

The Benefits Of Mineral Beneficiation To Liberia's Economy

Ousman Kante

Department Of Mining Engineering, College Of Engineering, University Of Liberia

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Abstract

It is obvious that, for any country that is anticipating success in today's minerals' sectors, that country's sectors' managers need to apply some sufficient efforts in order to render assistance to the indigenous mining companies to outcompete the other firms in the region. Among many possible activities, cost reduction in mineral beneficiation is regarded as one of the core areas presenting enormous opportunities for the West African country, Liberia. The

country Liberia which is endowed with a notable stock of mineral reserves and has habitually be dependent on mining, namely iron ore, gold, and diamonds, as a major source of income is also encouraged follow the same. And it has also been predicated by some geologists that there are traces of another valuable mineral such as Uranium, platinum, and niobium.

The recent growth in the mining sector in other parts of the world has potentially contribute significantly to the employment, income generation, and infrastructure development if Liberia's stakeholders engage in mineral beneficiation will benefit if not more will not be less than these benefits mentioned above. This research project is mainly about the benefits of the mineral beneficiation to Liberia's economy in which it is understood that Liberia's previous mining and minerals products contribute three-quarters of its exports and the industry employs three-quarters of a thousand workers, and it is foreseeing in this research that, this contribution could be much higher if our raw materials or ore were processed into intermediate and finished products before export. Our local authority must attempt to increase the level of mineral beneficiation through appropriate incentives and disincentives in order to increase employment and add more value to our natural resources before export. Moreover, this project should provide more appropriate inputs for manufacturing in Liberia.

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CHAPTER 1

1.0 TITLE PROPOSAL:

THE BENEFITS OF MINERAL BENEFICIATION TO LIBERIA'S ECONOMY

1.1 Background To The Project

It is obvious that, for any country that is anticipating to be successful in today's mineral's consumers' community, that country's sectors' managers need to apply some sufficient efforts in order to render assistance to the indigenous mining companies to outcompete the other firms in the region. Among many possible activities, cost reduction in mineral beneficiation is regarded as one of the core areas presenting enormous opportunities for the West country, Liberia. The country like Liberia that is awarded with an impressive stock of mineral reserves and has traditionally relied on mining, namely iron ore, gold, and diamonds, as a major source of income is not exempted.

The recent growth in the mining sector in other parts of the globe has potentially contribute significantly to employment, income generation, and infrastructure development. If Liberia's stakeholders engage in mineral beneficiation will benefit if not more, will not be less than the contributions mentioned above. This research project is mainly about the benefits of the mineral beneficiation to Liberia's economy in which it is understood that mining and minerals products contribute three-quarters of our exports and the industry employs three-quarters of a thousand workers, but this could be much higher if our raw materials were processed into intermediate and finished products before export. Our local authority must attempt to increase the level of mineral beneficiation through appropriate incentives and disincentives in order to increase employment and add more value to our natural resources before export. Moreover, this project should provide more appropriate inputs for manufacturing in Liberia.

The ultimate objective of the project is to offer recommendations for short medium and long-term mineral beneficiation for Liberia. Looking at the report in 2013, Liberia was ranked the 24th largest producer of iron ore in the world after just three years of production (BGS, 2015). This was and it is still done in "Direct Shipping Ore" (DSO), which shows that Liberia has one of the highest quality ores (ranges from 34.34% to 62% Fe content) in the world with little benefits to Liberia itself in term of human's capacity building, contribution to Liberia's economy (government revenue and employment rate etc.). Liberia is the land of gold, columbite-tantalite (Coltant) and diamonds among others and then, jewellery fabrication is another labour intensive value chain that will beneficiate these minerals. Also value chain interventions such as: (a) Establishment of a

metal advance scheme (b) Promotion of existing incentives in the jewellery sector. Value addition of our mineral resources is recommended in order to fast track the country's economic growth to tackle the challenges in our country's (LIBERIA'S) development agenda.

Furthermore, this research project seeks to give an overview of the current status of mineral beneficiation in the country, unpacks how the beneficiation strategy and its implementation plan seek to change the status quo and influence on the concerted effort of the provinces to contribute to balanced spatial economic development. After the discovery of high-grade iron ore in Bomu Hills, Bong, and Nimba and followed by Lofa and some parts of South-Eastern in Liberia, natural resources have been the basis of Liberian economy and its people livelihood, and more development and growth are expected if our stakeholders may engage in mineral beneficiation known as values addition of mineral resources in semi-finished or finished product or end product. It has been noticed that, the mining activities are emerging as significant social economic sector in Liberia to the point they have become major source of incomes for some Liberians and the government of Liberia as whole.

Liberia being part of the world's third mineral producing continent (Africa), not just that, but also historically Liberia was a major global producer of iron ore, exporting about 20 million tonnes annually up to 1980 (Wright, 1985). But how beneficial was and is it to Liberia's economy's growth and development as expected? During the research, we came across that mining of Iron ore had the backbone of the Liberian then economy in about 1960 and 1980, during which it contributed to Liberia's export and GDP earning up to 60% and 25% (Boakye et al. 2012). For this, Liberia became the largest iron ore exporter and occupied third position in the world. But this all rank has no or little benefit to the ordinary citizens of Liberia at that time. Had it been that Liberia had beneficiation plant, it would have derived many benefits from its mineral resources than it was. In short, this rank would have help Liberia in term of its economic and infrastructural development than it did, if Liberia's mineral resources were processed into intermediate or finished products before export. But nearly fourteen (14) years of war (1989-2003) destroyed much of the country's productive infrastructure and brought mining to a virtual halt. Look at Liberia estimated reserves which ranges from between two to five billion metric tons of iron ore and three million ounces of gold (Boakye et al.2012). I can say that with mineral beneficiation, Liberians economy can be energized more than before.

The major mineral commodities produced in Liberia are iron ore, gold, and diamond. Mining concessions cover an operational area of 113,256 ha (Ministry of Finance 2013). Besides the production of iron ore, gold, and diamond, Liberia remains largely unexplored and has shown other

minerals such as beryl, tin, columbite-tantalite, phosphates, zinc, copper, lead, rare earth minerals, nickel, molybdenum, beach sand (zircon, rutile, ilmenite, and monazite), bauxite, kyanite, chromite, uranium, and silica sands which with value addition, or beneficiation more government's revenues and jobs creation is expected. Our national stakeholders must attempt to increase the level of mineral beneficiation through appropriate incentives and disincentives in order to increase employment and add more value to our natural resources before export.

Therefore, there is a need to consider mechanization (Mineral Processing Plants) in Liberia's mineral extractive sectors in order to be an important driven force of the nation's economy and structural transformation to the expectation. Moreover, this policy should provide more appropriate inputs for manufacturing in Liberia.

Hence, I choose this research to shift us away from commodity (such as rubber) export dependency and colonial form of mining to enhance Liberia's industrial base through greater local beneficiation and value addition of minerals.

1.2 PROJECT PROBLEM STATEMENT

Benefits of mineral beneficiation to Liberia's economy. In looking at the below points as key parameters:

1. The project will underline well developed charts (strategies) that show the economic importance of mineral beneficiation to Liberian fragile economy in improving it.
2. How can the mineral beneficiation improve Liberian's Employment rate?
3. What will Mineral beneficiation change in Liberia's Gross Domestic Product (GDP)?
4. What will be the effects of mineral beneficiation on utilization of natural resources Liberia?
5. With the blessing of natural resources endowment in Liberia, what mechanization means to Liberia's economy?
6. Identifies mineral beneficiation as one of the primacy growth bulges for job creation in Liberia.

1.3 HYPOTHESES

It is perceived that because of the absent of the mineral beneficiation in Liberia mining sector its minerals are rapidly depleted without improvement in its economy. And also if Liberia local authorities embark on mineral beneficiation, it will significantly improve our national economy's status. As of now, a significant role was played by Iron Ore in the Liberian economy and earned about 16% to 18% of Liberia's total export earnings in 2017 (U.S Embassies Abroad 2019), furthermore, it can be increased to even up to 30% of the Liberian economy for total export earnings in 10-20 years to come. With the increase in mineral beneficiation in Liberia

mining sector will invariably increase Liberian employment rate significantly. It is assumed that if Liberia local authorities engage in mineral beneficiation in our mining sector, our local market's strength will increase which will undoubtedly strengthen our local currency.

