

Sustainability of economic benefits given to impacted communities of the mining project in Western Province, Papua New Guinea: A Case Study of Ok Tedi Mine

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Abstract

It is perceived by the mine impacted communities, and the respective stakeholders including key government officials, that the economic benefits received from the compensation agreement, also known as the social license to operate scheme, has not made any significant positive impact on the local economy of the study area covering Mine villages, North Oktedi, Highway and Lower Oktedi mine trust regions of the North Fly District of Western Province in Papua New Guinea. This paper investigates the sustainability performance of the economic sector benefit and the mitigation strategy of the lack of mine downscaling and closure negative impact on the mine impacted communities of the study area. A stratified random sampling method was adopted for the collection of primary data from the representative sample of 170 population interviewed from the study area to examine the adequacy and sustainability of the economic benefits invested in the local economic development area using research questions and hypotheses. The descriptive and inferential statistical analysis technique were employed to measure the sustainability performances of the economic dependent variable indicators (rubber, vanilla, eaglewood and investment) against the independent variable (environmental compensation benefit package). The results concluded that the compensation benefit received and invested in the local economic development area for the four trust regions is asserted to be inadequate and unsustainable as a result of lack of stakeholders' collaboration and project counterpart funding. This paper, therefore, recommends for adoption of stakeholder project counterpart funding agreement to collaborate with compensation benefit agreement to deliver sustainable local economic development programs for sustainability of the mine impact communities, the province and the country.

Keywords: *Corporate Social Responsibility, Economic Benefits, Local Economic Development, Mining and Agriculture Relationship Policy, Social License to Operate, Stakeholder Project Counterpart Funding Agreement,*

1. Introduction

In the context of this paper, Western Province in Papua New Guinea (PNG) on one hand is commonly regarded as a resource-rich province with abundant revenue generated by Oktedi Mining Project for the country, the province and the mine impact communities, but on the other the region is underdeveloped facing infrastructure and development challenges (Hong K. and Ren J., 2025). Although, Ok Tedi mine generated significant revenue and some local improvements, the community is faced by severe environmental and social disruptions that constrained broad-based development (Hong K. and Ren J., 2025). Impacts of environmental damages and the demand for compensation have been the cause of the signing of the community mine continuation agreement of 2001. Social license for Oktedi mine to continue to operate and in return adequately compensate for the damages done to the community and the environment was the resolution undertaken by Oktedi Mining Limited, the State, Western Provincial Government and the mine impact communities (Jenkins, 2016). This paper investigates the sustainability of the economic benefits given under the compensation benefit package using Oktedi Mining Project as a case study using findings from the study area comprised of Mine villages, North Oktedi region villages, Highway region villages and Lower Oktedi region villages of North Fly District in Western Province of Papua New Guinea. The compensation benefits given by Oktedi mining project to the impact communities derived from the evolution of Philanthropy to the emergence of social benefits in the 1800s.

Accordingly, compensation benefits given to the mining impacted communities evolved over time, since 1800s under social responsibility scheme to the introduction of corporate social responsibility. In the 1990s, both schemes then evolved to social license to operate Kozma (2025). Benefits under corporate social responsibility (CSR) and social license to operate (SLO) differs: benefits under CSR are voluntary and does not involve agreement whilst benefits under SLO involve agreement between the project operator and the impact communities. These benefit streams given to the mine impact communities according to Jenkins (2016) and Babarinde and Papa (2021) are: royalty, equity, land rental, general compensation and environmental compensation benefit.

Some of these benefits started with the mine in between 1984 and 1990s are: land rentals, general compensation and royalty. The environmental compensation benefit package was introduced in 2001 through a principal agreement called the Community Mine Continuation Agreement (CMCA) and continued through respective reviews of the agreement to 2025 (Jenkins, 2016). The funds given to the impacted communities are categorized under village development fund, women and children and investment funds. Of which some of the funds from the village development fund, women and children fund and investment funds are used to invest in agriculture, cash crop, livestock and investment economic sector projects.

Findings from both literature review and the empirical study concluded that the compensation benefits given to the impacted communities have not impacted the communities positively as Jenkins (2016) asserts that these benefits did not bring any tangible development to the impacted communities of the Oktedi mine which final draws a conclusion that the compensation benefit funds given to the mine impact communities under the social license to operate (SLO) are insufficient and unsustainable for development of economic infrastructures and programs in the local economy under the local economic development program for sustainability of the economic benefits given to the mine impact communities.

2. Problem Statement

According to World Bank (Hilson, 2019), the overall consensus in the literature revealed that industrial mining does not produce anticipated development as growth poles in the mine impacted communities. Instead, mining has no or negative effects on local economic development (Kolala and Bwalya Umar, 2019; Mtero, 2017). Jenkins (2016 p 38) supports that lack of tangible development in the Oktedi mine project impact areas is the result of lack of effective communication, relationship and co-operation amongst stakeholders that have been nominated through the Memorandum of Agreement (MoA) 1989, and Community Mine Continuation Agreement (CMCA) 2001 to hold and manage the impacted communities, provincial government and national government's share of royalty and dividends from equity and tax credit payments from Oktedi Mining project. The governance system of the benefits causes lack of the following attributes of the sustainable benefits: stakeholder communication, relationship and co-corporation, lack of master development plan, project development coordination, inadequate benefit and the governance system through which the benefits are delivered is considered unsustainable as well.

These inefficiencies are perceived to have been caused by lack of stakeholder project counterpart funding and participation agreement, and adherence to economic diversification programs through local economic development scheme in the mine impacted trust regions. The trend of governance practice will result in the lack of local economic development, which social investments are expected to deteriorate and the services are also expected to decline beyond the mine closure. Therefore, this paper is designed to assess the sustainability of the Oktedi Mining benefits invested in the local economic development focus areas that includes Mine villages, North Oktedi and Lower Oktedi trust regions together with the Highways areas.

3. Research Question and Hypothesis

3.2 Research Question

How can the key performance indicators of sustainable economic benefits in the mining projects in Papua New Guinea (PNG), through a case study of Oktedi mine in Western Province, be assessed?

3.3 Research Hypothesis

The economic benefit given to the impacted communities of the mining project in Western Province, Papua New Guinea, is sustainable.

4. Literature Review

4.1 Foundational Theories: Social Responsibility, Corporate Social Responsibility and Social License to Operate

From the perspective of the foundational theories through which the compensation benefit originates, the past and present scholars including (Howard R, Bowen, 1953; Archie B Carroll, 1999 September) jointly agreed that the schemes through which the compensation benefits derived, evolved back in the 1800s together with the evolution of mining in 1848 during the California gold rush according to (Leonard, 2008) and small scale mining operations in between 1888 and early 1932 in Papua New Guinea according to International Institute for Environment and Development (2001) and other parts of the world.

Carroll (1999 September) states that as business corporations increased and expanded over time through to 1970s, 1980s, 1990s and 2000 century, the compensation benefit delivery theories such as: social responsibility, corporate social responsibility, sustainability reporting, social license to operate, and local economic development also evolved based on respective inefficiencies of the schemes. Both Conde (2017) and Daewoo (2014) expresses that, in between 1970s and 1980s the Social Responsibility scheme became part of the mining sector industry companies' core operations across the world. Furthermore, Kozma, (2022 Jan 25), added that, in the 1990s, "Social Responsibility (SR) scheme was replaced by "Corporate Social Responsibility (CSR)" by appearing into a global picture as international events and agreements in Agenda 21 and the Kyoto Protocol compelled multinational corporations to adopt and broaden their Corporate Social Responsibility focus beyond local concerns. The three including Conde (2017), Daewoo (2014) and; Kozma (2022 Jan 25) jointly agreed that Corporate Social Responsibility came into global picture because of complaints from local communities that businesses take social responsibilities as part of business activity than just a Social Responsibility. However, Elservia (Hitch and Barakos (2021) and Prno and Slocombe, (2012) discovered that there still existed stakeholder dissatisfaction with the mining industry which resulted in the disruptions of the project operations costing millions of monies and bad reputation globally. The problem according to Kathleen M. Wilburn and Ralph Wilburn, (2011) was lack of consent from land owners and impacted communities on the use of their land and environment and the need for appropriate compensation benefits in exchange for use of their land and damages done to their environment. This consent is known as Social License to Operate (SLO) which came into existence.

