Application for
The First RCE Award on Education for Sustainable Development Initiatives 2012

Title of the Project:

"Sustainable Village":
A Pilot Project for a Socially Constructed Technology
as the Foundation of a Sustainable Way of Living in Harmony with Nature

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1. Short Description of the Program

The program exemplifies community involvement in defining their needs and developing the appropriate technology relevant to their needs. The university assists in translating community's ideas into technical design and instilling the awareness of environmental conservation along the process of the technology development.

The Sidoharjo Village community envisions a **"sustainable village",** i.e. the utilization of the local resources wisely to develop self-sufficiency. ChAIN Center assistance was started through community discussions that came up with a plan to establish an **organized community** built on synchronized functions for sustainable development. The strategy includes the development of **zero waste industrial cluster** applying the appropriate technologies to maximize their productivity while maintaining the harmony with the environment. The pilot project is a group of traditional cassava snack producers. We introduced an integration of the traditional stove with a custom made oven utilizing the hot flue gas from the stove as the heating medium. The students helped the community to design the ducting and the oven. The flue gas that used to cause unhealthy ash and heat pollution in the kitchen air is now confined in the duct to the oven and advantageous to accelerate drying. With the increasing production capacity, ChAIN Center introduces the virtual market to display their products online.

The program highlights several benefits at once. It provides a real case for the engineering students to learn about the importance of the social dimension in developing a technology. This is an important base for developing a sustainable technology because in the context of sustainable development, social and technical aspects need to be confluent. The community is involved in the process of developing technology so that they feel comfortable to improve the technology. The program also encourages the local government to refine their leadership by referring to the sustainable development concepts.

2. Description of the Context

2.1. Background

According to the 2011 data from Indonesian Bureau of Statistics, 63.4% of the low-income households in Indonesia reside in the rural areas, many of which are so remote that everything becomes more expensive and less accessible for these unfortunate communities. Ironically, the national budget for development is centralized in industrial estates which are assumed to be the main revenue generation areas while the rural areas and their agricultural cultures are considered as the nation's burden that cannot make quick money for a significant contribution to GNP. The government attention and policy to these rural communities is mostly implemented as the "technology transfer programs" in which the communities are given a technology package without sufficient socialization and assistance. At the end of the day, the technology packages are just abandoned and the gap between urban and rural advancement remains as wide as before during the 67 years of Indonesia independence.

The aforementioned situation motivate the Chemical Engineering Alliance and Innovation Center (ChAIN Center) to develop a new approach to introduce the appropriate technology to the rural communities with which they will feel comfortable to use it and to understand it so that they can create their own innovations in the future. Instead of transferring the ready-to-use technology TO the community, ChAIN Center leads the engineering students to merge with the community to develop the technology WITHIN the community. In this approach, students learn about sustainable development in the Indonesian context and the community understands the details of the technology to break the myth that technology is expensive, difficult, and destructive to their natural ways of living.

2.2. Location of the Pilot Project

The pilot project is the Sidoharjo Village in Kulonprogo District, Yogyakarta Province. The village is situated on the slopes of Menoreh Mountain and quite challenging to reach with its winding and steep roads. The difficult access to the nearby towns has forced the Sidoharjo Village communities to develop their self-sufficiency in a very traditional way. However, entering the 21st century with its globalization wave, they need to pace with the national and international economics fluctuations so that they need to strengthen their business practice while maintaining their harmony with the environment.

Despite the challenging terrain, Sidoharjo Village is blessed with the fertile soil and the variety of agricultural commodities such as clove trees, exotic herbs, and various carbohydrate sources (rice, cassava, and other local tubers). Besides, the cool climate of a highland terrain makes Sidoharjo Village also ideal for milk goat farms. On top of everything, the breathtaking view of the surrounding scenery is more than attractive to the adventurous tourists looking for unusual experience through its very natural track.

