Engineering Sustainable Development : Participation In The United Nations' MDG

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Abstract

The United Nations has agreed on a commitment to achieving the Millennium Development Goals (MDG) by 2015, which responds to the world's main development challenges. The MDGs are eight goals drawn from the actions and targets included in the Millennium Declaration that was adopted by 189 nations and signed by 147 heads of state and governments during the UN Millennium Summit in September 2000. Among these targets are: eradicating extreme poverty and hunger, achieving universal primary education, ensuring environmental sustainability, and developing a global partnership for development. Engineering academic institutions have much to offer in participating in this ambitious program, particularly in implementing Engineering Sustainable Development as part of the curriculum by combining education, research, and community services in an integrated and holistic approach, along with concrete actions. The design of activities needs to be set up carefully in order to ensure sustainability of the program, by involving all parties and stakeholders, such as universities (including academic staff and students), governments, industries, and local communities, etc. This paper will outline an initiative that integrates Engineering Sustainable Development into real life projects. An engineering project was initiated by two student groups from Australia and Indonesia who participated in the Mondialogo Engineering Award 2007, an intercultural dialogue and exchange initiative by Daimler and UNESCO. This international student project partnership on the development of renewable energy systems aimed to provide power and a clean water supply for remote areas, especially for disaster response and reconstruction in Indonesia. Through such student project-based learning experiences, all stakeholders involved can draw lessons on promoting sustainable development with the aim of attaining the UN Millennium Development Goals.

Introduction

The eradication of extreme poverty, the pledge of environmental sustainability, and the development of global partnerships to create a better world to live in are all part of the United Nations' Millennium Development Goals, the achievements of which are targeted to occur in 2015 [1, 2]. There have been many natural disasters in the past five years, primarily the Aceh Tsunami on Boxing Day 2004, and followed by many others, such as the earthquake in Yogyakarta in 2006, the Padang earthquake in 2007, and an earthquake in Manokwari, Papua, early this year. All of these disasters have been in Indonesia alone. Some other disasters in other regions include the Maldives, a country formed by a group of natural atolls located to the southwest of India (with around 80 percent of the total landmass is less then one meter above sea level), which was affected by the Asia Tsunami 2004; there was the China earthquake in 2008; and the cyclone in Burma, in 2008, to name but a few. Such catastrophes usually result in the affected areas being isolated, particularly if the events happen in remote locations. Most of these areas usually suffer from destruction of their vital infrastructure, such as power and water supplies. These occurrences demonstrate the need for an appropriate and environmentally-friendly solution to the lack of power and water supplies in remote areas as part of disaster response and reconstruction. All of these natural disasters have crippled marginalized people living in remote areas in those developing countries, so provide an avenue for concrete actions as part of the realisation of these goals. Providing a reliable and sustainable power and water supply with appropriate environmental considerations to remote areas, especially in developing countries, is the ultimate goal of this research project, in order to lift the

standard of living in such communities.

Sustainable development is a concept first introduced in a report by the World Commission on Environment and Development, "Our Common Future" (1987), which was chaired by the then Norwegian Prime Minister, Gro Harlem Brundtland [3], and defined as:

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [4, 5].

Furthermore, sustainable development is commonly approached by using the triple bottom line concept: the ecological/environmental, economical, and social - where neither one of them can be neglected during the design, process and implementation of the development [6]. Moreover, this triple bottom line approach on sustainable development needs to be based on five principles of equity, according to [7]: futurity - inter-generational equity; social justice - intra-generational equity; trans frontier responsibility – geographical equity; procedural equity – people treated openly and fairly; and inter-species equity – importance of biodiversity. As for engineering academic institutions, it is very important to embrace this sustainable development concept by adopting it into education, research and community services in an integrated and holistic approach as part of responsibility for ensuring the future of all human beings and biodiversity.

