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Feasibility Study: Online Learning for Supporting Rural Renewable Energy Projects

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Abstract

Indonesian government set the target for new and renewable energy (NRE) is expected to be 23% in 2025 and 31% in 2050, where in 2017, NRE was only 12,5%. Building a new and renewable energy project is the easy part. Keeping the generator working over time, however, is a complex business that requires money, training and innovative thinking. One of essential parameters that can help in achieving a successful sustainable project is community involvement. If the community feels a strong sense of ownership, they'll see their generator as a critical asset to everyone and take good care of it collectively. Training and educating the community about how to take care of the generator after the project construction has completed becomes important. Considering Indonesia's geographical location, e-learning might be a potential tool to reduce training and education cost in new and renewable project. This study aims to identify whether e-learning is an effective and efficient method to deliver training material and educate local people which will improve renewable energy project's sustainability in Indonesia.

Keywords*: Distance Learning, Rural Electrification, New and Renewable Energy*

1. Introduction

Energy supports community activities as well as the nation's economy. In rural area, electrification brings about improvements in the socio-economic welfare of the rural dwellers. It is a catalyst of development and at the same time their presence can serve as indicators of development. Indonesian government pays attention to New and Renewable Energy (NRE) as an alternative energy as stated in Government Regulation No. 79/2014. The target for new and renewable energy is expected to be 23% in 2025 and 31% in 2050, where in 2017, NRE was only around 12,5%. Government must put huge effort to meet the target in 2025 [1].

Some of the challenges and obstacles that are directly related to the development of NRE are inadequate infrastructure which halt energy distribution in Indonesia, the lack of investors because of the high risk of investment in energy. The government has made an effort to increase energy security through energy security fund. Energy security fund budget is obtained from the revised state budget 2016 amount of Rp 1.6 trillion [2]. This is a breakthrough that shows the government's commitment to increase national energy security. However, beside huge investment to build NRE power plant, there are also problem with the sustainability of NRE plant operation, especially those with small scale. Besides obstacles in development, there are some issues of sustainability of NRE plant, especially the small ones. Based on BPK (Badan Pemeriksa Keuangan) audit in December 2017, some of NRE plants were in minor and severe damage condition [1].

The project to build NRE power plant is usually performed by third party that bound to a certain contract period. As a result, handover and transfer knowledge to the local community cannot be perform. Even when the third party have time to handover it, it is incomplete or does not thorough. Once they are leaving, the community cannot operate neither maintain it. Without ensuring the NRE sustainability in long-term, it will be difficult to achieve the government's

target because as the number of NRE development projects increase, the number of break down plants also follows.

To solve this problem, Government should have an integrated plan, besides providing funds for infrastructure establishment, they should also provide funds for operation and maintenance. Furthermore, to maintain NRE project continuity, it should invite community since the planning of the project installation. Without community involvement, they do not see the projects as part of them. The projects in most cases, therefore suffer abandonment or at best low maintenance.

The general principle of participatory approach includes among others the following; encouraging communities to take responsibilities, promote participation for all, reconcile different interests, listen to the community, examine the situation/problem from different points of view and then adapt to local situations [3]. In order to encourage communities to take responsibility and promote participation among them, we must provide public awareness at the beginning of the project, necessary information about energy utilization and renewable energy resources, as well as education and training. Education and training are considered as the significant prerequisite for sustainable energy program. For this reason, a wide scope of specialized agencies and training facilities should be made available to public [4].

Considering Indonesian geographical condition as an archipelagic country, asynchronous learning environment that utilizes technology or e-learning becomes a potential solution to deliver training and education to people geographically distant from the capital city. Furthermore, we can provide standardized material for each participant and reach more participant at the same time compared with using traditional training. E-learning can be defined as the use of computer network technology, primarily over an intranet or through the Internet, to deliver information and instruction to individuals [5]. However, e-learning is still in its infancy in developing countries which experience challenges unique from developed countries. The objective of this study is to identify whether e-learning is an effective and efficient method to encourage community participation which will improve renewable energy project's sustainability in Indonesia.

