Design of Geothermal Drilling Training Curriculum as the Implementation of the National Competence Standard on Onshore Drilling

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Abstract. Indonesia is currently the second largest geothermal installed capacity in the world, with around 1948.5 MW installed capacity. However, this achievement is still far from the Indonesian Government’s target of 7000 MW installed capacity in 2025. Thus, it requires a lot of efforts, supporting policies, and a great deal of competent human resources to achieve this ambitious target. Fulfilling the need for qualified geothermal human resources will take a significant amount of time if it only relies on higher education graduates. Hence, vocational education institutions especially training centers are expected to contribute more to meet these needs. The government has issued a regulation on the Indonesian National Work Competency Standards (SKKNI) which covers aspects of knowledge, skills and work attitudes relevant to the implementation of assigned duties and terms including SKKNI of onshore drilling which is used as a reference for oil and gas and geothermal drilling. However, previous studies have identified the differences between geothermal drilling and oil and gas drilling. This might be due to the government still considers that those two are similar, so they only issued one competency standard for both fields. This paper discusses the implementation of SKKNI on onshore drilling competency standard to produce geothermal drilling curricula. The first part of this paper will map the current conditions of Indonesia's geothermal drilling human resources development including the estimated number of human resources needed. Furthermore, this study highlights the fundamental differences between the hydrocarbon and geothermal drilling to provide a better understanding of the competency needs of labor in the geothermal industry. Several research or publications and overseas competency standards are discussed and compared to decide which material needs to be included in the curriculum. Several alternative approaches related to human resource capacity development are also proposed in this paper to support the Indonesian Government's target in 2025.

1. Introduction
The National Energy Plan (RUEN) has been decided on March 2017 with a Presidential Decree Number 22 the year 2017. The RUEN shows that the potential of geothermal energy in Indonesia is estimated at 29,544 MW. This potential consists of 11,998 MW of potential resources and 17,546 MW of potential reserves. These resources are mostly located in Java and Sumatra followed by East Nusa Tenggara and Sulawesi Island which make it the focus of current development. The RUEN also emphasizes that the government's target for 2025 for renewable energy to reach 23% in the energy mix. This target includes 7,241.5 MW (16%) originating from geothermal energy. However, the current installed capacity of
geothermal power plants (PLTP) until the end of 2018 was only 1,948.5 MW [1] or less than 7% of the available potential.

To support the development of geothermal energy to reach the target of 2025, human resource development programs are indeed very substantial but has not been fully considered by the Indonesian government. The number of personnel requirements for geothermal development is certainly in line with the targeted installed capacity. It has been calculated that the geothermal development to reach the target of 2025 might create around 23,000 jobs for all stages of development includes operations and maintenance [2].

Accordingly, to provide competent geothermal workforce needs, several ways can be done such as formal education. Indeed, school is one form of human resources development to become qualified professionals in geothermal. However, official education graduates often lack competencies to work directly in the industry. The experienced worker is more likely to be recruited by geothermal companies and other industries. Hence, a competency measurement standard is needed for both formal school graduates and skilled workers.

The government of Indonesia has set a national qualification framework (KKNI) to equalize the competencies. In its implementation, the government establishes work competency standards (SKKNI) as a reference for the level of competence that is mastered by a worker.

This SKKNI is also needed for a geothermal human resource as important as the implementation of SKKNI in other industries. Several stages must be delivered in a geothermal development project, where drilling is one of the most critical stages since the cost may reach up to one-third of the budget [3] [4]. Therefore, the need for competent workers in the drilling activities is very vital to reduce the level of errors in the decision-making process that can lead to losses in equipment and time.

In Indonesia, the national competency standard for geothermal drilling is regulated using the decision of the Minister of Manpower and Transmigration number 241 of 2007 and was revised with the Minister of Manpower Decree number 133 of 2015 concerning the standard of competency in the field of onshore drilling.

