IOSR Journal of Multidisciplinary Research (IOSR -JMR)
ISSN: 3048-7439 Volume 2, Issue 3, Series 1, May. - June. (2025), PP 17-25
www.iosrjournals.org

Unearthing Realities: An Empirical Analysis Of The Economic, Social, And Environmental Impacts Of Stone Quarrying In Northeast India

Lithungo Emanuel Yanthan[1], Dr. Riweu Kenye[2], Dr. Khriemenuo Pusa[3], Dr. Fr. Pezalhoukho George

PG Student, Department Of Economics, St. Joseph's College (Autonomous), Jakhama, Kohima, Nagaland
Assistant Professor, Department Of Economics, St. Joseph's College (Autonomous), Jakhama, Kohima, Nagaland
Assistant Professor, Department Of Economics, St. Joseph's College (Autonomous), Jakhama, Kohima, Nagaland
Co-Ordinator (Post Graduate), St. Joseph's College (Autonomous), Jakhama, Kohima, Nagaland.

Abstract
This study examines the various ways that stone quarrying impacts the lives and means of subsistence of the local communities in Longsa and Wokha villages, located in the Wokha district of Northeast India. The study employs a mixed-method approach to analyse economic, social, and ecological aspects by combining quantitative and qualitative data from 56 respondents. Structured questionnaires and interviews were used to gather primary data, and articles, journals, scholarly publications served as secondary data sources. Seven hypotheses about socioeconomic factors and experiences related to quarrying were tested using SPSS and statistical methods such as Descriptive Statistics, Pearson correlation, and Chi-square tests. The results of the study shows that while stone quarrying offers some employment opportunities and a moderate income, the economic benefits are not distributed evenly and are frequently insufficient for covering basic necessities. Gender-based problems with health and education-based reasons for entering the field are revealed by social impacts. Environmental issues, including land degradation and deforestation, were publicly acknowledged but frequently ignored because of the economy's reliance on quarrying. Significant patterns between educational attainment and marital status, as well as a modest but significant association between age and experience, suggests that socioeconomic factors influences labour participation. Additionally, descriptive statistics and case-based research highlights the prevalence of necessity-driven participation and the shortage of voluntary engagement in the sector. In order to enhance livelihoods, preserve the environment, and ensure the long-term well-being of communities. The study highlights the urgent need for changes in regulations, sustainable quarrying methods, and socioeconomic interventions. These findings support policy recommendations for balanced regional development and advance a more sophisticated understanding of quarrying to enhance the livelihoods of the people.

Keywords**:** *Environmental Impact, Livelihoods, Health Hazards, Quarrying, Socioeconomic Impact, Sustainable Practices, Sustainable Rural Development*

Date of Submission: 05-05-2025 Date of Acceptance: 15-05-2025

I. Introduction

Stone quarrying stands as a critical economic activity in many developing regions, supplying essential raw materials for construction and infrastructure while simultaneously shaping the livelihoods of countless rural communities. In the Wokha District of Nagaland, quarrying has become a major means of subsistence for many communities. But this exploitative activity has far-reaching effects that go well beyond financial gain. Social well-being, environmental deterioration, and livelihood subsistence integrate to create a complex environment full of opportunities and difficulties. This study explores the various effects of stone quarrying in the villages of Longsa and Wokha, providing an in-depth empirical assessment of the ways in which this activity affects the socioeconomic framework, ecological balance, and occupational health of local communities in this region of Northeast India.

The generation of employment and household income are two benefits of quarrying, but there are also significant environmental problems such dust pollution, soil degradation, and health concerns. In addition, in this context, a social factor which includes community well-being, educational influence, and gender discrepancies are still not widely recognized. This study aims to fill this research gap and offer evidence-based insights into the relationships between demographic, occupational, and socioeconomic variables among quarry

workers by using a quantitative approach supported by statistical packages such as SPSS. The results are expected to encourage sustainable quarrying methods that enhance both the environment and resilience within communities, as well as impacting regional policy frameworks.