2. Research Method

Feasibility Study

According to a 2009 IDC (International Data Corporation) report on Improving IT project outcomes, 25% of IT projects experience outright failure [6]. Furthermore, according to Project Management Institute report, 39% of failed project is due to bad requirements [7]. In software engineering, requirement engineering aims to produce a set of agreed requirements that specifies a system satisfying stakeholder requirements. One of the main activities in requirement engineering process is feasibility study. A feasibility study is used to determine the viability of an idea, such as ensuring a project is legally and technically feasible as well as economically justifiable. A feasibility study should be relatively cheap and quick. The result should inform the decision of whether or not to go ahead with a more detailed analysis. There are mainly two criteria to judge feasibility in a project feasibility study according to Lean Six Sigma. The first one is the cost required and the second one is the value to be delivered. Another literature mentioned three criteria [8] and six criteria [9];

- Technical Feasibility focuses on the technical resources available to the organization. It helps organizations determine whether the technical resources meet capacity and whether the technical team is capable of converting the ideas into working systems. The technical assessment help answer the question such as whether the technology needed for the system exists, how difficult it will be to build, and whether the firm has enough experience using that technology.
- Economic Feasibility, assess a cost/ benefits analysis of the project, helping organizations determine the viability, cost, and benefits associated with a project before financial resources are allocated. One methodology for determining the costs of implementing and maintaining information technology is Total Cost of Ownership (TCO).
- Operational Feasibility is to gain an understanding of whether the proposed system will likely to solve the business problems or take advantage of the opportunities or not. A

workable solution might fail because of the end-user or management resistance, such as, how will the working environment of the end-users change, or whether end-users and management can and will adapt to that change.

- Schedule Feasibility to assess the duration of the project whether it is too long to be complete before it is useful which also considering the learning curve of the new technology and new system.
- Legal Feasibility to determines whether the proposed system conflicts with the legal requirement or not.
- Political Feasibility to gain an understanding of how key stakeholders within the organization view the proposed system.

Interview

Interviews can be thought of as a "conversation with a purpose" [10]. There are four main types of interviews: open-ended or unstructured, structured, semi-structured, and group interviews [11]. The most appropriate approach to interviewing depends on the purpose of the interview, the questions to be addressed, and the stage in the lifecycle. Semi-structured interviews which combine features of structured and unstructured interviews and use both closed and open questions. [12].

Direct Observation in the Field

Observation is a useful data gathering technique at any stage during product development. Early in design, observation helps designers understand the users' context, tasks, and goals. In the case observation take place in the field, the task is performed in the natural setting instead of controlled environment [12].

Studying Documentation

Documents such as manual, standard operation procedures, reports, newspaper articles are a good source of data about the steps involved in an activity and any regulations governing a task. This technique is good for understanding legislation and getting some background information on the work [12]. However, this technique should not be used as the only source for data gathering.

Table 1. The Performance of ...

Variable	Speed (rpm)	Power (kW)
x	10	8.6
y	15	12.4
z	20	15.3

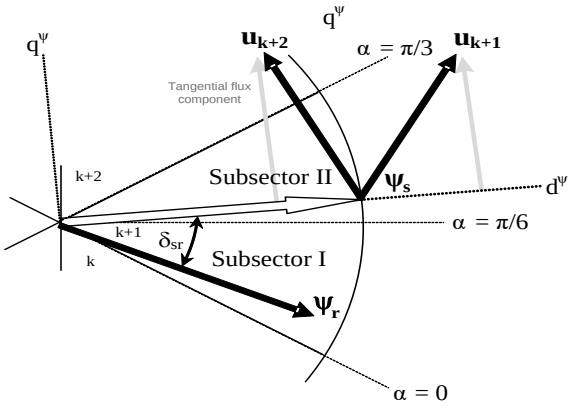

Figure 1. Effects of selecting different switching under dynamic condition

3. Results and Analysis

For feasibility study, this research used three criteria out of six as mentioned in Literature Review section. There are technical, operational and economic feasibility. Three data gathering techniques were used in order to provide multiple perspective. To explore the issue,

we use interview, direct observation to understand context of user activity and studying documentation to cross check and richen the data.

