinions about the improvement of the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier by using basic statistics such as number, percentage, mean and standard deviation.

5.2 Analyze the structural equation model, the second confirmatory component analysis model of the improvement of the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the

Ministry of Industry, which is an analysis of the importance of variables that have variations with each component and analyze the weight and importance of each component in all 3 aspects, namely knowledge, skills, and attribute, including analyzing the 3 components as a whole.

Results

1. The result of the opinion level analysis on the model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier.

The operators who operate water boiler or boilers that use liquid as a heat carrier had a comment on the model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier as a whole with the mean of ($\bar{X}$ = 4.29) and as per each aspect as ($\bar{X}$ = 4.18 - 4.35) which are at the high level. When each aspect was considered from most to least, it was found that knowledge had the highest mean, followed by attribute, and skill, respectively, as appeared in Table 1.

Table 1. Mean, standard deviation and the level of opinions about the model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier as a whole and each aspect.

Evaluation list	$\bar{X}$	**S.D.**	**Level of Opinion**
Knowledge	4.35	0.59	High
Skills	4.18	0.76	High
Attributes	4.31	0.77	High
As a whole	**4..29**	**0.71**	High

2. The results of the structural equation model analysis of the second order confirmatory component analysis model of the model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier.

The results of the analysis of the structural equation model, the second order confirmatory component analysis model, found that the model was consistent with the empirical data with all statistical values were within the appropriate criteria.

Chi-Square Probability Level (p) was 0.063 which was greater than 0.05 Diamantopoulos and Siguaw, 2000 : 83). Chi-square correlation (CMIN\DF) was 1.183 which was less than 3 (Bollen, 1989 : 278; Diamantopoulos and Siguaw, 2000 : 98). The GFI was 0.964, which was greater than 0.90 (Diamantopoulos and Siguaw, 2000 : 87) and the Root mean square error of approximation (RMSEA) was 0.019, which was less than 0.08 (Diamantopoulos and Siguaw, 2000 : 85; Arbuckle, 2011). When considering the weight of component (b), it was found that all positive values ranged from 0.70 to 0.90 and differed significantly from zero at the 0.001 level. Based on the hypothesis, it was found that all 3 components were under the same major component. The component weights were in the range of 0.97 to 0.99, ranked from the highest to the lowest in terms of knowledge, skills, and attributes, with weights of 0.99, 0.99, and 0.97, respectively.

When considering the standard component weight (B) for each component, it was found as follows.

In term of knowledge, the variable with the most weight was the knowledge about the components of the water boiler (k2) with a weight equaled to 0.95 and covariance with the Knowledge of 90%, followed by the knowledge about analysis of boiler explosion problems and solution guideline (k35) with a weight equaled to 0.93and covariance with the Knowledge of 87%, knowledge about the application of IoT systems to control the operation of water boiler (k13) with a weight equaled to 0.92 and covariance with the knowledge of 85%, knowledge about water boiler maintenance (k34) with a weight equaled to 0.88 and covariance with the knowledge of 78%, knowledge about structure of water tube boiler (k18) with a weight equaled to 0.87 and covariance with the knowledge of 75%, and knowledge about applying digital technology VR, AR and MR in water boiler work (k3) with a weight equaled to 0.85 and covariance with the knowledge of 73%, respectively.

In term of skill, the variable with the most weight was steam distribution system work (s3) with a weight equaled to 0.85 and covariance with the skill of 72%, followed by the application of VR, AR and MR digital technology to the work of water boiler (s12) with a weight equaled to 0.84 and covariance with the skill of 70%, digital understanding and use (s36) with a weight equaled to 0.74 and covariance with the skill of 55%, Application of AI technology

in water boiler work (s16) with a weight equaled to 0.70 and covariance with the skill of 49%, ways to improve water quality (s20) with a weight equaled to 0.68 and covariance with the skill of 46%, water boiler inspection work (s24) with a weight equaled to 0.65 and covariance with the skill of 43% and decision making in problem solving while working (s40) with a weight equaled to 0.60 and covariance with the skill of 36%, respectively.