Unfortunately, most of the productive ages in the community choose to pursue careers in big cities so that the village is left with elderly people, children, and just few of productive people. That is why the development is quite slow regardless the abundant resources. This situation has motivated the Chemical Engineering Alliance and Innovation Center (ChAIN Center) to offer voluntary assistance to the community in order to improve the village productivity with the limited number of the human resource. The challenging terrain, the eagerness of the community to learn, and the leadership of the Village Head has made this village an ideal pilot project for the realization of the concepts of sustainable development. With the progression of the business in the area, it is expected that the younger generations will strengthen the local business and hence reducing the rate of unproductive urbanization.

2.3. The Case Study

Cassava is an important carbohydrate source for Indonesians as an alternative to the rice as the main staple in most areas. The flexibility of cassava to grow well in either fertile or poor soil, with much or less water, makes it second to rice as the main source of carbohydrate. When rice is widely available, various snacks made of cassava also dominate the market due to the relatively cheaper price to be compared to the wheat-based snacks. One of the popular cassava snacks in Yogyakarta area is called "*slondok*" (Figure 1). *Slondok* is crispy snacks made of the paste of grated cassava mixed with some spices. The dough is shaped as big rings, dried under the sun, and the fried in hot frying oil. *Slondok* is usually produced in home industries in very traditional ways with the average production rate of 50 kg cassava per day (about 20 kg of fried *slondok* per day) per production house. In fact both the availability of the raw materials and the demand are much more than the production capacity. However, the *slondok* producers are limited by their long drying process that relies on the sun light intensity. In a very sunny day, it takes about 6-7 hours to dry the cassava dough until it is ready for frying. When the days is cloudy, it is impossible to dry the dough in one day and as the result of the prolonged drying period, the dough is often got fermented overnight and the *slondok* becomes slightly sour. In the worst case, the producers have to throw the dough away when there is no sun for several days during the wet season.

Figure 1. A traditional way of drying *slondok* under the sunlight

A group of students were assigned to conduct field observations and focus group discussions with the *slondok* producer community during their compulsory stay in the village (note: Gadjah Mada University includes field work as a mandatory part of the curriculum in all faculties, in which the students have to stay in rural areas for 2 months). After several weeks of survey, the students found some interesting facts in the kitchen of one major *slondok* producer in the village: 1) the frying process usually takes 5-6 hours to produce about 25 kg of *slondok* per day, 2) the *slondok* producers use a traditional stove fueled by woods (Figure 2), 3) the flue gas from the stove is as high as 300^{o}C on average and sometimes even higher, 4) the open pit of the stove makes disturbing ash and carbon in the kitchen air.

Figure 2. The old-fashioned traditional stove in the *slondok* producers' kitchen before the introduction of clean kitchen and drying oven technology

The students were then led in a discussion to find a solution for the *slondok* industry problem. The *mind-mapping process* is illustrated in Table 1, which in reality was constructed through the group discussion.

Table 1. Illustration of the *mind-mapping process*

Existing conditions	Problems	Ideas
Frying process takes 5-6 hours per day	Solar-drying takes too much time	The hot flue gas can be the good heating medium for a drying oven. It is piped into the oven so that the heat will not cause the discomforting air in the kitchen
Flue gas from stove is 300^{o}C	Hot flue gas make the kitchen very hot and uncomfortable	
Drying *slondok* with solar-drying (only abut 35^{o}C)	Dirty kitchen affect the women's health	
Open pit stove makes the kitchen dirty		

The next step was developing an action plan. More discussions were conducted with the students and the community, supervised by a group of faculty members and coordinated by ChAIN Center. The discussions converged into two engineering solutions:

1. The community collaborated with a non-governmental organization built a modified traditional stove so designed that there was no more open pits and the flue gas flew in a confined duct into the chimney (Figure 3). The students helped to determine the position of the stove and were involved in the construction process so that they well understood the characteristics of the flue gas.
2. The student designed the heat integration system between the stove and the oven (Figure 4). They made simulation to determine the optimum position of the inlet and outlet of the heating medium in the drying oven and the temperature distribution as well (Figure 5).

