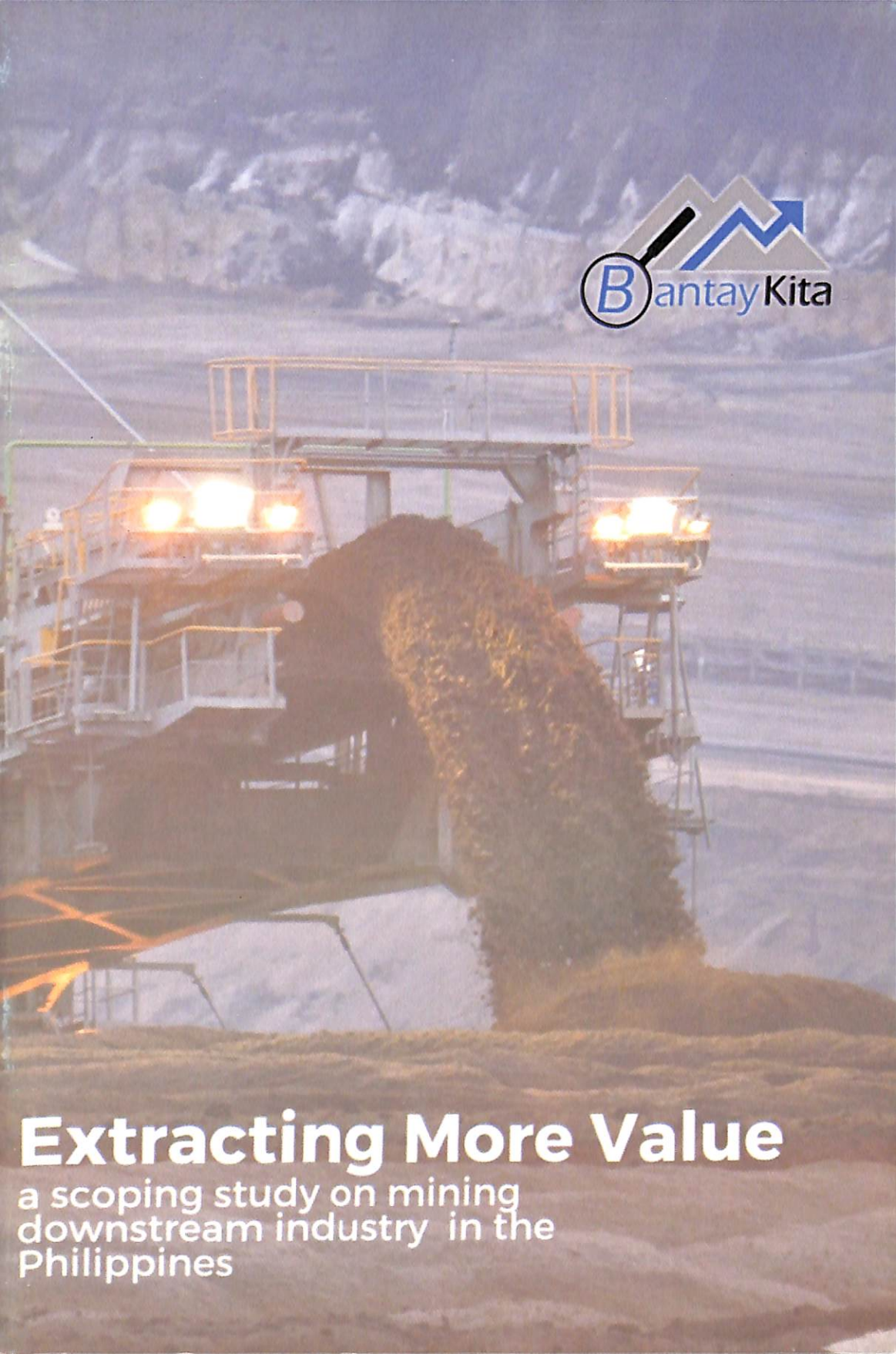

Extracting More Value

a scoping study on mining downstream industry in the Philippines

ABOUT THE AUTHOR

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I. Introduction

Production process is basically divided in into three, the upstream sector and midstream sector and downstream sector. These terms are used to differentiate between steps in the production process of several industries such as the metals industry, oil, gas, biopharmaceutical and biotechnology industries. The upstream sector focuses on the exploration and production or extraction of raw materials while the downstream sector refers to its refining, processing, and distribution (Salinger, 1989). Midstream refers to the storage, marketing and transportation and is sometimes lumped together with the downstream sector. In the oil and gas industry, downstream refers to operations that take place subsequent to the production phase, where petroleum crude oil is refined and the purification of raw natural gas is processed (Gary and Handwerk, 1984). In the mining industry, upstream refers to the exploration of ore reserves, extraction or mining and processing or refining while the downstream sector refers to the production manufacturing and transportation into the industry or retailer.

In the Philippines, there are 44 operating (large-scale) metallic mines as of the second quarter of 2015 (Mines and Geosciences Bureau, 2015). The most common metals that are produced are gold, silver, copper, nickel, iron and chromite. Mining and extraction of these minerals are primarily governed by their properties. Generally, the flow of ore is mill, smelter, and refinery. In the following section, basic processing of gold, silver and nickel will be discussed.

II. Gold and Silver

Gold has been one of the most known mineral because of its value and beauty. Its properties and characteristics –ductile, malleable, and resistive to corrosion –make it easier to work with than all other metals. Gold is mostly mined in its pure form or in nearly pure state. The naturally-occurring gold-silver alloy is called electrum. Gold also occurs with mercury (gold amalgam), sulfides and telluride-bearing minerals.

Silver is usually found with other elements. In fact, considerable amount of silver are recovered from extraction of gold. Silver also occurs as a constituent of lead, copper, and zinc ores, and half the world production of silver is obtained as by-product in the processing of such ores. Silver and gold ranks 66th and 75th, respectively, in the abundance of elements in the Earth's crust (Mines and Geosciences Bureau).

As of the second quarter of the year 2015, there are six large-scale gold mines operating in the Philippines. These mines produce gold as well as silver. Some of the copper mines also have gold and silver (Mines and Geosciences Bureau, 2015). Gold and silver are found to occur together in the same ore most of the time. With gold being the primary metal being extracted, silver is recovered in the latter part of the process.

III. Processing

Processing of gold ores has become a site-specific choice of techniques and processes, depending upon mineralogical, chemical and metallurgical factors. Gravity concentration is one of the oldest yet a very popular technique in separating gold. Because of density differences between gold and

the gangue materials, it is easier to obtain the former. Gravity concentration generally includes different combination of the following operations: communition, wet grinding, and granulometric classification of the mineral particles, multi-stage concentration, concentrate recovery and residue discard (Kongolo & M.D, 1998).

Usually, gold particles in ore are too fine to be efficiently concentrated by gravity methods. The gold is then leached from the ore by cyanidation. In cyanide leaching, "a cyanide solution, or lixiviant, is percolated through ore contained in vats, columns or heaps. Gold is dissolved by the cyanide and then removed from the heap or columns. It is then extracted from the pregnant leach solution by adsorption on carbon or resins. This cost-effective, proven method of ore extraction provides maximum recovery for many gold ores, including low grade and some refractory ores (SGS Philippines - Cyanide Leaching - Mining, n.d.)." Nowadays, carbon-in-pulp (CIP) and carbon-in-leach (CIL) recovery are majorly used for higher recovery of gold. Activated carbon effectively removes the gold from the cyanide, as the gold is adsorbed into the pores in the carbon.