2. Geothermal Drilling and The Challenges

2.1. Distribution of resources

Indonesia is located in the Pacific Ring of Fire. Thus, most of the geothermal prospect areas in Indonesia are commonly situated near the volcano with the high-relief terrain [5]. Figure 1 shows the distribution map of geothermal prospect areas in Indonesia [6]):

1. Insufficient geological, geophysical, and geochemical data in the area makes the early assessment of resource potential inaccurate.
2. High resource risk, especially in the upstream sector.
3. High upfront investment cost combined with uncompetitive pricing policy, limited equity funds, lack of financial incentive and funding.
4. Uncertainties in legal aspects and the lack of cross-sector coordination (i.e., government guarantee for the obligations of PLN against the developer of geothermal power plants, the dispute regarding the geothermal project location that intersects with conservation forest and/or national parks).
5. The limited number of human resources with specific competences in the geothermal sector.
6. Social issues, such as community rejection.
7. Lack of existing infrastructure to support the geothermal development project, especially during exploration.

From the challenges mentioned above, the need for the competent workforce in the geothermal field should be a serious concern of stakeholders. However, in addition to competency standards for drilling, the government has only issued SKKNI for geologists and geothermal geochemists, both of which have not been revealed in the form of curriculum.

As for drilling that is still incorporated between oil and gas and geothermal, existing certification material and assessment tools tends to be for drilling operators in oil and gas alone. Therefore, unique
or separated curriculum design for geothermal drilling needs to be made so it can be used for training and competency certification for geothermal drilling personnel.

Figure 1. Map of Indonesia Geothermal Prospects [7]

2.2. The differences between petroleum and geothermal drilling

The previous study [8] has shown that the current competency standard is more suitable for oil and gas drilling rather than for geothermal drilling. Thus, the competencies certificate holder of this SKKNI might not be sufficient to work directly in a geothermal drilling project. The comparison between the geothermal and hydrocarbon drilling in several areas is shown in Table 1.

In general, the problem of geothermal drilling is the same as in oil and gas drilling. However, stuck pipes are the most common problem due to the collapse of the hole wall due to the nature of rocks in fragile geothermal wells. The other cause of stuck pipe in geothermal is the hole cleaning issue where the severe lost circulation prevents the drilled cuttings to be transported to the surface and in time may stick the drill string.
Table 1. Summary of different character between petroleum and geothermal drilling [9]

| Parameters            | Petroleum                                      | Geothermal                                                                 |
|-----------------------|------------------------------------------------|----------------------------------------------------------------------------|
| Rock formation        | Mostly sandstone/ mudstone, sedimentation layer| Mostly Igneous & hard metamorphic rock (e.g., rhyolite, andesite, diorite, etc.) |
| Reservoir pressure    | High (might reach 90 MPa).                     | Relatively low, might be lower than hydrostatic pressure.                   |
| Reservoir temperature | May reach up to 200°C, but mostly relatively low| High temperatures (160°C to above 300°C)                                   |
| Drilling fluid        | Bentonite blends                               | Mostly using water, Aerated mud or water with air or nitrogen mixture due to severe lost circulation encountered |
| Drilling Bits         | Typically, Polycrystalline Cutter (PDC)       | Roller cone or drag bits, impregnated diamond bits                         |
| Drilling orientation  | Vertical, deviated, horizontal                 | Usually, vertical or J-shaped, horizontal drilling is unlikely             |
| Casing                | perforated production casing                  | Pre-perforated of the pre-slotted liner, large diameter casing            |
| Cementing             | protecting the casing from hydrocarbon corrosion perforating and swabbing with NaCl saltwater | Limit casing transformation/deformation due to high temperature, prevent thermal fatigue Slotted liner installation and swabbing with brine or stimulate using air |

Lost circulation event is widespread in geothermal drilling due to targeting fractures network that connected to the reservoir system. When the drill bit intersects the fractures in the drilling process, the drilling fluids (mud) will likely enter the fractures and only partially returning to the surface (partial loss circulation) or not at all (total lost circulation). Although the geoscience team expects the lost circulation, it technically brings challenges to the drilling process; therefore, proper mitigation is required. To overcome this, several drilling engineers suggest using aerated drilling mud, which believed can be very helpful in a drilling operation if used in a proper air ratio [10] [11] [12]. Overall, global geothermal drilling experiences still consider lost circulation as the main factor contributing to the hole problem in geothermal drilling [13] [14] [15].

