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Technology Management Practices for Sustainable Sand and Gravel Mining Industry along Surigao del Norte River

Vrian Jay Ylaya

Abstract

Sand and gravel were the underlying commodities for concrete mix in all construction materials. Through time, the sand and gravel mining industry (SGMI) has an adverse effect that leads to the destruction of the environment. To sustain the ecosystem of SGMI, the researcher sought to formulate a technology management philosophy of SGMI in Surigao del Norte River from the sociological aspect among the residents, ecological changes of the environment from the mining activities and the extent of preventive technological management practices (PTMP) of the mining operators. A researcher-made questionnaire to gather data for mining operators & local government officials and residents who reside on the mining site. Anchored with reflectivity, participatory, and social conflict theories used to develop technology management philosophy for SGMI. The data collected are analyzed using frequency count, ordinal rank, weighted mean, Pearson Product-Moment Correlation Coefficient, ANOVA, Scheffé Posteriori Test to analyze the data. The operations of the SGMI in the rivers of Surigao del Norte have both the desirable and undesirable effects on the community and environment. The activities have better contributions to the stability of the economic and socio-cultural aspects of human existence except in the advancement of education, and the participation of the mining industries does not necessarily mean the same benefits to all other dimensions to humanity and the environment. Sustainability in the operation of the SGMI is a function of regulations and practices that promotes environmental preservations of the ecosystem and social welfare.

Keywords:

Sand and Gravel Mining Industry SGMI;
Preventive Technology Management Practices PTMP;
Reflectivity Theory;
Participatory Theory;
Social Conflict Theory.

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1. Introduction

Sand and gravel are the necessary mixtures of construction. These are the fundamental components used to produce concrete, asphalt, and bricks, deemed essential building materials for residential, commercial, and industrial buildings, and in most public work projects such as roads and bridges. The importance of these materials has resulted in the aggressive mining of sources to meet the needs of new construction as well as rehabilitation of ageing infrastructures [1]. The abundance of these deposits is in rivers. From 2003 to 2009, the Philippine Industrial Sand and Gravel Production have increased, estimating to every year percentage change in the supply of about 23.39% [2].

On the other hand, the National Statistics Office reported that the construction materials wholesale price index (CMWPI) of sand and gravel in the Philippines from 2001 has increased to 217.6 as of 2012. The presence of sand and gravel extraction in the river beds can significantly alter the physical, chemical, and biological characteristics of mined streams and affects the environmental impacts such as noise, dust, truck traffic, pollution and visual changes which contributed to the lives of the community [3]. It also helped a conflict with competing land uses such as farming, especially where high-value farmland is scarce due to bank erosion [4].

In Barangay San Pablo and Barangay Mabuhay, Municipality of Sison, commercial gravel extraction to supply aggregate construction industry has been on the increase in recent years. Expansion of mining in the area results in the cutting of indigenous trees, which contributed to land degradation and desertification. This

malpractice leaves behind bare soil and a vast expanse of gullies that can collect water during rainy seasons. It can also evidently alter the topographical structure of the Surigao River since the climate in Surigao is always rainy season, and the typhoon is contributing to the possibility of soil erosion of the river. Excessive soil erosion is observed of the river banks along the Surigao River during the rainy season. Freshly eroded banks have a very steep slope 80-90 degrees, which are susceptible to further collapse even just due to its weight or by gravity [5].

With the scenarios cited above, the environmentally-oriented researcher becomes interested in studying the extent and effect of sand and gravel mining and the area of preventive technology management practices employed in rivers of Surigao del Norte.

2. Theoretical Framework

A priori of a theoretical model has given considerations to establish a model for sustainable technology management practice.

2.1 Reflectivity Theory

This is a theory developed by the Sociologist William Thomas. This refers to reflexivity, which includes both the subject process of self-consciousness inquiry and the study of social behaviour regarding theories about social relationships [6].

2.2 Participatory Theory

This theory is adopted in this study as it deals with the participatory involvement of the stakeholders of the sand and gravel mining industry. This is a theory, vision or framework which attempts to bridge the subject-object distinction. Ferrer explained that the kernel of this participatory vision is a turn from intra-subject experiences to participatory in the understanding of the person on transpersonal and spiritual phenomena [7].

2.3 Social Conflict Theory

This is a Marxist-based Social Theory which argues that individuals and groups within society have differing amounts of material and non-material resources [8]. This theory states that groups within a capitalist society tend to interact destructively, allows no mutual benefit, and little cooperation. The distinction of power and control by the government is challenging to balance over the resources such that sometimes they lead to constructive solutions regarding conflicts between different interests and conflicting values between ecological, economic and social aspects of sustainability [9].