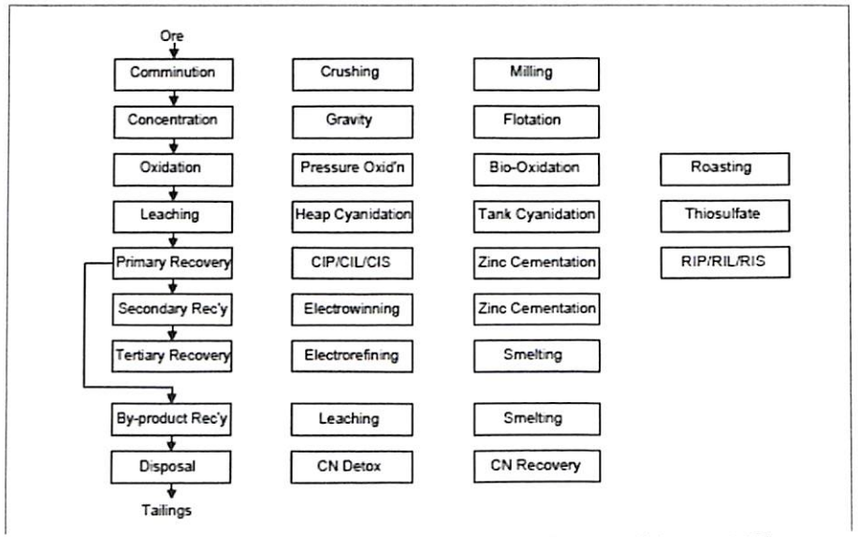


Figure. 1. Generic flowsheet for processing gold-containing ores (Adams, 2005)

Mineralogical and metallurgical investigation of ore properties must be thoroughly done before selecting unit processes. Figure 1 shows all the other processes that can be used alternatively in treating gold ore.

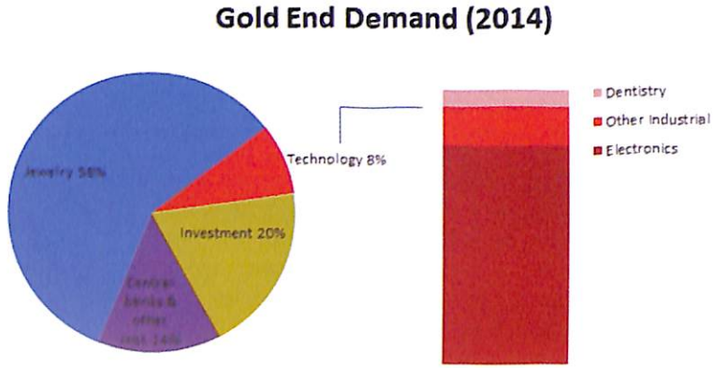
In the Philippines, production of silver mainly comes as by-product of gold or copper ore. During cyanidation of gold ore, silver dissolution also happens because of its affinity to cyanide. Silver and gold are then recovered by electrowinning and continuous zinc cementation (Adams, 2005).

IV. Production

- According to Mines and Geoscience Bureau, the production of gold and silver in 2014 was 18,423 kgs and 23,005 kg, respectively (Mines and Geosciences Bureau, 2015).
- The total export of gold and silver in 2014 was valued to be 3.04 million US$ (DTI-EMB, 2015).

End Demand of Gold and Silver

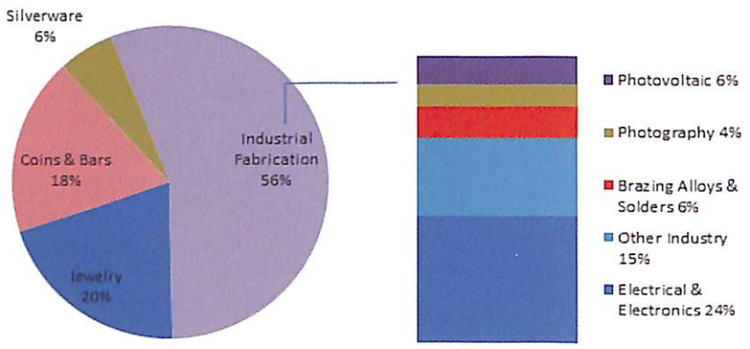
According to the World Gold Council, there was a total of 4217.4 tonnes of gold demand in the year 2014. The jewelry manufacturing still has the highest demand on gold, followed by investment, and technology with electronics as its major component, and investment (bar and coin demand). The combination of central banks and other institute has the lower demand.



Source: (World Gold Council, 2015)

The largest silver demand in 2014 came from the industrial application which is 56% of the total silver demand (30.334 tonnes). On a regional basis, this percentage can be accounted for the increasing industrial demands of developing countries such as China and Taiwan (The Silver Institute, n.d.). Electronics, alloys and solders, photography and photovoltaic constitutes the industrial fabrication demand on silver. Having several working properties similar to gold, silver also plays a major part in the manufacturing of jewelry. Lastly, coinage also relies on silver usage.

Silver End Demand (2014)



Source: (The Silver Institute, n.d.)

Jewelry Processing

In the past, native gold without addition of strength reinforcement are crafted into ornaments. But usually it is still alloyed with copper or silver for practical purpose. Gold is too soft in the pure state for the purposes to which it is generally applied. The former renders the gold more red and the latter metals paler than their true colors. So after the recovery and refining of gold, new set of process will be used depending on what end output is wanted for it. In the case of jewelry manufacturing of gold, assaying is done to measure the amount of gold.

Gold Assaying

There are five main assaying techniques, fire assay, ICP Spectrometry, X-ray Fluorescence, Touchstone and Density measurement.

The most common among the five is the density measurement. Density Measurement makes use of the high density of gold (19.3 g/cc) and the fact that the density of gold alloys decreases as caratage decreases. For instance, "14 ct golds have densities ranging from about 13.3 g/cc for a red gold to about 14.6 g/cc for white gold; 18 ct golds have densities in the range 15.15 - 16.0 g/cc (World Gold Council), However, density is determined not only by gold content but also by the actual content of every other constituent in the alloy. This method is thus not generally recommended.

In fire assay, "a weighed sample of pulverized rock is melted in a mixture of flour, lead oxide, soda, borax, and silica within a furnace at temperatures that range from 900–1,0001C. The lead oxide is reduced easily to the metal, which collects the gold, and this lead–gold melt separates to cool as a button. The button is then re-melted in a bone-ash cupel, which absorbs the lead oxide formed but leaves behind a bead of gold that is weighed to obtain the ratio of gold to rock (Adams,

2005)." In the possible presence of silver or platinum, nitric acid is used. By dissolution, the impurities are removed leaving the gold and *pgm's*.

The most basic assaying technique is the fire assaying technique, which is ideal for the determinations of the gold content of alloys with 30 to 99.9% gold. It is imperative non-metallic impurities be removed before sampling; thus, the technique may be used directly to samples from cast products, ingots, semi-finished or finished articles of jewelry and metallic scrap pieces.
The technique, however, has limitations on gold alloys with nickel as nickel may stay in the cupel as a black scale which can contain some of the gold, and does not immediately dissolves in molten lead. It also has limitations on gold alloys with palladium but without nickel, as it is possible that some palladium will stay in the gold bead even after parting and cupellation. Lastly, the technique has limitations on gold alloys containing insoluble platinum group metals (pgm's), such as rhodium, iridium, ruthenium or osmium, as the metal's resistance to oxidations and acids causes them to be carried over with the gold, thus affecting the accuracy of the final assay result.