1.4 PURPOSE OF THE PROJECT/STUDY

- a. The goals of this project are to develop Liberia's mineral resources or wealth to its great potential and to maximize the benefit of mineral wealth for all Liberia population. Local authority or/and sector manager is hence, encourage to take into consideration the formation of secondary and tertiary industries that is based on mineral beneficiation or adding maximum value to mineral resource.
- b. Project will target creating thousands of jobs in more than ten (10) years
- c. Identifies challenges of structural development that obstruct anticipated growth rates, including
 - Logistics, physical energy infrastructure, and skills which raise costs
 - Economic policy and price collusion in main parts of the economy, which elevate costs and limit innovation and new enterprise development
 - The weak currency that sets limits to employment's growth in Liberia's manufacturing, mining, etc.
 - An untiring balance-of-trade deficit funded with short-term capital flows attracted chiefly at high interest by international standards
 - Seeks to put our economy on mineral beneficiation a with growth targeted
 - It is a value chain with a stress on mineral beneficiation as well as improving the rate of mineral extraction in Liberia.

1.5 EXCLUSIONS FROM THE PROJECT SCOPE

In this project, actual enactment of these recommendations and timeline process will be excluded.

1.6 SCOPE OF THE STUDY

Nowadays with the improvement in mineral beneficiation techniques, it is possible to mostly mine low grade ores. Furthermore, this research project elaborates on the needs of Liberian's government to involve or encourage operation of the beneficiation plants in Liberia mining sector which will increase mining of low grade ores. This in turn, will greatly help Liberians to benefit from their mineral resources which in many years have been exploiting for little or no benefit to ordinary Liberians, but with mineral beneficiation, Liberia's economy is bound to excel.

Also our government/sector managers should be reminded that with these, our mineral resources which are non-renewable resources (Gold, Iron Ore, Diamond, Columbite Tantalite etc.) will be depleted if mineral's grades are not blended (i.e. mixing of high and low grade ore), DSO is not discouraged and mineral beneficiation is neglected; and also if our mineral resources are not turned into intermediate or finished products before exporting. Therefore, mineral beneficiation should be highly appreciated in Liberia to change our economy's status for better.

1.7 DEFINITION OF KEY WORDS AND ITS EXPLANATION

Mineral beneficiation: is the process to upgrade the mineral values of the ore by exploiting the physical properties of the associated mineral in the ores. It aims at the:

1. Elimination of undesired mineral species or gangue
2. Elimination of undesired size
3. Selective separation of desired mineral

Justin Lin argues that "a developing country can change its industrial and economic structure by changing its endowment structure" consisting of both its factor endowments (land/natural resources, labor, and physical & human capital) and its infrastructure endowments: both hard/tangible infrastructure and soft/ intangible infrastructure (institutions, regulations, social capital, value systems, etc.).

Thus, mineral beneficiation is simply the process of up-gradation of ores or/ and minerals. Therefore, indirect beneficiation in the wider economy which will be very influence to our national's economy as this project intended includes:

- Building the knowledge linkages (human capital and technology)
- Building the spatial linkages (hard infrastructure)

1.8 PROJECT OBJECTIVES

If this project is fully being implemented as it is, it is expected that within 10-25 years of its application Liberia GDP will significantly be amended positively that will invariably accelerate its employment rate to a significant point. The main objective of the project is to give some recommendations for short, medium and long-term mineral beneficiation for Liberia as it is done in other parts of the world (such as China, Europe, America and some parts of Africa). Mineral beneficiation, will increase Liberia total export to a point that, its uncompetitive currency local currency will once again gain its power as ever before. That is:

- Define the standard of mineral beneficiation in Liberia
- Determine the challenges of the sector
- Identify possible solutions and recommendations
- Higher growth, employment, exports and government revenue
- Provide possible strategies for attaining the solutions and recommendations
- Better use of Liberian mineral's wealth
- Improved talent pool of portable skills.
- Helps in creating valuable jobs that elevate Liberians from poverty.
- Expedite economic disparity.
- Fast-track growth and progress towards a knowledge that is based on economy.
- Encourages entrepreneurship development.
- Upsurge a fraction of beneficiation extent to mineral production and increase export revenue.

It is our expectation that this activity will create an acquaintance and helps brings on practices that will make Liberia's mineral resources to contribute to the drafting of codes that will promote future generation of mining industries growth and development in Liberia.

CHAPTER 2

2.0 LITERATURE REVIEW

Due to the extent of the research there are various literatures that interact in discussing the importance of minerals beneficiation to the economy as a whole.

- I. As The African Mining Vision (AMV), adopted by the First African Union Conference of African Ministers responsible for Mineral Resources Development, held in Addis Ababa in October 2008 Africa's mineral resources for sustainable development in Africa, to eradicate poverty and to achieve rapid and broad-based socio-economic development.

Here, the idea is eradication of poverty and development of socio-economic of Africa. Which links to this research project that is talking about benefits of mineral beneficiation to Liberia's economy. The difference therefore, is that they are talking about both those countries that already have beneficiation plants and those that haven't while here focus is on Liberia's iron ore mines where there is none yet.

- II. Ore blending referred to a process that tightens down the variability of feed material and allows a constant feed coming into the process plant. It is therefore of paramount importance that mines have a rigorous blending regime that caters to the needs of the mine and of the process plant. LKAB, located primarily in the northern region of Sweden is one such mining company. It has three functional mine sites namely Malmberget, Kirunavaara and Leveäniemi. The latter two are of importance to this work. The company has recently opened a new mine site (Mertainen) in the northern region of Sweden and unlike the previous ores, this ore is of a somewhat poor grade comparatively. In addition to this, the ore also contains a high quantity of silica and alkalis both of which are not desirable in further metallurgical downstream processes of the mine.

The concept of ore blending is a very relevant notion in modern high tonnage production mines that makes all linkages (both forward and backward) fruitful. In this project it is made clear that ore blending (especially Liberia's iron ore) is not only essential for the prolongation of the mine life but as well as a method to dilute different kinds of deleterious elements occurring in different ores from the same mine. In that regard, it is also employed as a method to merge desirable qualities from different ores so as to come up with a desirable feed in terms of both quality and quantity. The link here is the mineral blending which is very crucial to

this research project in the benefits of the ore grades blending will be elaborated. Grades blending is very much important to our economy, as depleting resources our local authority needs to encourage grades blending instead of DSO procedure which deals mainly with high grade ore alone.

- III. Mining economic statistics and production statistics of government revenues by sector contribution indicates that the mining sector contributed to 53% (USD 53.38 million) of the total revenues during the FY14/15 (Fig. 1) and generating about 10,000 jobs. In the same year, the sector faced a drop in demand, production level, investment, and loss of employment as a result of the twin shock—Ebola virus disease and the price of iron ore. The value of the sector production in 2014 was USD 78.85 million (58.3%), (Samuel T. K. Wilson et al 2017).

Hence, in this project there will be comparisons of 1980s to 2017 and that of the projected (2035) mining sector contributions to government's total revenue and mining sector contribution towards nation's employment rate.

Despite a slow recovery in the post-war era, the mining sector is fast regaining its pre-war role in the Liberian economy. In 2003, rubber emerged as the mainstay of Liberia's export sector until 2013 when, for the first time since the war ended, export earnings from mining surpassed rubber. Iron ore, gold and diamonds generated a combined USD 351.2 million, up from USD 155.8 million in 2012, and accounted for 64% of overall export earnings. In 2013, the resumption of iron ore exports contributed to 8.1% GDP growth. As a percentage of GDP, growth of the mining sector continues to increase steadily, rising from 4.6% in 2011 to 16.7% in 2013.