In term of attribute, the variable with the most weight was compliance with organization discipline and regulation (a4) with a weight equaled to 0.87 and covariance with the attribute of 76%, followed by having a sense of safety (a26) with a weight equaled to 0.85 and covariance with the attribute of 72%, self-confidence (a19) with a weight equaled to 0.83 and covariance with the attribute of 69%, humility toward executives and seniors (a13) with a weight equaled to 0.82 and covariance with the attribute of 68%, be patient at work (a9) with a weight equaled to 0.81 and covariance with the attribute of 66%, and be punctual (a18) with a weight equaled to 0.72 and covariance with the attribute of 52%, respectively.

Details are shown in Table 3 and Figure 1..

Table 2. Statistical value, structural equation model analysis of the model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier.

Variables	**Estimate**		**R^2**	**Variances**	**C.R.**	**P**
	standardized	**Unstandardized**				
Dependent Variables						
The model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier						
Independent Variables						
Knowledge	0.99	1.00	0.99	0.01		
Skill	0.99	0.89	0.98	0.01	29.137	***
Attribute	0.97	0.90	0.95	0.02	30.309	***
Knowledge						
Knowledge about the components of the water boiler (k2)	0.95	1.00	0.90	0.05		
Knowledge about analysis of boiler explosion problems and solution guideline (k35)	0.93	0.95	0.87	0.07	42.727	***
Knowledge about the application of IoT systems to control the operation of water boiler (k13)	0.92	0.95	0.85	0.08	41.017	***
Knowledge about water boiler maintenance (k34)	0.88	0.94	0.78	0.12	35.247	***
Knowledge about structure of water tube boiler (k18)	0.87	0.90	0.75	0.13	33.285	***
Knowledge about applying digital technology VR, AR and MR in water boiler work (k3)	0.85	0.89	0.73	0.14	31.709	***
Skill						
Steam distribution system work (s3)	0.85	1.00	0.72	0.15		

Variables	Estimate		R^2	Variances	C.R.	P
	standardized	Unstandardized				
Application of VR, AR and MR digital technology to the work of water boiler (s12X)	0.84	0.99	0.70	0.16	24.219	***
Digital understanding and use (s36)	0.74	0.86	0.55	0.23	19.964	***
Application of AI technology in water boiler work (s16)	0.70	0.83	0.49	0.28	18.351	***
Ways to improve water quality (s20)	0.68	0.80	0.46	0.29	17.555	***
Water boiler inspection work (s24)	0.65	0.80	0.43	0.33	16.619	***
Decision making in problem solving while working (s40)	0.60	0.70	0.36	0.34	14.815	***
Attribute						
Compliance with organization discipline and regulation (a4)	0.87	1.00	0.76	0.13		
Having a sense of safety (a26)	0.85	0.98	0.72	0.16	25.785	***
Self-confidence (a19)	0.83	0.95	0.69	0.17	24.795	***
Humility toward executives and seniors (a13)	0.82	0.97	0.68	0.19	24.424	***
Be patient at work (a9)	0.81	0.98	0.66	0.20	23.849	***
Be punctual (a18)	0.72	0.83	0.52	0.26	19.648	***

Note : *** There was statistical significance at the 0.001 level.