Other techniques include the field of ICP (inductively coupled plasma) spectrometry which has found application in some laboratories for analysis of gold with an accuracy of nearly 1 part per thousand. According to the (World Gold Council), "the technique is done by dissolving a small test sample of about 10 - 20 mg in a hydrochloric/nitric acid mixture and buffering it with a solution of copper chloride and sodium nitrate. A precision weighed amount of the solution is analyzed in the instrument together with reference solutions for calibration and standardization. The instrument measures the atomic emission lines for every element present in the sample. The intensity of emission is related to the amount of the element present in the sample."

Another technique is the Touchstone test. The test is conducted by "taking a rubbing onto the touchstone from the article to be tested. A similar rubbing is taken from a touch needle of known caratage and color so that a direct comparison can be made between the two. Various touch acids, usually nitric acid of increasing strengths for the different caratage ranges with perhaps other additives, are applied in turn to the rubbings by a dropper. After a suitable time has elapsed, a filter paper is used to soak up the excess acid and a visual examination of the rubbings is made. If the test rubbing is a darker color than that of the touch needle, or has even completely dissolved, it can be assumed that the test sample is of lower caratage than that of the touch needle (World Gold Council)."

A growing popular technique is x-ray fluorescence spectroscopy (XRF). Here, a sample for testing "is placed in an x-ray chamber and irradiated under appropriate conditions, with automatic display of analysis results via a computer terminal. The surface of the jewelry is bombarded with radiation and this causes the emission of x-rays, which are collected and measured in a spectrometer. The different metals of the alloy emit x-rays of different wavelengths and the amount emitted will depend on the relative number of atoms of that metal present (World Gold Council)."
There are a number of modern production technologies that dominate gold jewelry manufacturing: [1] Lost wax (or investment) casting; [2] Stamping (and other cold forming technologies); [3] Chain-making; [4] Hollow-ware [5] Electroforming; [6] Soldering and other joining techniques

(welding); [7] Finishing (polishing and texturing); [8] Manufacture of rings. There are also some newer technologies entering into the sector, including some that are rapidly gaining acceptance in the industry. Many are adaptations of engineering technologies that have been tailored to the needs of jewelry manufacturing, (Corti & Holliday, 2010).

Alloying

Alloying is done in either an induction furnace or a casting operation, depending on the alloy. If an induction furnace is used, the alloy is poured into bars or ingots for future use. While the combining of metal elements into an alloy may seem obvious, the process requires close control to avoid contaminates and oxidation

Casting

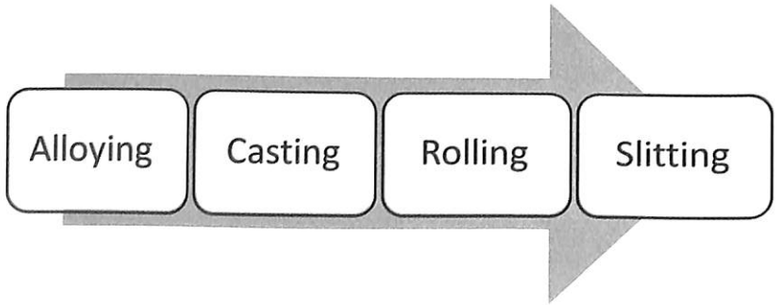
Casting re-melts the alloyed material and converts the alloy while in the liquid state to a cast strip or rod. The casting process requires a starting bar for the liquid-state metal to cling to; once the starting bar is in place, it slowly draws the liquids metal through a die to form cast strip or rod with the proper cross sectional dimensions. The result is a uniform bar or rod ready for subsequent processing.

Rolling

Rolling reduces the thickness of as-cast strip to the final dimensions required to stamp customer preforms or microstampings. Often, several passes through rolling mills are required to reach the final desired thickness. Metal is fed through the rolling mill at a predetermined temperature, pressure and speed to ensure creating the final desired properties. Precision gauges are used throughout the process to closely monitor strip thickness. Sometimes repeated rolling of the material causes it to become overly hard or brittle. In these instances, the material is annealed to soften it in preparation for subsequent rolling operations.

Slitting

Once the rolled strip has reached the specified thickness and hardness, the material is slit to the desired width and cut to the necessary length, then rolled onto a coil ready for stamping.
Basically, the downstream processes for the output products of gold is alloying, casting, rolling and slitting.



Electronics

Electronic devices use very low voltage and currents that can be easily interrupted by corrosion at node. This is why gold bested other conductors. Aside from being a good conductor of tiny currents, its resistance to corrosion makes it important in the manufacture of electronics. Connectors, relay contacts, soldered joints, edge connectors of memory chips and microprocessor all contain gold. Since gold is soft, it is alloyed with nickel and cobalt to increase its durability (Geoscience News and Information, n.d.).

The most common process in electronic product manufacturing that uses gold is electroplating. It is the application of a metal coating to a conductive surface using electrolytic process. The material subject to electroplating is cleaned first –removed the dirt, polished uneven surfaces, and rinsed. During the electroplating process, the gold in the plating solution will deposit to the surface of the material which acts as the cathode. Usually an underlying layer, nickel plating, is done first before gold coating. "Parameters such as current density, temperature, agitation system, bath pH, bath concentration and also plating time playing very important roles in the performance of the plating quality" (Kumar, Pande, & Verma, 2015).

Electronic products continued to be the top earner and major exported commodity for 2014. The Philippines have exported electronic products worth 26.79 billion US$ (Philippine Statistics Authority, 2015). Semiconductors such as capacitor, diodes, integrated circuits and resistors consists the 60-65% of the exported electronic products.

Dentistry

Dental wires, dentures, fillings, inlays, crowns and bridges may sometimes contain gold, silver and other metals. In fact, dentistry takes 5.7% of the technology category in the global gold demand (World Gold Council, 2015).

Gold foil are used for filing the cavities in teeth but since gold is not afford by everyone, there has to a substitute for it. In 1833, an amalgam of silver and mercury was introduced. For inlays, crowns and bridges that are used to repair the surface of a tooth, gold alloys are usually the choice of materials. This alloy consists of 70-80% gold with silver, copper and small amount of platinum.
The reaction of between the oral environment and these metal alloys had been primary concern in the past. Damaging reactions can be reduced by "two mechanisms: the alloy can either be noble or become passive. If the material is noble, it does not react to the oral fluids. Gold and the platinum group elements (platinum, palladium, rhodium, ruthenium, and iridium) are intrinsically inert in the oral environment. Iridium, ruthenium, and rhodium are difficult to fabricate. The cost of platinum has restricted its widespread use as a dental material (except for one brief period of time when gold was more expensive) thus leaving gold and palladium as the primary metals for use in dentistry" (Cascone, 2010).