The services and manufacturing sectors, which represent opportunities for up-stream linkages in the mining sector, both experienced growth since the end of the civil war. Services accounted for 42% of GDP in 2013; however, the sector relies significantly on demand from development organizations. Continued growth of the services sector will depend on its ability to adapt to new markets (such as mining) as development assistance withdraws from Liberia. (LEITI 2016)

2.1 RESEARCH SIGNIFICANCE

This research encourages our national's stakeholders to understand that mineral beneficiation is very much important to the growth and development of our nation's economy, it should be encouraged in the diamond industries to carry out cutting and polishing on diamond (processes in the diamond value chain) to maximize the local economic contribution which is the core objective of this research.

In this new period of development intrusions adapted by global community. Which is marked by the local implementation of the sustainable development goals that will guide the nation's collective efforts at transforming economies. The coming together of the member States mineral sector managers will in commitment support the integration of value chains and markets by 2030. One of the significance of this research is that it will provide suggestion on how to do away from this old colonial form of mining that remains a constraint in building critical linkages around minerals for the structural and economically transformation of Liberians standard of living, which is the priority of this research.

One of the ultimatum goals of this is to encourage our local authority to see the need of engaging in transformation of industrial minerals such as Iron ore, phosphates and Sand to their finished or semi-finished products. And also, one of its importance is to show that locally produced products from such as, iron ore and sand will demonstrate strong flexibility and depicts an outstanding transformation of Liberia's economy potentials. For example, manufactured cement of Africa from copious deposited limestone is witnessing enormous annually growth of five percent in consumption, and it is sturdily connected with Africa's GDP as well as suggesting minerals-based structural transformation. Indeed, it was exhibited in a new industrial article in Nigeria shows that for any one percent point increase in local production of cement adds over 5 percent points to GDP growth.

The three underlined significant of this research are as follows:

- i. First, it enlightens mining sector managers, the community they depend on (donors) and the investors with a thorough valuation of mineral beneficiation investment occasions in Liberia. It provides an advocacy document with which the government of Liberia can encourage and conscript the support of local authorities and development's partners in progress.

- ii. Secondly, the research makes the readers to be aware of the certain constraints of obtaining transformational and periodical growth—an effect that will be accomplished through strategic prioritization of mineral beneficiation that involves Liberian nationals in service delivery and includes the wider Liberian population within the local and regional growth opportunities at large. This inclusion is vital to securing Liberia's stability for the long term future.
- iii. To conclude, this research serves as the outgrowth for faster exchange of ideas on incorporation between Liberia and bordering countries, both in the background of the Mano River Union and in the context of ECOWAS.

For these ways, this research shall subsidize to the continual recovery and swift progressive of Liberia's development and growth. As it is understood that virtual Liberia's mineral resources such as, gold, Iron ore and diamonds give a combination of USD 351.2 million, up from USD 155.8 million in 2012, and accounted for 64% of overall export earnings. Which is great contribution to our national's economy which is the backbone of this research. In 2013, the recommencement of iron ore exports contributed to 8.1% GDP growth. As a percentage of GDP, growth of the mining sector continues to increase steadily, rising from 4.6% in 2011 to 16.7% in 2013 (Annual Economic Review 2013 Monrovia, Liberia: Ministry of Finance (MOF), 2014). Since mining is able to contribute such huge amount to our national cake, when mineral beneficiation is added to it, we should expect addition of half of this or more

CHAPTER 3

3.0 THEORETICAL/CONCEPTUAL FRAMEWORK

3.1 UNDERLINING WELL DEVELOPED STRATEGIES THAT SHOW THE ECONOMIC IMPORTANCE OF MINERAL BENEFICIATION TO LIBERIAN FRAGILE ECONOMY IN IMPROVING IT.

In mining sector, there is system that involves before obtaining the semi-finished or finished products. This system is well indicated in the left corner here from exploration to beneficiation or value addition. Also in each stage there is capital goods and services attached to it which will be explained below

