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A Study on Competency Assessment of the Geothermal Exploration Project Manager in Indonesia

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ABSTRACT

Indonesia, as one of the countries with the biggest potential for geothermal energy in the world, is currently trying to increase geothermal energy utilization from installed capacity of 1,700 MW to 7000 MW in 2025. One of the challenges identified in developing geothermal energy in Indonesia is the lack of skilled labor or experts to run a geothermal project, both in the exploration and exploitation stage. Project manager role is considered important because they are responsible in leading a multi-disciplinary team through various phases of the project, which at the exploration stage includes project socialization, 3-G survey, land acquisition, civil construction, drilling and well testing.

The initial hypothesis used in this study is that a project manager should have competency not only in project management and safety aspects but also various other basic competencies such as geothermal basic knowledge, which will be discussed in more detail in this paper. To test this initial hypothesis, the study team conducted a literature review of various competency matrices that already exist in several energy development projects throughout the world. Another method used in this study is a direct survey to several geothermal practitioners in Indonesia related to the competencies that must be possessed by a geothermal project manager.

This preliminary study aimed to identify the need to develop a training curriculum and assessment for personnel who wish to become project manager in a geothermal exploration project in Indonesia. In addition, this study also maps the competency matrix should be applied for the project manager position in order to increase the success rate of geothermal energy development projects in Indonesia.

1. INTRODUCTION

1.1 Geothermal Energy Development in Indonesia

Located at the Pacific Ocean ring of fire, Indonesia is believed to possess an enormous amount of geothermal energy potential, around 28 gigawatt electrical (GWe) (Bertani, 2016; MEMR, 2017; Pambudi, 2018; Munandar, 2018, Darma *et.al.*, 2010; Fauzi *et al.*, 2005; Suryantoro *et al.*, 2005; Ibrahim *et al.*, 2005) in 312 locations spread across the archipelago along volcanic areas of Sumatera, Java, Bali and several islands in eastern part of Indonesia. To-date the Government of Indonesia (GOI) has identified 325 geothermal prospects, of which more than 90 prospects have been surveyed and/or defined as geothermal working areas which have been put on production, in exploratory status, tendered out or are ready to be tendered. (Wahjosoedibjo and Hasan, 2018).

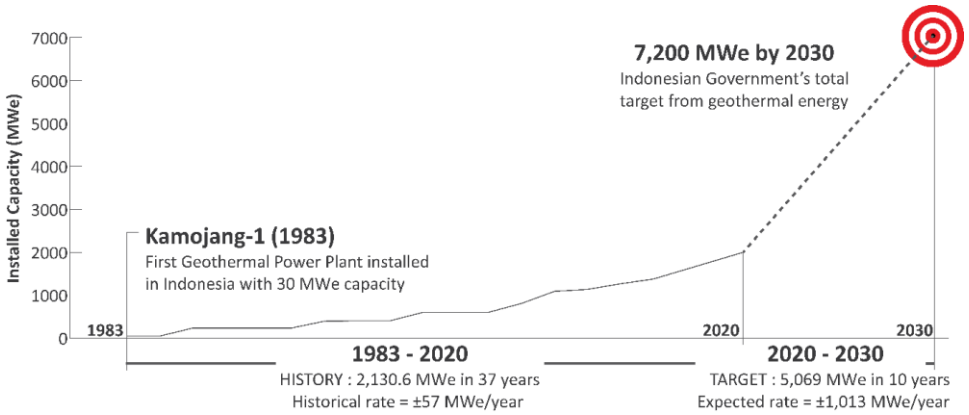

Figure 1: History and target of geothermal energy development in Indonesia (Purba et al., 2020)

The first geothermal power plant in Indonesia, Kamojang-1, was installed in 1983 with a capacity of 30 megawatt electrical (MWe) (Darma *et al.*, 2010; Hochstein and Sudarman, 2008). Figure 1 shows that until March 2018, the total installed capacity of geothermal power plants in Indonesia was 1924.5 MWe which equals to only 6.6% of its total geothermal energy potential or equal to an installation rate of 58 MWe per year (MEMR, 2017).