Research Overview

Objectives of the Study

1. To analyze the economic impact of stone quarrying on local livelihoods in the study area.
2. To assess the environmental and social impacts of stone quarrying in the study area.
3. To identify the challenges and opportunities for quarry workers and local participants in the study area.

Research Questions

1. How does stone quarrying impact the economic well-being of communities in the study area?
2. What are the environmental and social impacts of stone quarrying in the study area?
3. What are the challenges and opportunities for workers and stakeholders in the stone quarrying sector in the study area?

Hypothesis of the Study

Hypothesis 1:
Null Hypothesis (H): There is no correlation between age and years of experience.
Alternative Hypothesis (H): There is a correlation between age and years of experience.

Hypothesis 2:
Null Hypothesis (H): There is no association between marital status and educational qualification.
Alternative Hypothesis (H): There is an association between marital status and educational qualification.

Hypothesis 3:
Null Hypothesis (H): There is no correlation between the strength of families and the number of families employed.
Alternative Hypothesis (H): There is a correlation between the strength of families and the number of families employed.

Hypothesis 4:
Null Hypothesis (H): There is no association between gender and health issues.
Alternative Hypothesis (H): There is an association between gender and health issues.

Hypothesis 5:
Null Hypothesis (H): There is no significant correlation between age and monthly income.
Alternative Hypothesis (H): There is a significant correlation between age and monthly income.

Hypothesis 6:
Null Hypothesis (H): There is no association between educational status and motivation to join the quarrying business.
Alternative Hypothesis (H): There is an association between educational status and motivation to join the quarrying business.

Hypothesis 7:
Null Hypothesis (H): There is no significant correlation between working hours and daily wages.
Alternative Hypothesis (H): There is a significant correlation between working hours and daily wages.

II. Research Methodology

A mixed-method approach has been employed in this study, combining quantitative and qualitative data. Structured surveys and interviews were used to gather primary data, and papers, scholarly journals, and internet sources were used to gather secondary data. A combination of snowball sampling and simple random sampling methods was used to choose a sample of 56 responders. Responses were only limited to 56 due to field limitations, even though Cochran's calculation predicted a minimum sample size of 83 at a 90% confidence level. For basic tabulation, data were analyzed using Microsoft Office. Descriptive statistics, Pearson correlation, and Chi-square tests were applied using SPSS.

III. Literature Review

The literature on stone quarrying reveals an interaction of historical, ecological, employment, and socio-economic factors. Micheal (1999) emphasises the Acheulian site in Isampur, India, highlighting the advanced technology of early humans and its archaeological significance. Environment-related risks in sensitive Karst landscapes are discussed by Langer (2001), who advocates for sustainable quarrying practices. Raj,S (2005) reveals that the sandstone trade in Rajasthan involves environmental deterioration and labour exploitation. In light of health, gender, and regulatory issues, studies by Elizabeth (2006) and Dutt (2008) examine small-scale quarrying in Uganda and Eastern India and emphasise its contribution to livelihoods. In Eastern India, Nandini (2010) investigates the socio-ecological effects of basalt extraction, including displacement and changes in the use of land. In Ghana and Uganda, the balance between the beneficial impacts of employment and adverse environmental impacts, such as deforestation and water pollution, is highlighted by Felix et al. (2014) and Stephen (2014). While Ogunyemi, M (2019) relates income in Nigerian granite quarrying to education and job position, despite inadequate working circumstances, Mohamed et al. (2016) indicate the potential for revenue from quarrying. Jill (2018) highlights the loss of biodiversity and pollution in Nairobi's quarries and calls for regulatory changes. Abdul (2020) calls for increased environmental regulations and issues concerns about air pollution and deforestation in Jaflong, Bangladesh. According to John (2021), quarrying boosts Ghana's economy, but in order to reduce both social and ecological costs, it must be in line with sustainable development goals.