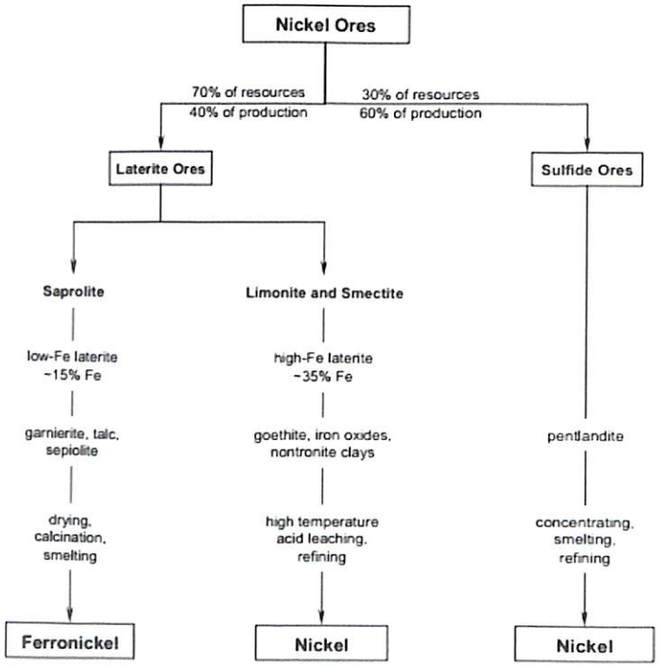
Nickel

Nickel is a hard, malleable and ductile metal commonly used as an alloy together with copper, steel, iron, cadmium and many other metals. Nickel is of high interest in a number of manufacturing

industries because of its strength and corrosion-resistant properties. It is usually used as a protective coating for corrosive metals such as iron and steel (Mines and Geoscience Bureau, 2004). Nickel is used in making stainless steel which in important in automobile and machine parts, especially in more demanding applications like in gas turbines and chemical plants. Nickel also forms alloys with iron for electronics and specialist engineering and copper for coinage systems and marine engineering (Nickel Institute,). Nickel also acts as a catalyst for certain chemical reactions. With its abundant use, it is no wonder that the demand for nickel in the market remains high for so many years.

Processing

Nickel ore usually occurs in two different forms, lateritic and sulfidic, each having its own set of processing steps. Sulfidic ores, which are often found to be associated with copper-bearing ores, requires flash smelting or electric smelting for processing. Lateritic ores, on the other hand, are associated with weathering processes in tropical countries and requires drying and acid leaching. Because of their different compositions and mineralogy, they require different methods of extraction. Saprolite, which has relatively low iron content, is smelted. Limonite and smectite ores, which have high iron content, are leached and refined (Crundwell, Moats, Ramachandran, Robinson, & Davenport, 2011). The minerals that represent each type of ore are also shown below



Sulfide ores commonly uses flash melting, wherein the dry ore is fed to an oxygen-enriched furnace to oxidize the iron and sulfur in the ore. The resulting smelted concentrate forms a liquid matte (upto 45% nickel) which is again subjected to oxidation processes to remove the remaining iron and sulfur. Electric smelting is used for more complex raw materials, employing an additional roasting step to reduce sulfur content and volatiles before smelting.

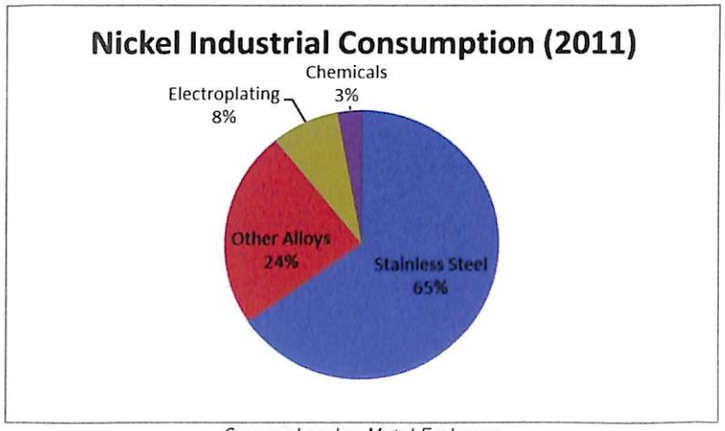
Lateritic ores which contains a high percentage of free and combined moisture undergo drying in a reduction furnace, reducing chemically bound water and nickel oxides at the same time. Hydrometallurgical processes based on ammonia or sulfuric acid leach are also used for betterrecovery. Some laterite smelters also add sulfur to produce a matte which will be subjected to further processing.

The resulting nickel matte are further refined using fluid bedroasting and chlorine-hydrogenreduction, producing high grade nickel oxide (>95%nickel). Vapor processes such as carbonyl process, and electrowinning technologies are also used for refining purposes (World Bank, 1995)

In the Philippines, two types of nickel ore, namely saprolite and limonite. Saprolite is defined as nickel ore with iron content of less than 20% and limonite as nickel ore with iron content of 20% or higher. Both types occur in the Philippines but the laterite deposits had been historically more economic than the sulfide deposits (Nickel Asia, n.d.)

End Demand of Nickel

Because of its corrosion resistance, workability (that is, ease of manufacture), strength at high temperature, nickel is a very valuable ingredient in stainless steel and all other alloys. Almost 90% of the total consumption of nickel goes to alloying. Small portion of nickel demand are for battery manufacturing (nickel cadmium), foundry casting, and catalytic purposes.



Source: London Metal Exchange

Production

Philippines is one of the leading supplier of nickel. In 2014, the total nickel export is 2.04 billion US$ (DTI-EMB, 2015). At the end of Q2 of 2015, a total of 27 nickel mines are operating at a large-scale basis (Mines and Geosciences Bureau, 2015). There are two nickel processing plants in the country, both uses high-pressure acid leach (HPAL) process. Low-grade limonite ore from Rio Tuba Mine and Taganito Mine are fed to Coral Bay HPAL and Taganito HPAL to produce mixed cobalt-nickel sulphide concentrates (Nickel Asia Corporation, n.d.). The mid-grade and high-iron limonite ore are directly sold to foreign customers. In Jan-Sept 2015, nickel industry produced 61,199 DMT (12.8 Billion Php) of mixed cobalt-nickel sulphide and 27,431,487 DMT of nickel ore with a value of 32 billion Php (Mines and Geosciences Bureau).

Stainless Steel

Stainless steel, an iron-containing alloy with at least 10.5% chromium, is resistant to rusting and corrosion and can withstand high temperature. The most common alloying element for stainless steel is nickel. "Nickel increases resistance to oxidation, carburization, nitriding, thermal fatigue, and strong acids, particularly reducing acids. It is an important alloying element in stainless steel and nickel-base alloys used for corrosive and high temperature applications" (Stainless Steel World).

Basically, the process of making stainless steel is just alloying. The iron ore, chromium, nickel etc. are melted together in an electric furnace for 8 to 12 hours. The alloy is cast into different shapes to form blooms, billets and slabs. The initial steel shapes are hot rolled into bar, wire, sheet, strip, and plate. The steel then undergoes further hot and cold rolling steps, annealing, descaling, and polishing to produce the desired form (Millberg, n.d.).

Other Alloys

Aside from stainless steel, nickel is used as the principal element in other non-ferrous alloys such as nickel –aluminum alloy, nickel-chromium alloy, nickel-titanium alloy. "The most widely used non-ferrous alloys are copper alloys such as monel, nickel brasses and bronzes. The products include propellers, crankshafts and hulls of premium tugboats, fishing boats and other working boats" (Metal Pedia).

Electroplating

Nickel is commonly used in electroplating. Coating of nickel in metal products prevents tarnishing, corrosion and other condition that may be destructive. As mentioned in the jewelry section under gold and silver, nickel is usually used for pre-coating the base metal before plating it with gold. The electroplating process using nickel is almost the same with the one with gold. There are currently 42 electroplating services in Philippines.