If the installation rate stays at this pace, the target set by the Government of Indonesia (GoI) to reach 7,000 MWe of geothermal energy utilization in 2025 seems impossible to achieve. There must be a significant improvement in the collaborated effort of all geothermal development stakeholders in Indonesia in order to be able to reach this goal.

1.2 Research Objective and Method

1.2.1 Research Objective

The Authors of this study believes that one of the first important steps to accelerating the development of geothermal energy in Indonesia is to ensure that every exploration project can meet the planned schedule.

Furthermore, authors also believe the key success of a project is mostly lies on the people running the show, where the level of Project Manager Competency become directly related to the chance of achieving successful geothermal exploration project. The idea is then become the initial hypothesis, which lead to the main question explored by this study "Do we need a competency assessment for Project Manager role in a geothermal project in Indonesia?"

In order to answer the main questions, this study is initiated by asking the following questions:

1. What are the challenges in geothermal energy development project in Indonesia?
2. What is the cost of failure in addressing those challenges?
3. What is the cost of competency assessment?
4. What are the main competences required by the geothermal project manager in Indonesia?

1.2.2 Research Method

To test this initial hypothesis and explore the research questions, authors conducted a literature review of various competency matrices that already exist in several energy development projects throughout the world. Another method used in this study is a direct survey to several geothermal practitioners in Indonesia related to the competencies that must be possessed by a geothermal project manager.

2. RESULTS AND DISCUSSION

2.1 Challenges in Developing Geothermal Energy in Indonesia

Previous studies have concluded that there are several identified geothermal development challenges in Indonesia (Purnomo et al., 2015; Umam et al., 2018; Darma, 2016; Purba et al., 2019):

2.1.1 High-relief terrain

Indonesia's geothermal systems are mostly located along high-relief volcanic arcs and are generally identified through surface manifestations that emit water or steam at boiling temperatures at ground level (Hochstein & Sudarman, 2008). These locations provide challenges for geothermal development companies due to volcanic areas generally have steep slope and are filled with a variety of hard but unconsolidated volcanic rocks such as pyroclastic and lava. In addition, volcanic areas in Indonesia are often filled with hydrothermal alteration areas that have the potential danger of H_2S gas and hydrothermal eruptions.

In general, mountainous area are comprised of fragile and unconsolidated formations, making it difficult to accommodate transportation traffic for transporting heavy equipment prior, during and after drilling activities. Utami (2010) describes in detail the various challenges that will be faced when conducting civil works in geothermal areas in Indonesia due to the unique characteristics of volcanic areas, where heat, rocks and liquids interact dynamically, naturally and actively.

2.1.2 Lack of Subsurface Data Combined with High Upfront Risk

Insufficient geological, geophysical, and geochemical data in the area makes the early assessment of resource potential inaccurate. This will certainly make discourage new investors to participate in Indonesia's geothermal development because it is difficult to measure the risks. IGA (2014) noted that the main challenge in developing geothermal energy is the high project risk upfront in a resource exploration phase, due to the uncertainty of available economic resources. Darma et.al. (2010) mentioned that a geothermal power project in terms of investment is different from other power projects and more similar to petroleum or coal mining. A geothermal power project needs to take account of the upstream cost of locating and verifying the resource.

2.1.3 Limited Number of Human Resources with Specific Competences in Geothermal

Umam et.al. (2018) mentions the need for 5,433 MW to create approximately 23,000 additional jobs. By using the formula proposed by Jennejohn (2010) which assumes that for every MegaWatt (MW) of electricity production by geothermal energy will require 4.25 full-time and 16-person positions, then to reach the target of Indonesia's geothermal utilization in 2025 it will take 87,000 people per year. These personnel including geologists, geophysicists, geochemists, drilling experts, engineers, hydrologists and other skilled personnel for operations and maintenance that must be prepared before starting geothermal development projects (Smillie et al., 2015).