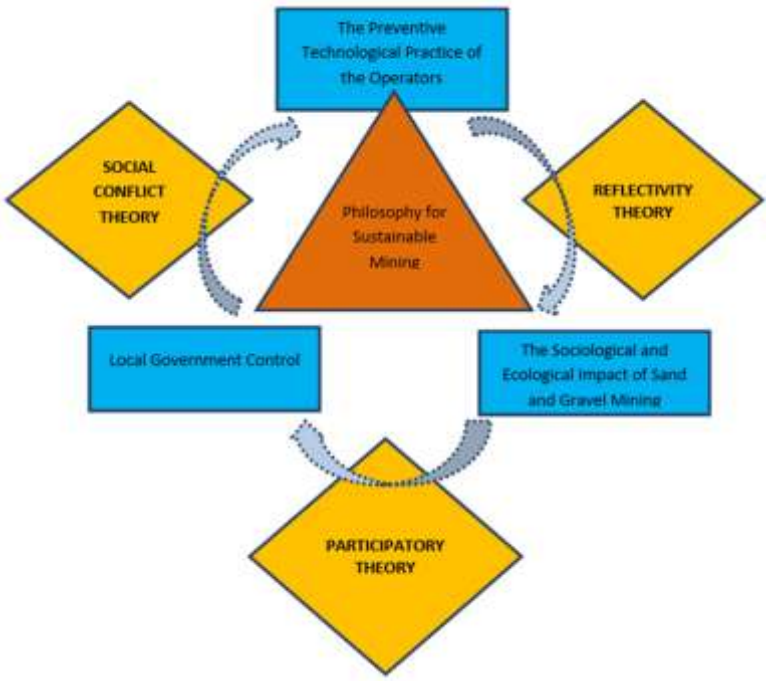

Figure 1. *Philosophy for sustainable mining based on reflectivity theory, social conflict theory, and participatory theory*

Reflectivity theory, as applied in this present study claims that the sociological impact of sand and gravel mining has immensely affected the familial community issues, educational status, occupational, recreational and water management [10]. The human-made activity like mining of sand and gravel has halo effect to ecological settings of the environment as to the existence of vertebrates, invertebrates, forestation, mineral, and water quality and social relationship which this study has anchored on the said theory. The theory further advances that the impact of the modern practices to the entire area is not only seen by one group but by the whole people concerned in the sustainability of the human and other living things around [11].

The participatory theory relates to the sand and gravel mining which the community is involved, the fact that the political processes are increasingly isolated and separated from the citizens and the people concerned, and the absolute power of the government that people has to participate in so whatever they want in the environment[12].

Figure 1 model represents the holistic interplay of the theories where the local government units' exercises control in the sand and gravel mining operations. This is to ensure that the mining operators are efficiently practising the preventive management details as can be reflected in the prevention of the negative impact on the sociological and ecological domains of environment [13]. Hence, there is a need for strong participation of the entire community through sound governance of the local officials and the people at large.

3. Conceptual Framework

Figure 2 illustrates the flow of the study from the focus of sand and gravel mining operation through the groups of community residents and mining operators down to the sociological and ecological impacts expressed in the first larger frame at the left and the preventive technological management practices at the right frame [13]. The final analysis of the two structures serves the basis in the formulation of the technical philosophy for the sustainable mining industry.

