Sustainable mined land reclamation: the pujada nickel case study

Recuperação sustentável de terras mineradas: o estudo de caso do níquel pujada

Recuperación sostenible de tierras minadas: el caso del níquel de pujada

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ABSTRACT
Decision making is severely challenging in mined-land reclamation where multiple interests of various and often conflicting stakeholders should be satisfied. Thru the use of Multi-Criteria Analysis (MCA), sustainable options of reclaiming the mined land in manner that is environmentally sound, technically feasible, economically viable, socially acceptable, culturally sensitive and spiritually rooted are fully explored and considered. Multiple stakeholders like; the indigenous peoples, mining host communities, the non-government organization, the church, the mining company, the Mines Bureau, the National Commission on Indigenous Peoples and the local government units were engaged in the study to determine their interests in mining reclamation. Having full appreciation of the stakeholders’ interests and proposed options, the Mine Rehabilitation Fund Committee and the Multi-partite Monitoring Team are confident that reclaiming the mined land thru the options-mix of Forestry and Botanical Park Development shall perform better and is more sustainable. The results of MCDA of the Pujada Nickel Project enabled the decision makers to have confidence that the blended options of Forestry Reclamation Approach (FRA), Sloping Agro-forestry Land Technology (SALT) and Botanical Park Development in transforming the Pujada Nickel Mine shall satisfy the best interests of the multiple mining stakeholders.

Keywords: multi criteria decision analysis, pujada nickel project, sustainable mined land reclamation, mine closure, participatory mine closure planning.

RESUMO
A tomada de decisões é um grande desafio na recuperação de terras mineradas, em que devem ser atendidos os múltiplos interesses de diversas partes interessadas, muitas vezes conflitantes. Por meio do uso da Análise Multicritério (MCA), as opções sustentáveis de recuperação da terra minerada de forma ambientalmente correta, tecnicamente viável, economicamente viável, socialmente aceitável, culturalmente sensível e espiritualmente enraizada são totalmente exploradas e consideradas. Várias partes interessadas, como os povos indígenas, as comunidades anfitriãs da mineração, a organização não
governamental, a igreja, a empresa de mineração, o Departamento de Minas, a Comissão Nacional de Povos Indígenas e as unidades do governo local foram envolvidas no estudo para determinar seus interesses na recuperação da mineração. Tendo plena apreciação dos interesses das partes interessadas e das opções propostas, o Comitê do Fundo de Reabilitação da Mina e a Equipe de Monitoramento Multipartite estão confiantes de que a recuperação da terra minerada por meio da combinação de opções de Desenvolvimento de Parques Florestais e Botânicos terá melhor desempenho e será mais sustentável. Os resultados da MCDA do Projeto Níquel Pujada permitiram que os tomadores de decisão tivessem confiança de que as opções combinadas de Abordagem de Recuperação Florestal (FRA), Tecnologia de Terras Agroflorestais Inclinadas (SALT) e Desenvolvimento de Parque Botânico na transformação da Mina de Níquel Pujada satisfarão os melhores interesses das diversas partes interessadas na mineração.

**Palavras-chave:** análise de decisão multicritério, projeto pujada nickel, recuperação sustentável de terras mineradas, fechamento de mina, planejamento participativo de fechamento de mina.