The oil and gas industry are considered more established than the geothermal industry, especially in Indonesia. This makes many geothermal developers looking for experts in the oil and gas industry to be directly brought into the geothermal industry to cover the personnel shortage. Unfortunately, many geothermal companies have not yet realized that although they look similar, there are a

considerable difference between geothermal development projects and oil and gas projects. Umam et.al. (2018) discusses these differences with more emphasize in drilling. Umam also mentioned that currently there is no specific competence standard for geothermal drilling personnel. All requirements for key drilling personnel still refer to the experience and competencies applicable in the oil and gas industry despite of their fundamental differences. So that all personnel who have certification and experience in the oil and gas industry can work directly in geothermal projects without realizing there are some differences between the two industries that could threaten work safety and the environment.

2.1.4 Lack of Knowledge Transfer to the Local Community

This issue is one of the challenges in the development of geothermal projects that have not been widely discussed in various scientific journals or seminar publications, which may be caused by the difficulty of measuring or quantifying the level of public understanding or awareness of a geothermal development project. Another possible cause is that developers and local governments often feel that the task of educating people living in the geothermal prospect area is not their responsibility.

The lack of public understanding of the importance of geothermal projects often leads to community rejection, which ultimately causes delays in geothermal development projects. This situation mainly occurs when geothermal projects are still in the exploration stage where local governments, developers, and local communities are still in the stage of recognizing each other and have not yet developed trust between each party.

Government and developers are aware of this issue, especially with the amount of news in the mass media covering the cases of community rejection towards geothermal projects in Indonesia. However, more often than not, developers have not conducted education or counseling in a sustainable and comprehensive manner. Often socialization events or public consultations are carried out only once at the beginning of the project in a 3-6 hours session. With such a very short session, the local community will not be able to comprehend the geothermal project, and this will most likely cause confusion and fears of environmental impact due to their misunderstanding.

Ideally, the education and counseling process for geothermal projects is carried out 3-6 months before the first physical activity at the site begins, with an increasing frequency of the socialization in critical stages of the project such as land clearing and drilling. To be able to build a sustainable and long-term relationships between developers, local community, and government, all public doubts must be answered properly and openly.

2.1.5 Land acquisition issue

Pisu (2010) states that the procedure for land acquisition for infrastructure projects in Indonesia is still complicated and has significantly hampered the expansion of road networks. Although Pisu does not directly refer specifically to infrastructure projects related to geothermal energy, the situation also occurs in geothermal projects. The process of land acquisition for geothermal projects is generally carried out by development companies in collaboration with local governments.

One of the main reasons of local people unwilling to sell their land is that landowners have not trusted yet the geothermal developer and are afraid of being deceived by offers submitted by the company. The lack of understanding of the landowners on the mechanism of real estate buying and selling because they have no experience at all in land transactions further complicates the issue.

Another reason is that land in several regions in Indonesia is not owned by one person but owned communally by one the whole village. This means that all decisions related to the land must be discussed together and might take a long time, especially if there is one community member who disagrees. The various causes mentioned above usually occur if the geothermal developers does not invest enough effort, time and money to conduct proper social mapping and fails to build sincere and open relationships with the community.

2.1.6 Lack of infrastructure

Sandee (2016) emphasizes that the main problem in projects on archipelagic countries such as Indonesia is inter-island connectivity which directly affects domestic shipping costs. Sandee also mentioned that the low level of Indonesia's investment in physical infrastructure such as roads and bridges has significantly contributed to connectivity problems in Indonesia. Transportation, congestion, and poor road quality problems are one of the major business constraints.

In addition, the location of Indonesia's geothermal prospects is generally located in mountainous areas, most of them are located far from the main road access, both provincial and district roads, making it difficult to carry out mobilization activities for drilling equipment. The higher the logistics costs and the mobilization of equipment, the higher the cost of geothermal development projects, which in turn can make investment in this sector more unattractive than other energy sectors such as coal or oil and gas.