Descriptive Statistics of Stone Quarrying Owners

Table 1: Demographic and Socioeconomic Profile of the Respondents

Variable	N (Valid)	Missing	Mean	Mode	Std. Deviation	Minimum	Maximum
Gender	8	0	1.00	1.00	0.000	1	1
Age	8	0	3.50	3.00	0.756	3	5
Educational Qualification	8	0	3.00	3.00	1.069	2	5
Marital Status	8	0	1.38	1.00	0.518	1	2
Strength of Families	8	0	2.12	2.00	0.641	1	3
No. of Families Employed	8	0	1.25	1.00	0.463	1	2
Employed in Unit	8	0	2.75	3.00	0.707	2	4
Years of Experience	8	0	2.50	3.00	0.926	1	3

Source: Field Survey, 2025; Analyzed using SPSS

Table 1 shows the demographic and socioeconomic details of 8 respondents. There are no missing values in any of the variables' data. All responders are generally men, as indicated by the consistent gender distribution (mean = 1.00). Given the acceptable average age (mean = 3.50), the majority appear to be middle-aged. There is a substantial amount of variation in educational attainment and marital status; the majority are married and have mid-level education. Small to medium-sized families and low employment levels per family are revealed by family strength and employment indices. With similar standard deviations across variables, respondents generally have intermediate experience and are currently working in their respective units.

Table 2: Business and Economic Aspects of Stone Quarrying

Variable	N (Valid)	Missing	Mean	Mode	Std. Deviation	Minimum	Maximum
Primary Supply Chain	8	0	1.62	1.50	0.744	1	3
Various Stone Products	8	0	1.12	1.00	0.354	1	2
Supply to Other Districts	8	0	2.88	3.00	1.246	1	4
Highest Demand Month	8	0	1.38	1.00	0.518	1	2
Permit for Marketing	8	0	2.88	3.00	0.641	2	4
Adjust Pricing	8	0	1.38	1.00	0.518	1	2
Monthly Income	8	0	3.00	3.50	1.195	1	4
Benefits from Stone Quarrying	8	0	1.00	1.00	0.000	1	1
Gains from Quarrying	8	0	1.12	1.00	.354	1	2

Source: Field Survey, 2025; Analyzed using SPSS

The business and financial aspects of stone quarrying are described in Table 2, which is based on replies from 8 participants. The statistics show that the majority deal with a small number of stone product types (mean = 1.12) and are engaged in the early phases of the supply chain (mean = 1.62). With demand maximum

early in the year (mean = 1.38), quarry goods are widely sold to various districts (mean = 2.88). The majority of those surveyed have marketing licenses and some price flexibility. A moderate monthly income (mean = 3.00) is reported by all, and quarrying activities are associated with advantages and small gains.

Table 3: Personal Motivations and Participation

Variable	N (Valid)	Missing	Mean	Mode	Std. Deviation	Minimum	Maximum
First Involve in Stone Quarrying	8	0	2.00	2.00	.926	1	3
Chosen Stone Quarrying Voluntarily	8	0	1.38	1.00	0.744	1	3
Benefits You and the Society	8	0	2.38	2.50	0.744	1	3
Motivation Behind Entering the Business	8	0	1.75	2.00	0.463	1	2
Issues for Marketing	8	0	1.88	2.00	0.354	1	2

Source: Field Survey, 2025; Analyzed using SPSS

The personal motivations and participation factors that influence involvement in stone quarrying among eight respondents are examined in Table 3, which includes complete data for all variables. The majority of participants entered the business through family or local influence (mean = 2.00), and they did not enter it entirely by choice (mean = 1.38). The respondents generally agree that quarrying benefits both individuals and the community (mean = 2.38). The main motivations for entering the business are need-based rather than aspirational (mean = 1.75), and marketing challenges are acknowledged but seem to have a moderate impact (mean = 1.88), indicating manageable but persistent constraints.

Correlation between Age and Years of Experience

Table 4: Pearson Correlation

		Age	Years of Experience
Age	Pearson Correlation	1	.267
	Sig. (2-tailed)		.522
	N	8	8
Years of Experience	Pearson Correlation	.267	1
	Sig. (2-tailed)	.522	
	N	8	8

Source: Field Survey, 2025; Analyzed using SPSS

A minor positive correlation (r = 0.267) is identified in the Pearson correlation analysis between the eight respondents' years of experience and age, suggesting that years of experience in stone quarrying tend to rise somewhat with age. Since the correlation is not statistically significant (p = 0.522), it is possible that the observed link is the result of chance and cannot be used to support definitive conclusions. The sample size (N = 8) necessitates more research with a larger population to establish any possible correlation between age and work experience.