Jenkins (2016) alleged that there has been lack of tangible development in the Oktedi mining project impact regions which was caused by lack of relationship and or lack of cooperation by the fund managers or stakeholders that manages the impacted community, the provincial government and the State funds, and the shareholders of the project. In conclusion, the social and economic benefits given to the impacted communities under the social responsibility, corporate social responsibility and social license to operate schemes are perceived to have produced temporary, insufficient and unsustainable benefits to the impacted communities of the Oktedi mining project in Western Province of Papua New Guinea.

4.2 Empirical Studies

4.2.1 Global Perspective: Impact of Mining on Local Communities and the Social Economic Benefits

From the empirical study literature review, Eggert (2001); Cochilco (2002); Jenkins (2016: p 6) jointly pronounced that, many developing nations such as Papua New Guinea (PNG) on one hand, are blessed with abundance of mineral resource, but on the other hand, have been poorly performing in the case of the sustainability of environment, social and economic benefits given to the impacted communities because of poor governance of mining sector projects. However, Esmail (2019) defend that mining sector significantly contributes to social and economic sectors through employment and spin off business opportunities, procurement, taxes and royalties, and so many contributions to mining countries. In support of Esmail (2019), (Eggert, 2001) added that, even though, mining is destructive to environment and society, it can stimulate local economies through local purchase of inputs that can form a basis for downstream processing, and manufacturing industries if mining is managed well. In addition, government also receive tax revenue from mineral production which are used to fund fiscal and social services such as health care, education, roads, electricity-power supplies, and other forms of infrastructure (Eggert, 2001). In contrast, Hegadoren and Day (1981), expresses that

mine closures produces economic downturn, environmental degradation and social dislocation to the host country, the province and the impacted communities. In agreement with Hegadoren and Day (1981), Marais & Nel, (2010) added that, boom and bust cycle associated with the mining industry occur, and in some point in time, mine down scaling and closures' negative consequences on the impacted community are inevitable. On this notion, efforts should be made to plan and mitigate the consequences of the mine downscaling and closure for the impacted community's economic sustainability. Rogerson (2016) argues that establishing a viable and diversified economy is of essence within the context of mine closures which Jenkins (2016: 6) also defend that the negative impact is reversable with sustainable economic programs and the post-mining land use activities under the mine closure and sustainability plan. In order to mitigate the mine closure and its negative impact, "Local Economic Development" has been adopted globally according to Commonwealth Local Government Forum (2020), purposely to underpin national or regional development, and furthermore used as catalyst to alleviate poverty in the commonwealth countries through achievement of the United Nations Sustainable Development Goals. Therefore, "Local Economic Development" is not a new concept nor it is not an alternative approach to international trade, instead, it is a building block that underpins the national or regional development (Commonwealth Local Government Forum 2020).

4.2.2 Local Economic Development: South Africa, Ghana, Australia and Papua New Guinea

4.2.2.1 South Africa

A case cited by (Ngobeni, Mutshutshu, Nekhavhamb, Maholec, 2025) on Thulamela Local Municipality of South Africa conducted jointly revealed that Thulamela Local Municipality has attempted to use local economic development programs to combat unemployment, poverty and inequality. Ngobeni et al., (2025) added that South African government in general attempts to combat unemployment, poverty and inequality through local economic development strategy. Thus, Ngobeni et al., (2025) concluded that failure to implement local economic development policy, the high unemployment rate, poverty, low income, inequality, and low skills will impede economic growth.

4.2.2.2 Papua New Guinea: Bulolo small scale mine, Misima and Oktedi mine

In the context of mine closure, local economic development, and the sustainability of the livelihood of the mine impact communities of the mining project in Papua New Guinea (PNG) including Oktedi mine, Jenkins (2016) confirmed that, PNG does not have any experience of any long-life mines that have closed and their impacts on the local economy and the livelihood of the impact communities, can be used as platform to plan better for other mines in the country.

Nonetheless, Bulolo gold mining operation back in the 1960s, according to IIED (Susapu and Crispin, 2001) has diversified its mining funds in the local economic development through forest farming, plywood production, and beef production which is currently in operation in Morobe Province of Papua New Guinea. These project operations continued to exist and supports the maintenance of the infrastructure and social services to the Bulolo community with regards to schools, hospitals and other social services including provision of employment and spin off business opportunity for the local communities IIED (Susapu and Crispin, 2001). PNG Forest Product (2020) confirms that out of the alluvial gold mine operated by Bulolo Gold Dredging Limited back in the 1920s diversified its funds into forest farming, plywood factory and cattle farming containing 600 hectares of cattle farms containing thousands of castles. PNG Forest Product supplying timber products in Papua New Guinea, and overseas, cattle products and hydro power station, bowling club currently employs 1500 Papua New Guineans

(PNG Business News (2025)). Bulolo and Wau local economic development has produced a success story of mine downscaling and diversification into other economic sectors and has grown the local and macro economy of the country.

In contrast, the impacted communities of the Misima Mine, the people enjoyed fifteen years of socio-economic infrastructure and services provided by the mine from 1989 to 2004 both (World Bank Group 2003 and Mineral Policy 2014) agreed that the company and government had not maintained these infrastructures and set aside funds to sustain them after the mine closure and beyond. Papua New Guinea Mine Watch, 20205 and Mineral Resources Authority (2024) confirmed that after the mine closed in 2004, the infrastructures deteriorated and the social and economic services declined significantly and affected the livelihood of the mine impact communities in terms of unemployment, low income and inequality of life began. However, the economy on the island has been kept alive by local alluvial mining and subsistence farming and fishing practices were revived. Papua New Guinea Mine Watch (20205) confirmed that before mine began the,

“Boiyo people were one of the biggest producers of cocoa, in the Milne Bay province. But when the mine came, the Boiyo people shifted to rely on the benefits that the mine was providing. And cocoa farming eventually came to a halt. However, when the mine closed the people returned to their abundant cocoa plantations”.

Mineral Resources Authority (2024) concluded that standard of infrastructure and services that were experienced during the mine operation had declined and severely affected the social and economic activities on Misima communities. The communities reverted to subsistence farming and cash cropping for income generation confronted by limited health and other services. Prior to mine closure, the socio-economic sustainability projects and programs were initiated for the impacted communities of the then Misima mining project. However, the programs and projects have not sustained due to these reasons: the sustainability plans were introduced and forced for people to adopt toward the end of the mine closure period; the customary land disputes over the projects and programs, and finally, the government failed to implement the sustainability programs at the earliest of the mine commencement and continued till the mine scale down. Consequently, all socio-economic activities in the island of Misima stopped after the mine closure and the people returned to their abandoned cocoa plantations to rehabilitate them in order to create some cash income base in the area (World Bank Group 2003; Mineral Policy 2014). In conclusion, Mineral Resources Authority (24) gave a challenge to other bigger mines currently in operation such as Ok Tedi Mine, Ramu, Lihir and Hidden Valley that, though Misima being a small mine with short lifespan, has given a mammoth challenge of managing the impacts of the mine closure.

Papua New Guinea (PNG) does not have any experience from any former long-term mines that have been formally closed, can be used as basis to plan better for mine operation, closure, post closure land use activities, and the sustainability of the impacted communities in Oktedi mine (Jenkins, 2016) and other mines. Consequently, Oktedi mine had no consistent mine closure and sustainability plans on post closure land uses, environmental, social and economic benefits sustainability planning and implementation that stages the mining operations since 1984 because of its environment, social and political impacts on the attempted mine closures in 2001, 2013 and 2025 (Jenkins, 2016).

Prior to attempted early mine closures, Jenkins (2016), stated that, early preparation for the attempted mine closures in 2001, 2013, 2025 has further caused Oktedi Mining Limited (OTML) and its agents, and the fund managers exhausted funds on skill development by preparing the impacted communities on subsistence agricultural programs as a short-term strategy to prepare people, and send them back to their homes to sustain after mine closure by

practicing the subsistence living. To name a few, food security programs and adhocery cash crop farming on trial-and-error practice was adopted as strategy to prepare people for mine closure and return to subsistence living after mine closure (Jenkins 2016). However, Jenkins (2016), confirmed that people failed to accept the livelihood projects and programs resulting in all livelihood economic programs a failed program.