Figure 3. The community built the modified stove with closed duct for the flue gas

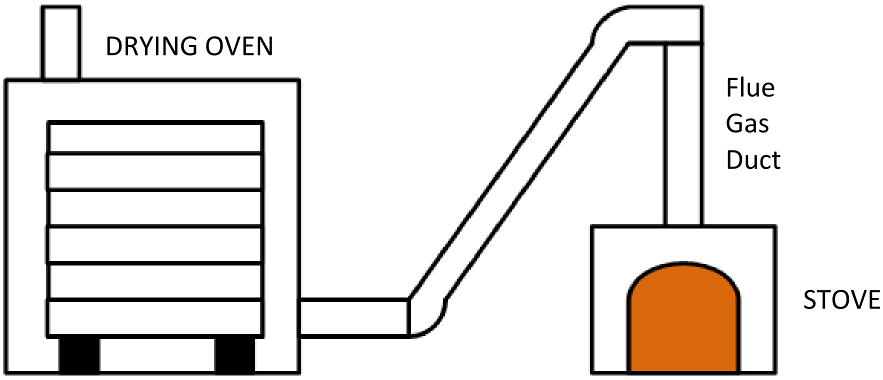
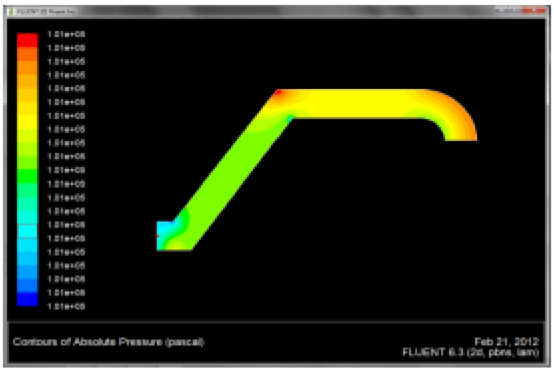
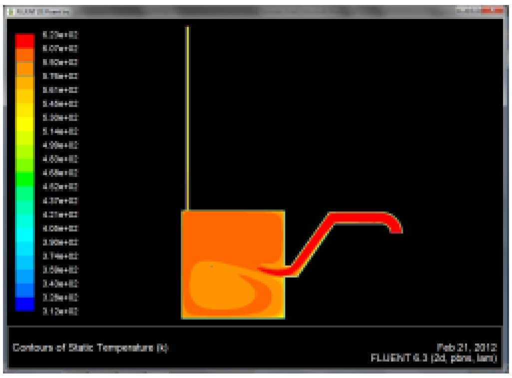


Figure 4. The design of the plan to utilize the hot flue gas from the stove as the heating medium in the drying oven



(a) Pressure drop at the inlet pipe into the oven as a function of inlet position/elevation



(b) Temperature distribution in the oven as a function of the flue gas inlet position

Figure 5. Simulation to determine the optimum design of the oven

The design was discussed with the *slondok* producers and they decided to put the pilot project at the house with the biggest production capacity but everyone else could also use the oven when they need to. So the community was ready to move forward to the construction phase. ChAIN Center helped the community to develop a proposal for funding and finally one program from the Indonesian Directorate general of Higher Education agreed to give the financial support for the pilot project. The construction was started and the oven was installed in the *slondok* production facility (Figure 6 and Figure 7) by the community and the students.

Figure 6. Construction of the oven

Figure 7. Installation of the oven in the *slondok* industry

The installed oven had not been perfectly running upon the completion of the installation because it needed to be optimized at the local condition (such as the fluctuating ambient temperature that could be drop about 10^{o}C below the normal average, etc.). Actually this was one of the uniqueness of this program. The community was involved in the optimization process so that they were learning by doing about the principles of pressure drop to force the flue gas flowing into the oven, temperature distributions, the importance of heat insulation, etc.). Another group of students were doing a research for their final project while teaching those engineering principles to the *slondok* producer (Figure 8 to Figure 10).