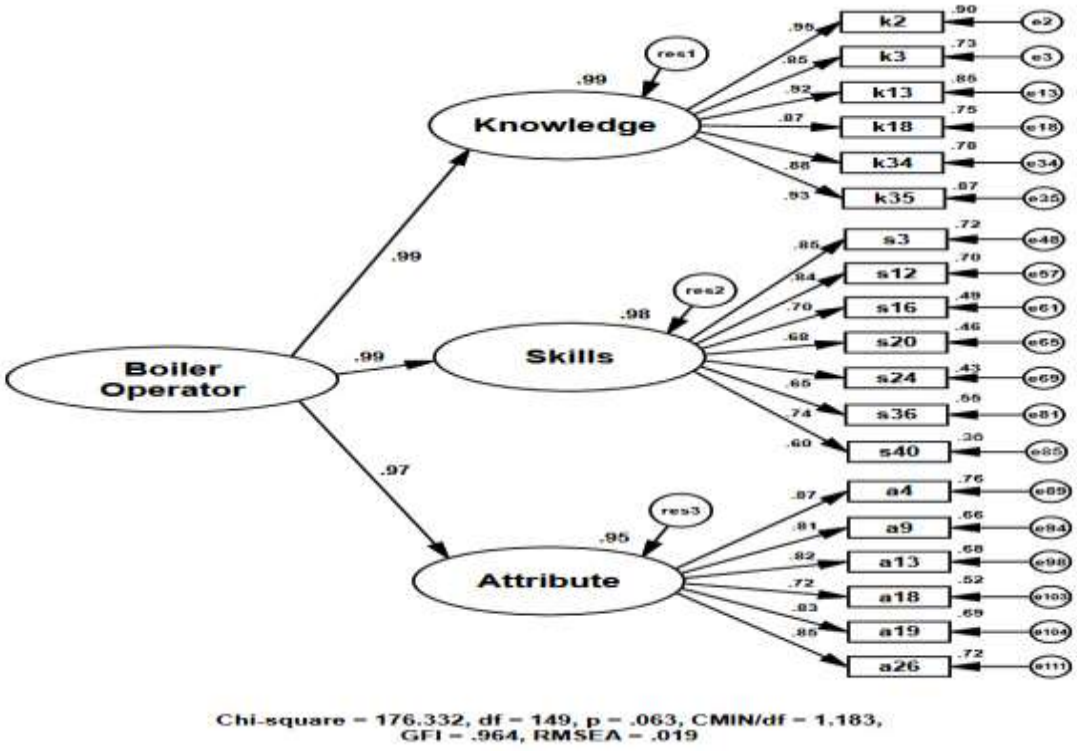

Figure 1. Structural equation of a model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry in Standardized Estimate Mode

Summary and Discussion

1. The results of the study of significant factors in improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry revealed that the participants attended the lecture need to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier at a high level as a whole. When each aspect was considered, it was found that the need to be improved in term of knowledge was at a high level. When considering each of the top 3 items, it was found that there was a need for the improvement of knowledge about how to improve water quality the most, followed by knowledge about evaluating horsepower compared to boilers and knowledge of the application of IoT systems to control the operation of water boiler. The need to be improved in term of skills was at a high level. When considering each of the top 3 items, it was found that there was a need for the improvement of skills in steam distribution system work, followed by water quality improvement, and decision making in problem solving while working. The need to be improved in term of attribute was at a high level. When considering each of the top 3 items, it was found that there was a need for the improvement of attribute in responsibility for assigned tasks at the highest level, followed by creativity and the ability to control one's emotions in different situations. This is in line with McClelland's (1973) theory mentioning that competency is a behavioral attribute resulting from knowledge, abilities, skills, and other characteristics that make a person perform outstandingly in an organization (OCSC 2010). This is also consistent with Thongprasit (2020), which was found that the person responsible for energy management had opinions about the potential model of the person responsible for energy management in the textile industry under the control of the Ministry of Energy as a whole and in all aspects, namely knowledge, skills, and attribute at a high level.

2. The result of the development of the model to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry was as follows.

2.1 Knowledge had 6 components, namely, 1) knowledge about the components of the water boiler 2) and knowledge about applying digital technology VR, AR and MR in water boiler work 3 knowledge about the application of IoT systems to control the operation of water boiler 4) knowledge about structure of water tube boiler 5) knowledge about water boiler maintenance and 6) the knowledge about analysis of boiler explosion problems and solution guideline. This is in line with the Department of Industrial Works (2020) which has set the roles and responsibilities of the operator who operates water boiler or boilers that use liquid as a heat carrier, which requires knowledge about the structure of water tube boiler, water boiler maintenance, analysis of boiler explosion problems and solutions, choosing a water boiler, water supply system to boiler, main steam valve, structure of fire tube boiler, structure of water tube boiler, automatic water level controller, pressure control switch, flame detection device, exhaust gas temperature gauge, and other related knowledge according to the announcement of the Ministry of Industry. This is consistent with Haesakul, P. (2022), which found that knowledge about the basic concepts of virtual reality (VR) technology was important for educational personnel in the digital technology age. It is also consistent with Thongprasit (2022) who found that using IoT systems in manufacturing and service industries will make production and service management more efficient.