Nevertheless, in 1991 Oktedi Mining Limited through the Fly River Development Trust, established a rubber cup lump processing plant in Kiunga of North Fly District in Western Province, PNG, for rubber farmers in the mine impact regions and the people of Western Province to produce rubber cup lump and sell at the rubber processing factory (North Fly Rubber Limited, (1997). The rubber processing plant is currently operated and managed by the North Fly Rubber Limited owned by the rubber growers of Western Province, PNG. This rubber processing facility is still in operational and producing rubber secondary product and selling it overseas and the mine impact communities are benefiting from the plant. However, DevPolicyBlog (Kamu amd Bourke 2022 May) sympathized that, though, rubber has been a successful cash crop in Western Province including the study area, lack of accessibility to transport rubber to the processing plant in Kiunga operated by North Fly Rubber to make rubber as profitable cash crop becomes a major challenge. Besides, Naomi Takoma (2025 March 31) stated that rubber industry in Papua New Guinea is significantly declining both on export value and production over the two decades. The export value picked up in 2011 at a value of PGK 41 million and dropped to PGK13 million in 2023 in total in the country. Similarly, rubber production level declined from 5,400 tone in 2009 and has reduced to 2,700 tons in 2023 (Naomi Takoma, 2025 March 31). Factors affecting the decline include: land disputes, lack of investment in plantations, and challenges in maintaining consistent production levels (Naomi Takoma, 2025 March 31). Though there have been fluctuations in the world market price, it has been in a stable pace relatively. These challenges can be collaboratively addressed by stakeholders such as government, private and the local communities in order to reverse the declining trend for long term viability of the rubber industry (Naomi Takoma, 2025 March 31).

4.2.2.3 Ghana and Australia: Mining and Agriculture Collaborate to Grow Economy

Similarly, to enable local economic development to become sustainable, mining and agriculture can collaborate and operate together to develop and grow local economy although both sectors compete for inputs for land, water, and labour (Yeboah (2016). For example, for two decades, both gold mining and agriculture have contributed consistently to economic growth and sustainable livelihoods of Ghana (Yeboah, 2016). Similarly, Burrow (2019) and Australian Mining, (2008), agrees that, both mining and agriculture industry drive economic growth in New South Wales (NSW) of Australia contributing a healthy trade surplus by providing inflow of investment capital. Burrow (2019) continue to affirm that the extractive resource boom comes on and goes off but Australian economy is dependent on domestic consumption and export of agricultural produce that generate export income. For more than one hundred (100) years New South Wales of Australia operated both mining and agriculture and the performance has been overwhelming (Australian Mining, 2008). Moreover, Burrow (2019) strongly support that mining sector is a strong ally of the agricultural sector on some of the key infrastructure such as road, railway, power, water and telecommunication in New South Wales (NSW).

Burrow (2019), asserts that, the government and mining companies should utilize revenue from extractive sector to develop and uplift agriculture sector to higher level of development which in turn can support the livelihood of the rural community. Some examples of countries that adopted mining and agriculture policy, Burrow (2019) has provided include: Madagascar under a policy known as “Buy locally, hire locally”; Newmont Ghana Gold and Barrick Gold supports

agribusiness development; Cuncashca agribusiness development in Peru; Australia and Chile also experience mining companies successfully support local agricultural sector.

In conclusion, Ghana in Africa, New South Wales in Australia, Madagascar, Peru and Chile, are countries that have adopted the mining and agriculture relationship policy. This policy enables mining and agriculture share common infrastructure through “national mining-agriculture relationship policy” that promote economic sustainability of benefits given to the impacted communities of mining projects.

In comparison with other developing countries, Athopane Nthatasi (2022) stated that South Africa adopted “Local Economic Development” concept as government policy to mitigate the negative impact of mine downscaling and mine closure for sustainability of the mine impact communities. Furthermore, Athopane Nthatasi (2022) added that the local economic development programs include: tourism, manufacturing, mining, agriculture, trade businesses and finance were planned for implementation in the 257 municipalities. However, 59 municipalities have demonstrated above average capacity to develop local economic development policies and supportive systems and procedures (BusinessTech, 2022). Some of the draw backs of the effective local economic development in the municipalities according to Kekana (2019), lack of private sector involvement in the rural areas, lack of capacity, maladministration in the local government institutions, operational and financial inefficiencies. Despite of the setbacks, in 2017 and 2018 18 municipalities managed to have their financial and physical reports on the local economic development programs cleared (Kekana, 2019). The local economic development is influenced by these factors: strategic intent and impetus, effective local institutions, collaboration and partnerships, human and financial capital. Finally, but not the least, social problems are economic problems, and therefore the reception made on local economic development must be treated similarly to provision of water, electricity and housing Athopane Nthatasi (2022). These two elements are complimentary and therefore when adequately addressed is expected to produce improved living conditions and livelihoods of the households in the mine impacted communities Nthatasi (2022).

From the three cases cited: Bulolo mine, Misima, Oktedi attempted mine closure, and North Fly Rubber Processing Plant of Papua New Guinea, and South Africa, these factors impede the sustainability of the local economic development programs: late implementation of local economic development programs such as enabling infrastructure and economic sectors at the end of the mine closure period, lack of stakeholder collaboration in the projects and program delivery and lack of financial capacity in the implementation of the local economic development programs such as enabling infrastructures, social and economic programs.

4.2.3 Stakeholder Collaboration and Counterpart Funding Program: Ghana and Germany

Amongst other factors, stakeholder collaboration is critically important to any project management and delivery. Collaborative approach to project funding and development is United Nations’ sustainability goal number 17 and it reads: “*Strengthen global partnerships to support and achieve the Sustainable Development Goals through resource mobilization, policy coherence, and multi-stakeholder collaboration*”. Under this notion, collaboration, Bouchard (2024) defined stakeholder collaboration in the context of project management and delivery as: mobilizing people to work on project to finishing line as the project manager make an effort to take care of the project management by ensuring the team’s requirement for task completion is met, through the execution of the entire process. On the other hand, Bouchard (2024) expresses that, if everyone is working in isolation and not knowing what one is doing, will not likely to see the finishing of the project. Similarly, without proper planning and other collaborative efforts, time and resources are expected to be wasted (Bouchard, 2024). In addition,

uncoordinated team effort could prolong the delivery of a critical project and the similar scenario can be applied on the budget and other resources. Therefore, project collaboration ensures limited resources are put to maxim use and project objective is ultimately achieved (Bouchard, 2024). In conclusion, collaboration is a teamwork involving mobilization of resources, manpower, knowledge and experience and funds to deliver a project or a program.

Similarly, (EuroMatech, Undated) mentioned that the stakeholder theory is a principle of stakeholder cooperation, which was introduced by Edward Freeman in 1984. He emphasized on stakeholders' collaboration in the project management and delivery than competing amongst each other to deliver desired projects and programs. Freeman (1984) expresses that long term success is dependent on fostering relationships built on mutual respect, trust and shared objectives where each stakeholder contributes to and benefits from the organizations' overall purpose. Stakeholder theory in the light of business, the stakeholders such as employees, customers, investors, suppliers, and communities all play a vital role through an interconnected system (Freeman, 1984). Based on the Stakeholder theory laid by Freeman, 1984, Elsevier, 2024 (Prahald & Ramaswamy, 2004) asserted that stakeholder co-operation is a collaborative process involving various actors such as public, private, civil society, and marginalized groups active participation in shaping not only the design and implementation of solutions, rather long-term vision for future project delivery. Miller (2018) added that future-making should not be reacting to problems rather, collectively envisioning and constructing desirable futures through concerted stakeholder effects.

Besides, involving skeptical stakeholders enhances innovativeness and implementation of the projects and programs intended for example according to Kroh and Schultz (2023) urban innovation projects in Germany, the skeptical stakeholders identify best solution concepts in the development and delivery of the projects. Moreover, Elsevier, 2024 (Kujala 2016; Derakhshan & Turner, 2022 and Kier et al., 2023) agreed that the socio-economic, environment, legal and political structures in relation to the project development and stakeholders relationships have been embedded in the past, present and the future. For example, Elsevier, 2024 (Bammer, 2019; Jones, 2018; Loureiro, Romero & Bilro, 2020) jointly presents an example that, in a complex and systematic issues such as climate change, global inequality, or public health crises require innovative approaches, which require exploring diverse stakeholders to co-create solutions is crucial. In conclusion, Elsevier 2024 (Li et al, 2024) unfolded the crucial role of stakeholder engagement in value creation in projects and programs that require multiple stakeholder attention and contribution in terms of funding, manpower, expertise and experience that can create mega project value through networking of multiple stakeholders.