Due to time and cost limitation, the study used secondary source. Instead of interviewing people in remote area, we interviewed Ricky Elson (the chairman of Lentera Bumi Nusantara, a company which moves in various industrial sectors based around technology and community development) and Dr. Ichsan (Senior Manager-Renewable Energy, Millennium Challenge Account-Indonesia, the institution that will manage the Compact grant). This research used semi-structured interviews, where the interviewer has a basic script for guidance, so that the same topics are covered with each interviewee.

In this researched we observed a rural area, a village named Tenjo in Bogor, Jawa Barat. We observed the signal strength of various telecommunication provider; Telkomsel, Indosat, XLAxiata, Three as well as people's computer literacy and device ownership.

Because interviewee cannot reveal their data, we check their information with annual reports, journals and newspaper, published conference proceedings provided by various government agency.

Interview with Ricky Elson

LAN involves local people since the beginning of the project. First, they got support from the community leaders then began construction with the community in early 2013 and has been operating since July 23, 2013, with funds from Pertamina's CSR. After the construction, LAN invited some selected local people to Ciheras, the research site, to educate and train them about wind turbine. So that they can do the maintenance and minor repairs independently in the future.

LAN believe if the community feels a strong sense of ownership, they'll see that electricity as a critical asset to everyone and take good care of it collectively. LAN team actively assist local people, they occasionally visit those 4 villages, trains local people, doing tune up and necessary repairs to keep the wind turbine working. As a result, the project keeps running well until now.

Figure 1. Local People Built Wind Turbine [11]

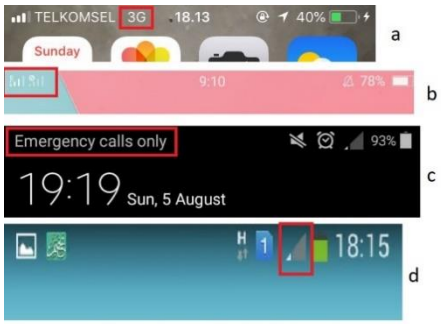

Figure 2. Signal Strength in Tenjo (a) Telkomsel (b) Indosat (c) XLAxiata (d) Three

Ricky Elson said that e-learning will not give much contribution compared to the current practice. Hands-on experience is considered more superior than virtual learning. Moreover, it requires additional skill (computer literacy or familiarity) and additional cost (pay the internet bill, buy computer set).

Interview with Dr. Ichsan

His assessment result shows that since 1990, Indonesia has a national program for rural electrification named Desa Mandiri Energi. From about 600 projects, most of the projects are not sustain. These projects succeeded in building power plants in various regions but was unable to maintain production capacity and utilization has not been maximized. His study showed several reasons of unsuccessful projects are; it focuses on procurement and construction without considering operation and maintenance costs, lack of transfer knowledge, technical support, and coordination with local community and government, using top-down

approach where government direct the location of the project which leads to lack ownership of facilities, interest and support from local communities.

Learned from the unsuccessful projects, MCA project uses different approach. MCA project covers Planning (Technical Feasibility Studies, Environmental Studies, Gender Studies, Social Studies, Licensing, Engineering Design), Equipment Procurement, Development of Renewable Energy Power Plants, Construction of Village Training Centres, Transmission / Distribution Development, Construction of Housing Installation, Commissioning, Operations, Plant Maintenance Electricity (25 years of assistance).When we proposed using distance learning as a tool for education and training, Dr. Ichsan explained several potential barriers such as rural areas usually out of the cellular coverage area, most people in rural areas do not own a computer and if they own a cellular phone, it is not a smart phone. Furthermore, although local communities are involved in maintaining the generator such as cleaning, regular checking and reporting, they are not allowed to repair it. The technology installed in their area either imported or manufactured nationally, performing repair might broke the product's guarantee. In this case, they will always need support from third party or the manufacturer.