Association between Marital Status and Educational Qualification

Table 5:

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Marital Status * Educational Qualification	8	100.0%	0	.0%	8	100.0%

Source: Field Survey, 2025; Analyzed using SPSS

Table 6:

Marital Status * Educational Qualification Crosstabulation

Count						
		Educational Qualification				
		HSSLC	Graduate	Above graduate	5	Total

Marital Status	Married	3	2	0	0	5
	Unmarried	0	1	1	1	3
Total		3	3	1	1	8

Source: Field Survey, 2025; Analyzed using SPSS

Table 7:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.156[a]	3	.161
Likelihood Ratio	6.766	3	.080
Linear-by-Linear Association	4.200	1	.040
N of Valid Cases	8		

a. 8 cells (100.0%) have expected count less than 5. The minimum expected count is .38.

Source: Field Survey, 2025; Analyzed using SPSS

According to the crosstabulation of marital status and educational attainment, which was based on data from eight respondents, all married people have graduate-level qualifications, while unmarried people are more evenly distributed across higher education levels, including those above graduate. The data indicates that while unmarried respondents are represented in the category of respondents with an above-graduate degree, no married respondent does. This points to a potential trend in which unmarried individuals may seek higher education prior to getting married. The tiny sample size, however, limits how broadly this result may be generalized.

There is no statistically significant correlation between marital status and educational attainment at the standard 0.05 significance level, according to the Pearson Chi-Square test result ($\chi^2 = 5.156$, df = 3, p =.161). The Likelihood Ratio (p =.080) supports this finding. An ordinal link or possible trend between the variables is suggested by the significant Linear-by-Linear Association (p =.040). All expected cell counts, however, fall below 5, which reduces test reliability and emphasises the need of a bigger sample size to provide strong statistical inference.

Correlation between Strength of Families and Number of Families Employed

Table 8:

Pearson Correlation between Strength of Families and Number of Families Employed

		Strength of Families	No.of Families Employed
Strength of Families	Pearson Correlation	1	-.602
	Sig. (2-tailed)		.114
	N	8	8
No.of Families Employed	Pearson Correlation	-.602	1
	Sig. (2-tailed)	.114	
	N	8	8

Source: Field Survey, 2025; Analyzed using SPSS

The Pearson correlation analysis between strength of families and number of families employed reveals a moderate negative relationship (r = -0.602), suggesting that as the strength of families increases, the number of families employed tends to decrease. However, this relationship is not statistically significant (p = 0.114), indicating that the observed correlation may be due to random variation within the small sample size (N = 8). Although the trend may suggest a potential inverse association, further research with a larger sample is required to confirm the reliability and validity of this finding.

Descriptive Statistics of Stone Quarrying Labourers

Table 9: Socioeconomic and Demographic Profile

Variable	N (Valid)	Missing	Mean	Mode	Std. Deviation	Minimum	Maximum
Age of the Respondents	48	0	1.96	2.00	1.071	1	4
Gender	48	0	1.29	1.00	0.459	1	2
Educational Status	48	0	2.04	2.00	0.459	1	3
Work Experience	48	0	2.58	2.00	0.821	1	4
Working Hours	48	0	3.67	4.00	0.519	2	4
Daily Wages Earned by the Respondents	48	0	1.52	1.00	0.799	1	4
Monthly Income of the	48	0	1.27	1.00	0.449	1	2

Respondents							
Sufficient Income of the Respondents	48	0	1.25	1.00	1.732	1	13

Source: Field Survey, 2025; Analyzed using SPSS

The demographic and socioeconomic characteristics of 48 stone quarrying workers are compiled in Table 1. The majority of responders are males between the ages of younger and middle-aged, with low levels of education and employment experience. They put in lengthy hours under tough settings (mean = 3.67). Economic challenges can be seen from the relatively low daily earnings (mean = 1.52) and monthly incomes (mean = 1.27). Differences in financial contentment are reflected in the perception of income sufficiency, which is particularly low (mean = 1.25), and differs considerably.