Local counterpart funding and community development of infrastructure delivery has been important in the lives of the rural poor through improvement of the quality of life of the people according (Kety and Nani 2025). Many projects in Ghana, Kety and Nai (2025) states that the project counterpart funding have improved the basic infrastructure development and services such as schools, health, electricity, water and sanitation. The practice has also helped in poverty reduction in many communities through community participation by directing the benefits to the people of the community (Kety and Nai, 2025). In conclusion, stakeholder collaboration and project counterpart funding has been proven to be successful in Ghana as strategy to alleviate the poverty in the rural centers in Ghana. In comparison with Oktedi mining project in Western Province of Papua New Guinea, Jenkins (2016) asserted that the, the fund managers that hold and manage the funds belonging to the impacted communities, the provincial government and the State lack cooperation and collaboration. Thus, resulted in the lack of tangible infrastructure, social and economic development in study area.

4.2.4 Conclusion

In conclusion, the findings from the literature view concluded that the mining economic benefits given to the mine impact communities under the corporate social responsibility scheme were temporary as they are voluntary benefits given by the mining company under its business corporate social responsibility program compared to benefits under the Social License to Operate (SLO). The economic benefits under the Social License to Operate (SLO) scheme has single funding source and the benefits are asserted to be insufficient and unsustainable as the programs are basically designed to last with the mine closure. However, experiences from other developing countries such as South Africa, Ghana and Papua New Guinea, confirmed that local economic diversification through the local economic development scheme as universal approved strategy adopted for mitigating mine closure impacts, require stakeholder collaboration and project counterpart funding to enable the sustainability of the local economic development programs for sustainability of the infrastructures and social programs.

This paper assesses the impact of the compensation benefit package on the local economic development sector projects such as: agriculture, livestock, cash crops, forestry, and tourism and investment (property and financial investment) including the enabling infrastructures on the local economic development and its sustainability performance in the mine impact communities covered by the study area of Oktedi mining project in Western Province of Papua New Guinea.

4.3 Research Gap

The gaps identified in the literature review are cover theoretical and research gaps. From the outset of theoretical perspective, the current economic sector benefits given under the social license to operate (SLO) scheme are asserted as inadequate and unsustainable, as a result of lack of stakeholder collaboration and project counterpart funding whilst the research gap identified in the empirical study review are study method and time gap. The cited literatures from Jenkins (2016) and others used qualitative method to collect data, analyzed and presented using descriptive approach. In comparison to this study, mixed method (qualitative and quantitative) has been used to collect data and analyzed the data using statistical technique.

5. Research Methodology

The researcher has selected the North Fly District of Western Province as a study area where Oktedi Mining Project has been used as a case study. The study has adopted a combination of qualitative and quantitative research methodologies in order to achieve the research question and hypothesis of the study. The study focused on the sustainability of social and economic benefits given by the Oktedi Mining Project to the impacted communities and the governance of the benefits of the North Fly District of Western Province, PNG.

Most of the primary data collected were from the survey questionnaire and interview of 170 participants. The participants (170) were from project area of the trust regions; namely the Mine Villages, North OkTedi, Highway and Lower OkTedi. The sampling method used in this research was the stratified random sampling method. The total population was categorized into different groups (trust regions) in the mine impacted areas. Then, simple random sample was performed in each trust region. After collection of all the completed questionnaires, the data were analyzed using Statistical Package for Social Science (SPSS) and MS Excel. Table 1 below summarizes the population sample and sample size for the study.

Table 1. Sampling Frame and Sample Size for the Study

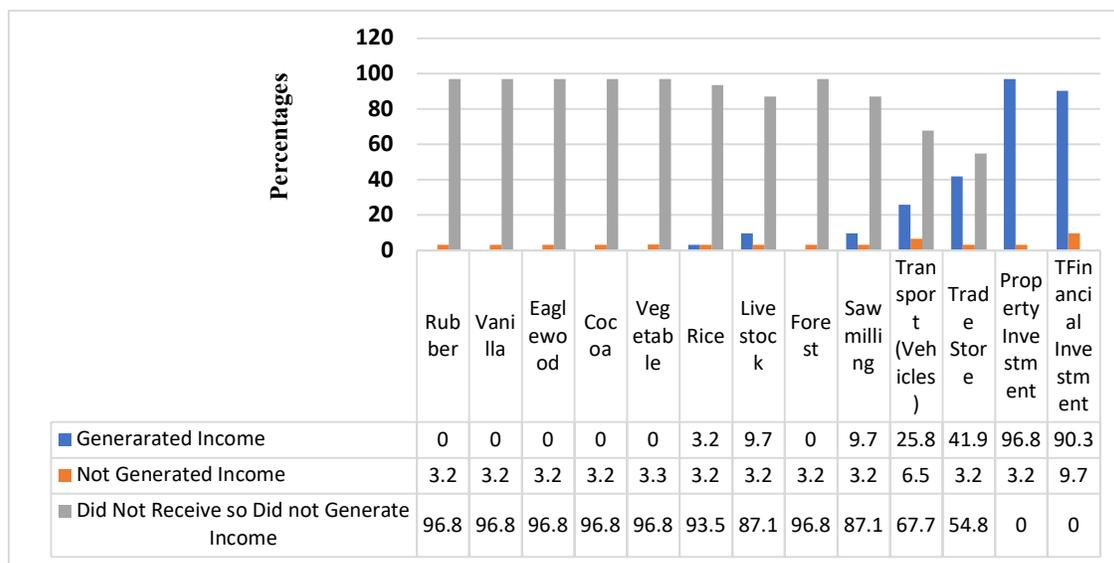
North Fly Four Oktedi Trust Regions	Population	Sample Size	Returned	Percentage returned
Mine Villages	2 650	40	31	77.5%
North Oktedi	2 700	41	40	97.6%
Highway	11 200	170	58	34.1%
Lower Oktedi	3 200	48	41	85.4%
Total	19 750	299	170	56.9%

Source: Author 2025

6.0 Findings and Discussions

6.1 2024 Mine Villages Economic Project and Programs Performance

The following are the economic sector projects delivered in the mine villages for which their performances have been measured using frequencies and percentages indicated in the bar graph in figure 1. The Statistical Package for Social Sciences (SPSS) software was used to analysis and process the results of the responses from the communities of 31 households from four villages. The indicators used to measure the performances include: rubber, vanilla, eaglewood, cocoa, vegetable, rice, livestock, forest, sawmilling, transport (vehicles), trade store, property and financial investment. The unconducive geographical condition of the Oktedi Mine villages has made it difficult for the agriculture and cash cropping activities to be developed. According to Jenkins (2016), attempts were made on agriculture and fisheries projects in 1997 but has failed, even the gardening as well. The people have left gardening into consuming processed food from the store. In consideration of these facts, the management of the Oktedi fund managers have allocated much of the funds under investments, and are invested in properties and financial investments for an on behalf of the people of the mine villages.



Source: Author, 2025

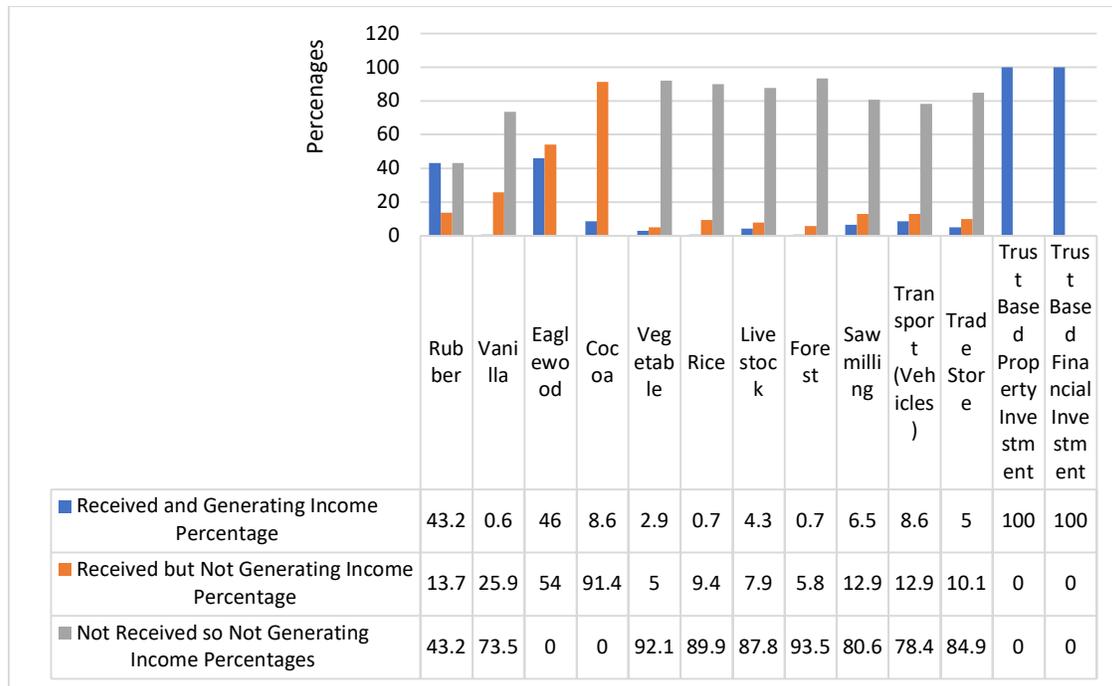
Fig. 1 2024 Mine Villages Economic Project and Programs Income Generating Performance Status