Observation in Tenjo, Bogor, Jawa Barat

Although does not have NRE project, this area is considered as a rural area. We use this village to understand rural people's activity and telecommunication quality. The village's location is close to the capital city (about 55 km from South Jakarta). The nearest station is Tenjo train station, it is about 10 minutes walking from the train station. Based on Badan Pusat Statistic (BPS, or Central Agency on Statistic) data in 2016, the population is 11,422 people; 42.7% aged below 19 years old, 50,8% aged 20-60 years old, 6,5% aged more than 60 years old and the proportion of male and female is 52:48. There are several educational facilities in Tenjo; 5 public elementary schools, 1 public and 3 private junior high schools, 2 Madrasah Ibtidaiyah and 2 Madrasah Tsanawiyah, 3 private high school, and 3 Islamic boarding schools.

The observation result shows that although located in Java and close to the capital city, the signal strength in Tenjo area is considerably not reliable. In Figure 2, we can see that Telkomsel provides the strongest signal in this area (3G with 3 bars signal means pretty good), while the other providers show only one bar which means a poor signal and an edge signal. It is out of the coverage area of XLAxiata provider.

In this area, not every household owns a computer. Even the school does not have computer facility. Students usually rent a computer with internet access from a computer rent service. Based on the observation, people in the productive age are having good level of computer literacy and are familiar with the internet. Observation shows that the fast internet service coverage is still limited and concentrated in area with high business value for the cellular operators.

Studying Documentation - Infrastructure

Because we cannot observe a lot of rural areas, we use data in the report from ministry of communication and informatics and data from knowledge-based websites. In Indonesia, there are several internet providers and some cellular operator that provide internet services. Internet providers use wired technology while the other one uses a wireless. In terms of coverage, most of the internet providers only available in several areas in big cities. Cellular operator is considered wider than internet providers, especially in rural areas.

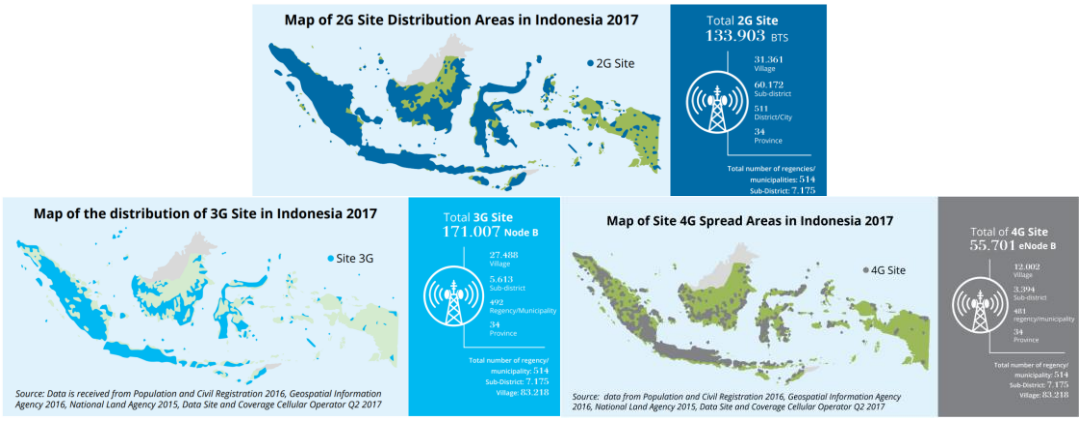

Figure 3. 2G, 3G and 4G Network Coverage [12]

We checked network coverage and signal strength of several major cellular operators in Indonesia from knowledge-based websites [13] [14] [15]. as well as from ministry of communication and informatics annual report [16]. The data in figure 3,4 shows that the network coverage of all cellular operators is concentrated in Java, while most MCA electrification projects are located in Nusa Tenggara Timur, Nusa Tenggara Barat, and Jambi. We found other organization that develop renewable energy programs in rural area, they have running project in Aceh, West Sumatra, North Sumatra, South Bengkulu, South Sumatra, Banten Jaya, West Java, Central Java, East Kalimantan, South Sulawesi, Lombok, Sumba [17]. From figure 3, some rural areas that have NRE project such as Aceh, West Sumatra, North Sumatra, South Bengkulu, South Sumatra, Banten Jaya, West Java, Central Java already have internet access.