2.1.7 Multitudes of work types

Geothermal exploration project consisted of a various amount of work type, starting from surface reconnaissance, resource assessment, drilling activities, and construction. This vast amount of work and very different nature of each phases in geothermal project is one of the challenges faced by a Project Manager in managing geothermal exploration project in Indonesia. Figure 2 shows roles that are required in each phase of a geothermal project.

Start-up	Exploration	Feasibility drilling	Drilling and Construction	Operation and Maintenance
•Geologists •Biologists •Hydrologists •Archeologists •Lawyers •Paralegals •Environmental engineers	•Geologists •Geophysicists •Geochemists •Engineers •GIS specialists •Exploration drillers •Sample analysts •Consultants	•Drilling engineers •Rig hands •Mud loggers •Drilling fluids personnel •Cementing personnel •Casing crews •Directional drillers •Rig transportation •Fuel transportation •Welders •Safety managers •Geologists •Construction personnel	•Engineers •Power plant designers •Document controllers •Project managers •Construction managers •Project engineers •Field engineers •Safety managers •Welders •Steel erectors •Concrete placers •Assembly mechanics •Inspection personnel	•Plant managers •Engineers •Plant technicians •Site operators •Service repairmen
Enabling activities: IT professionals, Human resource professionals, Health and safety consultants, Administration, Insurer representatives, Management, Government office workers, Educators and trainers, Accountants, Auditors, Financers, Publishers and Science writers				

Figure 2: Several roles that will be led by a geothermal Project Manager in a geothermal development project

2.1.8 Other Challenges Outside Project Manager Competency

The aforementioned issues and challenges turned out to be a serious concern for both of the new investors that plan to enter geothermal industry and for investors that have already invested on geothermal exploration in Indonesia. Extra effort is required from every stakeholder; central and local government, geothermal developers, and academic community to resolve all the challenges mentioned above in order to achieve 7000 MWe installed capacity target in 2025.

However, other challenges such as pricing policy, single buyer issue, and national park issue are considered outside of project manager authority, thus not discussed in this study.

2.2 Geothermal Exploration Project Objectives and Success Criteria

Contrary to popular viewpoint in Indonesia, the main objective of geothermal exploration project is to confirm the presence of the geothermal resources, and not necessarily to produce steam right away. Therefore, it is important for a Geothermal Exploration Project Manager to understand the nature of geothermal exploration project and appreciate the relatively high uncertainties bound to it. In general, a geothermal exploration project can be considered success when the exploration project can confirm the presence of geothermal resource in a timely manner and within the project budget. Figure 3 illustrates the geothermal energy development phases in Indonesia, with the exploration period of 7 years max. After 7 years, if the exploration has not concluded yet (as in no drilling has commenced), the geothermal working area has to be returned to the government.

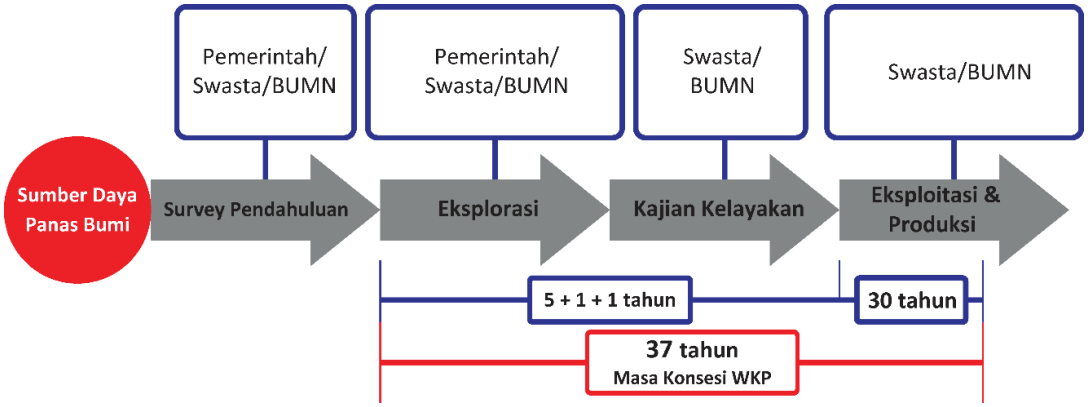

Figure 3: Geothermal energy development phases in Indonesia. Note that the exploration period given by Government is 7 years maximum (EBTKE, 2017a; Purba, 2018b)

2.3 Cost of Failure

After mapping the constraining factors of geothermal development in Indonesia, the team conducted a group discussion and literature review regarding the consequences of underestimating these various factors.