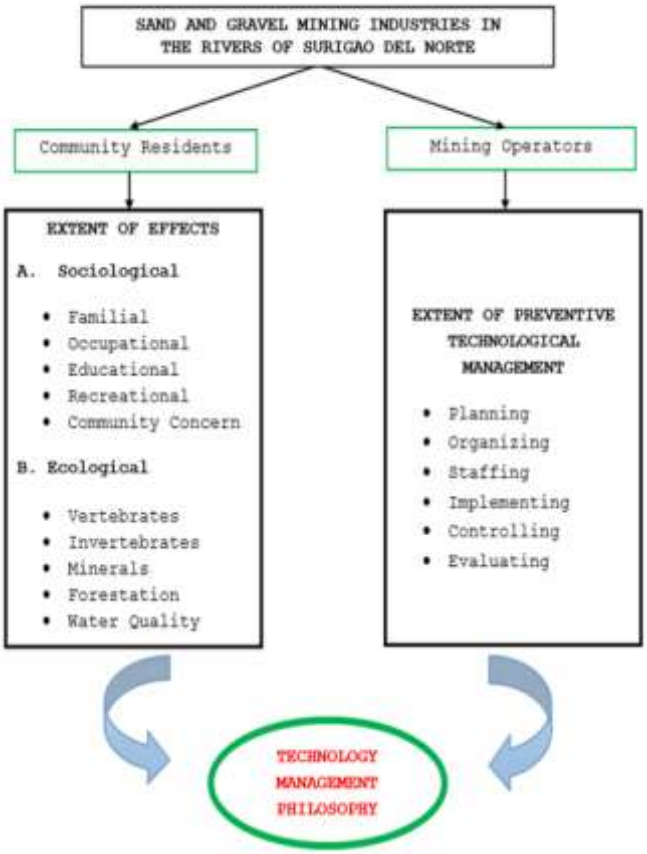

Figure 2. *Conceptual Framework*

Specifically, the sociological impact of sand and gravel mining to the community is in terms of familial, occupational, educational, recreational, and community concerns; and the ecological impact as to the existence of vertebrates, invertebrates, minerals, forestation, and water quality [13]. On the other hand, the preventive technological management practices in the different frame are expressed in terms of the extent how the mining operators employed thorough planning, organizing, staffing, implementing, controlling, and

evaluating to address the sociological and ecological issues as impacts of sand and gravel mining to the community [14]. Premised on the extent of environmental and sociological effects and the preventive technological management practices, the result of this investigation is the formulation of the Technology Management Philosophy for sustainable sand and gravel mining industries in Surigao Rivers [15].

Explaining research model, theory, technique of collecting the data, technique of analyzing the data, hypothesis.research chronological, including research design, research procedure (in the form of algorithms, Pseudocode or other), how to test and data acquisition [1]-[3]. The description of the course of research should be supported references, so the explanation can be accepted scientifically [2], [4].

4. Research Method

4.1 Research Design

The descriptive-inferential design was used in the study. The inferential was used to draw general conclusions about the effects of sand and gravel mining to sociological and ecological has to do with the preventive technological management practices by the mining operator[16]. It also involved the collection and analysis of data in order to test the hypothesis and answer questions on the presence or absence of significant difference and relationship in the ratings of the respondents[17]. Thus, the study also considered the combination of differential and correlation studies.

4.2 Respondents

The respondents of this study were the 64 households out of 75 families who lived in the vicinity of the river where the sand and gravel mining operation were taking place. The mining operators, consisted of the private contractor, offices of Provincial Mining Office, Planning Office of LGU Sison and Provincial DENR of Surigao del Norte, one per mining operators personnel were the respondents, 28 out of 35 staff were subjected to the survey. The minimum sample was determined using the 50% + 1 of the population targeted for the study.

Table 1. The distribution of responsent

Respondents	**Population**	**Sample Size**	**Percent**
Community/Household	75	64	85.50%
Regulator	35	28	80.00%
Total	110	92	83.63%

Purposive sampling was employed in the study for both the two groups of respondents under the criterion of their being involved in the operation of the sand and gravel mining industry. The same was used for the samples of the community residents in terms of their being exposed to the environment where the mining operation is located.

The random sampling through the use of the first two digits of the random numbers was adopted in the selection of the samples for the study. This method was used in getting the samples for the community residents only.

4.3 Research Instrument

The researcher used two sets of a researcher-made questionnaire with the help of the adviser and the research panel to ensure the validity of the data gathered. For community (Appendix A), Part 1 solicited information on the sociology aspect, where the family, occupation, educational, recreational and community concerns are affected by the sand and gravel mining. Part 2 delved into the extent the changes in ecology-based by the perception of the cities as to the observed vertebrates, invertebrates, mineral, forestation, and water quality.

Another set of the instrument (Appendix B) was designed for the operators of the sand and gravel mining industry. The device consisted of items along with the essential managerial functions on planning, organizing, staffing, implementing, controlling and evaluating.

4.4 Data Analysis

The data collected were analyzed and interpreted with the use of the following statistical tools.

4.5 Frequency Count

This tool was used to determine the occurrence of variables.

4.6 Ordinal Rank

This tool was used to determine the rank values of the rating scales used in the survey.

4.7 Weighted Mean

This tool was used to determine the extent of sociological and ecological impact to the respondents regarding sand and gravel mining, and the scope of practice by the mining operators and Preventive Technology Management PTMT in the operation of sand and gravel mining. The computed mean is based on this scale.

Scale	Parameters	Interpretation
4	3.50-4.00	Strongly Agree (SA)
3	2.51-3.49	Agree (A)
2	1.50-2.50	Disagree (D)
1	1.00-1.49	Strongly Disagree (SD)

4.8 Pearson Product-Moment Correlation Coefficient

This was employed in setting the reliability of the research instrument. This was also used in determining the presence or absence of a significant relationship between the sociological and ecological effects of the sand and gravel mining industries to the community residents.