From the observations of the column graph in figure1, it is clearly indicating that, there is no subsistence or commercial agricultural activities operated and generating income for the families of the mine villages; only property and financial investments. However, these

investments are done at the corporate level, where fund managers are directly controlling its management. Therefore, there is no export driven agricultural activities that is expected to sustain the local economy of the mine villages toward sustaining their social infrastructures and services after the mine closure. Investment is the only reinvestment activity occurring in the mine villages trust region areas using the benefits from the mine for the impacted communities, and there is nothing to show case on the local economic development.

6.2 North Oktedi, Highway and Lower Oktedi Trust Region Economic Sector Benefit Received and Generating Income Performance Status

The following are the economic sector projects delivered in the three trust regions (North Oktedi, Highway and Lower Oktedi) of the impacted communities of Oktedi Mine: rubber, vanilla, eaglewood, cocoa, vegetable, rice, livestock, forest, sawmilling, transport (vehicles), trade store, property and financial investment. The performance of these indicators generating income status have been measured using frequencies and percentages indicated in figure 2. The SPSS software was used to process the frequencies and percentages and then were converted to column graph for interpretation of the results.



Source: Author, 2025

Fig. 2 2024 North Oktedi, Highway and Lower Oktedi Trust Region Economic Sector Project Income Generating Status

6.2.1 Pearson Correlation Coefficient Analysis

6.2.1.1 Correlation analysis for Rubber

The Pearson Correlation Coefficient $r = -0.233$ which indicates that there is “negative” linear correlation or relationship between the “Environmental Compensation Benefit” and Rubber Cash Crop. This indicates that as the Environmental Compensation Benefit increases the Rubber Economic Sector Project decreases or vice versa. The statistically significant Correlation P-Value of $0.002 < 0.01$ significance P-Value. Therefore, there is enough evidence to show significant correlation between the two variables (Environmental Compensation Benefit and Rubber Economic Sector Project).

Table 2. Pearson Correlation Coefficient of the Rubber and Environmental Compensation Benefit

		Environmental Compensation	Rubber Income Generating Status
Environmental Compensation	Pearson Correlation	1	-.233**
	Sig. (2-tailed)		.002
	N	170	170
Rubber Income Generating Status	Pearson Correlation	-.233**	1
	Sig. (2-tailed)	.002	
	N	170	170

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Author 2025

6.2.1.2 Correlation Analysis for Vanilla

The Pearson Correlation Coefficient $r = 0.008$ which indicates that there is “positive but very weak” linear correlation or relationship between the “Environmental Compensation Benefit” and Vanilla. This indicates that as the Environmental Compensation Benefit increases the Vanilla crop generating income increases or vice versa. The statistically significant Correlation P-Value of $0.922 > 0.01$ significance P-Value. Therefore, there is not enough evidence to show significant correlation between the two variables (Environmental Compensation Benefit and Vanilla Crop).

Table 3. Pearson Correlation Coefficient of the Vanilla and Environmental Compensation Benefit

		Environmental Compensation	Vanilla Income Generating Status
Environmental Compensation	Pearson Correlation	1	.008
	Sig. (2-tailed)		.922
	N	170	170
Vanilla Income Generating Status	Pearson Correlation	.008	1
	Sig. (2-tailed)	.922	
	N	170	170

**Correlation is significant at the 0.01 level (2-tailed).

6.2.1.3 Correlation Analysis for Eagle Wood

The Pearson Correlation Coefficient $r = -0.016$ which indicates that there is “negative” linear correlation or relationship between the “Environmental Compensation Benefit” and Eaglewood. This indicates that as the Environmental Compensation Benefit increases the Eaglewood crop decreases or vice versa. The statistically significant Correlation P-Value of $0.841 > 0.01$ significance P-Value. Therefore, there is not enough evidence to show significant correlation between the two variables (Environmental Compensation Benefit and Eaglewood Crop).

Table 4. Pearson Correlation Coefficient of the Eaglewood and Environmental Compensation Benefit

		Environmental Compensation	Eaglewood Income Generating Status
Environmental Compensation	Pearson Correlation	1	-.016
	Sig. (2-tailed)		.841
	N	170	170
Eaglewood Income Generating Status	Pearson Correlation	-.016	1
	Sig. (2-tailed)	.841	
	N	170	170

**Correlation is significant at the 0.01 level (2-tailed)

Source: Author, 2025

6.2.1.4 Correlation Analysis for Investment (Property & Finance)

The Pearson Correlation Coefficient $r = 0.064$ which indicates that there is “positive but weak” linear correlation or relationship between the “Environmental Compensation Benefit” and “Investment”. This indicates that as the Environmental Compensation Benefit increases the Eaglewood crop generating income increases as well. The statistically significant Correlation P-Value of $0.405 > 0.01$ significance P-Value. This indicates that there is not enough evidence to show significant correlation between the two variables (Environmental Compensation Benefit and Investment).

Table 5. Pearson Correlation Coefficient of the Investments and Environmental Compensation Benefit

		Environmental Compensation	Trust Region Based Property Income Generating Status
Environmental Compensation	Pearson Correlation	1	.064
	Sig. (2-tailed)		.405
	N	170	170
Investment Income Generating Status	Pearson Correlation	.064	1
	Sig. (2-tailed)	.405	
	N	170	170

** Correlation is significant at the 0.01 level (2-tailed)

Source: Author, 2025

6.2.2 Linear Regression-ANOVA

6.2.2.1 Rubber (Dependent Variable) and Environmental Compensation (Independent Variable)

Rubber crop has been selected as outcome (dependent) variable and environmental compensation benefit were used were used in SPSS Software and generated results. Rubber has been one of the main livelihood economic cash crops delivered under village development project funds of each trust regions. Therefore, it was appropriate to use rubber as traditional cash crop of Western Province as dependent variable for test of linear regression analysis under the economic projects and programs.

Table 6. Model Summary if the Linear Regression of the Rubber Income Generating Status and Environmental Compensation Benefit

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.233 ^a	.054	.048	.903
a. Predictors: (Constant), Environmental Compensation				
b. Dependent Variable: Rubber Income Generating Status				

Table 7. ANOVA of the Linear Regression of the Rubber and Environmental Compensation Benefit

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.828	1	7.828	9.608	.002 ^b
	Residual	136.878	168	.815		
	Total	144.706	169			
a. Dependent Variable: Rubber Income Generating Status						
b. Predictors: (Constant), Environmental Compensation						

$R = 0.233$, $R^2 = 0.054$; $Adjusted R^2 = 0.048$; $D = 1.261$; ANOVA significant P-Value of 0.002.

The correlation coefficient of the linear regression is $R = 0.233$ indicates no relationship whilst $R^2 = 0.054$ or 5.4 percent change or impact of environmental compensation benefit (independent variable) on the rubber (dependent variable). In other words, there is very little percent of change or impact from the environmental compensation benefit on the rubber. ANOVA significant P-Value is $0.002 < 0.05$ significant value indicates that there is strong evidence to reject the Null Hypothesis. Therefore, there is significant relationship and the impact of environmental compensation benefit on the rubber in the Mine villages, North Oktedi, Highway and Lower Oktedi Trust Regions. This indicates that the rubber is proven to be generating income out of the CMCA benefits invested on rubber crop development.

6.2.2.2 Vanilla (Dependent Variable) and Environmental Compensation (Independent Variable)

Vanilla crop (dependent variable) and environmental compensation (independent variable) were used in the SPSS Software and generated linear regression results. Vanilla was one of the cash crops distributed as livelihood economic cash crops to the impacted communities of each trust regions of the Oktedi Mining Project. Therefore, environmental compensation benefit was used as independent variable to regress the dependent variable (vanilla crop).