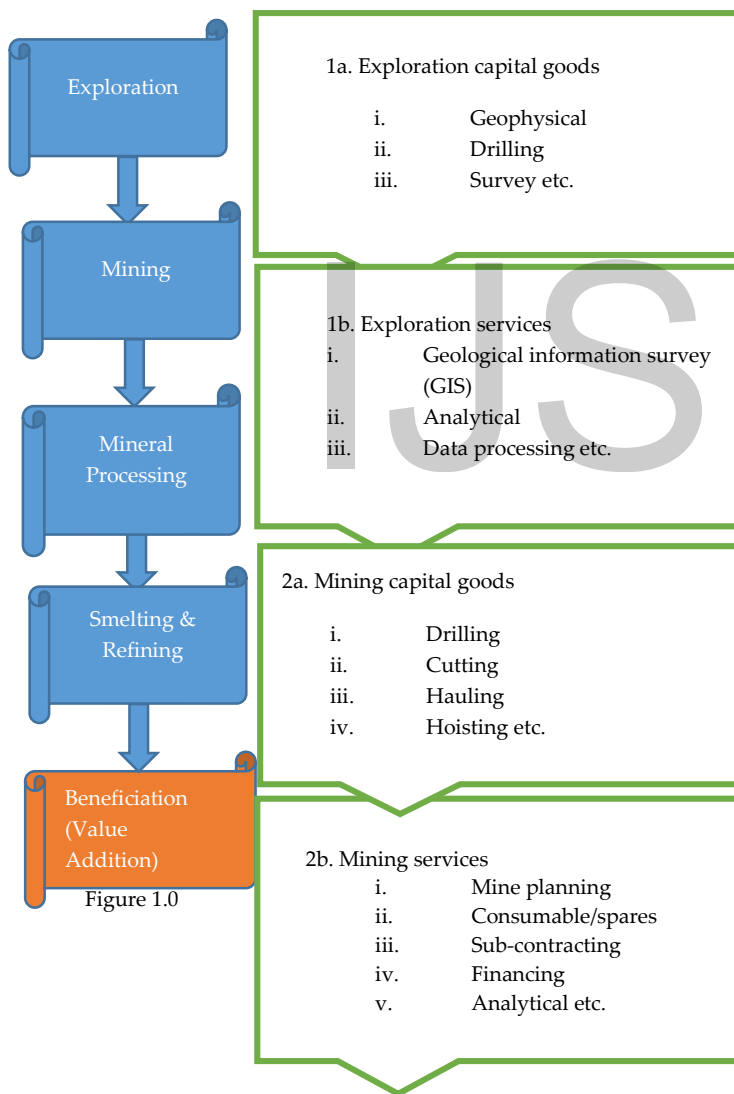


Figure 1.0

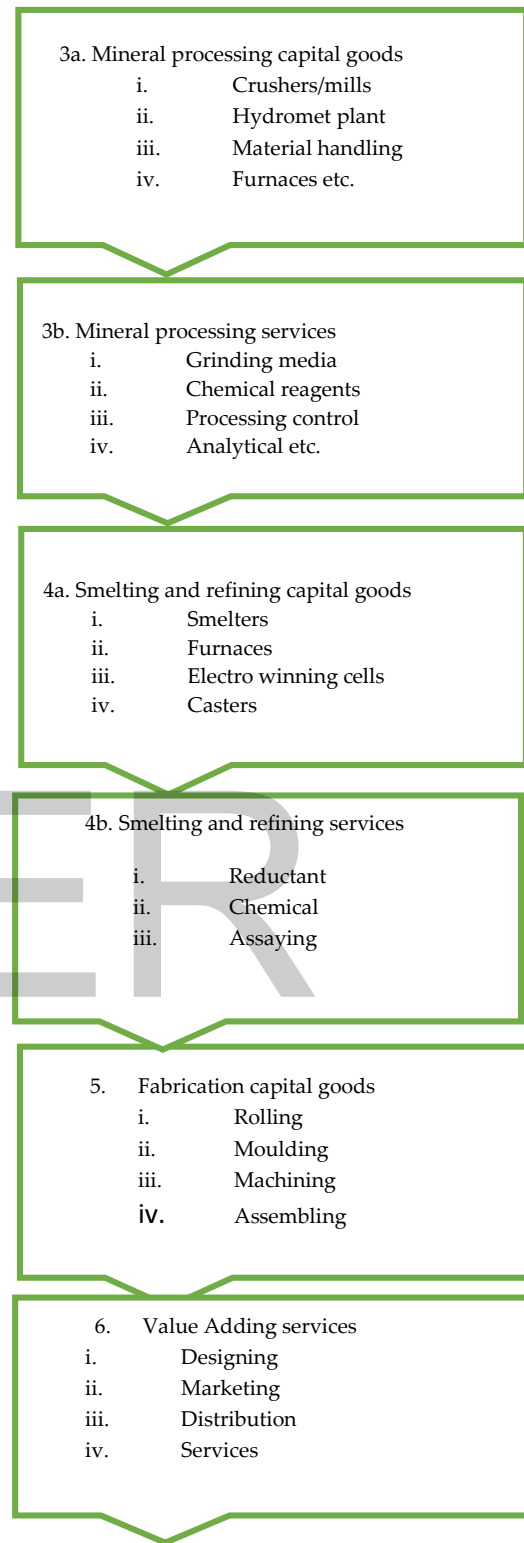


Figure 1.1

With this well-defined system above, and knowing that Liberia is endowed with rich reserves of mineral resources but, we are engaged in the first three mainly and neglecting the most profitable ones which is beneficiation that will highly increase our government revenues and national human resources utilization will increase also. Therefore, this project is routinely advising Liberian government to add value to our own mineral resources to drive economic development. It will be highly beneficial to have mineral beneficiation in Liberia to strengthen her mineral wealth for the benefit of all. Even though we have varying estimates given for Liberia's mineral resources because of our poor geological information, it is undoubtedly clear that Liberia possesses significant amounts of iron ore, phosphate, gold, diamond, columbite-tantalite, oil and gas, amongst several others.

- Despite the presence of these mineral resources, there is nothing home to talk about Liberia's value addition which is still very negligible as most of them are exported in their raw forms such as our iron ore that is exported in its DSO form. The vast and diverse mineral resources endowment of Liberia is still largely untapped. Looking at South Africa's mineral sectors, have highly developed and have great contributions to their GDP because their sectors run from exploitation down to beneficiation. For example, South Africa accounts for 1 in 10 autocats generally produced and shrinking emissions regulation will reinforce in this sector's future growth. Liberia too can be the next if we stop DSO method and venture in mineral beneficiation.
- A crucial challenge to Liberia's socio-economy's development is to widen and extend the mineral resources' impacts on the population in applying development of the Liberia's mineral's value chains. For instance, if our iron ore can be beneficiated before being exported, the steel roll for constructions prices wouldn't have been so exorbitant as it is in our local market. And also the standard of finished metal products (such as steel roll, zincs etc.) in Liberia's market will come closer to that of Westerners with affordable price than they are now, and employment rate will be increased to some extent which of course will boost our gross domestic product (GDP) and other government's revenues.
- This presented project paves a way to get enormous portion yields and enjoyed by others that should be enjoyed by the ordinary Liberians. This is a focused progressing policy based on mineral beneficiation which involves improving the economic value of a mineral by turning it into a final or intermediate product. The argument sounds logical. But the accessing rewards of this approach is not that simple but surely possible if our sector managers venture in it. One of the rewards will be

for instance, to use steel to manufacture eating pans/plates, cooking utensils washing machines for international markets, country would need to either establish its own brands and outcompete established ones, such as Samsung, Defy and Hisense, or alternatively, supply these popular producers with components. In Liberia as it is now, it is unlikely to happen but possible to happen.

3.2 Let's look at Liberia's mining sector value chain that analyzes the major costs of mining before beneficiation/value addition as we have in Liberia.

Table 1.0 ESTIMATES LIBERIA MINING SECTOR VALUE CHAIN

Mineral Production Value Chain			
	% of total cost	Value in 2011	Value in 2030
		USD millions	USD millions
Mining			
Load & haul	26.7%	11	1,505
Drilling	3.7%	1	206
Blasting	4.4%	2	249
Management and technical services	4.9%	2	279
Other costs	17.5%	7	989
Processing			
Crushing	3.8%	2	212
Grinding	19.7%	8	1,109
Recovery	9.7%	4	546
Laboratory	2.1%	1	118
Other	7.2%	3	406
Total		40	5,619

Value Chain estimates compiled from USGS survey 2010 and Achieving High Performance in Mining, Accenture.

With such expectation, Liberia can emulate China or South Africa to be a grown up industrialized country. We the Liberians can learn many lessons from South Africa or China one of the things to learn from them will be: to know and believe that it is possible to engage in resource-based industrialization. But Liberia's socio-economic is changing differently, evidence to this is shown in many researches in which it is understand that Liberia face with many initial obstacles and absence of readiness and capacity- one of the biggest barriers. However, basically this research depicts that Liberia has to swing focus from colonial mineral extraction to much broader growing rudiments in which mineral policy assimilates with economic development strategy. This is the core of this research – it makes it clear that mineral resources can play a transformative role in

Liberia’s development only if it builds appropriate social and economic development linkages that meet nationwide developmental objectives. Such linkages are of course diverse - whether this is with regard to improving equity/even-handedness and transparency in revenue collection and distribution; integrating small scale mining into rural economies, thus improving people’s livelihoods; or linking mineral extraction and to infrastructure development and the mineral fabrication/manufacture of products that support societal needs.

As per our iron ore, it should be vivacious to our infrastructures development if it’s being beneficiated before exporting. It is in this regard that I am deliberately ambitious conducting this research, it is what is needed to change the path, pace and fortune of Liberia’s mines’ mechanization and fight against poverty to meet up with the millennium’s goal. The realization of the project solely depends on solid political commitment and a will to develop a tough and capable mineral controlling systems and its institution; judicious understanding of Liberia’s relative benefits in the universal mineral value chain, take full advantage of the benefits of regional amalgamation, and establishing vigorous and beneficial relationships.

LIBERIA & REGIONAL MINING SECTOR MARKET SIZING

Mining Sector Market Sizing	Units	Liberia	Guinea	Sierra Leone	Cote d'Ivoire	Total Region
Market value of in situ reserves ¹ (2012 prices) ²						
Bauxite	USD millions	-	24,357	11,235	-	35,592
Iron Ore	USD millions	37,167	381,454	450,075	26,117	894,814
Gold	USD millions	2,605	3,165	76	14,238	20,085
Diamonds	USD millions	-	170	1,787	141	2,098
Rutile	USD millions	-	-	11,263	-	11,263
Total	USD millions	39,772	409,146	463,174	40,497	952,589
Export Value in 2011 ³						
Export Value in 2011 ³	USD millions	40	828	587	253	1,707
Export Value in 2030 ⁴						
Export Value in 2030 ⁴	USD millions	3,440	13,549	6,447	1,314	24,750

Sources: USGS survey 2010, International Trade Centre

¹ United States Geological Survey mean estimates of measured, indicated, and in most cases inferred mineral resources
² Iron ore 2030 price assumption is \$69.20, based on the mean of long term broker projections. All other prices assume no price inflation or price volatility
³ Includes export classifications 26, 71, and 72: Ores, slag, ash; Pearls, precious stones, metals, coins, etc.; and Iron & steel
⁴ Assumes production level targets of those facilities scheduled to be in operation in 2030, as reported by the United States Geological Survey

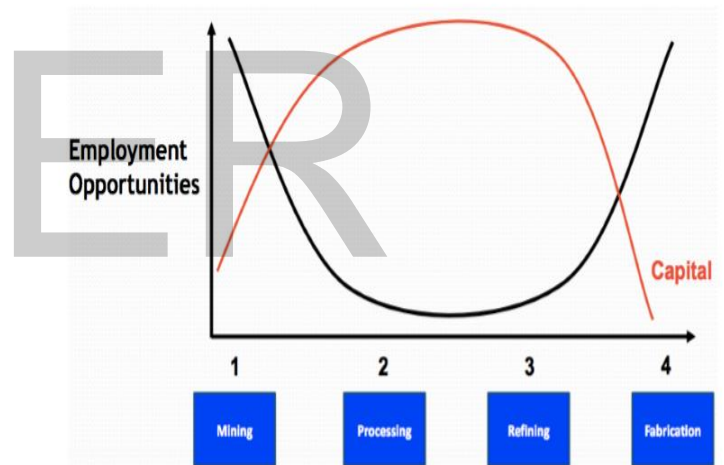
Figure 1.2

It is appreciable with above mining sector market sizing that estimates the growth of 3,400 million within less than 20 years if value addition and infrastructural development are put into place. Understanding that our economy now needs

such growth and it can be attained if Liberia changes its way of exporting unprocessed ores and bring about mineral fabrication. Although, many challenges are met by Liberians to attain mineral beneficiation which will be outlined in chapter 8 of this project which will be discussed later.