Table 10: Occupational and Business-Related Factors

Variable	N (Valid)	Missing	Mean	Mode	Std. Deviation	Minimum	Maximum
Role in Quarry	48	0	2.88	3.00	1.142	1	4
Motivation	48	0	1.42	1.00	.794	1	4
Choose Voluntarily	48	0	1.08	1.00	0.279	1	2
Improvements	48	0	2.02	2.00	.838	1	3
Financial Schemes	48	0	1.81	2.00	0.394	1	2
Benefits of Stone Quarrying	48	0	1.44	1.00	0.769	1	3

Source: Field Survey, 2025; Analyzed using SPSS

The occupational and business-related characteristics of 48 stone quarrying workers are shown in Table 2. With necessity as the main motivation (mean = 1.42) and few choosing the work voluntarily (mean = 1.08), the majority hold mid-level roles (mean = 2.88). The respondents revealed that they had a moderate opinion of sector enhancements (mean = 2.02) and a moderate level of knowledge on finances (mean = 1.81). Low reported advantages of quarrying (mean = 1.44) suggested low levels of job satisfaction and no beneficial outcomes from the work.

Association between Gender and Health Issues

Crosstabs

Table 11:
Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Health Issues	48	80.0%	12	20.0%	60	100.0%

Source: Field Survey, 2025; Analyzed using SPSS

Table 12:
Gender * Health Issues Crosstabulation

Count				
		Health Issues		
		No	3	Total
Gender	Male	33	1	34
	Female	14	0	14
Total		47	1	48

Source: Field Survey, 2025; Analyzed using SPSS

Table 13:
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.421[a]	1	.517		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.698	1	.403		
Fisher's Exact Test				1.000	.708
Linear-by-Linear Association	.412	1	.521		
N of Valid Cases[b]	48				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .29.

b. Computed only for a 2x2 table

Source: Field Survey, 2025; Analyzed using SPSS

The relationship between gender and health issues was investigated using the chi-square test for 48 respondents. According to the crosstabulation, no female respondents reported any health difficulties, whereas only one male respondent did. For the most part, neither men nor women mentioned any health issues. This distribution indicates a very low overall incidence of health issues, with little variance between gender groups. However, 20% of the data were missing, which could compromise the analysis's strength and completeness.

According to statistical findings, there is no significant association between gender and health problems. With a high p-value of 1.000 (two-sided) in Fisher's Exact Test and a Pearson Chi-Square value of 0.421 (p =.517), there is no significant relationship. Furthermore, 50% of cells tested had expected counts below 5, with a minimum predicted count of just 0.29, reducing the test's reliability. These findings indicate that, although a larger and more balanced dataset might enhance test validity, gender does not significantly affect the incidence of health concerns in these individuals.

Correlation between Age and Monthly Income

Table 14:
Correlations

		Age	Monthly Income
Age	Pearson Correlation	1	.334*
	Sig. (2-tailed)		.020
	N	48	48
Monthly Income	Pearson Correlation	.334*	1
	Sig. (2-tailed)	.020	
	N	48	48

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Field Survey, 2025; Analyzed using SPSS

A statistically significant positive relationship between age and monthly income among 48 respondents is shown by the Pearson correlation analysis ($r = 0.334$, $p = 0.020$). This suggests that older employees may have more experience or occupy higher-paying positions in the stone quarrying industry because monthly income tends to climb moderately with age. Because the significance level ($p < 0.05$) indicates that this relationship appears to be the result of randomness, it is a significant association for evaluating the age-related economic progression in the population under study.