This paper outlines an ongoing project on the development of a sustainable disaster reconstruction process to elevate standards of living for communities in developing countries with the aim of attaining these important MDG's objectives. This project was initiated by two student groups from Curtin University of Technology (CUT), Australia, and Gadjah Mada University (GMU), Indonesia, and was selected as the winner of the Mondialogo Engineering Award 2007 [8, 9]. The Mondialogo Engineering Award is a partnership initiated by Daimler and UNESCO that encourages engineering students in developing and developed countries to form international teams to create project proposals that address the United Nations' Millennium Development Goals – especially poverty reduction and sustainable development – to improve quality of life in the developing world. The purpose of this project is to provide sustainable power and water supplies to remote areas, especially as part of emergency relief in Indonesia, by utilising renewable energy sources, such as solar energy available in these particular areas. This would provide a significant improvement in the reconstruction process and thus improve the lives of the local community. It is also probable that the addition of power and clean water supplies to these deprived rural areas will improve their living standards beyond their original conditions.

The team from Curtin University of Technology has strong support from the Renewable Energy and Power Systems research group, formerly known as CRESTA (Centre for Renewable Energy Systems Technology Australia), where there currently exists an ongoing research project on minigrid hybrid power systems and reverse osmosis desalination plants by utilizing renewable energy technology [10-15]. The partner team, Gadjah Mada University, has been known for its outstanding track-record in education, research, and community services throughout Indonesia, and has been actively involved in reconstruction processes after the Aceh Tsunami in 2004 as well as the Yogyakarta earthquake in 2006. Moreover, the involvement of the local community is also very important to ensuring the success and sustainability of the project. This participation will be carried out throughout the life of the project through community education as well as in the building and maintenance stages of the project. So this project will provide an opportunity to mediate a transfer of technology and knowledge to improve the lives of the underprivileged. The concept of cooperation and intercultural dialogue that occurs within the project team and between the team members and other stakeholders is illustrated in Figure 1. One point that should be noted in this illustration is that it is a simplified diagram of the concept of communication that will eventually occur in the project, and it only includes the main stakeholders of the project. It is expected there will be other stakeholders, such as local government and local NGOs from Indonesia, who might also be involved in ensuring the successful implementation of the system. It is intended that these other stakeholders, and possibly some other industry partners, will be involved in supporting the current project team and local community in terms of manpower and financial assistance, should the need arise.

Project Location

After preliminary site visits by the Gadjah Mada University team, other site visits were undertaken jointly by a team member from Curtin University, and a location was chosen for the implementation of the project - Banyumeneng sub-village, Giriharjo Village, Panggang District, Gunungkidul sub-Province, in the Province of Yogyakarta. The

location is facing the common problem of lacking a water supply, especially during dry season. During the rainy season, water is collected in rainwater shelters (Penampungan Air Hujan, PAH), which then is able to serve water needs for the next three months. When the water begins to dry up in PAH, the local people start to buy water from water suppliers. Unfortunately, the price of water is not cheap. The families spend at least IDR 150,000.00 each month on clean water. This is a huge burden when, the average family income is only about IDR 300,000.00 each month. This level of expenditure for water means people are unable to increase their living standards, so poverty is never far away from the Banyumeneng. Actually, since 1993, the Regional Water Supply Company (Perusahaan Daerah Air Minum, PDAM) has operated in Banyumeneng. At the beginning, PDAM seemed to be successfully fulfilling Banyumeneng's water needs. However, in the past few years, PDAM's water distribution has been experiencing problems. Water did not reach all of the coverage area because of poor maintenance. Only small parts of Banyumeneng receive enough water, and the other areas return to the previous scarce conditions, especially in the Banyumeneng I area. So, this project is aimed at providing the water supply needs in Banyumeneneng I, which has a total of 153 people that do not receive a proper water supply.