Some unique aspects that make treatment of geothermal wells different from oil and gas wells include temperature. In terms of temperature, the target of a geothermal well is a formation fracture that has a high temperature. This fracture is where the heat energy to be extracted. The higher the temperature obtained, the more economically a geothermal well will be. Another important aspect that needs to be considered in geothermal drilling is the casing design. Generally, the purpose of the casings and the failure modes are similar between oil and gas and geothermal where they are required to withstand axial and radial loads. However, the casings need to be also withstand the temperature load or thermal stress in geothermal well [16] [17].

Subsequently, with such visible distinctive, the curriculum used for training and competency assessment should be different even though it still refers to the same SKKNI. Hence, several competency units need to be expanded to be useful for geothermal drilling.

2.3. Safety considerations

In terms of safety, it is evident that any drilling personnel, both in the oil & gas and geothermal environment, put health and safety of the human and environment above all else during the drilling operation. However, the differences between those two-drilling environments create several differences in the safety aspects as well, which discussed as follows:
2.3.1. **Well control.** From the issue of well control, there is a significant difference between geothermal and oil & gas mainly on the type of formation fluid encountered. In the case of oil and gas drilling, the formation fluids that will be anticipated are generally flammable and tend to be in high pressure. Well control is usually carried out by keeping the hole full of mud with enough hydrostatic pressure, which slightly exceeds the formation pressure. Whereas in geothermal drilling, the formation fluid is in the form of hot water or hot steam. When cold water is injected into the hole, there will be a decrease in temperature followed by a pressure drop until finally, the well becomes controlled.

Those differences in formation fluid make well control techniques or methods used in both drillings are different. Currently, the well control certification that available in Indonesia and the worldwide approved by IADC is more suitable for drilling oil & gas and considered to not fully accommodated for geothermal drilling.

2.3.2. **Toxic gas.** Another safety consideration is that toxic gas leaks. The geothermal area in Indonesia is commonly situated in a volcanic field that potentially releases several toxic gases (i.e., \( \text{H}_2\text{S} \)). Although oilfield may also release \( \text{H}_2\text{S} \), the percentage of this gas in the geothermal area is relatively higher [18].

2.3.3. **High-relief terrain.** As discussed previously, Indonesia geothermal prospects are mostly situated in the volcanic area, which has high-relief topography. This condition creates a hazard during drilling rig equipment mobilization as described by [19]. The high-relief terrain also brings challenges during drilling infrastructure construction and drilling operation due to extreme slopes and unstable ground [20]. In contrary, drilling for hydrocarbon is most likely happened in the relatively flat area and on the more stable field.

2.3.4. **Geohazard.** [20] and [5] discussed the geohazards in the site of a high-temperature geothermal prospect. Those hazards created by the surface thermal manifestations such as fumaroles, steaming grounds, hydrothermally altered grounds, hot springs, volcanic gas vents, craters, and mud pools. Several geohazards generally occurred in a geothermal area are:

- soft ground, landslide and unstable slopes due to hydrothermal alteration products, hot groundwater,
- poisonous gases released from surface thermal manifestations
- hydrothermal eruptions and ground collapse.