2.3.1 Project Delay

When a project manager fails to do his job in running a geothermal project on schedule, the obvious consequence is project delay. With the project stops running, several impacts to the community and geothermal development in Indonesia are:

1. Failure to meet national electricity target – this is something that will be felt immediately nationally. PLN has made an Electricity Supply Plan (RUPTL) that comprises supply from the geothermal sector. With the delay of a geothermal exploration project running, the development phase will also be delayed (Figure 3), and electricity supply will be hampered. Eventually, PLN will fail to reach the target of national electricity.
2. Delay in providing job opportunities to local communities - when a geothermal company conducts an exploration project in an area, it is very likely that the company promises to open jobs for the community. If the project stops, the company will find it difficult to continue to open jobs, thus creates a domino effect such as a loss of public trust in the developer's
3. Increase in the project cost that may lead to an increase in electricity price – project delay correlates directly to standby cost. When a project is stopped, the company will still have to pay personnel, equipment and other overhead costs. In the end, geothermal developers will try to include all these standby costs into the total project costs that ultimately will increase the electricity costs.

2.3.2 Trust Issues

Other than the impacts discussed above, some intangible things that will also be a problem when a geothermal project is stopped are:

1. Investors lose trust in the geothermal project in Indonesia and choose to invest in another type of project or another country. This makes it difficult for the Indonesian government to develop further geothermal projects due to minimal participation from investors.
2. Local communities lose trust in geothermal project. Such a situation would be a risky point for the country because trust is usually more difficult to rebuild once it is damaged. Local communities tend to continue to live in their hometowns and will pass down their negative perceptions of the geothermal project to their next descendants.

2.4 Effort of Conducting Competency Assessment

A simple yet very possible scenario where project manager role may fall into incompetent personnel is when a new investor that have no experience in running geothermal project in Indonesia are about to appoint a project manager for geothermal exploration project without any proper competency assessment.

Authors' experience in two geothermal exploration projects in Indonesia showed that most of the project manager candidates are from civil or construction project background. This is not to say that people from civil or construction project cannot be a good project manager in geothermal exploration, but they should have an open-minded perspective and appreciate the subsurface uncertainties in geothermal exploration, something that they may not find in common civil construction project. One way to ensure that the project manager candidates really understand the risk and uncertainties in geothermal exploration by assessing their competency. According to Nieman et al., (2004), several competency assessment methods are:

- formal written test;
- review panel with qualified experts;
- accreditation through a professional organization;
- job reference;
- prior supervisor's performance assessment;
- self-assessment.

While several points need to be addressed in a competency assessment are:

- The metrics or scale used to define a person's competency,
- How different values of that scale translate into the likelihood that a person will perform different job assignments successfully.

Currently there is no specific regulation in Indonesia regarding the project manager competency for geothermal exploration, thus there is no exact cost for the competency assessment. The associated cost for certification/training for several core subjects in geothermal exploration were used for the cost estimate. The cost estimates are as follow:

1. Project Management Certification (PMP) by Project Management Institute ~ 600 USD;
2. Basic Geothermal Training ~ 1,500 USD;
3. Geothermal Drilling (Well Control) ~ 2,000 USD;
4. Operation Supervisor Certification by Indonesia Ministry of Energy and Mineral Resources ~ 600 USD.

The total estimated cost for the following skills assessment is around 4,700 USD, a very small numbers compared to the total geothermal exploration project cost. Those assessment or certification are conducted by third party organization, ensuring their objectivity. Generally, if the competency assessment is not too costly and is reasonably accurate, then it makes sense to be done since it can increase project success probability. This become more crucial when considering the long term and nation-wide impact of geothermal exploration project failure or delay.