Figure 8. A student helped Mr. Rumbiyat (the owner of the *slondok* production facility) to measure the flue gas temperature

Figure 9. The student measured the temperature of the flue gas

Figure 10. The oven with simple heat insulation made of locally available material

The aforementioned case illustrates how the technology is socially constructed WITHIN a community. It took about one year for the technology development, from the first focus group discussion with the *slondok* producers until the oven functioned well. Although the process took time and a lot of patience, the *slondok* producers as the owner of the technology felt comfortable with the new addition in their kitchen and they were more than happy to share the new knowledge to their peers. Without any formal theoretical background, the home industries in the Sustainable Village of Sidoharjo have practiced the sustainable production system by saving energy, reducing pollution, and improving their productivity.

2.4. What the Students Learn

During their work with the community in the Sustainable Village of Sidoharjo, the students learned many things by doing and applying the principles that they so far just read in the textbooks, such as:

a. The concept of sustainable development can be generalized by definition. However, when it comes to the implementation, the interpretation of each aspect of the sustainable development needs to be “domesticated” within the community. The students learn how to adjust the technology to the needs of the community and <u>NOT</u> the other way around. The students learn about the flexibility of technology once they understand the underlying principles of the technology. This practice can enhance the students’ creativity so that as professional engineers in the future they will not depend on ready-to-use technology but they can develop their versions of technology.
b. The students learn to respect the harmony with nature. The community in the Sustainable Village of Sidoharjo does not only take the knowledge brought by the students but they also exemplify the natural way of living. The students learn how to carefully construct the technology without destructing the synchronous lives of all elements in the ecosystem. This experience is very important for these future engineers to be careful in their future careers not to sacrifice the ecosystem for the sake of technology advancement in the name of efficiency and productivity.
c. The students learn to work under so many limitations in the village, from the budget to the human resources. While they can survive under such a difficult situation, they will be able to excel in a much more ideal situation in their future profession.

2.5. How the Community Learns

The interactions with the students have brought a new dimension to the village's routines. The new ideas brought by the students open a new horizon to improve the village productivity. The community is involved in the development of the technology, including the failures at the initial phase, so that they understand the details of the technology. With the students accompanying the community to study the technology, the process of "domesticating" the technology proceeds smoothly and the community eagerly takes it as an integrated part of their way of living.

3. Main Partners and Their Role

This program has involved all relevant stakeholders since the formulation of the concept, design, fabrication, installation, training, and eventually the maintenance and improvement of the applied technology. The highlighted roles of each partner are listed in Table 2.

Table 2. The roles of partners

Partners	Roles
The slondok producers (represented by Mr. Rumbiyat)	Formulation of the idea and optimization of the technology (assisted by the students)
The Village Head	Direction to the team (students and slondok producers supervised by ChAIN Center) based on the Village Grand Strategy (short term and long term)
The community informal leaders	Monitoring of the program and assisting the dissemination of information related to the program
The funding agency (The Institutional Competitive Grant)	Providing funding to accelerate the progress of the program
The manufacturing company	Fabrication of the equipment based on the design developed by the students and the community
ETH Zurich Switzerland	Development of online marketing system

4. Contribution of the Program

The most innovative aspect of the program was the effort to synchronize the technical and social/cultural aspects of a technology. The program was not only about transferring a technology to the community but developing a technology within the community. While doing so, the faculty members and the students did not only deal with the engineering aspects of the technology but they needed to interact with the community in order to understand the social and cultural characteristics of the community that would affect how they would perceive the technology.

The contributions of the program mainly included 3 areas as the following:

a. Building the confidence of the community to develop their self-sufficiency based on local resources
b. Instilling the concept of eco-efficiency (i.e. conservation of raw materials, conservation of energy, minimization of environmental impacts, and improving durability/functionality of the products), which is the important foundation for sustainable development, in the simple language and practice so that the students and the community can make it an integral part of their lifestyles.

c. Providing an example of good governance model for a developing country (which is in general facing the dilemma of resource limitations and fast-growing populations). Development of local self-sufficiencies will add up into the improvement of the national prosperity.