Table 8. Model Summary of the Linear Regression of the Vanilla and Environmental Compensation Benefit

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.008 ^a	.000	-.006	.437
a. Predictors: (Constant), Environmental Compensation				
b. Dependent Variable: Vanilla Income Generating Status				

Table 9. ANOVA of the Linear Regression of the Vanilla and Environmental Compensation

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.002	1	.002	.010	.922 ^b
	Residual	32.051	168	.191		
	Total	32.053	169			
a. Dependent Variable: Vanilla Income Generating Status						
b. Predictors: (Constant), Environmental Compensation						

Source: Author 2025

$R = 0.008$, $R^2 = 0.000$; Adjusted $R^2 = -0.006$; ANOVA significant value of 0.922

The correlation coefficient of the linear regression is $R=0.008$ indicates no relationship whilst $R^2 = 0.000$ or zero percent change or impact of environmental compensation benefit (independent variable) on the vanilla (dependent variable). In other words, there is no percentage of change or no impact from the environmental compensation benefit invested on vanilla crop. ANOVA significant P-Value is $0.922 > 0.05$ significant value, This, indicates that there is no evidence to reject the Null Hypothesis. Therefore, there is no significant relationship and the impact of environmental compensation benefit on the vanilla crop in the Mine villages, North Oktedi, Highway and Lower Oktedi Trust Regions. This indicates that though CMCA funds were invested on vanilla crop in the impacted communities of Oktedi mine project four trust regions of North Fly, the crop has not shown any evidence of generating income.

6.2.2.3 Eaglewood (Dependent Variable) and Environmental Compensation (Independent Variable)

Eaglewood crop (dependent variable) and environmental compensation benefit package (independent variable) were used in the SPSS Software and generated linear regression statistical results. Eaglewood was one of the cash crops distributed as livelihood economic cash crops to the impacted communities of each trust regions of North Fly District of Western Province. Therefore, environmental compensation benefit (dependent variable) was used to regress on the eaglewood crop to ascertain the linear regression statistical result under the economic sector project and program.

Table 10. Model Summary of the Linear Regression of the Eaglewood and Environmental Compensation Benefit

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.016 ^a	.000	-.006	.489
a. Predictors: (Constant), Environmental Compensation				
b. Dependent Variable: Eaglewood Income Generating Status				

Table 11. ANOVA of the Linear Regression of the Eaglewood and Environmental Compensation Benefit

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.010	1	.010	.040	.841 ^b
	Residual	40.137	168	.239		
	Total	40.147	169			
a. Dependent Variable: Eaglewood Income Generating Status						
b. Predictors: (Constant), Environmental Compensation						

Source: Author 2025

$R = 0.016$, $R^2 = 0.000$; Adjusted $R^2 = -0.006$; ANOVA significant P. Value of 0.841

The correlation coefficient of the linear regression is $R=0.016$ indicates no relationship whilst $R^2 = 0.006$ or 0.6 percent change or impact of environmental compensation benefit (independent variable) on the vanilla (dependent variable). In other words, there is no percentage of change or no impact from the environmental compensation benefit invested on Eaglewood crop. ANOVA significant P-Value is $0.841 > 0.05$ significant value, This, indicates that there is no evidence to reject the Null Hypothesis. Therefore, there is no significant relationship and impact of **environmental compensation benefit on the eaglewood crop** in the Mine villages, North Oktedi, Highway and Lower Oktedi Trust Regions. This indicates that though CMCA funds were invested on eaglewood crop in the impacted communities of Oktedi mine project four trust regions of the study area, there is no indication of those eaglewood crop matured and generating income for the families of the impacted communities.

6.2.2.4 Investments (Property and Finance)

Investments (dependent variable) and Environmental Compensation Benefit Package (independent variable) were used in the SPSS Software and generated linear regression statistical results. Investment is one of the main economic sector programs given to the impacted communities of each trust regions. Therefore, it was appropriate to test for linear regression statistical result under the economic sector projects and programs.

Table 12. Model Summary of the Linear Regression of the Investments and Environmental Compensation Benefit

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.064 ^a	.004	-.002	.077
a. Predictors: (Constant), Environmental Compensation				
b. Dependent Variable: Trust Region Based Property Income Generating Status				

Table 13. ANOVA of the Linear Regression of the Investments and Environmental Compensation Benefit

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.004	1	.004	.697	.405 ^b

	Residual	.990	168	.006		
	Total	.994	169			
a. Dependent Variable: Trust Region Based Property Income Generating Status						
b. Predictors: (Constant), Environmental Compensation						

Source: Author 2025

$R = 0.064$, $R^2 = 0.004$; Adjusted $R^2 = -0.002$; ANOVA significant P. Value of 0.405

The correlation coefficient of the linear regression is $R=0.064$ indicates no relationship whilst $R^2 = 0.04$ or no change or impact of environmental compensation benefit (independent variable) on the vanilla (dependent variable). In other words, there is no percentage of change or no impact from the environmental compensation benefit invested on investments (property and financial). ANOVA significant P-Value is $0.405 > 0.05$ significant value, This, indicates that there is no evidence to reject the Null Hypothesis. Therefore, there is no significant relationship and impact of environmental compensation benefit on the investments made on property and financial investments in the Mine villages, North Oktedi, Highway and Lower Oktedi Trust Regions. This indicates that though CMCA funds were invested on properties and financial investments, the proceeds of the returns of the investments have not been returned to the impacted communities to support in their community development projects.

6.2.3 Chi-Square Tests for Asymptotic Probability Values of Rubber, Investment (dependent variables) against environmental compensation benefit package (independent variable)

The hypothesis to be tested is H_1 : That the economic benefit given to impacted communities of the mining project in Western Province, PNG is sustainable;

6.2.3.1 Chi-Square Test for Rubber

A Chi-Square Test result with Asymptotic or Probability significance P-Value of $0.001 < 0.01$ indicates very strong evidence against the null hypothesis. It suggests that there is a statistically significant association between the two variables: rubber (dependent variable) and environmental compensation benefit (independent variable).

The chi-square statistical test result of very strong evidence against the null hypothesis, is because of the price enhancement program from provincial government and OTML shipping freight support program. This chi-square test result not based on high market price as the current world market price is very low at K0.80 per kilo and the farmers are tapping rubber because of additional K1.20 from the provincial government and North Fly Rubber Limited’s price enhancement programs that increased the price up to K2.00 per Kilogram (North Fly Rubber, 2024). Thus, encouraged farmers to continue to tap and produce rubber latex. Therefore, the Chi-Square Asymptotic significant P-Value of $0.001 < 0.01$ is influenced by the K1.20 price enhancement and freight subsidy program. The farmers produce and sell rubber because of the price enhancement program. The rubber economic sector industry is predicted to become unsustainable if price support program and freight subsidies are removed during or after and beyond the mine closure.

Table 14. Environmental Compensation and Rubber Income Generating Status Crosstabulation

		Rubber Income Generating Status			Total
		Rubber received and Generating Income	Rubber received but Not Generating Income	Rubber Not received so Not Generating Income	
Environmental Compensation	Cash Only	17	10	50	77
	Project Only	1	0	4	5
	Cash and Project	41	7	31	79
	No Cash and No Project	1	3	5	9
Total		60	20	90	170

Table 15. Chi-Square Test for Probability Value Rubber Income Generating Status and Environmental Compensation Benefit

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.212 ^a	6	.001
Likelihood Ratio	22.114	6	.001
Linear-by-Linear Association	9.142	1	.002
N of Valid Cases	170		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .59.

The Chi-Square Test Value is 22.212; Degree of Freedom is 6; the P-Value is 0.01

Source: Author 2025

6.2.3.2 Chi-Square PV Test for Vanilla (dependent variable) and Environmental Compensation Package (independent variable) selected to test Chi-Square Probability Value

The expected dependent and independent variables Significant P.V is 0.01. The Pearson Chi-Square Test Value is 14.734; Degree of Freedom is 6; the Asymptotic Significance P-Value is 0.702. A Chi-Square Test result with Asymptotic or Probability significance P-Value of $0.702 > 0.01$ indicates very strong evidence against the null hypothesis. It suggests that there is no statistically significant association between the two variables: vanilla (dependent variable) and environmental compensation benefit (independent variable).