At this point of discussion, authors of this study come to conclusion that with that many challenges and risks identified, it is not advised for geothermal operators to appoint a project manager without proper skills and knowledge regarding geothermal energy. The benefit of conducting competency assessment for geothermal exploration project manager far outweigh the effort of doing so, especially considering the potential cost of project failure.

2.5 Survey to geothermal practitioner

To test the initial conclusions taken based on the authors discussion and literature review, this study conducted a survey to the geothermal practitioners in Indonesia. The respondent's profile is shown in Figure 4.

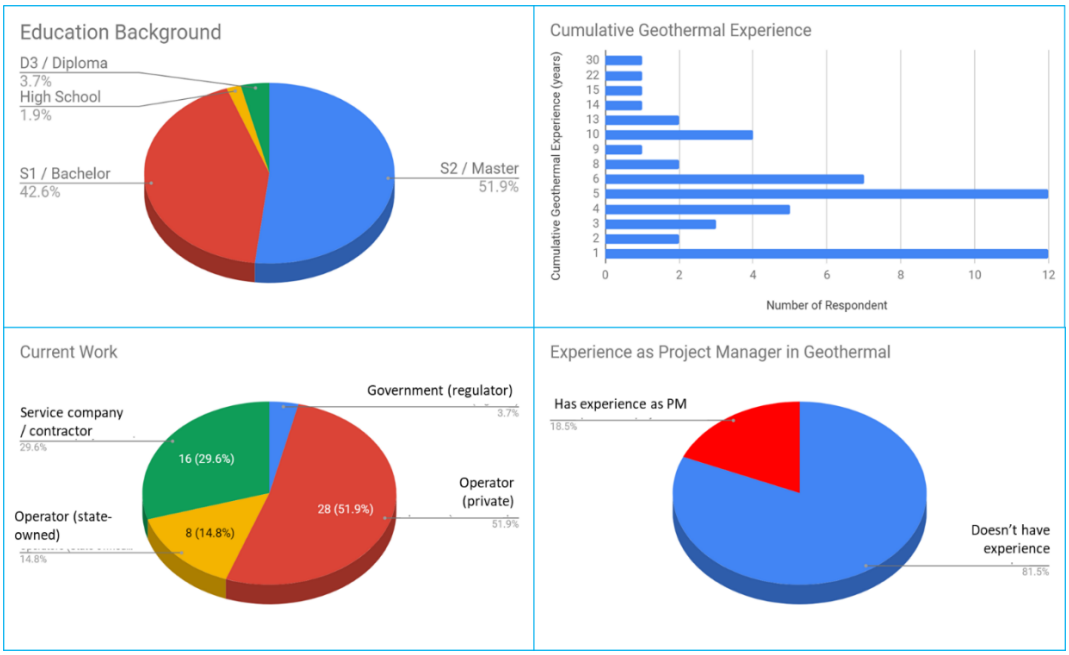

Figure 4: Survey respondent profile (54 respondents)

There were 54 total respondents participated in the survey who all have experience working in geothermal industries with a range of 1-30 years of experiences. Based on education, almost all respondents have a high level of education, specifically bachelor and master's degree. And more than half of the respondent population is working in a geothermal operator company.

This study considers that the respondent profile obtained is quite representative of the geothermal community in Indonesia, so a survey related to the importance of the competence assessment for the project manager's geothermal role can be conducted. Questionnaire survey is conducted by using the WhatsApp application and Google Form.

Figure 5 shows the results of the first two main questions where the responses obtained correspond to the initial conclusions drawn by the authors of this study.