3. **National Competency Standard on Onshore Drilling**

3.1. **Indonesia**

The SKKNI is a reference and standard of worker's competence in a workplace, supported by certain factors so that they can occupy certain positions. This standard is determined by the Ministry of Manpower and applies nationally. This standard is also an instrument used by the government to prepare qualified and competent human resources that are recognized throughout the sector and are universally applicable in the country.

Work competency is the ability to work which includes aspects of knowledge, work attitude, and technical skills that are by established standards. The references for the national standard of working competency is the legislation No 13 of 2003 concerning Labour and Government Regulation No. 31 of 2006 concerning the National Job Training System. SKKNI compilation is carried out using the Regional Model Competency Standard or RMCS format which was introduced in 1998 [21]. The formulation of SKKNI using the RMCS model is regulated in Minister of Manpower and Transmigration Regulation No. 21 year 2007 concerning Procedures for Determination SKKNI. The RMCS based on job competency analysis and has three main components, namely the description and scope of industry, functions and main units. The unit is structured with four sub-components, which are performance criteria, evidence requirements, critical skills and essential knowledge and range statements [21].
SKKNI for onshore drilling consists of fifty core competencies, and five qualifications can be obtained as shown in Table 2. This standard also divides competency into three types of competencies, namely general competencies consisting of seven units, competencies the core consists of 40 units, and special competencies consisting of three units.

Table 2. Qualification and competencies of onshore drilling based on [22].

| Level | Qualification | Unit Competencies* |
|-------|---------------|--------------------|
| 2     | Floor man (OLB II) | 4 GC, 7 CC, 1 SC |
| 3     | Derrick man (OMB II) | 4 GC, 9 CC, 2 SC |
| 4     | Driller (JB III)   | 6 GC, 19 CC, 3 SC |
| 5     | Tool Pusher (APB III) | 7 GC, 17 CC, 2 SC |
| 6     | Rig Superintendent, Drilling Supervisor (DS III) | - |

* GC = General competencies. CC = Core competencies, SC = Special competencies

These competencies include comply with applicable regulations, maintain well control, establish the mud program, develop casing and cementing program, perform drilling operation, prepare drilling equipment, perform well completion and stem test, establish evaluation program, and perform extraordinary activities.

3.2. New Zealand

The New Zealand Qualification Authority (NZQA) issued the standard of competencies in New Zealand, which is reviewed periodically [23]. For drilling, the NZQA has three domains of competency standards: general drilling, hydrocarbon drilling, and non-hydrocarbon drilling. Each domain is further subdivided into several levels that reflect the level of difficulty and qualifications that can be obtained. The general drilling standard does not have qualifications and is divided into three levels from level 3 to level 5, while the standard for hydrocarbon drilling has four qualifications and five levels. In contrast, non-hydrocarbon drilling has four levels and four qualifications as shown in Figure 2. The general drilling is a set of new qualifications that introduced to replace the NZQF Non-hydrocarbon and Hydrocarbon onshore/offshore drilling qualification [24].

Each level consists of one or more standards (coversheets). Each cover sheet explains what needs to be known or what needs to be achieved to meet the standards. Further, each standard has several credits that need to be determined to go towards national qualification. This credit may be provided by the licensed organization after an assessment. To earn a qualification, credit can be accumulated from different institutions or different learning places [25]. In addition to accredited institutions, the NZ Motor Industry Training Organization (MITO) is the drilling qualifications provider under the Industry Training and Apprenticeships Act 1992 as a qualified developer and industrial training organization [26].