4.9 One-way Analysis of Variance (ANOVA)

This repeated data tool was used to determine the significant difference among the ratings of the respondents on the sociological and ecological effect of sand and gravel mining, and the significant difference among the preventive technology management practices.

4.10 Scheffé Posteriori Test

This post-hoc analysis was used to accurately determine the existence of the significant difference established by the ANOVA among three or more variables. It was not used in a factor with only two variables.

5. Results and Discussion

This study formulates the effective technological management for sustainable sand and gravel mining based on the data and findings of the study, as illustrated in Figure 3.The philosophy represents a cycle of the event. It emphasizes that preserve the sociological and ecological settings, the regulations and practices will not halt to what it is presently done. Still, it will always look forward to the extent of effects then back to rules and practice because as time goes by, the results will not ever be the same.

Sand and gravel mining is an integral part of the Philippine economy. Sand and gravel have a variety of uses including road building, construction, concrete production, landscaping, glass manufacturing, sand casting in iron and steel foundries and petroleum extraction. The urge of the development and the strong effect on the environment is an issue that needs to be addressed to sustain the growth

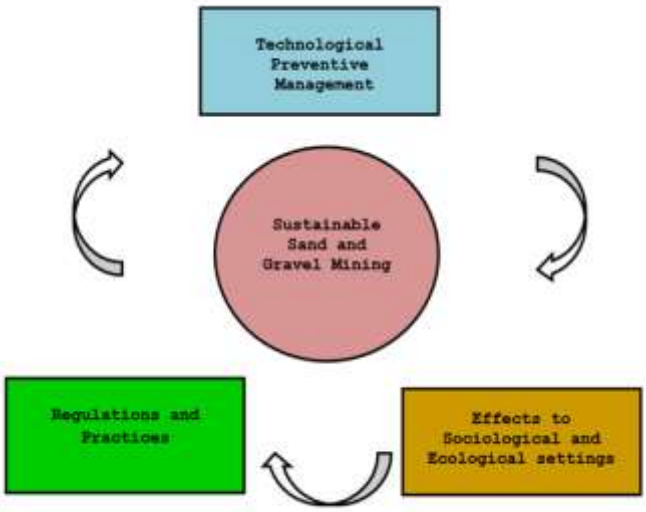

Figure 3. *Philosophy on Sustainable Sand andGravel Mining Industry*

In the increasing demand for the sand and gravel, Philippine government imposed implementing rules and regulation in mining, the RA 7942 also known as the "The Philippine Mining Act of 1995", the EO 79 entitled "Institutional and Implementing Reforms in the Philippine Mining Sector Providing Policies and Guidelines to Ensure Environmental Protection and Responsible Mining Utilization of Mineral Resources" and the RA 7076 known as the "Small-scale Mining Law". The operation in sand and gravel mining in the Philippines has also governed the stipulated contract in the MGB where the contractor must comply with the obligation under its ECC, Environmental Protection and Enhancement Program (EPEP) and Annual EPEP. The rules and regulations in the mining are stipulated, but is there someone evaluating that these rules and regulations are strictly followed and implemented by the contractor and the regulator. Under the environmental awareness especially in sociological and ecological settings, the ECC and EPEP measure and monitor the best practices in sand and gravel mining where the contractor has the power to bribe to have the EPEP and ECC compliant. On the sociological aspect, the effects of sand and gravel mining in the locality as to familial, occupational, educational, recreational, and community concerns. In the ecological perspective, the impact of sand and gravel mining to the vertebrates, invertebrates, minerals, forestation, and water quality. The sociological and environmental effects of the sand and gravel mining are always present. Proper practices by the regulators, contractors and stakeholders in the sand and gravel mining will help lessen the sociological and ecological effects. The vision for the future is to preserve the earth, and its abundance of life is the only gift that can be inherited by the next generations of men.

6. Conclusion

The operations of the Sand and Gravel Mining Industries in the rivers of Surigao del Norte have both the desirable and undesirable effects on people and the environment in the locality. The operations have better contributions to the stability of the economic and socio-cultural aspects of human existence except in the advancement of education. The lives of the living organisms and other creatures are protected despite the operation. The mining industries greatly affected the preservation of forests and quality of waters. The preventive management practices of these industries greatly affected humanity and environment as it lacks proper staffing, controlling, and evaluating the operations. The effects of understanding also mean the impact on nature; thus, preservation of nature means sustainable human lives. The contribution of the mining industries in one aspect of human life and environment does not necessarily mean the same benefits to all other dimensions of humanity and nature. Sustainability in the operation of the Sand and Gravel Mining Industries is a function of the balance between management operations, understanding, and environment.Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

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