Mining Technology for Sustainability: Practices, Challenges, and Sustainability of Community – Managed Small-Scale Mining Project through Community – Led Integrated Non-Cyanide, Non-Mercury Gold Extraction Method (CLINN-GEM) in Compostela Valley, Philippines

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Abstract

To assess the sustainability of development projects for small-scale mining, this qualitative and descriptive study examined the practices and challenges of the Community–Led Integrated Non-Cyanide, Non-Mercury Gold Extraction Method (CLINNGEM) project in Compostela Valley province, now Davao de Oro. The case study showed the efforts of the government and its partners to address the challenges of small-scale mining in the country and its attempts to quash the "top-down" management approach of technology-based projects. Acceptability of the project, information gap, project delays, availability of utilities, safety and security, and sustainably were the challenges encountered in implementing the project. Logistics, economic, community, equity, institutional and environmental dimensions were factors which affected the prospects of the project's sustainability. Thus, aside from ensuring efficiency, all issues and problems were addressed. Therefore, to perfectly manage the mineral processing plant, the following are recommended: 1) promoting and popularizing the technology by allowing the people to access and use the mineral processing plant; 2) reducing information gap by increasing information dissemination efforts and education activities, developing information tools as well as education and communication materials, and conducting trainings and workshops; and 3) enhancing people's sense of ownership of the project by organizing and mobilizing them, thereby allowing them to participate in and decide on future activities, recognize their own capacities, and be treated as active members of the community.

Keywords: small-scale mining, community-led projects, CLINN-GEM project, Compostela Valley.

Background of the Study

Mining is an emerging development topic not only because of its expanding international opportunities nor because of its adverse effects on the environment but because of how it has been reformed to concur with the principles of sustainable development. Recent mining technologies are developed to improve production and the quality of life of the people in mining communities while mitigating the adverse effects of mining to the environment.

In highly mineralized countries like the Philippines, mineral resource development is perceived to be an economic driver that spurs development. However, in a study conducted by the Senate Economic and Planning Office, the results revealed that the Philippine mining industry has not lived up to its potentials. The industry has had a negligible contribution to the domestic economy and has absorbed only a few workers. Also, the industry has had a destructive impact on the environment and the welfare of the people (SEPO, 2013).

Therefore, this project is an answer to the call of providing clean and low-cost alternative technology for the small-scale miners through the Department of Science and Technology Region XI and the University of the Philippines Diliman, along with the Provincial Government of Compostela Valley, BLGU of Katipunan, MLGU of Nabunturan, Nabunturan Integrated Miners Development Cooperative (NIMDC), with the assistance of Compostela Valley State College (CVSC) and the Municipal LGU of Nabunturan Implemented the Community – Led Integrated Non-Cyanide, Non-Mercury Gold Extraction Method (CLINN – GEM) Project in Barangay Katipunan, Nabunturan, Compostela Valley. As a development project, CLINN-GEM is a bold step toward addressing the human insecurities of small-scale miners brought about by low and destructive mining technology. However, not all development projects in developing countries succeed or are sustained. International funding institutions and ministries of less developed

countries still report serious problems in project execution while usually ignoring factors affecting the longer-term sustainability of project benefits (Rondinelli, 1976). Because of these problems, development projects either become unsustainable or fail to create a social impact on communities. Thus, this paper explores the link between the practices and processes of the CLINN-GEM and its sustainability. Anent this, this article aims to describe the status of the current practices of the CLINN-GEM Project, identify the challenges and factors have affected its sustainability, and assess its prospects as an innovative development project.

Research Methodology

This study examined the sustainability of the CLINN GEM, which is a technology-based project, in a small-scale mining community. The case study approach was employed to investigate the practices, processes, key players, and organizational mechanisms project. Further, the study also examined the issues, challenges, and factors that affected the project's sustainability (Alkin, 1972, as cited in Rutman, 1977).