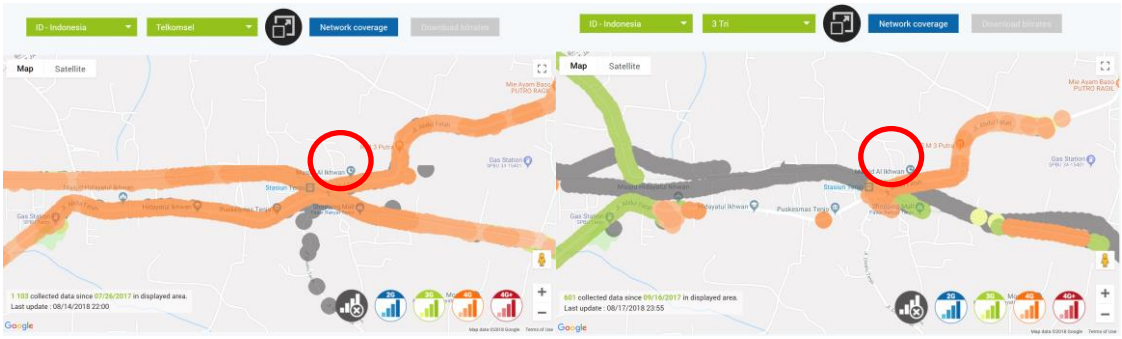

Figure 4. 3 Signal Strength in Tenjo [11]

Furthermore, each cellular operator offers different speeds in different location and most cellular operators provides the fastest speed in big cities especially in the highly populated region. We need to note that even if the data shows a certain level of signal strength, in the reality we can and probably get slower connection. Tenjo Village discussed in Section III.C is the example of area that is easily reachable from big city and does not have any geographical feature that make it difficult to be accessed, hence still get limited fast internet access because this area is not commercially visible for cellular operators. The comparison from this website (Figure 4) and field observation result (Figure 2) shows that area close to Tenjo station get 4G signal provided by Telkomsel, while during the field observation we only get 3G signal. Similar things occur in other providers except 3 operators, the website shows it does not cover that area, though in field observation we got low signal.

Analysis

The feasibility study allows us to preview the potential outcome and to decide whether they should continue. It tells us whether a project is worth the investment and doable. Most importantly, a feasibility study evaluates the project and its potential for success. Although the cost of conduct this study may seem high, there are relatively minor when compared with the

total project cost. This small initial expenditure on feasibility study can help to prevent larger loss later.

The major driving force for e-learning is the people geographically distant from the source. Online learning systems provide benefits for stakeholders located around the world. Advantages of e-learning for learners include an increased accessibility to information, better content delivery, personalized instruction, content standardization, accountability, on-demand availability, self-pacing, interactivity, confidence, and increased convenience. E-learning reduces classroom and facilities cost, training cost, travel cost, printed materials cost, labor cost, and information overload.

From technical perspective, using e-learning as a training tool is highly feasible. There are a lot of open source platform to develop e-learning. Some was proven to be a robust, secure, scalable and have been used worldwide. As an open source platform, it is backed by a strong community. Establishing an e-learning is considered low risky because there are a lot of people who are familiar in developing the system. Beside e-learning itself, internet access is mandatory. However, in most of the remote area internet is not available yet. Technically, this is not a problem because there is abundant technology with various specification as well as its technical experts.