**RESUMEN**

La toma de decisiones supone un gran reto en la recuperación de tierras minadas, donde deben satisfacerse múltiples intereses de diversas partes interesadas, a menudo en conflicto. Mediante el uso del Análisis Multicriterio (ACM), se exploran y consideran opciones sostenibles de recuperación de tierras minadas que sean respetuosas con el medio ambiente, técnicamente factibles, económicamente viables, socialmente aceptables, culturalmente sensibles y espiritualmente arraigadas. Múltiples partes interesadas, como los pueblos indígenas, las comunidades mineras anfitrionas, las organizaciones no gubernamentales, la iglesia, la empresa minera, la Oficina de Minas, la Comisión Nacional de Pueblos Indígenas y las unidades de gobierno local, participaron en el estudio para determinar sus intereses en la recuperación minera. El Comité del Fondo para la Rehabilitación de las Minas y el Equipo Multipartito de Supervisión, que conocen perfectamente los intereses de las partes interesadas y las opciones propuestas, confían en que la recuperación de las tierras minadas mediante la combinación de opciones de silvicultura y desarrollo de un parque botánico sea más eficaz y sostenible. Los resultados del MCDA del Proyecto Níquel Pujada permitieron a los responsables de la toma de decisiones confiar en que las opciones combinadas de Enfoque de Recuperación Forestal (FRA), Tecnología de Terras Agroflorestales en Pendiente (SALT) y Desarrollo de Parques Botánicos para transformar la Mina de Níquel Pujada satisfarán los mejores intereses de las múltiples partes interesadas en la minería.

**Palabras clave:** análisis de decisión multicriterio, proyecto níquel pujada, recuperación sostenible de tierras minadas, cierre de minas, planificación participativa del cierre de minas.

**1 BACKGROUND OF THE STUDY**

Globally, mining and sustainability have been a major subject of discourse among interest groups eyeing towards mining closure. At any given time, all mining firms will
be challenged in its operation and possibly be closed due to mineral exhaustion or even due to regulatory, environmental, technical, social or economic influences making it as a toughest challenge. Legacy issues surrounding many closed mines have been haunting the industry up to the present. The country is not spared by this global threat. The same agony has been suffered by the country’s mining firms both in its exploration and operation stages affecting mining-dependent workforce and their families as they will lose their source of livelihood. This incident has become traumatic and devastating in the local communities where mining is considered as their prime economic driver.

However, closure has evolved from mere technical solution. There is a wider demand to integrate diverse interests in the formulation of rehabilitation criteria and closure plan. The industry and the mining regulatory institutions together with mining community stakeholders must collaborate to collectively explore alternatives for a transformative and sustainable mined land reclamation. It is emphasized that closure and its reclamation plans must be feasible and is site-specific (Sellers, R., & Vogel, P., 2015). Closure efforts should give emphasis on sustainable development with the intention of creating the “Second Economy” that enable people to help themselves in consonance with biodiversity, land stewardship and sustainable development (Prinsloo, HB & Pieterse F, 2015).

Highlighted in the mineral policy framework adopted by the Inter-Governmental Forum (IGF) on Mining and Sustainable Development of the United Nation, it reaffirms that mining is considered consistent to sustainable development when planning for closure is present during the entire operation of the mine. Therefore, it requires that stakeholders be involved in the development of closure plans. Further it also encourages progressive rehabilitation as soon as the disturbed area is no longer needed for mining to reduce future closure liabilities and reverse the adverse environmental, social and economic impacts (IGF, 2013).

Locally, the Pujada Nickel Project is among the contentious mining projects in the country. It is located in Mati, Davao Oriental, near the two protected areas; the Hamiguitan Protected Area inscribed as World Heritage site by the UNESCO and also near the declared Pujada Protected Seascape. Moreover, it is also within the ancestral lands of the Mandaya indigenous people who gave the company its Free and Prior Informed Consent. Multiple stakeholders have expressed their interests on the sustainable use of the area and the transformation of the mine disturbed lands into sustainable land
uses. Thus, the study is conducted to determine the best reclamation option of the Pujada Nickel Mine.

1.1 STATEMENT OF THE PROBLEM

The study is conducted to determine the mine closure options of Pujada Nickel Project. Specifically, it answered the following question;

a) What are the interests of stakeholders over the mined land?

b) What are the options of reclaiming the mined land?

c) What is the decision on how the mined land be reclaimed?

1.2 OBJECTIVES OF THE STUDY

The study primarily aimed to determine a sustainable reclamation option of the Pujada Nickel mined land.