2.2) Skill had 7 components, namely, 1) steam distribution system work, 2) application of VR, AR and MR digital technology to the work of water boiler, 3) application of AI technology in water boiler work AI, 4) ways to improve water quality, 5) water boiler inspection work, 6) digital understanding and use and 7) decision making in problem solving while working. This is in line with

Department of Industrial Works (2020) that has prepared a manual for the operator who operates water boiler or boilers that use liquid as a heat carrier which determines that the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry must have skill in ways to improve water quality, water boiler inspection, water level indicators, insulation work, practical work on the use of water boiler, water boiler relocation and other skills related to water boiler or boilers that use liquid as a heat carrier according to the notification of the Ministry of Industry. In addition, the research results of Plaipetch et.al. (2020) found that the development of human potential in terms of ethics, morality and honesty, analytical thinking in problem solving, and thinking and planning to deal with problems with new methods was an important component of the competency development model for human resource executives in the automotive parts manufacturing industry of the future. This is in line with the results of Thongprasit (2022) research, which was found that the skills of the manpower in the manufacturing and service industries in the industrial zone in Rayong Province consisted of specific operational skills of the targeted industries, digital skills, foreign language communication skills, advanced thinking skills, organizational communication skills, operational coordination skills and the skills to adapt and be flexible to situations. This is corresponding with Makkaew (2015), which was found that the operational skills of steam boiler operators to prepare for supervisors in industrial factories consisted of problem-solving skills, decision making skills, and analytical thinking skills. It is consistent with Wittawat (2018), it was found that the potential of industrial boiler production quality controllers consists of skills in thinking, planning, solving problems in new ways and analytical thinking skills.

2.3 Attribute had 6 components, namely, 1) compliance with organization discipline and regulation, 2) be patient at work, 3) humility toward executives and seniors, 4) be patient at work, 5) self-confidence and 6) having a sense of safety, which is in line with Chairat (2015), which revealed that the model to improve the operator of water boiler's competency to be ready to be promoted as supervisors in industrial plants consisted of main factor on interpersonal roles are made up of sub-factors : 1) courses for readiness development, 2) ability to look for opportunities 3) roles and responsibilities in supervisory positions, 4) commitment to preparing to be supervisors, 5) continuous work experience. The main factor on the role related to information consisted of sub-factors: 1) good attitude towards job position, 2) courses for readiness development, 3) human resource development policy, 4) selection system, 5) cost awareness, 6) authority to command the work. The main factor on the role related to decision making consisted of sub-factors: 1) good attitude towards the position 2) specialization 3) human resource development policy 4) readiness in knowledge of work 5) ability to work under pressure, 6) authority to command the work. The results of the expert evaluation showed that the model was the most appropriate in all aspects. This is in line with Pariyasoot (2018) who conducted research on the development of the competency of industrial water boiler production quality supervisors. The results showed that the development of the competency of industrial water boiler production quality supervisors consisted of main factor on the role related to management which consisted of sub-components, namely, honesty, responsible and professional ethics, coordinating with other employees, having commitment to work and having decision-making authority to command the work.

3. The results of the preparation of the manual for improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry found that improving the competency of the operator who operates water boiler or boilers consisted of Part 1: The importance of improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier consisted of principles and reasons, objectives, main component of the model, and sub-components of the model, Part 2: Guidelines for improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier consisted of knowledge, skills and attributes. The result of the evaluation of the manual by experts found that the manual for improving the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry had been unanimously

approved by experts as being suitable and can be applied in practical. This may be due to the fact that the manual has been developed through examination by experts who have specific knowledge related to the operator of the water boiler or boilers that use liquid as a heat carrier under, including those involved in the organizing training and experienced in training courses for the operator who operates water boiler or boilers that use liquid as a heat carrier. In addition, the content in the manual is modern, especially the application of IoT, AI, VR AR and MR systems used to control the operation of a water boiler or a boiler that uses liquid as a heat carrier, resulting in a more efficient operation. Therefore, the developed manual is appropriate and can be applied in organizing training for operators of a water boiler or a boiler that uses liquid as a heat carrier.

Suggestion

1. Suggestions for applying the research results

Relevant government agencies especially Department of Industrial Works, Ministry of Industry, the training center for the operator who operates water boiler or boilers that use liquid as a heat carrier should apply the results of this research to be utilized in terms of policy to improve the competency of the operator who operates water boiler or boilers that use liquid as a heat carrier under the supervision of the Ministry of Industry to have knowledge, skills and attribute necessary for the efficient and effective performance of safety measures related to water boiler or boilers that use liquid as a heat carrier according to government requirements.

2. Suggestions for further research

This research study is a study in the curriculum for the operator who operates water boiler or boilers that use liquid as a heat carrier, which is a curriculum under the supervision of the Department of Industrial Works. However, the Department of Industrial Works also has many courses under its supervision, such as the factory environmental personnel course, etc. There should be a study of competency improvement models to be a guideline for further development of curriculum and personnel in the industry.

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