3.2 THE EVIDENCE OF HOW MINERAL BENEFICIATION IMPROVES LIBERIAN'S EMPLOYMENT RATE.

It was known during the research that Liberia’s unemployed and those are in vulnerable employment account about 80% of its population. It should be made known that the Liberia mining industries can more to provide jobs to these unemployed or vulnerable employed citizens through direct employment, indirect employment and induced employment as it was also reported by the United States Agency for International Development (UASID 2014). Furthermore, Liberia’s mining sectors managers and their



Source: Diversifying a Mineral Based Economy, EcoPartners

Graph 1.0

partners need to cover the gaps between mining companies and the local market by engaging and encouraging mineral beneficiation to maximize and increase the benefits of Foreign Direct Investment (FDI) in our mining sector for all Liberians.

One of our aims in this research is to help Liberia which is a developing country, receives huge profits from extractive industries and achieve sustainable growth with development. This can only be achieved if major contributor to our economy (mining sector) deviates from its colonial way of mining to mechanized one with direct involvement in value addition.

Mining and minerals products approximately contribute one-fourth ($1/4$) of our exports and the industry employs one-third ($1/3$) of a hundreds of thousand workers. Even with the already estimates of the mineral development agreements (MDAs) signed to date by the government between thirteen thousand (13,000) and fourteen thousand (14,000) direct jobs over the next fifty (50) to eighty (80) years will be created by Liberia government, with the maximum level of employment happening over the next 10 years, as mining projects enter construction phase. In 2027, mines will directly employ projected numbers seven thousand one hundred seventy-three (7,173) persons, based on regional job multipliers that project the creation of three jobs for every one (1) million invested in Liberia.

Nevertheless, the projection may be higher if Liberia's mineral resources or ore are converted into midway or end-products before export. If

unemployment must be decreased and increase employment rate in Liberia, the foreign investors and mining sector managers must use an adequate incentive and disincentive to carry the mineral beneficiation to next level before exporting the mineral resources. Additionally, this procedure shall deliver an adequate and appropriate inputs for mining industrial process in Liberia. Perhaps, one of the greatest needs in Liberia mining sector is the concept of mineral beneficiation that has to be developed and pertinently embedded within Liberian's Mining and Minerals policy, which will categorize the need to implement a guiding principle that shall adapt convenience sector for the development of Liberia's mineral resources wealth to its broadest potential. As it is illustrated here from the graph 1.0 above, it is understood that during mineral beneficiation employment rate is higher than the capital intensity. At this time local supply linkages are involved that creates more employments in return.

Indeed, mining sector had been main source of employment in Liberia prior to the Liberian civil war. Even looking at the influences of Liberia's mining by 1970, its contributions to Liberia's gross domestic product (GDP) and exports, concessions only employed 5% to 7% of the Liberian workable force, while the majority of the workable forces (74%) survived by their subsistence farming. Because of the enclosed ways of mining by then was entourage by corruption, foreign investors took an advantage of this and repatriate a lion share of the profits, as a result, they auto-regulated the economic benefits for ordinary average Liberians. Mining sector in Liberia had held half of Liberians' work force in 1960s-1980s, but the major parts of the profit being repatriated because of lack of manufacturing plants, mineral beneficiation etc.

It should be understood that mining sector employment positively affects Liberians' economy through employment.

If consideration is giving to mineral beneficiation, indigenous supply-chain connections will present an utmost formation of jobs opportunities as illustrated in graph 1.0. contrary to this anticipation, mining direct jobs shall comprise of scanty fraction of overall provided jobs. One of the evidence of the benefits of mineral beneficiation to Liberia's economy is that, it will create three times more than the numbers of direct jobs. According to the United States Agency for International Development (USAID) report in 2017, aggregate spending suggests mines will support 12,552 jobs (1.5% of the Liberian labor force), indirectly through supply chain linkages and induced through employee income spending. Thus, the local business linkages to the mining companies will determine the magnitude at which mining sectors provide jobs to the ordinary Liberians. The greater focus on mineral as end products will maximize the profit of mineral extraction in Liberia.

3.3 WHAT WILL MINERAL BENEFICIATION CHANGE IN LIBERIA'S GROSS DOMESTIC PRODUCT (GDP)?

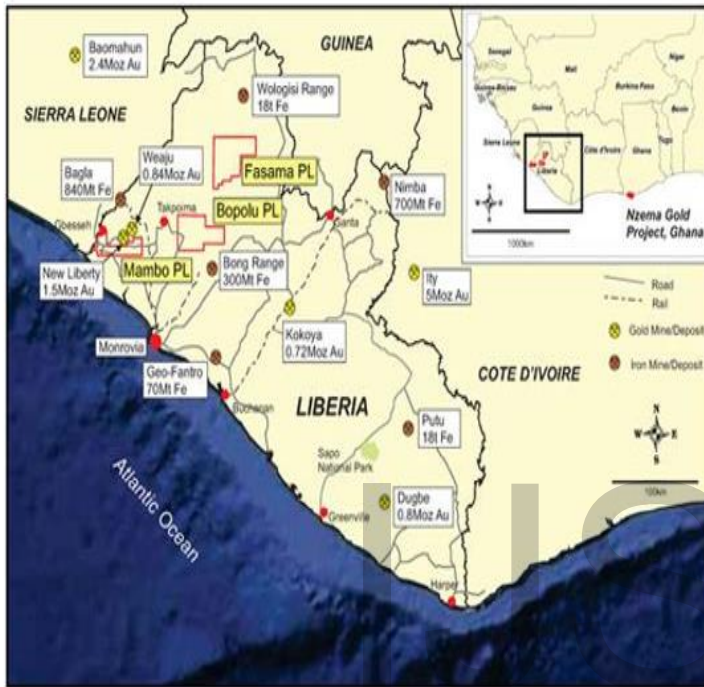
Dependency of Liberian government on mineral wealth for the growth and development of citizens' livelihood and its economy started from the discovery of high iron ore grades in, Bong, Bomi Hills, Nimba County and now even in Lofa county. Mainstay of the Liberian economy from 1960 to 1981, has been iron ore mining that had contributed more than 62% of export earnings and about 24% of Liberians' gross domestic product (GDP) (Boakye et al. 2012), because of this Liberia was the highest iron ore exporter in Africa and third largest in the world. Diamond and gold that was and is being mined, their mining is carryout by small-scale alluvial mining method, they are projected to be over 100,100 small-scale miners in the republic of Liberia. Much of Liberia's productive and infrastructures were destroyed in almost 14 years' civil war (1989-2003AD) and this war brought mining to a halt.

Here raises a big question, that is what was the impact of those days mining sector to Liberians' economy's growth and development? Past mining operations has little or nothing impact to our economy because the mining by then occurred as mostly enclosed cooperatives that has a limit relationship to the economy of indigenous. The worst thing there, was because of the over dependency on foreign workforces, and it retarded the development of Liberia's economy for the benefit of the ordinary.

Liberia's estimated three to seven billion metric tonnes of iron ore and two to three millions ounces of alluvial and hard gold. Diamond, iron ore and gold are the most concentrated mineral resources produced in Liberia. The total areas covered by Liberia's mining concessions that are operating are 113,256 ha (Ministry of Finance 2013). Putting aside the production of these minerals, Liberia is a virgin

land that is unexplored for most of its potential mineral such as, sand (zircon, rutile, ilmenite etc.) columbite-tantalite, beryl, molybdenum rare earth minerals, zinc, lead, tin, silica sand etc. The few areas explored are shown below figure 1.2 below.