1.3 SIGNIFICANCE OF THE STUDY

The study can serve as a concrete basis for mining companies and environment department in the reconfiguration of mined land reclamation design making it more community responsive, sensitive and adaptive. Further result of the study will also serve as a tangible and reliable source for designing a policy relative to sustainable mining.

1.4 SCOPE AND LIMITATION

The study focused only in Pujada Nickel Project in Mati City where other mining areas have different set-ups and experiences. Moreover, it only utilizes qualitative research design employing Multi-Criteria Analysis which may be challenged by its generalizability. This study was also conducted from December 12, 2017 to April 24, 2018. Experiences, desires and situations outside the months covered may be different.
1.5 DEFINITION OF TERMS

Mining refers to the process of mineral exploration, development, extraction, utilization and decommissioning of mining areas.

Mine Closure refers to the period when mine operation ceases due to reasons such as legal, political, social, technical, environmental and economic and resource exhaustion. It is either temporary or permanent in nature depending on the reason of the stoppage.

Mined land or Mine-Out Area refers to the site where ore extraction is completed due to mineral exhaustion. This is an area where reclamation shall be undertaken to transform the site into other land uses.

Mine Reclamation refers to the process of transforming the mined land into other land uses such as; park, agriculture, forest, biodiversity and others.

Mining Stakeholders refer to the individuals and groups of people with interests and influence over the mining area. They are those people who are affected or shall be affected by the mining projects either positively or negatively.

Multi-Criteria Analysis refers to the branch of Operations Research that integrates multi-interests and multi-perspectives of various stakeholders in the decision making using coherent steps in determining best alternatives in addressing a particular problem, in this case, mine closure and reclamation.

1.6 THEORY BASE

The study is anchored in the theory of Five Capital Development Model as developed by the “Forum for the Future” where authors recommended that businesses and organizations should take full accountability in enhancing the natural Capital: land, air, water, fisheries, forest, and others including genetic resources; Human Capital: the skills, knowledge, health and well-being that enables people to function and live effectively; Social Capital: network and relationships of trust and reciprocity that enable people to live in harmony with each other and cooperate; Economic Capital: income and financial resources and, access and sharing of these resources; Built Capital: infrastructures and facilities including buildings, telecommunication and transportation that enhances mobility and exchange in driving their operations and projects efficiently (Brereton & Pattenden, 2007).
Further decision theory also supports the study. It assumes that people make decision or make a choice between and among options on the basis of some standards or criteria where values are subject to moral philosophy. The theory postulated that problem solving consist of five consecutive stages; first, the felt of difficulty, second, the definition of the character of that difficulty, third, suggestion of possible solutions, fourth, evaluation of the suggestions and lastly, further observation and experiment leading to the acceptance or rejection of the suggestion (Hansson, 2005).

1.7 CONCEPTUAL FRAMEWORK

The conceptual framework follows three stages. Stage 1: is the determination of the stakeholders’ interest over the mined land and the recognition of instruments covering the Pujada Nickel. Stage 2: is the identification of reclamation options. Local and international best practices in mine reclaims, landscape architectures and legal requirements form part of the basis of options proposed. Stage 3: is the decision phase. All proposed options are assessed in conjunction with the multiple-interests identified in the stage 1. The decision is validated using Pairwise Comparison Technique thereby validating the result of the MCA Performance Scoring to increase confidence in the decision arrived.

2 METHOD USED

The study employs a qualitative research design in understanding the deeper meanings of the reclamation project to the view-point of mining stakeholders who have influenced and or to be impacted by the reclamation project. These meanings are generated thru in-depth interviews, focus group discussions and brainstorming involving the research participants who manifested their interests and proposed options in reclaiming the mined land. These interests and options are analyzed using the Multi-Criteria Analysis. Findings of reclamation researches, best practices and, guidelines in mine reclamation around the globe and within the country also form part of the document review to enrich the study.