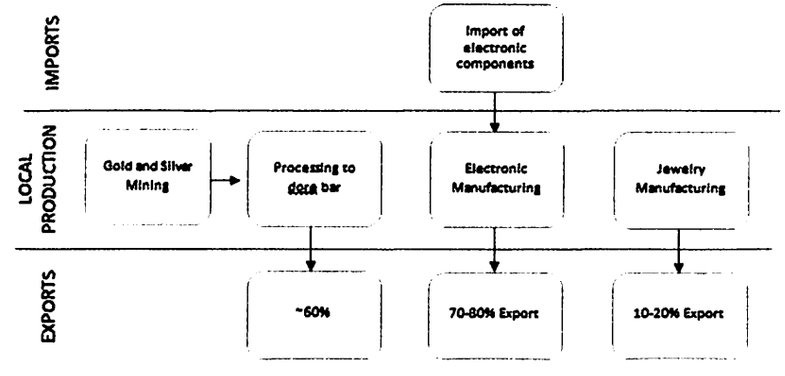
CURRENT STATE OF DOWNSTREAM INDUSTRY IN THE PH

Gold and Silver Industry

As of March 2016, there are only two large-scale gold processing plants in the country, Mindanao Mineral Processing and Refining Corporation and Philippine Gold Processing & Refining Corp. Both are coupled to large-scale mines, Co-O Gold Project and Masbate Gold Project, respectively. These two can further process and refine the gold to achieve its pure form.

Other gold plants end their processing of gold ore in its dore form. Since gold ore is not sealable in its raw form, it has to be processed to being a dore bar (Invest Philippines). Dore bar is a semi-pure alloy of silver and gold that has to be further refined. Hence, these dore bar have to be exported to other countries that has the technology of further purification. In 2014, 18,423 kgs of gold and 23,005 kgs of silver were produced.

- "250 enterprises nationwide engaged in the manufacture and exporting of jewelry. Most of these firms are located within Metro Manila and in the province of Bulacan" (Magkilat, 2014). Only 10% of this total manufacturers export their products. The local jewelry industry is estimated to be valued at $250 million, assuming that 15% of the market represents the diamond market. In terms of exports, the International Trade Center through Trademap.org estimated that the country's exports of fine jewelry surged to $55.9 million in 2011–around 20% of its production (Magkilat, 2014).



According to the Confederation of Philippine Jewelers Inc. they have listed 222 registered companies. Most of these jewelers use the traditional method of jewelry making. With the geographic location of these jewelry manufacturers, it can be assumed that these jewelers actually get their supply from small-scale mining. The provision of RA 7076 Section 17, also known as People's Small-scale Mining Act of 1991" states that all gold produced by small-scale miners shall

be sold to the Bangko Sentral ng Pilipinas. Any individual who wishes to purchase gold for jewelry manufacturing and industrial purpose may buy at BSP.

In the case of large-scale mines, they have stronger ties and long-term stable contracts with foreign countries. Hence, to supply them means to export the mined gold. It is also a factor that only few of the jewelry companies do have corporate structure –an implication that such industry is not much of a developing one –have an unstable demand for the LSM to supply.

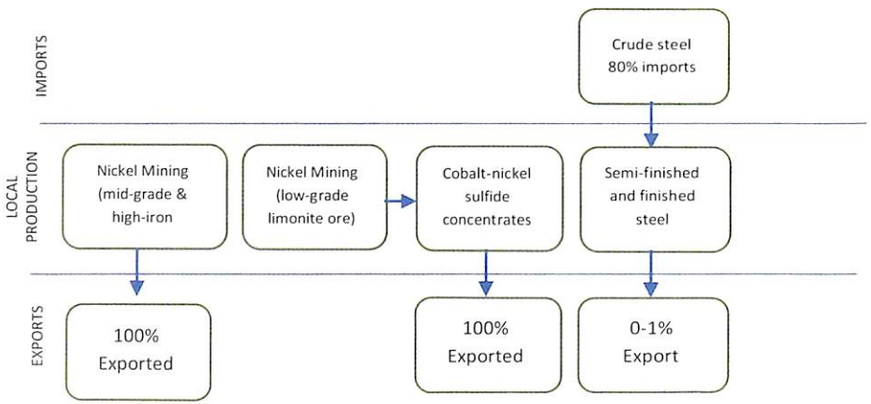
- Philippines is a net exporter of electronic products. This commodity remained as the top import for 2014, accounting for 23.4 percent of the total import bill, to be valued at $15.297. At the same time, it continued to be the top earner and major exported commodity for 2014 with 43.1 percent of the total exports and which accelerated by 11.9 percent from $23.931 billion in 2013 to $26.790 billion (Philippine Statistics Authority, 2015).

  Semiconductor and Electronics Industries in the Philippines, Inc. (SEIPI) with around 250 members, have classified the Philippine Electronics Industry as 73% Semiconductor Manufacturing Services (SMS) and 27% Electronics Manufacturing Services (EMS). Most of these companies practice the best known methods in manufacturing with capabilities ranging from IC packaging, PCB Assembly and Full Product Assembly (Semiconductor and Electronics Industries in the Philippines, Inc., 2016). The country imports the semiconductor components and devices that are to be assembled yet. But it is important to note that we also have a growing base of electronic component suppliers in the country.

WEAK LINK

With the current condition of downstream industry presented above, it can be evaluated that there is a weak, rather than missing, link between the upstream and prevailing manufacturing industries. The former have already established mines and processing plants. However, as mentioned above, only two of these plants can actually purify gold. Establishment of refinery and advancement of plants to further process the gold are needed. In downstream, jewelry industry and electronic industry (particularly the component suppliers) should be encouraged to expand more.

Nickel Industry



As mentioned in the earlier section, mid-grade and high-iron limonite ore are hundred percent exported. Low-grade ores are processed in HPAL plants to produce nickel concentrates. The major purchaser of nickel is China. They don't have much resource of nickel but do have the technology to process the metal as well as industrial factories that hugely depend on nickel.

According to Roberto Cola, chairman of the Southeast Asia Institute of Iron and Steel (SEAISI), Philippines imports around 80 percent of its steel requirement (Magkilat, PH's steel industry turns 80% import dependent, 2015). The country also exports steel products but with a huge amount of imports, Philippines had become a top net importer of steel. Imports include flat products such as hot rolled coils, tin plates and slabs, and long products such as billets and wire rods (Lignes, The Philippine Iron & Steel Industry, 2014).

MISSING LINK

Philippines is endowed with great nickel reserves –nickel which is substantial in making steels – steels that are very much needed in infrastructures –yet the country has huge imports of steel because of the lack of casting facilities. Remember that the manufacturing of copper rod product which is casting is also used in making steel. These metal products are basically alloys –can be a combination of iron and nickel and or copper. Therefore, the strategies to develop nickel downstream industry can be derived from the report of Icamina on copper.

Challenges and Concerns

We are exporting our resources to other countries; supplying them the raw materials for the products that we will –in a sense –buy back at a higher price. The gold and nickel map that are shown above suggests that there is a weak/missing link. There is already the mining sector as well as the industry that output consumer products; what is missing is the bridge that connects these two disjoint industries. As presented in copper road map report of Icamina, there is a need to rebuild and strengthen the downstream industry.

Downstream industry in the Philippines is already underway. But it is losing pace because of several factors and challenges.