Fig. 1.3 Distribution of known mineral deposits, current mining activity and mineral potential in Liberia



Operations in Liberia, Endeavor Mining, May 2014

From the end of Liberia's hostilities or civil war, recovery of mine's activities Liberia's government main object has categorically been its fortitudes to revamp the nation definitely fortify economic growth by leveraging Liberia's mineral wealth in a way of attracting immense foreign investment. According to LEITI 2016's and Rep. of Liberia's ministry of finance 2013's reports state that government of Liberia has attracted the direct foreign investment of USD 7.6 Billion and creating about 10,000 jobs. These investments among other include, construction of rail-ways, old roads rehabilitation and **new mining plant installation**, and bridges. Consequently, a legal framework was indorsed (2003–2006) by Liberians government to provide sustainable use and conservation of natural resources.

Having such resources, it's highly recommended to our local authority to install new mining plants with mineral beneficiation or value addition included, with this, it is expected that instead of 60% export earnings in 1980s will approximately increase to 75% to 80% by 2035 and

contribution of 25% 1980s to GDP will increase to about 35% to 40% or more by 2035. And this is huge contribution and benefit to our fragile economy.

3.4 THE POSITIVE EFFECTS OF MINERAL BENEFICIATION ON UTILIZATION OF NATURAL RESOURCES IN LIBERIA

Mineral beneficiation as it is in mining, it is highly needed in Liberia mining sector in order to derive the maximum benefits of our natural resources by applying the proper use of beneficiation, our depleting ores which are mostly non-recyclable in nature will fully be utilized by bringing in mineral beneficiation in which will enables the use of lean grade ore (i.e. low and high grades ores blending) to get the optimum benefits of our natural resources. Say for example in Arcelor Mittal where the acceptable grade is between 58% to 62% Fe content can use lean grade ore in blending to enhance Liberia production capacity from DSO to twofold of DOS in Arcelor Mittal Mining Company in Yekepa, Nimba county and others like China Union in Bong Mines etc. Therefore, our stakeholders should therefore, for example encourage the leader and one of the biggest Direct Foreign Investor (DFI) – Arcelor Mittal to take lead in mineral beneficiation. Research suggests clear indication that projects that combined demand of mining sectors may hit 2.2USD billion in about 2026. The demand here will be created by mining's infrastructures, that may comprise support infrastructure investments like roads and rail-ways. We can categorically place goods and services into three; and they are construction equipment and plants and core services, none core products, services and mining consumables (ventilation, cable hooks, spare parts etc.). According to the report of African Economic Outlook, (Last updated May 19, 2014). Stated respectively that, the above categories take about 65%, 22% and 16% of annual projected demand. For instance, demand for materials of the building types and even the other significant services may affect earnings for local made goods and services to the highest expectation at the time of erection stage.

Moreover, if during this transformation meets up with the period of beneficiation for example iron ore being finally manufactured as steel rolls and find in our local market; the cost of this important infrastructure material will mostly be appreciable as South Africa, Zambia, Zimbabwe and Senegal have done. Below is the Republic of Senegal's processing plant in Sambola.



Teranga, Sambola, Senegal Processing Plant (Day and Night Views) www.google/image-indianmart.com Figure 1.4



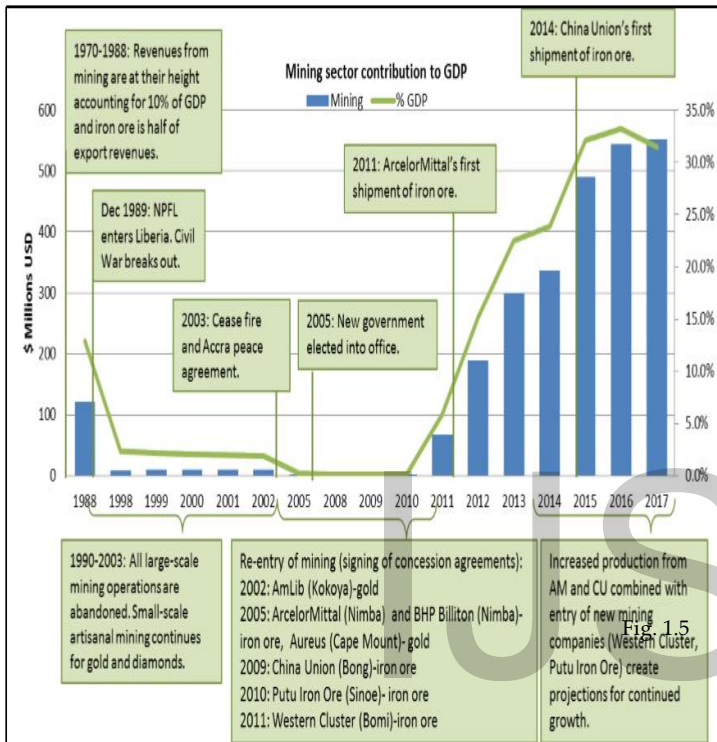
3.5 WITH THE BLESSING OF NATURAL RESOURCES ENDOWMENT IN LIBERIA, WHAT MECHANIZATION MEANS TO LIBERIA'S ECONOMY?

Mineral beneficiation as a whole is crucial in national development because we should know that mineral resources are non-renewable, in this view, mineral beneficiation helps us to better manage our mineral resources' wealth for sustainable development of Mama Liberia. It helps in nation's infrastructural development. Mineral beneficiation manages resource to avoid the resource curse and manage price volatility during the production. Mineral beneficiation will strengthen Liberia's bargaining power in the region and even in the continent because of its iron ore which 96% is used for steelmaking. Since Sub-Saharan is mostly comprising with developing countries that are in need of construction's materials such as steel rolls, cement, etc., mineral beneficiation, if implemented will greatly help Liberia to win the fight for more fiscal space by implementing self-adjusting resource tax regimes to capture dividends; and introduce innovative licensing schemes/plan to boost competition. Go beyond the "first come and first served" approach; explore competitive auctioning through differentiation of terrains (Liberia).

For example, some south African countries like South Africa, Zambia and Zimbabwe have advanced in mineral processing with the application of plants like ore crushers or Ball-Mill in crushing the rocks that are Ore bearing in mine processing plants and also some West African nations making good move in mineral processing like, Senegal Sambola's ore processing plant and Republic of Guinea has a bauxite mineral separation production line, Nigeria has cement processing plant in Kogi state. Looking at this upgrade in mineral beneficiation, its magnitude and scope can be extended, which invariably will expand its cope and magnitude of employment that will help to develop it economy. The historical experience of the U.S.A. and some European countries like Norway, for instance, has confirmed the constructive incentive of their long journeys. The thrity (30) years transformation of these two countries have made they to be the leaders in mining equipment which comprises mine drill rigs and mine dump trucks. As Liberians, we can follow their footprints, with the essential amendments in its mine liscenses and other regulatories, and then yield the small hanging fruits of resource benefaction as such DSO system in Liberia, and we leap-frog to achieve the same over a short period.

Here we can quickly gaze mining sectors' contributions to Liberians' economy development and growth at the war and post-war periods with some important events as described below in figure 1.1. which was produced by Kayla Casavant for USAID's report in May 2014.

Evolution of the mining sector in Liberia during the war and post-war periods, including key events in the sector's development



Kayla Casavant (USAID May 2014)

It is crystals clear that in Liberia mostly, economic growth and development highly depend on the mining sector operations. Furthermore, one of the best developments in the mining sector is mineral beneficiation that helps the nation to derive the maximum benefits of mineral resource wealth. To back up this, the average growth of 22% per year with double gross domestic product was noticed between 1970 and 1980 (Economic Trends, UNCTADSTAT, accessed May 2013). During this period of growth and development, Liberia infrastructures were improved by mining sectors, they built health care and educational facilities and open job's opportunities. For instance, Yekepa in Northern Liberia was transformed from village to town in Nimba county by mining company called LAMCO in the Mount Nimba with an access to well modernized supermarket, golf course, tennis courts, movie theater, swimming pool, nice community center, secured Yekepa by providing police station, pubs and night clubs and hospital.