Historically, development projects were introduced and popularized by the so-called "developed countries," and therefore the traditional understanding of projects is "dole - out." Similarly, the conceptual definition of project sustainability is western, so the primary limitation of the study was the difficulty of finding an appropriate term for sustainability in the local dialect, to suit the local context. Another limitation of the study is the timing of the data-gathering schedule. Data gathering was conducted during the commissioning phase of the project. At this phase, the project's economic performance had not yet been established; thus, dimensions of sustainability were primarily determined through the participants' experiences with Carbon-in-Pulp (CIP) plants and their future outlook.

Data were obtained through key informant interviews, focus groups discussions, and document review. There were 19 focus group discussion participants comprised by barangay residents, small-scale miners, and CLINN-GEM operations group members.

Meanwhile, there were four critical informants from the local government units and the project team. All the participants were selected through criterion sampling. Their ages ranged from 20–61. There were 13 males and 10 females. Moreover, the documents reviewed included the Project Proposal, Memorandum of Agreements, Organizational Structure, and other related texts and documents.

To determine the project's sustainability, the study employed a program sustainability analysis (Khan, 2000), taking into account the different dimensions of program sustainability such as logistical, economic, community, equity, institutional, and environmental dimensions.

The CLINN-GEM Project and Its Sustainability

The data gathered were summarized and discussed based on two themes: description of the CLINN-GEM project and discussion of the implications for sustainability. The first theme covers the development, processes, and practices of the CLINN-GEM project, as well as issues and challenges encountered. The second theme covers definition, dimensions of sustainability, and prospects of the project as an innovative development project.

The CLINN - GEM Project

History and Nature of the CLINN – GEM Project

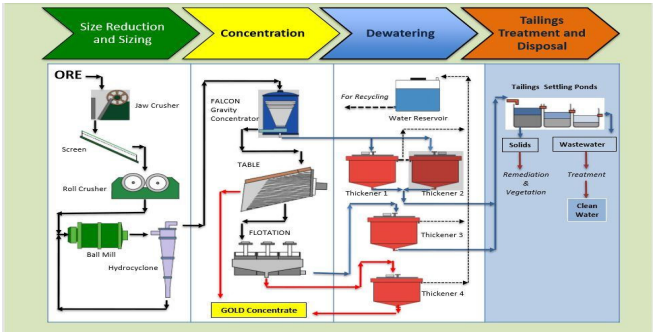
The history of CLINN-GEM Project can be traced from the technology produced by Project C (Copper Flotation Technology for Small Scale Mining) and project D (Alternative Methods to Amalgamation and Cyanidation in the Recovery of Gold) of the Better Mine Program of the Environment and Infrastructure track of the Engineering Research and Development for Technology (ERDT) in 2015. These projects led to the establishment of GoldCopper Integrated Mineral Processing Pilot Plant in four regions: 1) sitio Basil, Barangay Gumatdang, Itogon Benguet in Cordillera Administrative Region (CAR); 2) Barangay Sta. Rosa Norte, Jose

Panganiban, Camarines Norte (Bicol); 3) Barangay Del Pilar, Cabadbaran City (CARAGA); and 4) Barangay Katipunan, Nabunturan Compostela Valley (Davao Region). The integrated gold-copper mineral processing plant is composed of four major components, namely: a) Beneficiation: size reduction and concentration (Crushing, Grinding, and Flotation Section), b) Quality Control: sampling and analysis (Laboratory Section), c) Extraction and Refining (Extractive Section), and d) Tailings disposal and water treatment. Also, the plant is capable of processing 10-15 metric tons per day of gold ore.

The field Implementation of the Integrated Gold-Copper Mineral Processing Pilot Plant in the in selected small-scale mining regions/ communities is a bold step towards introducing and promoting an environment-friendly and high yielding alternative process of extracting gold from ores, using enhanced gravity concentration to separate fine gold values, and flotation to separate fine gold values associated with sulphide minerals, like pyrite (FeS2). The alternative processes of Flotation and Gravity concentrations are emerging as the "GREENER" technologies, which have shown high recovery of gold and other valuable minerals like copper at higher efficiencies. One significant feature of this technology is the high recovery of gold values that reaches up to 90-95 % as compared to only 40% recovery by the existing small scale mining operations. The process flow (see Figure 1) includes ore size reduction, concentration, dewatering, tailings treatment, and disposal.