This method of analysis has five components; 1. Goal, 2. Decision Maker (stakeholders), 3. Decision Alternatives (Options), 4. Evaluation Criteria (Interests) and,
5. Decision Outcome associated with alternatives and interests combination (Natural Resource Leadership Institute, 2011).

2.1 SOURCES OF DATA

The data are generated from primary and secondary sources. Primary information is collected from stakeholders such as: the leaders of indigenous cultural communities and the mining-host communities, the officers of non-government organizations, leaders of the church, the technical experts and persons in authority. Secondary data include reports and documents in the repository of the Mines and Geosciences Bureau, the Environmental Management Bureau, the Department of Environment and Natural Resources (DENR), the National Commission on Indigenous People, minutes of the meetings of the Mine Rehabilitation Fund Committee (MRFC), local government units and, the non-government organizations.

2.2 DATA GATHERING INSTRUMENT

The data gathering instrument consist of open-ended interview guide administered during the field interview, brainstorming (Focus Group Discussion), workshops and roundtable discussions. The interview guide is divided into three phases. Phase I: is the description of Mine Reclamation Area (Decision Context); What is the size, terrain, soil characteristic of the mine-out area (physical attributes)? What are the ownership, access and uses of the area (social, economic and environmental attributes)? Who are those with interests and influence over the area (Stakeholders analysis)? Phase II: Identifying Options, Criteria and Objectives; What are the interests of stakeholders in the reclamation? What are alternatives (options) to develop the mined land? What are the attributes of each of these alternatives? Phase III: Scoring and Weighting; What are the environmental significance of each of the alternatives? What are the social significance of each of the alternatives? What are the cultural significance of each of the alternatives? What are the economic significance of each of the alternatives? What are the most preferred alternatives (ranking and prioritization)? Why are these alternatives being preferred (sensitivity analysis)? Moreover, for greater appreciation to decision makers, the use of imagery collected from drone photos is sought to ascertain location and spatial attributes of the mine reclamation areas to the surrounding ecosystem and communities.
2.3 RESEARCH PARTICIPANTS

The study purposively engaged multiple stakeholders as primary sources of data. The inclusion criteria is based on the following: those who owns the land and resources, who currently use the area, who plans to develop the area, who uses the area legally or illegally for access, extractive and productive purposes, who uses the land and resources at different period of the day or year (Beukering, P.V., Brander, L., Tompkins, E., McKenzie, E., 2007).

Further they are classified as to basis of their interests and their use of the land and resource such as: being an on-site users, off-site users, stakeholders from the province, region, and country with interests over the area. Those who will be affected positively or negatively by the decision and those who have the power and those who have no power to influence the decision are also categorized. These include the, tribal council of Barangay Macambol and Cabuaya in Mati City, Davao Oriental, the leaders of various sectors of community, the Local Government Unit of Mati City, Provincial Planning and Development Office, Mines and Geosciences Bureau, technical Personnel of MGB, Non-Government Organization, Philippine Catholic Church, the Parish Priest, the National Commission on Indigenous Peoples and the Mining Company.

2.4 PROCEDURE OF THE STUDY

The procedure adheres to the prescribed steps in the Multi-Criteria Decision Analysis as enumerated: Establish the decision context. What are the aims of the MCA, and who are the decision makers and other key players? Identify the options. Identify the objectives and criteria that reflect the value associated with the consequences of each option. Describe the expected performance of each option against the criteria. Assign weights for each of the criteria to reflect their relative importance to the decision. Combine the weights and scores for each of the options to derive and overall value. Examine the results. Conduct a sensitivity analysis of the results to changes in scores or weights (Beukering, P.V., Brander, L., Tompkins, E., McKenzie, E., 2007). Based on the foregoing steps, the study commenced by defining the mining areas for closure that needs to be rehabilitated; its size, location, terrain, soil features, flora and fauna of the area, land tenure, access and contribution to the surrounding communities. Then come-up with the
best reclamation alternatives after a thorough analysis and weighing of the criteria being considered.