Drilling qualifications in New Zealand support equality with Australian drilling qualifications known as the Australian competency standard that is part of the DRT03 Drilling Training Package [26], [27] translated that "the Training Package is a set of nationally endorsed competency standards, assessment guidelines, and Australian Qualifications Framework (AQF) qualification for a specific industry, industry sector or enterprise." Therefore, the classification of drilling sectors in New Zealand is also aligned with the Australian Competency Units required for each qualification Training Package. It has been described that the drilling industry in Australia comprising ten sectors in two domains [7]. First, the competency standards of the non-hydrocarbon sector drilling industry that has coverage for drilling of the environment, foundation or construction, geotechnical, mineral exploration, seismic, water well, and blast hole drilling. Second, competency standards of hydrocarbon drilling which include onshore and offshore oil and gas drilling.
Figure 2. The domains of drilling standards in NZQF [26]

The simplification of non-hydrocarbon competency standards is because each sector shares some common elements in drilling even though each has specific demands to that sector. Thus, a flexible cross-sector qualification framework will allow people to gain the qualifications recognized by each sector and by related industries such as building and construction industries [26]. As in Australia, in these standards, however, geothermal drilling is included in the non-hydrocarbon NZQF level 4 drilling domain even though training on geothermal drilling in many institutions is indeed involved in oil and gas drilling.

The separation of domains has several advantages and drawbacks. The advantages include specific education to become a qualified drilling engineer in a particular field, which makes the process of the transfer of knowledge from experts easier. It also ensures that no missing link between experts in the industry with prospective workers on problem management and success stories are based on their experience. In the long term, this will establish an improvement in drilling duration and in escalating the success rate of drilling.

Another advantage is that it is more flexible in accommodating any changes that occur in the drilling industry. Due to its focus on only one field, input from either new technology usage in the industry or adjustment of international standards can be directly applied. This adjustment will be more difficult if using only one standard for all types of drilling.

On the other hand, the disadvantage of this system is the complication of moving equipment and people from one industry to another. Drilling equipment that is already dedicated to oil and gas drilling would require a long process and adjustment if it is to be used for geothermal drilling. In a geothermal environment, for example, the problem is usually more on lost circulation so that the drilling fluid equipment needs to be adjusted to accommodate aerated and freshwater drilling.

3.3. Comparison between standards of IQF and NZQF

The comparison between standard competencies of onshore drilling in Indonesia, which are quite similar to the hydrocarbon-drilling standards of NZQF as can be seen in Table 3. However, there are many differences when compared to non-standard hydrocarbons. This table shows that both industries are developing standards independently.
Table 3. Comparison between NZQF hydrocarbon and non-hydrocarbon drilling standard with IQF onshore drilling standard.

| Lvl | NZQF - Non-hydrocarbon | NZQF - Hydrocarbon onshore/offshore | IQF - Onshore drilling |
|-----|------------------------|------------------------------------|------------------------|
| 5   | Driller Supervisor     | Rig Manager, Tool Pusher           | Tool Pusher (APB III), Drilling Supervisor (DS III) |
| 4   | Senior Driller         | Driller                            | Driller (JB III)       |
| 3   | Driller                | Derrickman                         | Derrickman (OMB II)    |
| 2   | Driller’s Assistant    | Floorman                           | Floorman (OLB II)      |

3.4. Critical Aspect to Apply SKKNI on Geothermal Drilling

From the description above, it is known that the application of SKKNI on onshore drilling in geothermal drilling will be slightly different from the application of oil and gas drilling. The ranked tasks of the geothermal drilling staff with the required knowledge or skills shown as following [6]:

1. Comply with applicable regulations
   Understand the requirement of Health, Safety, and Environmental (HSE) protection, cooperation, fire prevention and suppression, first aid on accidents, emergency conditions, pollution prevention, and implement laws of oil and gas and geothermal mining.

2. Develop a casing and cementing program
   Casing Design program, implement casing installation and cementing, design cementing program, and perform casing lowering and cementing job.

3. Perform drilling operation
   Drilling bit selection, perform pipe trimming, drilling optimization, core drilling, directional/horizontal drilling, stem test operation, and hydraulic drilling, control solids/gas separators and drilling rig instrumentation, control the tilt, and design a directional well drilling and hydraulics program

4. Maintain Well Control
   Maintain well pressure control and blowout prevention devices including assembling and operation.