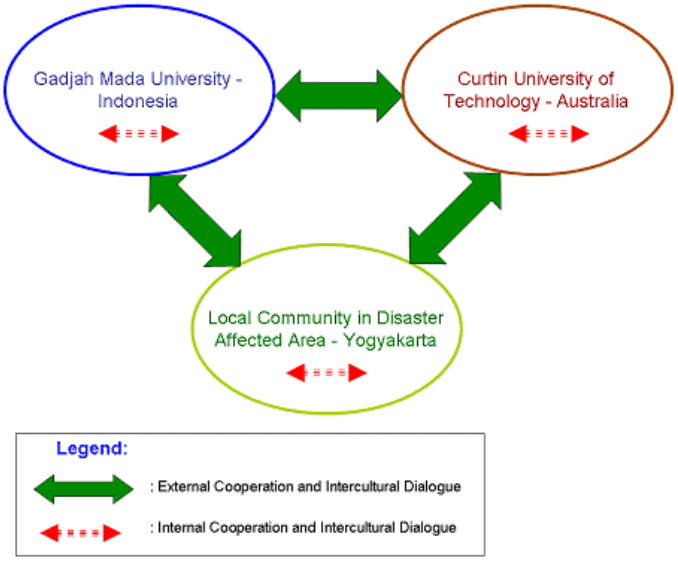
Project Implementation

The project implementation has been designed to be incorporated into the student community services program run periodically by Gadjah Mada University, known as KKN - Kuliah Kerja Nyata. In this program, groups of final year student from interdisciplinary backgrounds are deployed for a period of two months into rural areas in order to be actively involved in the development process in those particular areas. This way, students obtain first-hand experience of dealing with local community problems, and they are supposed to become agents of change and agents of development, together with local community. There will be some stages planned for the completion of specific program stages throughout the project's lifetime as outlined below:

A. Stage 1

The first stage has been completed during the student community services KKN-GMU program between July - August 2008. This stage was designed for preparing the technical and social installation program. Details on the engineering design of a solar water pumping system with feasibility study were prepared carefully while the social preparation in this stage included the socialization of the technology and preparing for independent organization to manage the system. With the installation of independent organization within the local community, it is expected that people will develop a sense of belonging as part of the solar water pumping system team to maintain the sustainability of the project.

Figure 1 Concept of cooperation among stakeholders



B. Stage 2

The second stage of implementation process was initially planned to be executed by the beginning of 2009; however, due to the Indonesian general election and related activities during this period, there was advice given to postpone the community service until July - August 2009. During this stage, construction of the solar water pumping system will be commenced. Activities carried out in this stage include technical and social activities. Technical activities include construction preparation, such as providing logistics, storage and material for the solar water pumping system construction process. Social activities include organizing system building and launching the independent organization for managing the solar water pumping system.

C. Stage 3

The last stage will provide the finishing touches on the solar water pumping system building process. This stage will arrange a few possibilities for the development of the system to the next level in water distribution. During this stage, training programs that aim to provide the basic technical maintenance of the system for local communities will be conducted. So, if any problems in the system arise, the local communities are expected to be able to overcome the problem independently.

Implementation of the First Stage

The District of Pangggang, in the sub-Province of Gunungkidul, has several villages, which include Giriharjo, Giriwungu, Girimulyo, Girisuko, and others, as shown on the map in Figure 2. The student community service conducted by the GMU during the period of July 1st to August 28th, 2008 took place at the Giriharjo village. The activities comprised of the planned program with some additional agenda items arising during the community service implementation. The planned programs need to consider potential local resources, the amount of water demand by local people, time, funding, and the response and participation by the local community. In all of these aspects, the local community response and participation are considered as the most important factors for ensuring the sustainability of the program.

Overall, the student community service program in the first stage has progressed well. Most of the planned programs can be achieved as expected, although there were some plans that did not match with the local community's needs so that alternative actions were taken to accommodate the aspirations of the local community at that time. Cooperation and participation from all parties in the village (village leaders, the youth villagers - Karang Taruna - and local people who had always been enthusiastic in supporting all activities) were the keys to the success of completing the planned program and fulfilling people's desires.

A. Technical preparation activities

For technical preparation, activities related to a feasibility study of the location to obtain details for optimum engineering design of a solar water pumping system. This feasibility study included topographic mapping, pipe route mapping and research on the capacity of the water supply. These programs were completed with results being as expected.