2.5 MATHEMATICAL TREATMENT

The nature of the study requires that it presents a decision matrix as output in the evaluation and treatment of alternatives or options being identified and considered. The matrix is shown below in table 1, where $i$ is the evaluation given to options $i$th with respect to criterion $j$th, $w_j$ is the weight of criteria $j$, $n$ is the number of criteria and $m$ is the number of options (Opricovic S, Tzeng GH, 2004).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Criteria 1: Economic Viability</th>
<th>Criteria 2: Social Acceptability</th>
<th>…</th>
<th>Criteria n:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weights</strong></td>
<td>Assigned Weight on Economic</td>
<td>Assigned Weight on Social</td>
<td>…</td>
<td>Total Weight (100)</td>
</tr>
<tr>
<td><strong>Options</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option 1: Forestry</td>
<td>Score on Criteria 1</td>
<td>Score on Criteria 2</td>
<td>…</td>
<td>Total Score of Forestry</td>
</tr>
<tr>
<td>Option 2: Agriculture</td>
<td>Score on Criteria 1</td>
<td>Score on Criteria 2</td>
<td>…</td>
<td>Total Score of Agriculture</td>
</tr>
<tr>
<td>Option 3: Park &amp; Tourism</td>
<td>Score on Criteria 1</td>
<td>Score on Criteria 2</td>
<td>…</td>
<td>Total Score of Park</td>
</tr>
<tr>
<td>…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Options</strong></td>
<td><strong>Total Sub-weight</strong></td>
<td><strong>Total Sub-weight</strong></td>
<td>…</td>
<td><strong>Total Scores</strong></td>
</tr>
</tbody>
</table>

Source: Decision Matrix, Opricovic S, Tzeng GH, 2004

3 RESULTS AND DISCUSSION

3.1 INTERESTS OF STAKEHOLDERS

The kind of reclamation options must satisfy and address the interests and criteria raised by the stakeholders with influence and interest over the mine disturbed areas. The criteria identified during the data gathering include; economic viability, environmental soundness, social acceptability, cultural sensitivity, technical feasibility and spiritual rootedness: These criteria are presented in Figure 1 below;
Reclamation Options. The stakeholders proposed that the mined land of the Pujada Nickel Project should be reclaimed in three major identified categories such as; 1. Silviculture thru Forest Reclamation Approach, Analog Forestry and Sloping Agroforestry Land Technology; 2. Agriculture such as; livestock production, poultry production, food crop production and orchard development and, 3. Park and Tourism including; botanical park, environmental park and tourism development. Parks and Tourism Development. These reclamation options is indicated in Figure 2.
Decision of the Mine Rehabilitation Fund Committee. The Mining Regulation of the Philippines requires the creation of the Mine Rehabilitation Fund Committee (MRFC) which shall perform among others; discuss the adequacy of control and rehabilitation measures; resolve issues involving rehabilitation programs and; hire experts to do independent studies and researches on the environment, engineering and socio-cultural to assist them in making judicious decisions and help ensure that the mine disturbed areas is transformed into beneficial land uses (Section 182, paragraph a, c and, d of DAO 2010-21).

The establishment of a functional and post-disturbance land use capability that is proximate to the land prior to disturbance or other more beneficial land uses as agreed in partnership with local communities and LGUs is mandated in the regulation (Section 167, paragraph b., DENR Administrative Order 2010-21, the Revised Implementing Rules and Regulations of the Philippine Mining Act of 1995).

The Multi Criteria Analysis Framework (Natural Resource Leadership Institute), is one of the decision-making tools that helped the Mine Rehabilitation Fund Committee to fully satisfy the mandates of establishing a functional and post-disturbance land use capability that respond to the multi-interests of various reclamation stakeholders. Thus, Mine Rehabilitation Fund Committee (MRFC) and Multi-Partite Monitoring Team (MMT) during their meeting last April 24, 2018, at Seda Hotel in Davao City, Philippines rated the options based on the agreed main criteria and sub-criteria generated by the
researcher during the interview, Focus Group Discussions and also based on best practices.