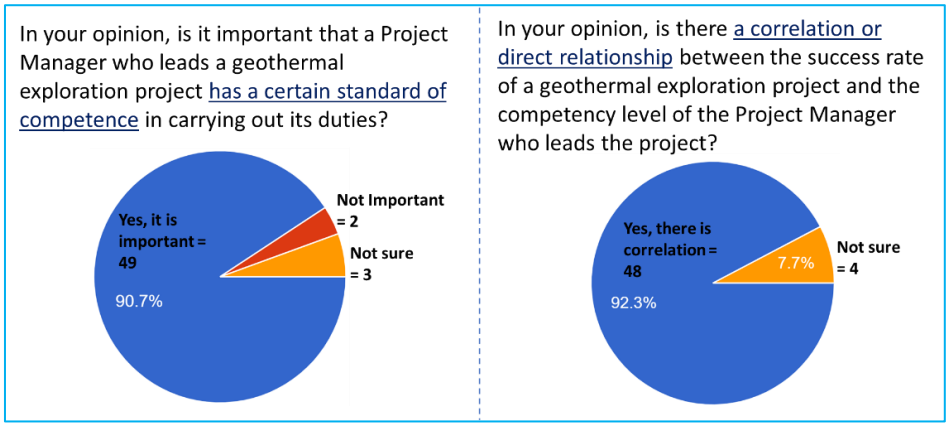

Figure 5: Survey result on two first main questions

The next logical question is what kind of competence or knowledge required in a Geothermal Exploration Project Manager. Figure 6 shows the survey result regarding the knowledge subjects that are deemed important by respondents. The interesting result is that apart from the standard competence required for a project manager such as project management and risk assessment, the drilling engineering, resource assessment, and permitting/regulation are also considered as an important knowledge to have. This supports author's initial conclusion that the exploration risk due to subsurface uncertainties has to be fully understood and appreciated by a project manager. The permitting and regulation regarding the geothermal exploration and development in Indonesia is also crucial, as geothermal exploration (especially drilling) project can be stalled for a long time due to the permitting issue.

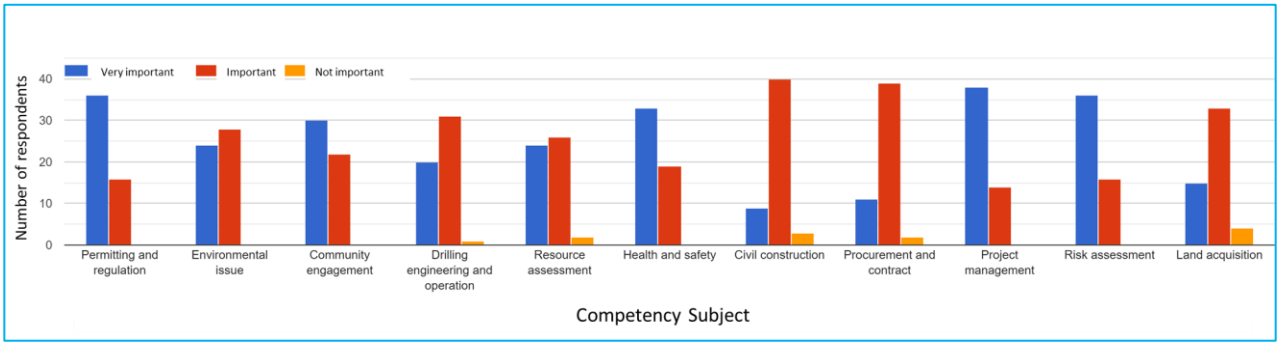

Figure 6: Survey result regarding what competence subject(s) are required for a Geothermal Exploration Project Manager in Indonesia.

Survey result in Figure 6 shows similarity to the requirements requested by the World Bank (2017) for the qualification of an Exploration Project Manager (EMP) although not too similar in terms of rank or priority.