Figure 1

The Process of the UP-DOST Integrated Gold-Copper Mineral Processing Plant

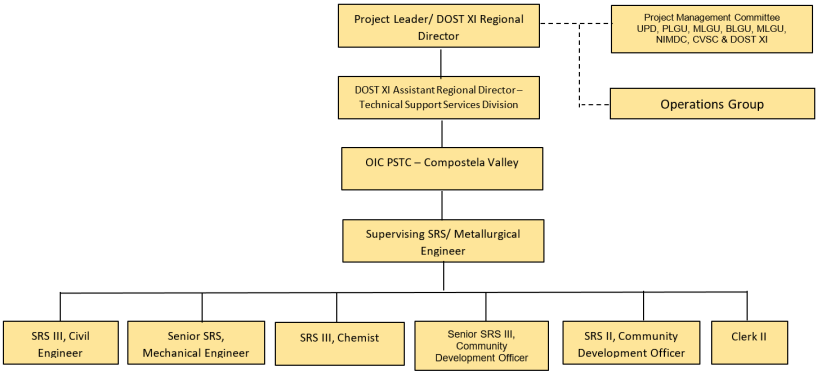


Establishing a technology that would significantly improve the gold recovery and mitigate damage to the environment in small-scale mining operations will boost the overall gold production of the country and improve the quality of lives of the small-scale miners, thus contributing to economic growth. However, growth does not always translate to development. Therefore, though the project's primary goal is technology validation, it is also essential to include social development dimensions in the project. Putting people in the center of development (inclusion), strengthening the social fabric of communities so that their members can work together (cohesion), and finding ways for people to exercise their voice to authorities (accountability) in the projects are vital operation principles to promote social development in projects (ADB, 1994).

CLINN – GEM Project Structure

Putting people at the center of development and strengthening the social fabric of communities are the underlying principles that govern the project structure. "Community-led" as the project title suggests the project structure (see Figure 2) embodies collective and collaborative governance through multi-stakeholder design to ensure participation and cooperation among the different stakeholders. This governance framework is manifested through the presence of a Project Management Committee composed of UP Diliman, DOST XI, PLGU Comval, MLGU Nabunturan, BLGU Katipunan, and NIMDC, as well as CVSC which served as the highest decisionmaking body of the project. The implementing team (DOST XI) was composed of the project technical staff headed by the project leader who supervised and monitored the implementation of the project. Along with the UP DMMME is the operations group that managed the operations during the commissioning, marketing and management, and turn-over phases. The operations group was comprised by residents and small-scale miners in Barangay Katipunan and its neighboring barangays.

Figure 2
CLINN – GEM Project Structure



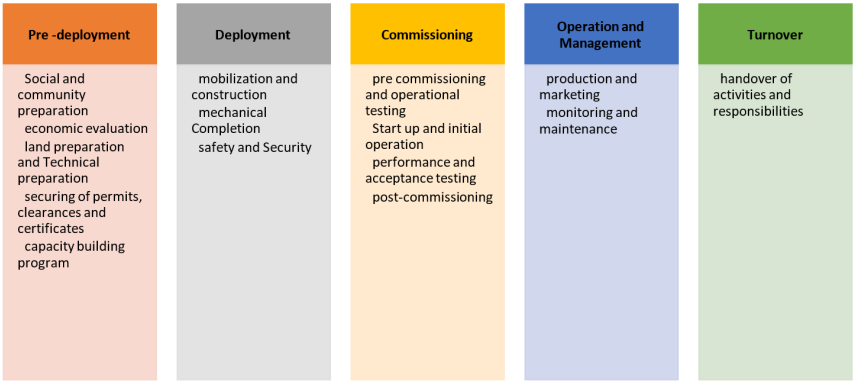
CLINN – GEM Project Phases

The inclusion of people in project planning and implementation are vital factors for sustainability. Thus, like other development projects, the implementation of the CLINNGEM project involved five phases: pre-deployment, deployment, commissioning, operation and management and turnover (See Figure 3). Each stage consisted of different activities involving different stakeholders.