1) Topographic mapping

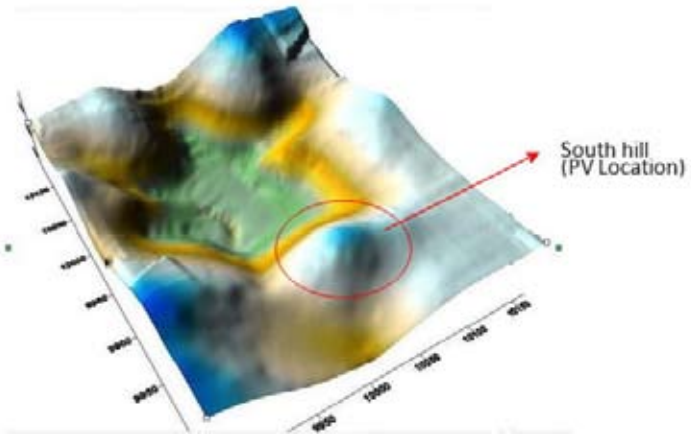
Topographic mapping was performed by a team that consisted of students from geodetic engineering and engineering physics from Gadjah Mada University. Mapping of water resource areas was accomplished, designed to find the best location for PV array and pump installation. The results were 2-dimensional and 3-dimensional maps for water resource areas with a 300 meters range. From the mapping and site visit activities, several options for PV location were obtained. Finally, after considering the solar radiation and distance from the water resources, where the pump will be located, it was decided that the location of the PV array would be in the south of the water resource in a small hill, as shown in Figure 3.

Figure 2 Map of water potential sources in Panggang District, Gunung Kidul, Yogyakarta

2) Pipe route mapping

Pipe route mapping activities were executed within 3 weeks of the community service period. This program was started after a site visit to plan the pipe route from water resources to flow to the location of the water tank. After deciding the optimum pipe route with minimum losses, then mapping the entire pipe route to obtain a profile map could be completed, as shown in Figure 4. This profile map determined the head from pump to reservoir, pipe distance, and pipe losses from coil pipe. From this result, it will be possible for the system construction to be arranged by utilizing a solar water pumping system with 2 pumping stages. First, water is pumped from the resource to the first tank, which is just a temporary storage tank, before the water is then pumped to the second storage tank, as depicted in Figure 5. In the second storage tank, the water is able to be consumed by local community.

Figure 3 Topographic map on the planned location for PV array



3) Research on debit water pumping

Research on debit water pumping was carried out to find the optimum pumping capacity by considering the approximate water demand, the economic growth rate of the region, and solar water pumping system operation time. The water pumping debit should also consider the availability of the debit of the water resources, because there are farms fields in nearby areas that also need water for irrigation. The average water consumption by the local community, for minimum daily use, is 30 liters per person per day. Considering the growth rate in Gunung Kidul, which is 0.4162%, the number of persons needing a water supply is approximately 160 people in the next 10 years. In addition, the maximum solar radiation occurs between 11 am to 3.30 pm, so that the solar water pumping system operation time is 4.5 hours. Thus, to cover total water demands, the pump capacity would need to be 0.296 l/s. According to the collected data [16], this debit will not consume all of the water resources, because the water resource debit is 4 l/s

Figure 4 Contour map of the location

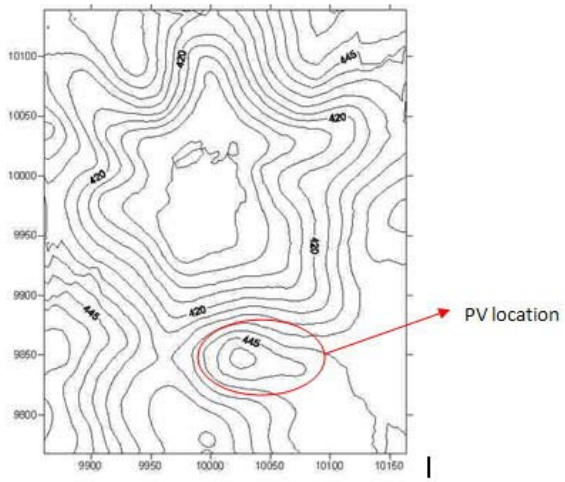
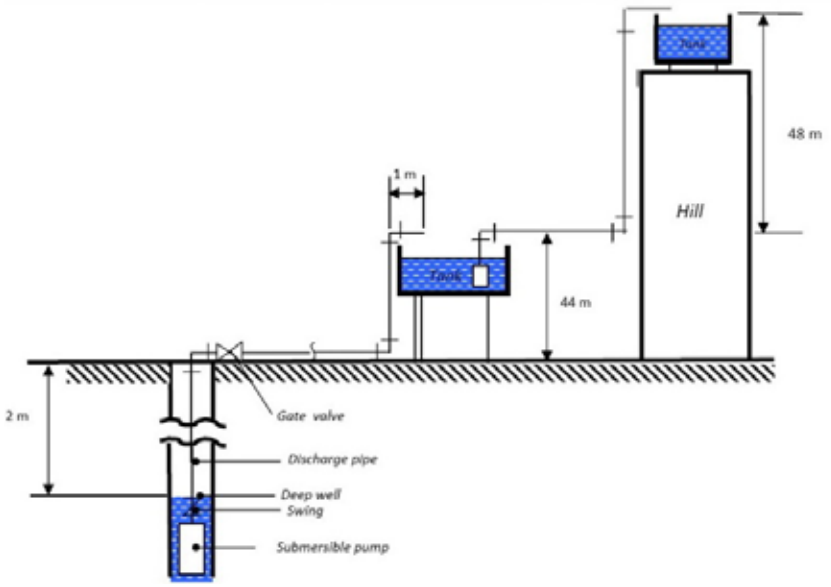