Association between Educational Status and Motivation to Join the Quarrying Business

Table 15:
Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Educational Status * Motivation to enter Quarrying Business	48	80.0%	12	20.0%	60	100.0%

Source: Field Survey, 2025; Analyzed using SPSS

Table 16:
Educational Status * Motivated to enter Quarrying Business Crosstabulation

Count					
		Motivated to enter Quarrying Business			Total
		Job security and stability	Personal satisfaction	Opportunities for over time	
Educational Status	Illiterate	3	1	0	4
	HSSLC	28	10	0	38
	Graduate	3	0	3	6
Total		34	11	3	48

Source: Field Survey, 2025; Analyzed using SPSS

Table 17:
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.995[a]	4	.000
Likelihood Ratio	15.880	4	.003
Linear-by-Linear Association	8.205	1	.004
N of Valid Cases	48		

a. 7 cells (77.8%) have expected count less than 5. The minimum expected count is .25.

Source: Field Survey, 2025; Analyzed using SPSS

The chi-square test was used to analyze data from 48 valid respondents in order to investigate the relationship between educational attainment and motivation for starting a quarrying business. The crosstabulation reveals that the majority of people with HSSLC qualifications were motivated by stability and work security (28 out of 38), whereas graduates displayed a mixed response to prospects for overtime and job security. Job security was the main motivator for illiterate respondents. These trends imply that educational background may have an impact on how motivated someone is to work in the quarrying industry, with those with less education setting a higher value on stability and those with more education preferring more opportunities.

The result of the Pearson Chi-Square test is highly significant ($\chi^2 = 22.995$, df = 4, p =.000), suggesting that motivational variables and educational status are strongly correlated. This significance is further supported by the Linear-by-Linear Association (p =.004) and the Likelihood Ratio (p =.003). But 77.8% of the cells have predicted counts below 5, with 0.25 being the lowest, which could jeopardize the test's validity. Despite this limitation, the findings imply that education significantly influences the reasons people choose to work in the quarrying sector, which calls for further studies with a larger sample size.

Correlation between Working Hours and Daily Wages

Table 18:
Pearson Correlation

		Working Hours	Daily Wages
Working Hours	Pearson Correlation	1	-.342*
	Sig. (2-tailed)		.017
	N	48	48
Daily Wages	Pearson Correlation	-.342*	1
	Sig. (2-tailed)	.017	
	N	48	48

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Field Survey, 2025; Analyzed using SPSS

According to the Pearson correlation analysis, there is a statistically significant inverse association between 48 respondents' daily salaries and working hours (r = -0.342, p = 0.017). This implies a potential mismatch between labor input and remuneration since daily salaries tend to decline as working hours rise. The adverse relationship appears to be the result of randomness, as confirmed by the significance level ($p < 0.05$). Further research into fair wage regulations is necessary since this conclusion may be an indication of problems like informal labor practices, wage reduction, or a lack of uniform pay structures in the quarrying sector.

IV. Recommendations

- Formalize quarrying through licensing, worker registration, and safety checks.
- Offer skill training and financial literacy to improve worker incomes.
- Provide health insurance and checkups to address work-related health issues.
- Promote cooperatives to ensure fair profits and community ownership.
- Enforce eco-friendly practices to reduce environmental harm.
- Support women's participation with safe, equal job opportunities.

V. Conclusion

This study reveals the diversified nature of stone quarrying as a source of income in Wokha District, Nagaland. Despite being an essential source of income and employment, especially for those with less education, engagement with the sector is primarily motivated by financial constraints rather than choice. The information indicates potential exploitation and reveals systemic inefficiencies, such as a negative correlation between daily wages and working hours. The sector as a whole delivers little job satisfaction and income sufficiency, despite the fact that older workers often earn more.

Although some relationships lack statistical significance because of the small sample size, statistical findings show minor but noteworthy correlations between demographic characteristics and socioeconomic outcomes, such as the impact of age on incomes and education on motivation. Furthermore, the study emphasizes the significance of focused governmental responses, including safety measures, progressive wage reforms, and educational assistance. To turn stone quarrying from a marginal subsistence activity into a sustainable livelihood that promotes ecological preservation and the growth of communities, these processes are essential.

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