The Implementing Agency (DOST-XI) was responsible for undertaking the pre-deployment and deployment phases with the supervision of the team from DMMME-UP. DMMME – UP provided all the technical data and specifications needed in all the activities under the said phases and conducted workshops for the project technical staffs who were directly involved in the project. Afterward, DMMME-UP would take over during the Commissioning phase, Operation and Management, and Turnover phases in coordination with DOST-XI, Provincial Local Government Unit (PLGU) of Compostela Valley, and other stakeholders. The specific activities under each phase are as follows:

Figure 3

CLINN – GEM Project Phases



Pre-Deployment Phase. Activities in the pre-deployment phase were primarily characterized as social/ community and technical preparations. Regional partners such as the PLGU, DENR (EMB, MGB), MLGU, CVSC, and small-scale miner groups were actively involved during coordination and organization, drafting of management and technical tasks, development of a curriculum and training modules, and identification. The local people attended and participated in information dissemination and consultation meetings and research activities (value chain analysis).

Deployment Phase. The activities during deployment phase included mobilization and construction. During this phase, some barangay residents were directly involved in the project as skilled and unskilled construction workers of the mineral processing plant.

Commissioning Phase. The activities in the commissioning stage were divided into three components: 1) pre-commissioning and operational testing. 2) Start-up and initial operation; and 3) performance and acceptance testing. During this phase, the operations group were able to observe the processes in the mineral processing plant. They also had their preliminary operation.

Operation and Management Phase. The activities in the operation and management phase primarily included production and marketing and monitoring and maintenance. Along with UP-DMMME, the operations group took a partnership stance with

DOST XI. The operations group was directly involved in the operations of the mineral processing plant.

Turnover Phase. Handover of activities such as workshops for planning are conducted to ease out the transition and delegation of the process implementation, maintenance, and monitoring. During this phase, the operations group directly manages the day-to-day activities of the plant under the supervision of the PLGU as the state representative. This mechanism allows the people to have control over the technology and decisions about the operations of the mineral processing plant.

Issues and Challenges

Implementation of project design is about translating concepts into reality. Project management is a crucial element in the implementation of projects. Political, economic, operational, social, and physical difficulties either seriously delay projects or cause them to fail. In implementing the CLINN-GEM project several issues and challenges were identified. Some issues were addressed while others have remained as challenges.

Acceptability of the Project

The residents and small-scale miners of barangay Katipunan and their neighboring barangays expressed different reactions upon hearing about the CLINN-GEM. Some residents were happy to hear about the non-mercury non-cyanide gold processing technology while others were excited to witness the high recovery of gold which the project espouses. While the residents believed that the mineral processing plant would be the answer to their poverty, they also expressed their concerns about the project. They were apprehensive due to the following reasons. First, they questioned the efficiency of the technology because they had never heard of such technology until then. Second, the people were apprehensive of the possible social and environmental impact of the processing plant. They argued that if the processing plant would yield gold and provide more income to the people, social problems such as prostitution, alcoholism,

domestic violence, and dysfunctional families would also occur. In regards to environmental impact, high yield and income encouraged more miners to operate, which could lead to the destruction of mountains, rivers, and other natural resources. The participants also pointed out a possible increase in mining waste and noise pollution if mining operations would not be regulated.

Information Gap

Since the project is technology-based and highly technical, the implementing team had difficulty in communicating the project aims and processes to the people using the layman's language. This problem was expressed by the project staff and was observed during the focus group discussions. The people had a limited idea of what the project is all about. They also had difficulty in explaining the operations of the project. As such, their perceived benefits from the project were limited to employment in the processing plant rather than improving their quality of life through the increase in income and environmental security.

Project Delays

There were three types of delays experienced by the people and the project implementing team. First was the delay in the procurement and construction. Since the project was a governmentfunded project, purchase of supplies and materials had to undergo government procedures. Bidding procedures and the highly bureaucratic procurement system were identified as primary reasons for the delays in procurement and construction of the mineral processing plant. The weather conditions also contributed to the delays in construction as it started during a rainy season. Second, procurement and construction delays had spilling effects to the payment of salaries of the construction workers as their payments were based on their accomplishments. And third, on the management level, the multi-stakeholder project structure made problem-resolution and decision-making more time consuming as members of the Project Management Committee met once every

three months to discuss problems and concerns of the project.