Industry Cost (Power and Transportation)

Philippines has one of the highest rate of electricity in the Southeast Asia, moving our potential investors out of the country. Consequently shrinking foreign investments in the Philippines, while kicking up in other countries in the SEA region

Based on Meralco's tariffs (using residential rates of 200 kilowatt hours per month consumption) which averaged 24 US cents per kilowatt hour in 2013, the price we pay for our electricity is the fifth highest in the world. We cannot convince foreign investors to build industries here if the cost of our power is much higher than the competitors' in the neighborhood. The Philippines is the only country in the region that has privatized its electric power sector and has no state subsidy on rates. Contracts with the power generators must be renegotiated to bring down the cost. Also

studies have to be undertaken to strategically put up power plants as well as renewable energy source.

Electricity is very crucial in operations of recovery and refinery of metals. There has to be no power interruptions during the extraction process as metals concentrates will be wasted (Icamina, 2012). Renewable energy sources have to be strengthened then.

A study done by the National Renewable Energy Board (NREB) shows that the entry of 200 MW of FiT-supported RE, including solar energy, using the proposed feed-in-tariff (FiT) rate, can reduce WESM Luzon prices by between 59 centavos and P3.15 per kWh, or an average reduction of 17 centavos per kWh nationwide. The Melbourne Energy Institute verified the study and came up with an even higher annual savings projection of P11.3 billion. This study proves that the injection of RE, including solar, into the grid will not jack up electricity prices and instead even cause power prices to go down (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2013).

Benvenuto N. Icamina in his report entitled *Philippine Industry Roadmap for Copper,* also identified transportation as one of the freight costs are also high, not only because of shipping charges but also because of other port charges. It is said that shipping goods from Manila to Davao is more expensive than shipping from Manila to Japan on South Korea. This in turn raises the cost of Philippine products and exports, which lessens the country's competitiveness.

Technical

In the upstream sector, the technology of processing the minerals is not widely available, mainly because the cost of building the plants is really big. Predominantly in small-scale mining, they process the ores with the use of mercury. The use of this chemical is discouraged because it is not very competent in extracting the metal and foremost, it is environmentally harmful. Also efficiency in mining, extraction and all the way to manufacturing is steered by the equipment used. A few may have held this equipment but these few are of course, the large-scale companies.

In the jewelry manufacturing, one reason why this industry is not very prolific is because most of the companies uses traditional or hand method. Technology for jewelry is not widely-used. For electronics, semiconductor fabrication plants are highly costed and require highly-skilled professionals/facilitators.

Other concerns

- Mining laws and regulations are unstable as well, as manifested by the conflict between the national and local government regarding the Tampakan vs South Cotabato's Open-pit Ban. Also there is the Executive Order No. 79 of 2012 which partially inhibits the advancement of the industry. EO No. 79 Section 4 states that:

  "No new mineral agreements shall be entered into until a legislation rationalizing existing revenue sharing schemes and mechanisms shall have taken effect. The DENR may continue to grant and issue Exploration Permits under existing laws, rules, and guidelines. The grantees of such permits shall have the rights under the said laws, rules, and guidelines over the approved exploration area and shall be given the right of first option to develop and utilize the minerals in their respective exploration area upon the approval of the declaration of mining project feasibility and the effectivity of the said legislation. "

With the provisions stated who would actually want to explore and discover mineral deposits without the certainty of entering mineral agreement for extraction of minerals?

- Integration of key players, the mineral sector and manufacturing companies –Investors that eye establishment of downstream industry have to be secured that the mineral resources that will feed their processing plants/factories, are locally available. It is important then that the upstream industry is well producing for it to supply and feed downstream industry.

- Lack of motivation in competing with international products and services

DEVELOPMENT STRATEGIES

GENERAL SUPPORT

The government has several policies and support for potential industries. BOI, PEZA, SBFZ are the possible and applicable incentives in manufacturing industries of jewelry, electronics and steel.

1. Board of Investments

Under Book I of the Omnibus Investments Code, BOI-registered enterprises are given a number of incentives in the form of tax exemptions and concessions. These are:

1.1 Fiscal Incentives

a. Income Tax Holiday (ITH)
   - Six (6) years- new projects with pioneer status
   - Four (4) years- new projects with non- pioneer status
   - Three (3) years- expansion/ modernization projects
   - Six (6) years- new or expansion projects in less developed areas

b. Exemption on Wharf age Dues, Export Tax, Duty, Impost and Fees

c. Tax Exemption on Breeding Stocks and Genetic Materials

d. Tax credits (for export producers only)
   - Tax credit on tax/duty portion of domestic breeding stocks and genetic

e. Additional Deductions from Taxable Income
   - Additional deduction for labor expense
   - Additional deduction for necessary and major infrastructure works

1.2 Non-Fiscal Incentives

a. Employment of foreign nationals

b. Simplification of customs procedures

c. Tax and Duty-free Importation of Consigned Equipment for a period of ten (10) years

d. Privilege to operate a Bonded Manufacturing warehouse

1.3 Incentives for Regional Headquarters and Regional Operating Headquarters in the Philippines

2. **Philippine Economic Zone Authority (PEZA)**

PEZA provides the following fiscal incentives for existing PEZA-registered enterprises-export These enterprises should be registered with the Export Processing Zone Authority.

a. Income Tax Holiday (ITH)
   - 100% exemption from corporate income tax
   - Four (4) years ITH for Non-pioneer Project
   - Six (6) years ITH for Pioneer Project

b. Three (3) years ITH for Expansion project (ITH applies to incremental sales)

c. Upon expiry of the Income Tax Holiday - 5% Special tax on Gross Income and exemption from all national and local taxes.

d. Tax and duty free importation of production equipment and machineries, breeding stocks, farm implements including spare parts and supplies of the equipment and machineries.

e. Exemption from export taxes, wharf age dues, impost and fees

f. VAT Zero Rating on local purchases of goods and services, including landbased telecommunications, electric power, and water bills

g. Exemption from payment of local government fees such as Mayor's Permit, Business Permit, permit on the Exercise of profession/Occupation/Calling, Health Certificate Fee, Sanitary Inspection Fee, and Garbage Fee

3. **Subic Bay Free Zone (SBFZ)**

Subic Bay has a veritable edge as an investment area because of its Freeport status. It is considered a special customs territory where there is free flow of goods and capital equipment. Investors in SBFZ enjoy these following business incentives and privileges:

a. Exemption from all local and national taxes such as ad-valorem and excise taxes Investors are only required to pay a corporate tax of 5 percent from their gross adjusted income. Subic Bay Freeport Enterprises (SBFEs) may also avail of tax holidays if they register with the Philippine Board of Investments (BOI).

b. Duty-free importation of raw materials, supplies, capital equipment and other items for consumption within the Freeport

c. Foreign investors may invest up to 100% equity in almost any economic activity in the SBF except for businesses where foreign ownership is limited by the Constitution.

d. There are no foreign exchange controls in the Freeport and full repatriation of profit is allowed.

e. The SBMA also processes and grants special resident and investor visas. A foreign investor with an investment of at least US$250,000 may be granted a Subic Special Investor Visa. Temporary work permits and Subic Special Work Visas could also be granted to foreign nationals subject to certain requirements.

INDUSTRY-SPECIFIC

According to the CPJI president Mia Florencia, there is a growing for luxury good in the global market and this should be reserved as an opportunity to develop further the jewelry industry.