5. Establish the mud program
   Design mud program, calculate the mud weight to maintain well control, select acceptable mud types, specify mud properties, assist mud treatment, and operate mud pumps

6. Prepare drilling equipment
   Specify equipment, design drilling rig mobilization/demobilization, moving, rig-up/rig-down, select and operate prime mover system, hoisting system, rotating system, circulating system, and perform activities before and after drilling operations.

7. Establish an evaluation program
   Develop an evaluation program, evaluate drilling problems, maintain rotating equipment, and perform daily inspection and daily rig equipment maintenance.

8. Perform well completion and stem test
   Design and Operate drill stem, perform well completion and stem test.

9. Perform extraordinary activities
   Perform special activities such as hazardous/toxic gas prevention and fishing job

4. Curricula Development

The curriculum is a reference or guideline in the implementation of a learning process. It is also an educational program that contains a variety of instructional materials and learning experiences that are programmed, planned and designed systematically containing various teaching materials and learning experiences both from the past, present and future based on prevailing norms that are used as guidelines.
in the learning process for education personnel and students to achieve educational goals. Previous researcher further detailed that the curriculum is a series of units of learning material that are arranged in such a way that training participants can learn it based on abilities possessed or mastered before [19]. It is mentioned that training is developing people as individuals and encouraging them to become more confident and capable in their lives and work [20]. Education and Training is a systematic process to acquire knowledge, skills, and skills as well as behaviors that are useful to find a match between ability and demand for organizational needs to achieve goals.

On the other hand, training is a process which systematically changing employee behavior to achieve organizational goals, to carry out current work and help employees to gain specific skills and abilities.

Competency-based learning systems have been explained in the Decree of the Minister of Manpower and Transmigration no. 227 of 2003 that encourages the development of a national skills training system and the application of competency standards in the skills training sector. As a result, a national skills training system is implemented based on three pillars of competency-based training systems, namely user-defined competency standards, competency-based skills training programs, and competency certifications.

In principle, the implementation of SKKNI in the field of oil and gas and geothermal drilling can be carried out on drilling in geothermal industries, both in terms of the stages of the process, technology/tools, and drilling experts. But several aspects need to be considered such as the difference from drilling geothermal wells is related to hard formation rock and high temperature so that geothermal well operations are more complicated than oil and gas wells. With this basis, it is necessary to build knowledge with a curriculum that supports existing SKKNI. An example of nine weeks training curriculum for Floorman (level 2) can be seen on Table 4.

For the fulfillment of competencies for geothermal drilling human resources (HR), it is necessary to increase knowledge which includes:

1. Drilling technology
   Drilling technology is basic knowledge for this training. These include an overview of geothermal drilling technology and the geological perspective.

2. Drilling rig and working principle
   The drilling rig subject includes drilling machine components and working principles, the type of sludge and fuel used during drilling activities, work safety facilities, waste disposal facilities.

3. Parameters used in drilling
   The material for drilling parameters includes Rate of Penetration (ROP), Rotation Per Minute (RPM), how to focus on safety while controlling the parameters.

4. Drilling fluid
   Drilling fluid subject includes basic knowledge of drilling fluids, drilling fluid systems, materials, and chemicals used in drilling fluids, mud tests, and drilling mud conditions.

5. Casing and Cementing Design
   Casing design is based on loading factors; the casing capability must meet the minimum safety factor requirements. This subject will also highlight the differences in casing design in oil and gas drilling.

6. Handling of Toxic Gases
   Make a simple analysis of the various possibilities for toxic gas problems in geothermal drilling operations.

7. Well logging
   Well logging material includes the introduction of Pressure Tempering Spinner (PTS) Logging, types of logging, well testing using PTS Logging, and simulation of drilling wells.

8. Reservoir Management
   Reservoir management material is in the form of reservoir engineering in Geothermal field.

9. Case studies on drilling activities
   Case study material such as a blowout, lost circulation, stuck pipe.

10. Contracts in drilling activities
Drilling contract is a unique subject that includes contract schemes, drilling contract models, turnkey contracts and day rate contracts.