Availability of Utilities such as Water, Electricity, and Chemicals

Because the project industrial, utilities such as water, eletricity, and chemicals needed as inputs are essential. One of the most significant challenges of the project was to acquire a three-phase transformer because securing such would mean additional work for the implementing team. They underwent several activities to comply with the electrification requirements. Activities conducted solely to address this problem include consultation of the affected landowners and tree planting to replace those that were cut and removed.

Safety and Security

With regards to safety and security, the research participants were very much aware of the possible security threats. The first threat was associated with the presence of the New People's Army (NPA) in the province. According to the participants, there were two possible scenarios where the NPA would interfere and pose a threat to the project operation. First, if the NPA would collect the revolutionary tax and the plant management refused to pay; second, if the NPA heard complaints of injustices in the operations and management of the mineral processing plant, then most likely, the NPAs would burn the entire mineral processing plant. On the other hand, crimes such as robbery and kidnapping were identified as significant threats to small-scale miners who were processing their ores in the mineral processing plant.

Sustainability

Given that the technology was new to the people, and the process flow was complicated, the research participants feared that the project would not be sustainable. Dimensions of sustainability identified by the participants are discussed in the succeeding sections.

Implications for Sustainability

Defining Sustainability

There seems to be as many definitions of sustainability as there are different stakeholders in development projects. The differing definitions of sustainability are brought about by the varying views of the different stakeholders – the project donors, implementers, partners, and beneficiaries. The leading definitions of sustainabilitycome from the international financial and non-governmental organizations which focus on the continuation of significant benefits and maintenance of an acceptable level of benefit, which flows after the donor has completed the projector throughout its economic life (Hutaserani & Bayley, 2010). Moreover, the definition of sustainability varies depending on the nature of the project. In community–managed infrastructure and service delivery projects, sustainability is defined as the capacity of the community to maintain the service (Lockwood et al., 2015). Meanwhile, the research participants' emphasized that a "sustainable project" is one that adds value to all three dimensions of sustainability – economic, social, and environmental. As such, their definition is comprised of three aspects: operation, impact and technology transfer, and adoption.

The first aspect is on the economic, social, and environmental feasibility of the project (mineral processing plant operation). The research participants explained that sustainable projects must be self-sufficient/financing and environmentally sound, where the beneficiaries manage them. Sustainable projects also emphasize the importance of the plants' effects on the environment since they are highly aware of the environmental degradation they are experiencing.

The second aspect of the definition of sustainability centers on the impact of the project on human development, health, livelihood, and the environment of their community. The research participants pointed out that the CLINN-GEM project must improve the quality of life of the people (i.e., through improved income, health, education, and other social services) and increase gold production as well as the income of people. Moreover, the participants believed that the

project must not contribute to environmental problems of the community.

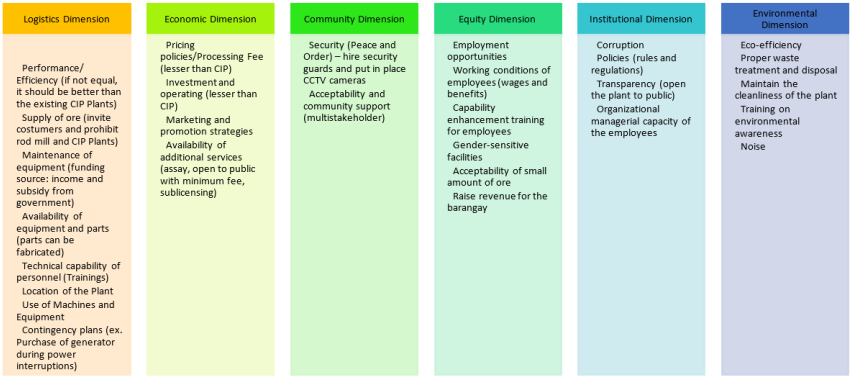
Lastly, the research participants expounded that a sustainable project is one that is adopted by the end-users, which, in this context, refers to the small-scale miners. The participants claimed that it was not enough that the mineral processing plant would operate continuously; instead, technology must be accessed, used, and adopted by the small-scale miners. Thus, the adoption aspect of the project highlights utilization and adoption of technology as fundamental considerations in measuring the sustainability of the CLINN-GEM project, and other economic, social, and environmental factors.