Operational Feasibility, there are two important questions about effectiveness that addressed; (1) Can people learn from courses conducted through technology? (2) Can e-learning be replacing the objective of face-to-face training? Based on a study discussed in [5] learners with low computer self-efficacy, or with anxiety regarding computers, may have difficulty using the computer as a learning tool. Another study mentioned that computer anxiety, technophobia, and lack of IT confidence are some of main barriers e-learning implementation [17]. In rural area such as Tenjo, although not every household own a computer, there are computer rent services available where young people usually use it to help them doing their school assessment. However, in other rural areas where electricity just established, considering the frequency of using computer, most probably people in rural area have a low computer literacy skill which might lead to difficulty using computer as a learning tool. Operationally, there is a need for preliminary training for people with low computer self-efficacy to get familiar in using computer before replacing existing training method with e-learning.

Economic Feasibility, while the potential advantages of e-learning make it appealing, there are a number of potential drawbacks to using e-learning. Up-front cost was the most frequently mentioned drawback of e-learning [4]. Here, we analyze direct monetary costs associated with e-learning versus on-site training, considering a number of different costs. A primary fixed cost for both e-learning and on-site training is the initial development of the course. On-site training can be held in the location where the project take place (rural areas) or in the provider premises (just like what Ricky Elson did, explain in section III.A). In both cases, it requires cost such as travel, lodging, meals, printing training material, and some incentives either for the trainer or for the trainee. Although e-learning can eliminate several variable costs associated with on-site training, considering the digital divide, e-learning initiatives can require considerable investment in Indonesia. Rural area's economically calculation have not been considered feasible for telecommunication and network service providers. So, those area have not received enough attention from. Building one Base Transceiver Station (BTS) requires an investment around eight hundred million to one billion Rupiah [18]. E-learning initiatives possess some initial cost such as; infrastructure establishment (server side – computer and storage server and client side – internet access and computer set), the cost to develop e-learning content. Roughly calculated, the cost for infrastructure establishment is lot higher compared with the transportation cost from source to rural area for assisting and educating local community. Although technically and operationally feasible, if we have to bear the cost of establishing the internet access in the rural area the solution is not cost-effective.

Currently, ministry of communication and informatics focuses on the development of infrastructure to provide equal access to information in all regions in Indonesia. One of its programs is BTS for Rural, Remote and Border Area of Indonesia. The program has started since 2015 and will ended in 2019. The program aims to provide access to underserved areas. Partnering with local governments, cellular operators, local community and civil society, and academia, the target is all rural/remote locations and border areas in Indonesia will have basic telecommunication services, one of them through GSM technology with a total of around 625

BTS in 2019 [18] [19] [20]. Similar programs are Development of Last Mile in village in Rural, Remote and Border area (The construction of 3,900 BTS at priority location of 5,135 villages will start in early 2018 and is targeted to be completed by the end of 2018) and Integrated broadband village solution (Appropriate provision of network, device, application, and capacity building in communities in Rural, Remote and Border areas and priority locations) [12].

With this strategic plan, e-learning might become a potential method to train and educate people in rural area in the near future. Further research needs to be conducted in order to measure computer literacy in rural areas in 2020.

Training and educating local people to take care the facilities is intended to make them independent. So that, if in the future there is a problem with the generator they can do minor repairs. However, in some project, local people are not suggested to do any repairs due to guarantee from the manufacture. They just need to do some checking and cleaning up [21]. In this case, people do not need to learn about the mechanical or technical. Communication channel such as posters or short video is considerably sufficient method to give them guidance in performing those simple tasks.

4. Conclusion

Information technology is increasing in importance in education and is becoming much more prevalent. E-learning is a popular mode of delivering educational materials where the participant located far from the training premise. This study revealed that in Indonesia, a digital divide exists between social groups with different levels of income and education, between young and old, rural dwellers and urban dwellers. While most homes in the developed world have access to a telephone, a computer with access to e-mail and the Internet, this is not the case in Indonesia. Although e-learning claimed has huge potential to reduce training cost, e-learning initiatives also require considerable investments in technology such as hardware costs, software and technical support for both launch and maintenance, as well as training. From the discussion we can conclude that using e-learning to educate and train local community is not an effective and efficient approach from economic perspective. The discussion is based on existing condition in rural areas in mid-2018. However, the telecommunication infrastructure which change over time and it may reveal additional interesting findings.

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