11. Plan and management of drilling programs
   Drilling program material includes plans, stages, procedures, and reporting techniques in drilling activities.

12. Management of human resources
   Human resource management material includes an understanding of human resource management, the introduction of several theories related to human resource management.

Table 4. A curriculum of nine weeks geothermal drilling training program for floorman (level 2)

| No. | Subject                          | Competency Element Code | Theoretical (Hours) | Practical (Hours) | Instructor |
|-----|---------------------------------|-------------------------|---------------------|------------------|------------|
| 1   | Blow Out Prevention equipment   | B.060001.012.02         | 12                  | 24               |            |
| 2   | Casing & Cementing              | B.060001.009.02         | 12                  | 16               |            |
| 3   | Circulation Equipment           | B.060001.019.02         | 8                   | 24               |            |
| 4   | Directional and Horizontal Drilling | B.060001.047.02      | 8                   | -                |            |
| 5   | Drill Stem                      | B.060001.025.02         | 8                   | 24               |            |
| 6   | Drilling Basic                  | -                       | 8                   | 16               |            |
| 7   | Drilling Bit                    | B.060001.045.02         | 8                   | 8                |            |
| 8   | Drilling Mathematics            | B.060001.013.02         | 8                   | -                |            |
| 9   | Drilling Mud                    | B.060001.015.02         | 12                  | 16               |            |
| 10  | Drilling Safety                 | B.060001.001.02         | 8                   | -                |            |
| 11  | Field study                     | -                       | 8                   | -                |            |
| 12  | Geology & Hydrothermal Basic    | -                       | 8                   | -                |            |
| 13  | Geothermal Reservoir            | -                       | 8                   |                  |            |
| 14  | H2S safety & Breathing Apparatus| B.060001.004.02         | 6                   | 4                |            |
| 15  | Hole Problem                    | B.060001.024.02         | 8                   | -                |            |
| 16  | Labor regulations               | B.060001.007.02         | 8                   |                  |            |
| 17  | Lifting Equipment               | B.060001.008.02         | 8                   | 24               |            |
| 18  | Rotating Equipment              | B.060001.014.02         | 8                   | 16               |            |
| 19  | Well Completion                 | B.060001.010.02         | 4                   | -                |            |
| 20  | Well control                    | B.060001.021.02         | 8                   | 4                |            |
| 21  | Well Head                       | B.060001.028.02         | 6                   | -                |            |
| 22  | Well Logging and Testing        | -                       | 8                   | 12               |            |

| Total (Hours) |             |
|---------------|-------------|
|               | 164         |
|               | 196         |
|               | 360         |

5. Conclusions and Recommendations

5.1. Summary
The curriculum is an education and training program plan that contains training materials, methods, which are used as guidelines in the implementation of an education and training and to achieve the objectives of the training.

Currently, there are no existing geothermal drilling curricula in Indonesia. This study recommends that a proper geothermal drilling curriculum needs to be designed and established as it is crucial for the implementation of SKKNI on onshore drilling competency standard in geothermal drilling operation in
Indonesia. This curriculum should be applied independently for trainees who will work on geothermal drilling projects.

This study also believes that this geothermal drilling curriculum may help to improve the competencies of geothermal drilling personnel in Indonesia, and in turn, will support the Government of Indonesia's target to achieve the 7,000 MWe installed capacity in 2025.

5.2. Path Forward

The current SKKNI for Onshore Drilling of Oil and Gas and Geothermal lacks the competency elements regarding work competencies in geothermal. Thus, further study is required to review and revise the current SKKNI. This review can be carried out by collecting and analyzing the actual human resource competency requirement in the geothermal industry in Indonesia. This revision can also be done by examining the existing qualification standard in geothermal drilling such as NZQF.

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