World Bank (2017) competency requirement of an EMP	**Competency rank based on "very important" votes**
1. Fundamentals of geothermal energy – this will cover geothermal system frameworks, geothermal resource assessment, exploration, drilling, development and power production, as well as an understanding of geological, geochemical, geophysical concepts and data collection, and optimization of field development.	**Resource assessment** – ranked 7 in the survey result of this study
2. Understanding the drilling process; objectives of the drilling, geological conditions, well structure and configuration, equipment and services required to construct the well, materials used for the well and for the drilling process, different types of well and drilling that might be used for exploration purposes, understanding the specialist words;	**Drilling engineering and operation –** ranked 8 in the survey result of this study
3. Drilling infrastructure requirements: well pads, access roads, water supply, lay-down areas, office and accommodation requirements;	**Civil construction –** ranked 11 in the survey result of this study
4. Well completion and testing; what happens, equipment required, time frame;	**Drilling engineering and operation –** ranked 8 in the survey result of this study
5. Drilling management on site: who does what, who is in management control, what happens when things go wrong, downhole equipment losses, health, safety and the environment;	**Health and safety** – ranked 4 in the survey result of this study **Environmental issue** – ranked 6 in the survey result of this study
6. Procurement options: materials and services, packaging of services etc, time-based services and possible alternatives, contract formats (with particular reference to World Bank standard form contracts), special considerations for long-lead items including procurement to inventory;	**Procurement and contract** – ranked 10 in the survey result of this study
7. Procurement processes: the tender package, tendering activities including clarification meetings and site visits, tender evaluation, contract negotiations and pre-award activities (equipment inspection etc), timing of activities; and	**Procurement and contract** – ranked 10 in the survey result of this study
8. Contract administration: checking and certification of daily tickets, mobilization and demobilization, rig moves, rig release, invoice review and approval	**Procurement and contract** – ranked 10 in the survey result of this study

The next two questions show results that also support the initial hypothesis of this study, where 76% of respondents believed that a competency assessment test or certification should be carried out by Indonesian Government for Geothermal Exploration Project Manager candidates.

Another interesting thing is the result of the last question (Figure 7, right-hand side) which shows that respondents have varying answer regarding the minimum years of experience required for someone to be able to lead geothermal exploration project in Indonesia. The majority answers "at least 10 years", the second most answer is "at least 5 years", while the answer of "at least 15 years" is ranked third. These results indicate that the duration of one's experiences is not seen as the only parameter for establishing someone as a project manager in geothermal exploration in Indonesia. Nevertheless, most respondents agreed that a competency assessment is important to be conducted.

Figure 7: Survey results of the two last questions

3. CONCLUSION

Several conclusions that can be drawn from this preliminary study are:

1. Geothermal exploration in Indonesia has many challenges that make it unique compared to other projects such as civil construction or power plant EPC (Engineering, Procurement, and Construction), thus someone without enough background in geothermal resources and drilling will have difficulties in fathoming the whole project cycle and its associated risks.
2. Cost of failure in geothermal project exploration is significantly higher than cost of performing a competency assessment. The stalled or overbudgeted geothermal exploration has a nation-wide impact, as it will hinder Government of Indonesia's plan to achieve its national electricity target (RUPL).
3. Based on authors' survey result, duration of one's experiences in geothermal exploration project cannot be used as the only determinant for establishing someone as a project manager in geothermal exploration in Indonesia.
4. The top three competences required for a Geothermal Exploration Project Manager, based on this study, are understanding of permitting, regulation, project management, health, safety and environment. While the World Bank (2017) top three competency requirements for an Exploration Project Manager are resource assessment, drilling engineering and operation and civil construction.
5. To be able to objectively asses someone's competencies for a Project Manager in Geothermal Exploration position, it is important for Indonesia to establish a competency assessment standard.

4. PATH FORWARD

1. Conduct further study regarding the following issues:
   - Project Manager competency assessment cost;
   - Detailed risk assessment of having incompetent project manager of geothermal exploration project in Indonesia, including the associated cost of project failures.
2. Propose a competency assessment matrix for Project Manager role in geothermal exploration project
3. Exercise the proposed competency assessment test to get the following data:
   - Probability that a COMPETENT PM will "Pass" the proposed competency assessment;
   - Probability that a NOT COMPETENT PM will "Pass" the proposed competency assessment;
   - Correlation between project success rate and PM competency level.
4. The data will be used to assess whether the proposed competency assessment method and matrix proposed is reliable to filter a competent Project Manager, that in turn will increase the success probability of geothermal exploration project in Indonesia.

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