Table 2. Reclamation Options Performance Scoring

| Source: Pujada Nickel Project, Mine Rehabilitation Fund Committee, April 24, 2018 |

The overall scores in Table 2 shows that forestry options ranked high. The Forest Reclamation Approach (FRA) is the most preferred followed by Analog Forestry and Sloping Agro-forestry Technology (SALT) having the same scores and Botanical Park Development at fourth rank. The least preferred are the conversion of mined land into livestock and poultry farm which ranked 9th and 10th respectively.

The Pairwise Ranking Method. To increase confidence on the decision arrived, the use of pairwise ranking method is introduced to validate the options being evaluated. During the pairwise comparison, every option is compared against all other options taking the criteria as basis of comparison. The options that valued more against its paired option scored ONE (1) or ZERO (0) if it is valued less. In summary, options that scores the same shall be re-examined until consensus is arrived on which option should be ranked higher.
Table 3 below is the pairwise ranking output of the MRFC and MMT showing scores of the reclamation-options. Thru consensus, the members of the Mine Rehabilitation Fund Committee (MRFC) and The Multi-Partite Monitoring Team (MMT) have paired each options against all other options considering the expressed interests by the various stakeholders during the data gathering phase. The result of pairwise revealed that both the MMT and the MRFC preferred to develop the mined land using Forestry using Forest Reclamation Approach (FRA) and Sloping Agro-forest/fruit Technology (SALT) and, into Botanical Park. The three options got the same highest scores dominating the rest of the other seven alternatives.

### Table 3. Pairwise Ranking of Reclamation Options

<table>
<thead>
<tr>
<th>Reclamation Options</th>
<th>(1) FRA</th>
<th>(2) AF</th>
<th>(3) SALT</th>
<th>(4) LPD</th>
<th>(5) PP</th>
<th>(6) CFCP</th>
<th>(7) OD</th>
<th>(8) BP</th>
<th>(9) EP</th>
<th>(10) ETD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10) Forest Reclamation Approach (FRA)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(2) Analog Forestry (AF)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>(3) Sloping Agro-fruit/forestry (SALT)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>(4) Livestock &amp; Dairy Production (LDP)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(5) Poultry Production (PP)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(6) Cereal/ Food Crop Production (CFCP)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(7) Orchard Development (OD)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>(8) Botanical Park (BP)</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(9) Environmental Park (EP)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>(10) Eco-Tourism Development (ETP)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: Pujada Nickel Project, Mine Rehabilitation Fund Committee, April 24, 2018

While it is suggested to re-evaluate the top three options to determine the most preferred, the MMT and MRFC resolved to blend the three options in the preparation of the landscape design. The decision makers believed that a Reclamation Design with influenced of the three options shall perform better. Having agreed on the option-mix, the two bodies passed a resolution adopting a Mined Land Reclamation Project that embraces the principles, criteria and approaches promoted by the Sloping Agro-forest Land Technology, Botanical Park Development and Forest Reclamation Approach. It is resolved further that the kinds of plants and vegetation which suits to the local conditions and the soils including those identified by local herbalists and the tribal elders be studied further to enhance the success of the reclamation.
Comparing the output of pairwise ranking and the option performance scores, still the Forest Reclamation Approach, Sloping Agro-forest Land Technology and Botanical Park Development outperformed the rest of the options except the Analog Forestry which ranked high in performance scoring. While Analog Forestry ranked the same with SALT in MCDA Performance Score, it lagged behind ranking 5th in the pairwise. The urgency of the transforming the land into functional and more beneficial post-mine land use somehow limits the attractiveness of the Analog Forestry establishment. Understandably, mimicking the natural ecological succession as one of the salient features of Analog Forestry may take some time of which the mining industry does have much leeway. The circumstances and the mandates are pressing hard to the industry for immediate restoration and reclamation of mined land.