- Conversion of small-scale businesses into world class players through strengthening of domestic market
- Develop linkages with mining industry
- Strengthen the Confederation of Philippine Jewelers Inc. as a Business Support Organization through a larger membership base
- Retail Project to be endorsed/supported by the DTI
- Executive Order providing for the Competitive Environment for the Jewelry Industry of the Philippines Continued subsidy for international exposure through trade fairs & missions

Immediate measures must be taken such as having jewelers the greater accessibility to gold and silver. There should be consideration in the simplification of RA 8502 (Jewelry Industry Development Act) accreditation process and export/import policies and regulations. Also, to reach out to bigger consumer products must be exposed through establishment of a permanent local showroom for the manufacturers & exporters in strategic prime locations in Metro Manila, and requiring mall operators to reserve 10% of prime selling area to domestic enterprises especially for SMEs (Confederation of Philippine Jewelers, Inc., 2014).

In the report of Mr. Lignes about iron and steel industry, he identified support measures and called for policy response for the following (Lignes, 2014)

- Incentives to encourage iron making facilities and flat products manufacturing
- Incentives to modernize and rehabilitate facilities
- Strictly enforce customs laws and technical regulations
- Discourage export of iron ore and scrap iron
- Support R&D for product development
- Review tariffs to remove distortions

DEVELOPMENT POLICIES

The major weakness identified in the South African economy is the relatively poor performance of non-traditional tradable goods and services that are generally the most low skill intensive sectors. Hence, the crafting of National Industrial Policy Framework (NIPF) was set out a policy framework of South Africa's industrialization trajectory.

National Industrial Framework (NIPF)

It identifies and addresses the cross-cutting and sector specific constraints and opportunities prevailing in the industrial economy through thirteen strategic programs: These are: 1. Sector Strategies; 2. Industrial Financing; 3. Trade Policy; 4. Skills and Education for Industrialization; 5. Competition Policy and Regulation; 6. Leveraging Public Expenditure; 7. Industrial Upgrading; 8. Innovation and Technology; 9. Spatial and Industrial Infrastructure; 10. Finance and Services to Small Enterprises; 11. Leveraging Empowerment for Growth and Employment; 12. Regional and

African Industrial and Trade Framework; 13. Coordination, Capacity and Organization (Department of Trade and Industry). Sector strategies, Trade Policy will be discussed as these are the programs that are seen to be immediate to the downstream industry in the Philippines.

SECTOR STRATEGIES

High impact sector strategies that are well designed and implemented are crucial to place the economy on a higher growth and more developmental industrialization path. While it is not the intention of the NIPF to provide a definitive identification of sectors that should be prioritized, it is possible to indicate five sectors in which it is anticipated much of our industrial growth and employment opportunities lie. Given the value chain nature of a number of sectors it will ultimately be a matter of judgment into precisely which grouping a particular sector falls. The sector that includes downstream mineral beneficiation is identified to be the *Medium technology sectors.*

Medium technology consists of long-established sectors such as metals fabrication; machinery and equipment; chemicals and plastics; and paper and pulp; as well as emerging sectors such as oil and gas and jewelry. A number of these sectors represent potential for downstream beneficiation of South Africa's traditional mineral and mineral-processing sectors. These include various sources of local demand – including public expenditure; existing capabilities that have been established; and underdeveloped value chains due, for instance, to the pricing of raw input materials. Further development of these value chains could add significant value and employment opportunities due to the much higher labor intensity than their upstream counterparts. Obstacles to downstream beneficiation include the pricing of raw materials, skills development, industry-specific infrastructure and transport requirements. Interventions to unlock the potential of these sectors include a regulatory framework for more internationally competitive raw material pricing inputs and leveraging domestic and continental capital expenditure coupled with sector-specific support mechanisms (Department of Trade and Industry).

TRADE POLICY

Tariff reform in South Africa since 1994 has been extensive in terms of the scale of tariff reduction and in simplification of the tariff structure. Over the last decade trade has made a positive contribution to growth and efficiency in South Africa. Exports have increased in volume and value, contributing positively to GDP. Greater import competition has encouraged specialization, and improved resource allocation and productivity.

Improving non-traditional export performance – particularly in more sophisticated, value added products – is an important objective for industrial policy. At the same time, a range of questions with respect to tariff policy issues arises. Recognizing that tariffs are instruments of industrial policy and have implications for employment, investment,

technology and productivity growth, and objectives our fundamental approach is that tariff policy should be decided primarily on a sector-by-sector basis dictated by the needs of imperatives of sector strategies.

However, the economic costs and benefits of certain cross-cutting issues need to be addressed in the context of a review of selected aspects of the tariff regime.

- relative costs and benefits of further simplification of the tariff book
- issue of so-called "nuisance tariffs" or tariffs less than five percent
- implications of tariff peaks (tariffs that are significantly higher than the national average), tariff escalation (which imply higher rates of effective protection), as well as situations of negative rates of effective protection (where tariffs on inputs are higher than on the final product)
- removal of tariffs on imports of machinery and equipment that are neither made in South Africa or are likely to be made in the future. Such a review also requires a consideration of the trade negotiation impact of any unilateral liberalization of our tariff regime.

Additional refinements of tariffs will focus on two areas.

- Tariffs on upstream input industries will be reviewed and may be reduced or removed, in the interests of lowering input costs into downstream manufacturing, taking into account issues such as domestic production capabilities and the levels of global distortions in these products.
- Tariffs on downstream industries will be treated more carefully, particularly those that are strategic from an employment or value-addition perspective. All tariff determinations will be conducted on a case-by-case basis, taking into account the specific circumstances of the sector involved.

In boosting exports, both to address employment creation and current account deficits, the sector strategy processes will also need to consider constraints to exports. Part of this is clearly related to the objectives of industrial policy itself, but it should also inform the development of more refined foreign direct investment (FDI) and export promotion strategies. This will entail more targeted FDI promotion driven by the opportunities identified from the sectoral strategies, as well as a more focused export promotion strategy, based on detailed analysis of trade opportunities. It is also related to our negotiating strategy and objectives with respect both to economies and products we should be targeting. Industrial policy objectives should, in other words, underpin our export and negotiating strategies.

NIPF, as well as the Industrial Policy Action Plan (IPAP2) "were designed to provide clarity and transparency to the private sector and other partners, both domestic and foreign, on the direction of critical elements of economic policy. The documents constitute the framework for Government's

industrial policy and related interventions over the next few years" (Industrial Development Corporation, n.d.).

Beneficiation or mineral value addition is a deliberate government intervention to facilitate a shift from a resource-based to a knowledge-based economy. In South Africa, the Department of Mineral Resources (DMR) has developed a beneficiation strategy to create a broader framework to promote mineral upgrading. The strategy also aims to increased local value addition consistent with other programs of government such as the National Industrial Policy Framework, and the more recent Industrial Policy Action Plan (IPAP2).

Beneficiation Strategy

The beneficiation strategy provides a framework that seeks to translate the country's sheer comparative advantage inherited from mineral resources endowment to a national competitive advantage.

The strategy selected five value chains which are intended to indicate the inherent value for South Africa in embracing beneficiation for all strategic mineral commodities. The challenge for these value chains therefore, is largely to identify where greater final stage beneficiation (fabrication) can be initiated.