To give another evidence of the importance of mineral beneficiation to Liberian's economic growth and development is that, all these developments mentioned above occurred only in the concession zone with little or non-impact to other economy of the country due to the lack of mineral beneficiation. If the mining companies in will embark only on direct shipping ore, that is exporting ore before processing, the many indirect and most of direct jobs mentioned earlier that take place during the mineral beneficiation will be highly limited if not terminated. However, this unsustainable extraction of our mineral resource can be discouraged and encourage value addition through appropriate incentives and disincentives in the country as it is done in South Africa, Zimbabwe and other parts of Africa for the benefits of all Liberians. In order for us to excel in our economic growth and development, we need to encourage the trends of infrastructure development by mining companies that depends on their needs, but must rather depends on the general economy needs.

With this enclaved system, internal and cross border trade that provides more jobs opportunities were not encouraged in that its rail-way system and roads that transported ore from mine directly to the sea port failed to adhere this cross border and internal trade. Additionally, this self-centered mining roads and rail-ways did not develop movement of Liberians to conduct their across distant counties or border with their goods and services. Referring to figure 1.1 above, it can be understood that Liberia's mining sector had once contributed 30%-35% of country's GDP from 2015-2017, and this can be doubled up if our local authority and foreign investors see need to engage in mineral beneficiation.

3.6 IDENTIFYING MINERAL BENEFICIATION AS ONE OF THE PRIMACY GROWTH NODES FOR JOB CREATION IN LIBERIA.

Table 1.2 shows the categories of labor in the mining sectors.

Category of Labor	Education level or experience	Examples of employment
Unskilled	Sometimes, school knowledge is desired, even without credentials. It's through workshops and on-site training provide needed skills to do the tasks.	<ul style="list-style-type: none"> • Line cutters • Miners
Semi-skilled	Here vocational education is needed for relevant skill. Some experience of mining needed, particularly, some site training is essential.	<ul style="list-style-type: none"> • Truck drivers • Heavy machinery operators • Drillers • Geologists • Mining Engineers • Administrative staff • IT technicians etc.
Skilled	University education like Bachelor or Master's degree or their equivalent in an appropriate field. It's highly recommended to have experience of mining.	

Liberia is a country where almost 78% (820,000 population) of the work force (i.e. ages 15 onward) is unemployed or in vulnerable employment, the needs of jobs' creation should be high on government of Liberia's priorities. Even though some of the mining companies are shut down now due to ore price fluctuation in the international market, Liberia's national labor force is generally expecting mining sector to make a substantial contribution to creation of employment. In the meantime, in Liberia, gold mines employ about 200 to 500 and those that are into iron ore business are projected to employ about 2500 to 5000. Now Liberia has about 45 active mines and the expected ones that are processing their licenses are estimated to employ directly in Liberia in the next 30 to 70 years. This projection considers both direct and indirect employment; mining companies' employees, even those contracted companies that provide goods and services to the mining company. Operation of mining company is a capital intensive and operating it requires sophisticated technologies operated and maintained by professionals that have technical know-how; hence, it requires high capacity from the employees. According to the report of Liberia Institute of Statistics and Geo-Information Services, 2011, lack of Liberians' employability directly through the mines is due to low capacity building and lack of mining professional experience. Thank God, today we some young and potential

Liberians with expected capacities in various mining engineering disciplines.

With the consideration of the statements above, the clarity of mining employability is largely lie on indirect employments. That is work created by contracted companies in a mining sector that provides goods and services to the mining company, this will vividly be understood through the mines employees induced effects or spending their money in local economy. The discuss here supporting the jobs opportunities providing directly and indirectly by the mining sectors in response to the Liberia's human's capacity building. Then, with mineral beneficiation that involves in more jobs creation as indicated by graph 1.0 above will increase local businesses' incomes through indirect employment in Liberia.

It is essential to provide the future jobs' market needs of mining sectors which is important to increasing jobs opportunities for Liberians. Categorization of employment in mining sectors are into three: Skilled, Semi-Skilled and Unskilled. These categories are defined by table 1.2.

Mining is capital intensive business that needs professionals to operate and maintain its sophisticated machineries. In Liberia one of the challenges in mining sector employment opportunities for Liberians was and/is qualified geologists and mining engineers which was and/is lacking in Liberia labor force as needed by the companies. But, I think now is much better, because of the number of fresh graduates with bachelor degrees in geology and mining engineering and expecting more to come from the University of Liberia (UL) and young Liberians with Master degrees in geology and mining engineering that can now serve the mining companies with the expected capacity. With all of these positive changes in Liberia labor force, our local authority/stakeholders plus mining companies should see need to bring in mineral beneficiation in Liberia which will make better use of our human resources. Our mining sectors' managers should see Beneficiation as a major way of improving nation's economy with a driving forces to change economic opportunities for Liberia because it is an ultimate prospect that is needed to underwrite towards balanced spatial economic development standard. Liberia that endowed with the blessing of mineral resource escalation of mineral beneficiation will represent win-win phenomenon for Liberians including participants (direct foreign investors) across the various mineral value chains.

CHAPTER 4

4.0 METHOD OF RESEARCH

The past studies' data (primary and secondary data) collected are some of the sources of this research project, information gathered from mining sector managers' workshops on mining sectors assessment centered on past research or study reports and interviews' information and evolution mining sectors in Liberia with administrators in the ministry of lands, mines and energy of the republic of Liberia. Opportunity was gained to view and review relevant documents on policy in order to establish tendencies and make known some relevant issues of mining sectors, and such documents were Liberia Mineral Development Agreement and reports of the current mining companies. To establish facts on current local suppliers, the combination of information gained from Mineral Resources department of South Africa, mining buyer's surveys, Liberia institute of statistics and geo-information, building markets, local suppliers' databased and other studies and findings. Interviews with some instructors at the department of geology and mining engineering, University of Liberia also helps to inform about employment aspect of the project. For the purpose of research, please term local supplier refer to all registered businesses that are present in Liberia physically, either owned by foreigners or Liberians.

4.1 EXPECTED OUTCOME

- I. **Increase in mining sectors annual expenditure:**
It's projected that demand annual cumulative demands of mining companies will elevate to 2.4 USD billion in 2026. Due to fluctuations in ores prices that cause low production, this projection may be extended to 2030. This increase mining sectors spending will be due to mining sectors infrastructural development such as rail-ways and roads.
- II. **Jobs creation through local supply chain linkages.**
Mining jobs opportunities created by mineral beneficiation is mainly in an indirect jobs market. With mineral beneficiation, indirect jobs will triple the number of job's opportunities in Liberia. In about 2030, aggregate expenditure projects that mines shall support 13,554 jobs (2.02% of Liberian labor force) indirectly over and done with supply chain connection and induced through employees' income spending. And so, the mining sectors ability to provide job's opportunities depend on its supply linkages with the nation's economy or local businesses.

Unpreparedness of local suppliers for local track down prospects.

- III. Lack of supports from the mining sectors, has rendered local suppliers inadequately prepared for supplying goods and services to mining companies in Liberia. For instance, in current mining procurement, the firms that account 40% Liberian undertaking or ownership are just 12 to 13% for procurement expenditure currently in Liberia. If mineral beneficiation will be in the list of priority of iron ore companies in Liberia, the involvement of local suppliers in supply chain linkages will be tripled which will help to develop Liberia's economy to benefit it ordinary citizens.

The research here qualified local beneficiation to a point where local iron ore or other raw materials, labors or capital are used to produce goods and services. The qualified or registered local businesses that are relevant in supply chain linkages are growing, but their requisite delivery capacity is still low to satisfy the mining companies. Technical and financial constraint make it difficult for local businesses to make it to the level of quality, price competitiveness and scale of mining sectors demand. Although, some local businesses are dynamic and competitive yet, their businesses are scanty in size lacking behind to meet up with the formal business format that are essential for cooperating in business. Most of the local businesses in Liberia are only engaging in supply goods and services that are not essential to the mining companies.