The decision is consistent to the Mining Policy Framework (MPF) of the Inter-Governmental Forum (IGF) on Mining, Metals, Minerals and Sustainable Development of the United Nations as a global policy guidance and assessment tool. The MPF promotes that stakeholders participation in the decision making on post-mine-transition should be sought. It also encourages that mine disturbed areas should be progressively rehabilitated when no longer needed by mining to reduce future liabilities and to reverse environmental, social and economic impacts (IGF, 2013).

The Mine Rehabilitation Fund Committee (MRFC) in one of its meetings has approved the reclamation design illustrated in Figure 4 prepared by a landscape architect commissioned by the MRFC.
4 CONCLUSIONS

Decision making in mine reclamation is significantly influenced by multiple stakeholders’ varying interests. The use of Multiple Criteria Analysis enabled the Mine Rehabilitation Fund Committee and the Multi-partite Monitoring Team of the Pujada Nickel Project to consider an environmentally sound, technically feasible, economically viable, socially acceptable, culturally sensitive and spiritually rooted mine reclamation project with blended characteristics of Forestry Reclamation Approach, Sloping Agro-forestry Land Technology and Botanical Park Development. It recommends that the same study be conducted however, to other mining areas of different characteristics (e.g. location, stakeholders involved and size) with an increase number of participants and integrating different methodologies. This will validate the existing mine reclamation characteristics established in the study. Moreover, the mine reclamation plan can be reviewed and be further evaluated for its feasibility.
REFERENCES

Adams, Mary Beth, The Forestry Reclamation Approach: Guide to Successful Reclamation of Mined Lands, United States Department of Agriculture Forest Service, 2017


Brereton, D. and Pattenden, C., Measuring what matters: Monitoring the contribution of mining to community sustainability, Third International Conference on Sustainable Development Indicators in the Minerals Industry, June 2007, Melos Island, Greece


Dr Deanna Kemp, Phil Clark, Tian Zhang, Estimating Socio-Economic Impacts of Mine Closure, Centre for Social Responsibility in Mining (CSRM) - Sustainable Minerals Institute, 2007


Inter-Governmental Forum on Mining, Minerals, Metals and Sustainable Development, Mining Policy Framework, Switzerland, 2013


Jo-Anne Everingham, Rodger Barnes, Joni Parmenter, David Brereton, Social Impacts of Closing Century Mine, Centre for Social Responsibility in Mining (CSRM), 2014

JJ Van Heerden, Sustainable mining communities post mine closure: Critical reflection on roles and responsibilities of stakeholders towards local economic development in the City of Matlosana, Stellenbosch University, March 2016


May Hermanus, Phillip Frankel, Dr Annelie Naude, Julie Stacey, the Socio Economic Aspects of Mine Closure and Sustainable Development, Centre for Sustainability in Mining and Industry (CSMI), University of the Witwatersrand, January 2010

Michael Haney and Maria Shkaratan, Mine Closure and its Impact on the Community: Five Years After Mine Closure in Romania, Russia, and Ukraine, The World Bank Europe and Central Asia Region Infrastructure and Energy Services Department, June 2003
M.J Mahase, C. Musingwini, and A.S. Nhleko, A survey of the application of multi-criteria decision analysis methods in mine planning and related case studies, the Southern African Institute of Mining and Metallurgy, 2016

Natural Resource Leadership Institute, Multi-Criteria Decision Analysis, North Carolina, USA, 2011


Richard Sellers & Paul Vogel, Guidelines for Preparing Mine Closure Plans, Department of Mines and Petroleum and Environmental Protection Authority Government of Western Australia, May 2015

Sven Ove Hansson, Decision Theory A Brief Introduction, Department of Philosophy and the History of Technology, Royal Institute of Technology, Stockholm, 2005

UNESCO, Mount Hamiguitan Range Wildlife Sanctuary, 2014