Table 16. Vanilla and Environmental Compensation Package Crosstabulation

		Vanilla Income Generating Status			Total
		Vanilla Received, so Generating Income	Vanilla Received but Not Generating Income	Vanilla Not Received, so Not Generating Income	
Environmental Compensation	Cash Only	1	16	60	77
	Project Only	0	0	5	5
	Cash and Project	0	20	59	79

	No Cash and No Project	0	1	8	9
Total		1	37	132	170

Table 17. Chi-Square PV Test for Vanilla Income Generation and Environmental Compensation Benefit Package

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.816 ^a	6	.702
Likelihood Ratio	5.329	6	.502
Linear-by-Linear Association	.010	1	.922
N of Valid Cases	170		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .03.

Source: Author 2025

6.2.3.3 Chi-Square PV Test for Eaglewood (dependent variable) and Environmental Compensation Package (independent variable) selected to test Chi-Square Probability Value

The expected dependent and independent variables Significant P.V is 0.01. The Pearson Chi-Square Test Value is 0.166; Degree of Freedom is 3; the Asymptotic Significance P-Value is 0.983. A Chi-Square Test result with Asymptotic or Probability significance P-Value of 0.983 > 0.01 indicates very strong evidence against the null hypothesis. It suggests that there is no statistically significant association between the two variables: eaglewood generating income (dependent variable) and environmental compensation benefit (independent variable).

Table 18. Eaglewood and Environmental Compensation Benefit Package Crosstabulation

		Eaglewood Income Generating Status		Total
		Eaglewood Received and Not Generating Income	Eaglewood Not Received, so Not Generating Income	
Environmental Compensation	Cash Only	29	48	77
	Project Only	2	3	5
	Cash and Project	30	49	79
	No Cash and No Project	4	5	9
Total		65	105	170

Table 19. Chi-Square PV Test for Eaglewood Income Generation and Environmental Compensation Benefit Package

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.166 ^a	3	.983
Likelihood Ratio	.164	3	.983
Linear-by-Linear Association	.041	1	.840
N of Valid Cases	170		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is 1.91.

Source: Author 2025

6.2.3.4 Chi-Square Test for Investments (Property & Finance)

The expected dependent and independent variables Significant P.V is 0.01. The Chi-Square Test Value is 1.159; Degree of Freedom is 3; the P-Value is 0.763. A Chi-Square Test result of Asymptotic Significance P-Value of $0.763 > 0.01$ indicates strong evidence against the null hypothesis. It suggests that there is no statistically significant association between the two variables (investment-dependent variable and environmental compensation benefit package - independent variable).

Table 20. Environmental Compensation and Investment Generating Status Crosstabulation

		Investment (Property and Investment) Income Generating Status		Total
		Investment Received and Income Generated for the Impacted Communities	Investment Received but Not Generating Income for the Impacted communities	
Environmental Compensation	Cash Only	77	0	77
	Project Only	5	0	5
	Cash and Project	78	1	79
	No Cash and No Project	9	0	9
Total		169	1	170

Table 21. Ch-Square Test for Probability Value for Hypothesis Test for Investment and Environmental Compensation Package

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.159 ^a	3	.763
Likelihood Ratio	1.540	3	.673
Linear-by-Linear Association	.698	1	.403
N of Valid Cases	170		

a. 5 cells (62.5%) have expected count less than 5. The minimum expected count is .03.

Source: Author 2025

a. Rubber, Vanilla, Eaglewood, Cocoa and Vegetable Farming

Out of rubber received in figure 3.2, 43.2 percent of the farmers or the families have generated income and 13.7 percent have not generated income whilst 43.2 percent have not received so did not generated income. Vanilla generated only 0.7 percent of income and 25.9 percent have not generated income whilst 73.5 percent of the families have not received so have not received any income. Eagle wood generated 0.0 percent of income and 46 percent have received but have not generated income whilst 54 percent have not received so did not generate any income. Cocoa have received 0.0 percent meant that, though the families received, have not generated income and those who have received have not generated any income whilst 91.4 percent have not received so have not generated income. In vegetable farming sector had received 2.9 percent have generated income and out of those that have received, 5 percent have not generated income whilst 92.1 percent have not received so have not generated income.

b. Rice, Livestock, Forestry, Property and Financial Investment

Those that have received livestock sector, only 4.3 percent generated income and that that have received and those that have received but did not generate any income amount to 7.9 percent whilst 87.8 percent did not receive so did not general any income. In a forestry sector only 0.7 percent generated income and 5.8 percent that received did not generate any income whilst 93.5 percent have not received so have not generated income. In property investment, 28.8 percent of the communities received income whilst 17.3 percent did not receive any income generated income because they have not received any property investment opportunity, whilst 31.7 percent represented those that did not receive financial investment so did not receive any income.

On average, 10.9 percent of the ten economic sector projects have generated income, and 22 percent have not generated income, whilst those that have not received the ten economic sector projects, 67.4 percent have not received any income. There is a big gap between economic sector projects that have generated income and not generated income of about 78.47 percent.

6.3 Economic Sector Benefit Sustainability Hypothesis Test

The hypothesis to be tested cover four economic dependent variable indicators (rubber, vanilla, eaglewood and investment) against the independent variable indicator (compensation benefit package) reads:

H₂ “That the economic sector benefit given to the impacted communities of the mining project in Western Province, PNG, is sustainable.”

The four economic indicators used to measure the inferential statistical tests include: three cash crops and investment have been the major economic sector projects funded using compensation benefit for the four impacted community trust regions: Mine villages, north Oktedi, Highway, and Lower Oktedi. The inferential statistical test techniques used to test the null hypothesis include: Pearson Correlation Coefficient Relationship, Linear Regress and ANOVA, and Chi-Square. Tables 2 to 21 is a summary of the statistical test results for the Pearson correlation, Linear Regression and Chi-Square.

a. Pearson Correlation Coefficient Test Results of the Economic Benefits: Rubber, Vanilla, Eaglewood and Investment

According to the Pearson Correlation Coefficient test between the environmental compensation benefit package (independent variable) and the economic projects (rubber, vanilla, eaglewood and investment) in tables 2 to 5, the rubber indicates a negative correlation coefficient and the observed correlation or relationship is statistically significant. Vanilla has positive but very weak linear correlation or relationship with the environmental compensation and the observed correlation does not have enough evidence to show significant correlation with environmental compensation benefit package. Eaglewood has low negative” linear correlation or relationship whilst observed correlation does not have enough evidence to show significant correlation. Investment has positive but weak linear correlation with the compensation benefit but the probability value does not have enough evidence to show significant correlation. In a summary, only rubber and environmental compensation benefit portrays negative correlation. However, Pearson Correlation Coefficient probability value indicates significant correlation or relationship. Vanilla has a positive linear correlation with the environmental compensation benefit package, but the probability value indicates not enough evidence to support the significant correlation of the two variables (vanilla and environmental compensation benefit). Finally, the Pearson correlation coefficient between investment and environmental

compensation package indicates positive relationship, the probability value indicates not enough evidence to show significant correlation.

b. Linear Regression and ANOVA Test Results of Economic Benefits: Rubber, Vanilla, Eaglewood and Investment:

The Linear Regression and ANOVA test results indicates the impact of the independent variable on the dependent variable. The probability values indicate the influence or impact or the changes caused by the independent variable (environmental compensation benefit package) on the dependent variable (economic projects: rubber, vanilla, eaglewood and investment). The linear regression strength of correlation is represented by “**r**” and the impact or change is represented by “**r²**”. ANOVA significant probability value decides the acceptance or rejection of the null hypothesis.

According to the order of the economic projects’ strength of correlation states as:

- i. Rubber** $r = 0.233$ indicates no relationship and $r^2 = 0.054$ or 5.4 percent change or impact, and ANOVA $p_v = 0.002 < 0.05$ indicates strong evidence to reject the Null Hypothesis. It is perceived that environment compensation has no significant impact on the rubber. However, the ANOVA probability value indicates strong evidence against the null hypothesis meant that the environmental compensation benefit package has an impact on the rubber cash crop development.
- ii. Vanilla** $r = 0.008$ indicates no relationship; and the $r^2 = 0.000$ or 0.00 percent change or impact and the ANOVA $p_v = 0.922 > 0.05$. Indicates no evidence to reject the Null Hypothesis. This indicates that the environmental compensation benefit has no impact on the vanilla cash crop.
- iii. Eaglewood** $r = 0.016$ indicates no relationship; and the $r^2 = 0.006$ or 0.6 percent change or impact; ANOVA $P_v = 0.841 > 0.05$ indicates no evidence to reject the Null Hypothesis. This indicates that the environmental compensation benefit has no impact on the eaglewood cash crop production and generation of income.
- iv. Investment** $r = 0.064$ indicates “positive but weak” linear correlation or relationship; $r^2 = 0.004$ or 0.4 % change or impact; ANOVA $P_v = 0.405 > 0.05$ indicates no evidence to reject the Null Hypothesis. This indicates that the environmental compensation has caused no change or impact on the investment funds invested.