Dimensions for Sustainability

For innovative projects, such as the CLINN-GEM project, to become sustainable, they must be popularized, utilized, adopted, and owned by the people. These processes require time, resources, capacity building, and participation. Ali et al. (2016) stressed that project management has great potential for the design of sustainability especially on organizational parameters and human side factors. Sustainability indicators are essential tools in helping individuals, institutions, communities, and societies make different and better choices about their future (Lawrence, 1998). In this study, the research participants were asked to identify factors which could affect the sustainability of the project. Using Khan's (2000) classification of dimensions in analyzing program sustainability, a summary of factors that could affect the Sustainability of the CLINNGEM Project were identified (see Figure 4).

Figure 4

Summary of Factors that could Affect the Sustainability of the CLINNGEM Project



As can be viewed from among the different dimensions identified above, logistics dimensions have the most number of factors which need to be considered. The performance or efficiency of the processing plant is a significant consideration for sustainability. Since the technology is new, the people are expecting that it can deliver what it has promised. They said that the mineral processing plants' performance if not equal should be better than the Carbon in Pulp (CIP) plants. In measuring efficiency, Martens and De Carvalho (2014) suggest considering indicators such as cost, time, and scope.

Other factors identified by the participants include the funding source, availability of parts for the maintenance of equipment and the technical capacity of the operations group to handle mechanical problems. The participants expressed some apprehensions as regards the maintenance of the plant since they knew that post-construction maintenance would require a significant amount of money. A side from budget the participants were also unaware of the availability of the parts and the technical capabilities of the operations group. They explained that the operations group members were not engineers and therefore did not possess the proper technical training; thus, troubleshooting of mechanical problems might be a challenge . This finding supports the idea that sustainability of projects is not only determined by community management but also by the strength of post-construction support (Bakalian & Wakeman, 2009). Therefore, there is a need for government and development

partners to strengthen post-construction support on operations and maintenance systems (Foster, 2013).

Furthermore, the participants also shared the reasons why most CIP plants failed, aside from lack of budget for maintenance . One reason was that the owners also had problems with theirlocation and the supply of ore. According to the participants, the processing plant should be accessible and strategic. The location of the processing plant is not very strategic because it is far from tunnels with regular operation. With this, small-scale miners will not be interested in processing their ores in the plant because of the possible high transportation cost, which, in turn, can affect the supply of ore and its operation. In view of these problems and other factors to be considered, the participants suggested that the management team must address post-construction problems by providing funding support and technical training, and formulating contingency plans.

Aside from efficiency of the processing plant, economic dimensions, such as pricing policies/processing fees, investment and operating costs and availability of additional services are essential factors that influence small-scale miners's decision to patronize mineral processing plants' services. The participants emphasized that owners of CIP plants were collecting too much. Thus, the participants, who were small-scale miners, were expecting that the mineral processing plant would ease this burden with minimal fees. Likewise, the participants affirmed that the minimal fees and the availability of other services such as assaying, firing, and sublicensing were the comparative advantages of the mineral processing plant. The participants proposed that the management team must plan for its marketing and promotions strategies, so it could reach its desired market.

Apart from the logistics and economic dimensions, community dimension specifically on peace and security and community support were pointed out by the participants. The participants expressed their security concerns because they have heard and witness mining equipment burnt by the New People's Army while some experienced robbery. They argue that both the mineral processing plant and their community are threatened by the presence of NPA in the province. Thus, problems on security must

be addressed by hiring security personnel, installing CCTV cameras and asking the people to secure their community to ensure that the operation of the plant will not be affected.