Figure 5 Design of solar water pumping system



B. Social installation

To achieve the goal of the program, it is necessary to consider proper social preparation apart from the technical preparation in order to maintain the sustainability of the project. The social preparation activities in the first stage of this community service program include the following:

1) Program socialization

This socialization process was held to introduce the program that will be carried out by students. Good communication between students and the local society will create a supportive atmosphere for both parties. The purpose of this socialization was to gain support from the local community for the program's implementation. This was implemented in two ways: formal and informal socialization. Formal socialization was implemented by inviting the prominent figures from the local society to the program discussion. Informal socialization was implemented by direct discussion with the local community in several situations. These socializations are believed to be very useful in helping students build the installation.

2) Technology socialization

Socialization for the solar water pumping system technology is seen as important because the local community needs to be aware of its existence and its benefits with the aim of building a sense of belonging to the system installed in their nearby area. The socialization was achieved effectively, for the local communities were very interested in this technology. Moreover, they felt electrical power from the sun was unbelievable.

3) Socialization on maintaining water source

This socialization was aimed to inform the local community about the importance of traditions to conserve water sources in their village. Besides, this was one of the ways to increase society awareness about environmental care, which is important for water source sustainability. This socialization was implemented through discussions with expert forestry representatives from Gadjah Mada University, who explained the geological conditions in Gunung Kidul regency, which consist of limestone that can cause water source debit decreases.

4) Formation of an organization for water management

Water management organization will be established in the next stage of the community services with the purpose of organizing water distribution and maintaining the system. In forming water management organization, several site visits were conducted to learn about the organizational system from several water management organizations that are already established in Gunung Kidul. From the results of consultation and discussion with the many sources, an

independent organization to manage water distribution under coordination from village government was advised. Discussions with prominent figures from local community were conducted to prepare an organization charter and organization system. The results of the discussion were an organizational charter, water management organization establishment for the next stage, and member elections were also planned for. The Water Management Organization will consist of local community representatives who were elected for the role.

Conclusion

Engineering academic institutions have much to offer in participating in the United Nations Millennium Development Goals program, particularly in implementing Engineering Sustainable Development as part of the curriculum by combining education, research, and community services in such an integrated and holistic approach, along with concrete actions. An Engineering Sustainable Development process implemented through student-based project community service has been presented in this paper. The project implementation in the development of a sustainable power and water supply in remote areas and disaster response and reconstruction is an international project partnership by two student groups from Curtin University of Technology, Australia, and Gadjah Mada University, Indonesia. The implementation program is incorporated into the student community services activities within the Gadjah Mada University, Indonesia. The program is carried out in the district of Panggang, Gunung Kidul, Yogyakarta. Through this project partnership, all stakeholders involved, such as universities (including academic staff and students), governments, industries, and local communities, etc., can draw lessons on promoting sustainable development with the aim of attaining the UN Millennium Development Goals.

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