In a summary, according to the Linear Regression and the ANOVA Tests, the environmental compensation benefit package has not caused any changes or made any impact on the four economic sector indicators include: rubber, vanilla, eaglewood and investment.

c. Chi-Square Test Results of the Economic Benefits: Rubber, Vanilla, Eaglewood, Investment

The Chi-Square test result of the economic benefits include: rubber, vanilla, eaglewood and investment (dependent variables) measured against the environmental compensation benefit (independent variable) to ascertain Chi-Square probability values.

The Chi-Square probability values for economic benefits:

- i.** Rubber $PV = 0.001 < 0.01$ indicates very strong evidence against the Null Hypothesis
- ii.** Vanilla $PV = 0.702 > 0.01$ indicates no strong evidence against the Null Hypothesis

- iii. Eaglewood $PV= 0.983 > 0.01$ indicates no strong evidence against the Null Hypothesis.
- iv. Investment $PV=0.763 > 0.01$ indicates no strong evidence against the Null Hypothesis.

In summary, the environmental compensation benefit package (independent variable) has impact on the rubber generating income based on the Chi-Square probability value and the ANOVA probability value less than the significant probability value. This impact is partly caused by the price enhancement program supported by the provincial government and OTML on the transport subsidy. However, the Linear regression strength of correlation indicates no relationship and the percentage of change caused by the independent variable is leveled at 5.4 percent. Environmental compensation benefit package has no single impact on the vanilla and eaglewood cash crops and investment projects, generating income for the families of the impacted communities. Although, there has been hard evidences of investment funds invested in properties and financial shares indicated by figures 1 and 2, the proceeds have not be returned to the impacted communities of the study area to support in the community social and economic projects and programs.

The Chi-Square Asymptotic Significance P-Values and the ANOVA Significant P-Values of the three dependent variables of the economic sector indicators: vanilla, eaglewood and investment, have indicated no strong evidences against the Null Hypothesis which suggested no statistically significant association between these economic sector indicators and the environment compensation benefit package (independent variable). On the other hand, the Chi-Square Asymptotic Significance P-Value of rubber crop generating income indicated strong evidence against the null hypothesis which suggests statistically significant association between the rubber crop generating income status and the environmental compensation benefit package. Rubber, vanilla and eaglewood are main cash crops funded under the by the compensation benefit package under the village development fund for each village of the study area. However, the cash crop farming failed because of lack of monitoring and evaluation, and insufficient funding, except rubber has exceptionally survived. Rubber survived because of the price enhancement and transport freight subsidy program from the provincial government and OTML respectively to counter the low world market price as low as K0.80 per kilogram of dried rubber latex. The provincial government and North Fly Rubber Limited jointly subsidize K1.20 per kilo and increase the rubber selling price to K2.00 per Kilogram to encouraged the famers to tap rubber and sell at North Fly Rubber Limited's processing facility in Kiunga, Western Province, Papua New Guinea (PNG). Therefore, in the event the Oktedi Mining Project closes and the provincial government price support program ceases, and OTML's transport freight subsidy is removed during and after the mine closure, rubber industry will become unsustainable. This meant that the farmers will abandon and cease from tapping rubber as North Fly Rubber Limited does not have its own rubber farms instead depends on the small holder farmers or the families who hold family size rubber farms.

Though investments have been made since 2012 to 2023 for North Oktedi, Highway and Lower Oktedi Trust regions and a total mine villages village development funds including investment of, none of the proceeds returned to the impacted communities to support in the village development projects and programs. Therefore, the Chi-Square Asymptotic P-Value indicated no strong evidence against the Null Hypothesis. Based on the collaborated outcome of the Pearson Correlation Coefficient, Linear Regression-ANOVA and Chi-Square Asymptotic Significant Probability Values Test results of the economic sector indicators including the rubber, vanilla, eaglewood and investment, concluded that the hypothesis:

H₁ “That the economic sector benefit given to the impacted communities of the mining project in Western Province, PNG, is sustainable” has been rejected.

This meant that the Environmental Compensation Benefit Package under the Compensation Agreement given to the impacted communities through the Social License to Operate (SLO) scheme has no impact on the economic sector programs and as a result, the economic sector benefits of the compensation agreement in the study area are considered unsustainable during the mine operation and beyond the mine closure.

7. Conclusion and Recommendation

7.1 Conclusion

It is concluded that the compensation benefits given under the social license to operate have not impacted the local economy of the study area: Mine villages, Highway, North Oktedi, and Lower Oktedi. It is because the compensation agreement has a single funding source which is the mine operator and therefore concluded that the benefits are inadequate and unsustainable. The inadequacy and unsustainability of economic benefits is the result of lack of fund managers' or stakeholders' collaboration and counterpart project funding program on the enabling infrastructures and economic sector programs.

The paper reveals that the Ok Tedi Mine has been disturbed by the short notices of attempted mine closures in 2001, 2013 and 2025 influenced, which forced the Ok Tedi Mining Limited to have short term economic sustainability programs which failed miserably. Besides the time for planning and implementation of the local economic sector programs were just five years before the attempted mine closures similar to Misima Mine. Therefore, the performance of the economic sector indicators revealed a very poor performance in the local economy of the study area.

The bar graph indicates that majority of the compensation benefit package fund was invested in property and financial investments both in Papua New Guinea and overseas. However, the proceeds of the investments failed to return to the mine impact region for investment in the local economic development programs in the study area.

Therefore, the inferential statistical tests indicated rubber with a positive correlation and no strong evidence against the null hypothesis, whilst vanilla, eaglewood, and investment indicated negative relationship and strong evidence against the null hypothesis. This meant that the compensation benefit package has impact on the rubber crop generating income for the impact communities than the vanilla, eaglewood and investment. Rubber processing plant established by Ok Tedi Mining Limited in 1989 for the North Fly Rubber Limited and the rubber farmers in Western Province in Kiunga is an example of investment in the local economic development in the mine impact region. Rubber crop is performing positively in the local economy of North Fly and Western Province because of provincial government and North Fly Rubber Limited's price enhancement program and transport subsidy from Ok Tedi Mining Limited. Compared to investment, substantial compensation benefit funds have been invested in property and financial investments in the country and overseas, but the proceeds of those funds have no been returned to study area for investment in local economic sector programs, whilst vanilla and eaglewood crop farming projects failed. In conclusion, the economic benefits given to impacted communities are inadequate, and unsustainable as a result of poor collaboration and stakeholder project counterpart funding and implementation.

7.2 Recommendation

Local economic development, stakeholder collaboration, and project counterpart funding schemes are universally adopted schemes introduced to combat unemployment, poverty and inequality particularly in the developing countries. Some countries cited in the literatures that have adopted these schemes and have proven to be successful in the mitigation of mine downscaling and closure impacts such as poverty, unemployment, and lack economic growth are: Ghana, South Africa, Liberia and New South Wales in Australia. However, in the case of Ok Tedi Mine, Jenkins (2016), Hong and Ren (2025) agreed that, though Oktedi mine operates in Western Province there is lack of broader development such as infrastructures and social and economic development in the mine impact trust regions and the province. Jenkins (2016) further asserted that the lack of tangible development has been caused by lack of stakeholders or the fund managers collaboration and stakeholder counterpart funding of the social and economic projects and programs. This paper observes that the United Nations' Sustainability Goal number 17 "Stakeholder Collaboration" has not been observed and implemented in the Oktedi Mine impacted regions by the fund managers that hold and mangers the funds belonging to the people, provincial government and the State.

This paper therefore recommends for adoption of stakeholder project counterpart funding agreement and the local economic development as government policy in Oktedi mining project, and the other mines in Papua New Guinea. The funds from the stakeholder project counterpart funding agreement and the compensation agreement collaborate to deliver enabling infrastructures, and the economic sector programs for sustainability of the social and economic benefits after the mine closure.

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