On equity dimension, the CLINN-GEM project was expected to provide employment opportunities to the residents of Barangay Katipunan and its neighboring barangay. The participants were highly aware that the management must abide by labor standards including good working conditions, provision of wages and benefits, capability enhancement training, and gender-sensitive facilities. They made sure that while the management focused on the technical operation of the mineral processing plant, they should also establish a good working relationship with employees and customers , who play significant roles in the plant operation. Also, inclusivity was identified as an essential factor for sustainability. Since the project was designed for small-scale miners, the participants were curious if the plant would accommodate a small amount of ore (5 metric tons); if this is true , then the project could be beneficial to miners who have lesser produce. Finally, the success of the project was perceived to be helpful to the barangay, for it could raise revenue that could be used to provide social services to the people.

In relation to the foregoing, there are four different aspects of institutional dimensions identified by the research participants: The presence of corruption, the existence of policies and standards of operation, transparency, and organizational and managerial capacity of employees. The participants observed corrupt practices in government projects and CIP plants, and they posited that developing standard operating procedures would be of great help in minimizing corruption. They stressed that penal sanctions should be imposed on employees guilty of bribery and corruption. The participants further argued that once there was corruption inside the plant, then problems and the downfall of the operation would follow. Furthermore, they also mentioned that some CIP plants did not disclose their operations to the public due to security and trade concerns. However, theparticipants asserted that the processing should be open to the public. Opening the plant to the public is a marketing strategy and could mean extra income; but more than this , doing so would be a manifestation of transparency. The participants

further reasoned that opening the operation to the public would allow the people to witness how the technology worked and would enable them to check if indeed the plant was environmentally friendly and if it used non-harmful chemicals. In sum, opening the operation to the public was viewed by the participants as a way of making the technology close to people.

On the other hand, some of the participants were worried about the preparedness of the people to adopt the technology while others were hesitant of to accept innovations. They posited that they lacked the organizational and managerial capacities to handle and operate the mineral processing plant. With this, they tapped UP Diliman and DOST for support. These findings imply that sustainability is not only determined by financial and technical indicators but also by leadership capacities (Annis, 2006). Since mining is associated with environmental destruction (Hentschel, 2003), the participants were very critical of the environmental dimensions. They emphasized that for the mineral processing plant to be sustainable, it must be eco-efficient; it must treat and dispose of its wastes properly; it must also maintain cleanliness; and it must be aware of its possible effects to the environment, such as noise pollution. Environmental programs such as training on environmental awareness have helped to sustain the project. They explained that eco-efficiency could be achieved when production is maximized as the environmental impacts of production are also reduced or mitigated. Moreover, the participants were also very meticulous in regards to treatment and disposal of waste because most of the CIP and ball mill processing plants did not maintain cleanliness and disposed of their wastes in the creeks and rivers, resulting in the death of fish and farm animals.

Participation as a Dimension for Sustainability

Participatory development seeks to engage local people in development projects. It hopes that development projects will be more sustainable and successful through the engagement of local people in the process. As regards innovative projects such as the CLINN – GEM, Chambers (1997) argues that outsiders do not

transfer technology; they share methods which local people can use for their appraisal, analysis, planning, action, monitoring, and evaluation. Outsiders do not impose their reality; instead, they encourage and enable local people to express themselves. In participatory development play an active role in the development of the project, as the project progresses, the peoples' roles and responsibilities also increase.

Looking at the typologies of participation (Pretty 1995, as cited in Oxford Policy Management, 2013) the types of participatory activities in the CLINN-GEM project phases were passive participation, participation by consultation, participation for material incentives, and interactive participation. During the pre-deployment phase, the people were both passive and active participants of the project. They attended and participated in consultations conducted by the Implementing Team. The results and discussions during consultations were used to design plans and activities for the people. During the deployment phase, some residents participated in the construction of the mineral processing plant. Interactive participation was evident among the members of the Project Management Committee and the operations group as they were the ones who developed action plans, decided on solutions to solve problems, and managed the mineral processing plant. These groups took control over local decisions and determined how available resources are used, so they have a stake in maintaining structures or practices.