The community involvement since the early stage of the program development guarantees the sustainability of the system developed by the program. Besides, the most important aspect of the success of a technology development process is the economic gain of the users. Therefore, in parallel with the technology development process, a marketing system is also constructed. The breakthrough of this program is the introduction of the "virtual market" to display the village product online. The website is still under construction and will be launched in November 2012.

The critical factors that made the program successful were listed as the following:

a. The coordinative role of ChAIN Center. The described program involved various stakeholders, each with its unique characteristics. To make every element in the program confluent towards the same vision, it takes a specific management system focusing in the particular area of community-oriented programs. ChAIN Center is a special unit under the management of Chemical Engineering Department established to serve a function as the interface between academic inventions to the community needs. Being specialized in such a focused area, ChAIN Center has equipped itself with the multidisciplinary networks to develop a comprehensive approach on various needs in the community.
b. The leadership in the community, both formal and informal. In Indonesia, faculty members must carry out three parallel tasks which comprise teaching, conducting research, and community development programs. The community outreach programs are very time consuming while the faculty members must also excel in their teachings and researches. Therefore, they need partners who can assist the community in daily basis. That is the reason why the first thing to be carried out in every community development program is identifying the community leaders and building the trust among them to be the part of the working team.
c. The economic feasibility of the program. Every community outreach program will multiplies itself quickly once people see the economic gain out of it. Therefore, economic aspects including marketing strategy of the products need to be integrated in all technical programs introduced to the community. When we introduce a new technology, we cannot rely on the conventional market anymore. Otherwise, the technology will not make a significant difference. With respect to sustainable development, it will remains a philosophy far fom realization at the grass root communities if we cannot make them believe the economic values of managing wastes and conserving the environment.

In addition to the aforementioned success factors, there were also some critical governance elements to strengthen the program, which are among others:

a. The visionary village leaders
b. The collaboration among government, community/the business owners, university, and the funding agency
c. The supervision to the students by the faculty members to develop a structured education program based on real cases

Despite the success factors of the program, there were also some socio-cultural and economic dilemmas along the progress of the program. The main hindrance was the lack of human resource because most people of productive ages prefer urbanization to staying in their remote village to create their own business. It will take time to change the current preference. With respect to this problem, the program also included the campaign and socialization to the younger generation to make them realize the potentials of their own village. The program also gave special attentions to the women in the community to encourage them to be the backbone of the growing economic activities in the village.

The aforementioned description of the program implies that there is so much a university can do to make “sustainable development” a reality in the community. Ironically, the formal appreciation for the dedication of faculty members and students in developing an appropriate technology in the community is not as high as the appreciation to the “cutting edge” publications in the scientific journals, although the published paper might not relevant at all with the needs of Indonesian community. This unfair situation does not encourage bright faculty members/students to make a significant contribution to the community-oriented programs. With respect to this problem, ChAIN Center is developing a “new culture” to help the faculty members who are active in the community development programs to get an appropriate appreciation by assisting them to publish their invention in a respected journal. Actually the motivation behind the submission of this application to the 1st RCE Award is also to one of the effort to make the idealism of the faculty members to make real contributions to the community become more “visible” and hopefully more will follow the path.

5. Upscaling the Project Results

The technology has been optimized for one year, so that the *slondok* producers and the supervising faculty members as well have understand the behavior of the system very well. Another group of small/home industry producing crystallized palm sugar has expressed their interest to have one similar oven built in their industrial clusters in the neighboring village. It proved that good practice can be replicated so quickly in the rural communities once they feel confident with the technology. Technology diffusion can become as easy as spreading good news. The palm sugar industry is currently being surveyed for the feasibility to apply the same drying technology as the drying oven installed in the *slondok* factory.