- IV. **Direct jobs limitation due to labor force deficiencies:**
With the application of mineral beneficiation, and preparedness of Liberia labor force in terms of well managed workshops and trainings by mining experts, Liberia direct mining jobs market is expected to increase 12,000 to 15,000 over 30 to 60 years, with its highest level occurring within next ten years. Base on regional job multipliers, mine will approximately employ 7,217 persons directly by 2030. Conversely, mining and geology departments of the university of Liberia are strongly advise to practically involve the school attendant mining and geology students in updated curriculum activities and internship that will prepare them for current job markets. If Liberia mining labor force is not being reinforced with the required activities the result will be the hiring of

the skilled and experienced expatriates for long and short term. Since limited educated and experience are major causes of this, Liberia government and industries are encouraged to concerted mining experience and skills developing programs for mining and geology students before or upon graduation.

V. **Lack of regulations and policies making and implementation:**

Employment of local staff and local procurement are limited due to lack of understanding the local content of the mining law and framework. As the result, Liberia mining system has been like fractional efforts with different approaches and procedures across mining agencies. Overlaps in monitoring and implementation of different pieces of legislation led to poor coordination and regulatory overload.

4.2 CHALLENGES

Despite the significant amounts of mineral resources held by Liberia, most of her mineral products are exported in raw form. Therefore, in order to unlock Liberia's mining potential, it needs to overcome the challenges that hinder the development of the mining industries. Revenues produced from mining can help Liberian's economy fortification of its comparative advantage and achieve greater economic variation. To achieve the goals of this research, many obstacles are on the way and overcoming them will strengthen Liberian mining industries competitively in regional and international wise. Chief among them is the exportation of raw products from mines without beneficiation or downstream processing. Others are including but not limited to:

- I. **Bad road networking:** In Liberia is a serious impediment to mineral beneficiation in the country. Some parts of Liberia that are richly endowed with mineral resources are almost inaccessible for mining development. For example, Lofa County is enriched with mineral resources markedly with, Columbite, iron ore, tantalite, diamond, gold etc. but the county has deplorable road condition.
- II. **Low industrialization of the industry:** Even though Liberia is blessed with many needed mineral resources, still the country remains underexplored. Exploration activity expenditure in Liberia is below \$5 per square kilometer as compare to unweighted average of six-five USD (\$65) per square meter in Australia, Canada and Latin America. Moreover, most of the minerals produced in Liberia are still exported without

downstream processing, thus, reducing value addition.

- III. **Lack or Low energy availability:** Processing plants as a whole need significant amount of electrical energy supply in order to keep the plants operating. At least 60% of mining cost is found in here. Most especially, Liberia needs to reenergize its epileptic electrical power supply. Without this, it's almost impossible to venture into mineral beneficiation which needs a stable electrical power supply.
- IV. **Low national capacity development in human, technical and financial resources** needed to improve national investment and development of the mineral resources sector in Liberia.
- V. **Lack of coordination between government agencies** such as National Bureau of Concessions (NBC) Ministry of Land, Mines and Energy (MLME) etc.
- VI. **Lack of unified market** that consumes what it produces. This also has created brand loyalty in our local market.
- VII. **Lack of harmonized regional development policy** for the mineral resources sector by national economic communities that provides a clear framework for coordinating and monitoring the activities of the sector.

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CHAPTER 5

5.0 CONCLUSION

In order for any country to succeed in today's competitive market, that country must increase its products' efficiency for the existing companies' activities so that they will completely gain available opportunity to overcome competitive advantage over the other companies in the region. Among many possible activities, cost reduction in mineral beneficiation is regarded as one of the core areas presenting enormous opportunities. A nation, Liberia known to be blessed immensely with impressive mineral reserves and traditionally, Liberia has been depending on mining revenues from, gold, diamond and iron ore companies in 70s to 80s as main incomes. New growth in mining sectors is with potential to significantly contribute to the employment, generate income and develop Liberia infrastructures if our stakeholders engage in mineral beneficiation will benefit the same.

This research project is mainly about the benefits of the mineral beneficiation to Liberia's economy in which it is understood that the contribution of three-quarters of Liberia's exports and improvement in employment that have been made by mining sectors can greatly be enhanced if mineral resources will be beneficiated as finished or intermediate goods before exporting. Liberia mining sectors' managers should make an attempt to endeavor in mineral beneficiation.

Furthermore, this research provides great inputs for manufacturing in Liberia. The ultimate objective of the project is to give appropriate recommendations for various mineral beneficiation's terms such as, long-term, medium-term and short-term in Liberia. Looking at 2013's report, 24th place was occupied by Liberia as iron ore producer in the world after just three years' production (BGS, 2015). This was and it is still done in "Direct Shipping Ore" (DSO), which displays that Liberia has ones of the highest iron ore grades (ranges from 34.34% to 62% Fe content) in the world with little benefits to Liberia itself in term of human's capacity building, contribution to Liberia's economy (government revenue and employment rate etc.).

Liberia is the land of gold, columbite-tantalite (Coltant) and diamonds among others and then, jewellery fabrication is another labor intensive value chain that will beneficiate these minerals.

Also value chain interventions such as: (a) Establishment of a metal advance scheme (b) Promotion of existing incentives in the jewellery sector. Value addition of our mineral resources is recommended in order to fast track Liberia's economy growth to tackle the challenges in our country's (LIBERIA'S) development agenda. With the application of below recommendations, our nation's mineral resources will benefit our struggling economy.

5.1 RECOMMENDATION

1. Based on this research, it is recommended that Liberia should incentivized a market that is unified and should consume her products and export them when they are beneficiated.
2. Liberia has to invest in her human resources and physical infrastructures like electricity power-supply, bridge, roads and rail-ways. These are critical and driven factors for industrialization and beneficiation of any country which are seriously challenging to Liberia.
3. From this research, it is recommended to establish joint facilities for applied research, specialized services and training, especially for geologists and mining engineers.
4. To eliminate DSO in our existing mining companies and encourage turning our iron ores to finished products. Direct shipping ore method is with no or little benefit to nation's economy and it quickly ends the life of mine with its colonial way of mining.
5. Well detailed knowledge of Liberia mineral inventories of the existing and potential mineral resources. Most importantly, the research of rational use Liberia unrenewable resources for sustainability of our reserves. With mineral beneficiation, it easy to build the basic industries that make up intermediate products such as; iron and steel, aluminums, base metals. In the economic assessment of the resources account should be taken of the structural variations which have transpired in the world due to the effect of the energy crisis, the new technologies as well as the augmented needs for local consumption of some raw materials.
6. In order for Liberia to benefit from her mineral resources, grade control and

- blending of ores is a shared practice in almost all mines of world, notwithstanding in changing degrees. And it's highly recommended grade control and blending should be employed here in Liberia in order to help us maintain our depleting mineral resource. Grade and blending is carry out to have a constant feed in term of the mineral grades toward circuit, and even for balancing factors that affect ore comminution like ore hardness in the bid to preserve process equipment.
7. It is highly recommended that, Liberia should create as a nation or institution level of industrial environment, technical backup with an efficient scientific research center that assist in development of mineral extraction in Liberia. At this, focus should be shifted toward the reinforcement of the strength of Liberia national department mining Geological surveys. This will be done in order to promote the ideas of bringing in multi-departmental centers for mineral resources development that will enhance the techniques of research.
 8. Finally, there will be a need of Science and engineering college coming together to correlate for domestic programs of of geological research and mineral surveys at the regional levels in view of increased efficiency and establishing a cooperative operational activity. Of particular importance will be co-operation among the science college and geology and mining departments of engineering college for exploitation of the resources of the sea-bed.

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Author's Information:

Name: Ousman Kante
Contact #: +231776027727/+231886782651
Email Add: ousmankante34@gmail.com

School: Department Of Mining
College Of Engineering
University Of Liberia

Address: Monrovia, Montserrado County
Liberia, West Africa, Africa.

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