While efforts to include the local people in the different project's phases are evident, still the concept of "communityled"remained unclear. As regards the degree or level of people'sparticipation (Arnstein, 1969, as cited in Oxford Policy Management, 2013), activities participated in by the local peoplewere categorized as tokenism (e.g., informing, consultations) although there were few who exercised citizen power (e.g., partnership, delegation, citizen control), such as the Implementing Group, the Project Management Committee, and the Operations Group. This seemingly disproportionate degrees of participation have posed a significant challenge to powersharing, technology-adoption, and ownership concerns.

Prospects of Sustainability

At present, the CLINN-GEM project has caught the local people's attention; however, it is not yet part of their everyday life. When asked about the prospects of sustainability of the project on a scale of 1-10, with 10 as the highest rating, the participants gave responses that were categorized into the following themes:

1. The efficiency of the technology. The sustainability of the project depends on the efficiency of the new technology. One participant rated the project 7-8 because there was a need to wait for the mathematics of the project (i.e., the actual production cost and percentage of gold recovery), to see if the figures would be acceptable. The same participant added that the project would be a game changer not only in the ComVal but in the whole country, if it would be sustained.
2. The capacity of the implementing team and the project management committee to address issues and concerns. Prospects of sustainability are measured through the ability of the stakeholders to solve problems in several critical components. Since the project is a pilot study, there were several unforeseen problems which the stakeholders needed to address; when these problems are solved and the project becomes self-sufficient/financing, the projects unattainable can be achieved.
3. The support and acceptability of the people. While the people awaited the results or the pilot plant, some believed that the project would be sustainable if it had public support. One participant rated the likelihood of sustainability of the CLINN - GEM project 10 because the local people gave their best to support the project.

Conclusions and Recommendations

The study highlighted several themes in the examination of the practices, processes, issues, and challenges of the CLINN-GEM Project.

First, the development of the CLINN-GEM project as an innovative development project shows the efforts of the government through science and technology to address the challenges of 2015) smallscale mining. And since the initiative cascades through a "top-down" management approach, the ultimate challenge is on how to share the technology to the local people for them to understand, learn, use, adapt, own, and improve it. The adoption of a multi-stakeholder structure and inclusion of various types of participatory activities in the project process suggest that while participation may cause a delay in decisions, projects could be easily implemented through collective actions. Close integration and convergence of stakeholders could result in successful projects (Lockwood et al., 2015).

Two, unlike other development projects, the utilization, adoption, and ownership of this technology are considered as the primary indicators of sustainability. Since the project is technology driven, its efficiency, costs, and resources for maintenance are crucial in sustaining its operations. Meanwhile, peace and security, and community acceptance and support are equally important dimensions to consider in maintaining the project. Moreover, equitable sharing of benefits for the workers and the community are essential while institutional problems, such as corruption and organizational incapacities, need to be addressed. Apart from all these, people consider environmental dimensions such as ecoefficiency and proper waste management as indicators of project sustainability.

Third, as an innovative development project, the prospects for sustainability of the CLINN- GEM project heavily rely on its performance. Hence, aside from ensuring efficiency, all issues and problems must be addressed. To perfectly manage the mineral processing plant, the following actions are recommended: 1) promoting and popularizing the technology by allowing the people to access and use the mineral processing plant; 2)reducing information gap by increasing information dissemination and education activities, developing IEC materials, and conducting trainings and workshops; 3) enhancing people's sense of ownership of the project by organizing and mobilizing them, thereby allowing them to

participate in and decide on future activities, recognize their capacities, and be treated as active members of the community.

Fourth, the results of the study suggest that future research on community-led projects, ownership of technology, and sustainability should be conducted. The following research questions on these topics can be explored :

- What is a community-led project? What is its nature and elements?
- What does ownership of technology mean? From this context, who owns what?
- What is the extent of sustainability of technology-based projects?
- Is its commercialization, utilization, adoption, behavioral change, sustained benefits, or social Impact (e.g., people are liberated from poverty because of the technology)?

Lastly, as we look forward to a sustainable CLINN-GEM project, we might as well want to examine whether the economic viability of the project makes the economy of mining communities better off, the people's well-being is improved, the environmental integrity is assured over the long term, and people get a fair share of resources.

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