Five value chains selected

1. **Energy commodities** – Coal, Uranium and Thorium
   The Department was quantifying the country's uranium and thorium reserves and supporting R&D into alternative future energy sources
2. **Iron and Steel Industry** – Iron, Chromium, Manganese and Vanadium
   The Department would invoke regulatory provisions to ensure developmentally priced input commodities and encourage investment to break anti-competitive behaviour
3. **Pigments and Titanium metal industry** – Titanium
   The Department was investigating the viability of establishing a chlorine plant in conjunction with a pigment plant, and was seeking to develop a more cost effective primary titanium metal production
4. **Automotive catalytic converters and diesel particulate industry** – Platinum group metals
   The Department would invoke legislation to ensure the security of PGM supply and was seeking to develop a metal access mechanism to unlock the intrinsic value in the PGM sector
5. **Jewelry industry** – Gold Diamonds and Platinum Group metals
   The Department wanted to establish a metal advance scheme and promote incentives in the jewellery sector.

For the purpose of this paper, only the (3) Iron and steel industry and (5) Jewelry Industry value chains will be discussed.

South Africa is a major producer iron ore, manganese, chromium, etc., of which steel and stainless steel production extensively use. Thus, according to (Source), "access to these raw materials will therefore be essential to increase levels of local beneficiation of these minerals. Steel products are vital inputs into labor intensive manufacturing processes. However, current anticompetitive pricing practices in the steel industry are one of several constraints to the growth of manufacturing industries. Increasing competition in the local steel industry should be looked at as one of the interventions for countering anti-competitive pricing strategies."

Various government departments have combined efforts to create a conducive environment for the development of steel and stainless steel plants in South Africa. Access to competitively priced iron ore, as well as manganese, chromium, nickel and vanadium, are important for the projects, which were identified through this process, to be viable and to enable the new facilities to compete with existing players. The development of the plants would also help result to an environment for competitive pricing in the domestic market. The task of the interdepartmental team is thus to facilitate the beneficiation of these ferrous minerals to the final stages of the value chain.

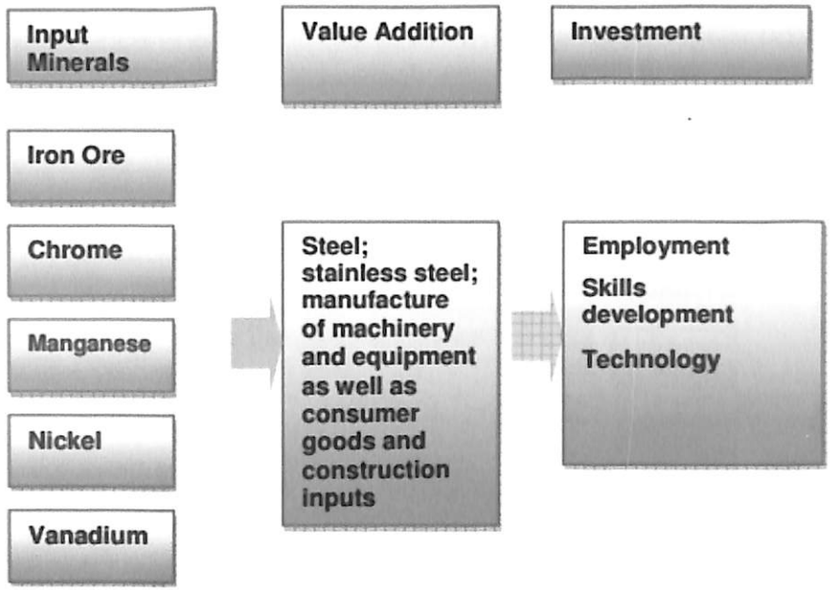


Figure 2: Iron & Steel Strategic Outcome (Department of Mineral Resources, 2011)

For the iron and steel value chain, intervention in the import-parity pricing of iron ore and steel is needed to be able to support the final fabrication process. Measures to achieve this end could include taxes on exports and conditionality linked to the provision of infrastructure.

- Invoke regulatory provisions to ensure sustainable and developmentally priced input mineral commodities for new and existing steel manufacturers in South Africa
- Investigate mechanisms to protect and support the competitiveness of existing intermediary plants, such as ferro-chrome smelters
- Encourage investment into South African steel industry to break prevailing anti-competitive behavior of current operators

Other strategies to address other constraints on downstream steel fabrication, including identifying major opportunities for using steel for local product, should be developed.

The beneficiation of gold and diamonds requires the establishment of integrated Jewelry Hubs throughout the country (Figure 3). The fabrication of platinum jewelry, however, is not a priority area for PGM beneficiation.

The high value and low bulk of gold, platinum and diamond jewelry lends itself to export markets such as the United States of America, Japan, and Europe. The African Growth and Opportunity Act (AGOA), which provides access to markets in the USA gives an opportunity for local beneficiations to grow their markets internationally.

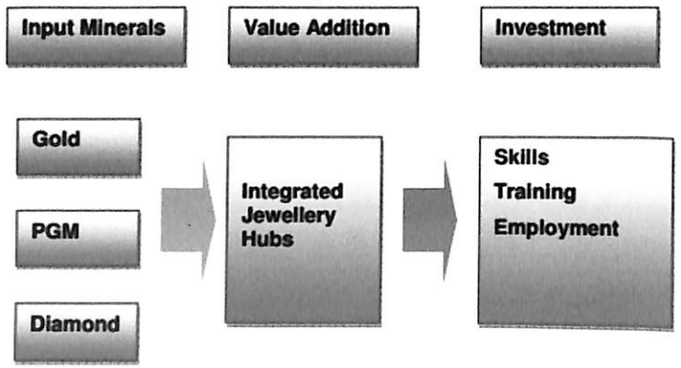


Figure 3. Precious Minerals Strategic Outcome (Department of Mineral Resources, 2011)

The following actions for jewelry include:

- Consider the establishments of an applicable and effective metal advance scheme aimed ensuring local metal/mineral access for local value addition.
- A structured training programs which takes into consideration current specific demand and the expansion of the jewelry industry could be developed in collaboration with the jewelry sector

- Initiatives of private related-sectors must be prioritized and provided with necessary support for further development.

Mineral beneficiation in South Africa has been low and mostly concentrated in the high capital sectors of the mineral value chain. Endowment of mineral resource does not automatically translate to downstream benefaction. It requires adjustments and actions to address possible constraints to materialize competitive advantage for mineral beneficiation. The strategy identifies the constraints, while also outlining instruments that the South African Government can use to mitigate the constraints and what corresponding actions business is expected to take.

Cross-Cutting Constraint	Potential Instruments at Government's disposal	Action by Business
Limited access to raw materials for local beneficiation	• Leverage the state's custodianship of the country's minerals to facilitate downstream beneficiation • The MPRDA is currently being amended to strengthen beneficiation provisions • Leverage the beneficiation offset element of the Mining Charter • Strengthen provisions within existing pieces of legislation such as the diamond export levy to promote reliable and competitive access to raw materials • Address import-parity pricing especially of steel and heavy chemicals, including if necessary through export taxes, conditionality placed on infrastructure, and regulation	• Take advantage of the mineral value proposition to expand local demand for mineral ores • Comply with legislation
Shortages of critical Infrastructure	• Identify specific infrastructure needs over the next ten to 20 years. • Ensure that existing infrastructure planning mechanisms and programs such as the critical infrastructure programs properly consider infrastructure requirements for mineral beneficiation	• Align production plans with national programs • Embrace energy efficiency • Explore co-generation prospects

	• Leverage on the NGP, which seeks to unlock infrastructure bottlenecks through massive expansion of transport, energy, water, and communications capacity. • Utilize the state's infrastructure (public good) as an effective instrument to promote local beneficiation	
Limited exposure to Research and Development	• Align beneficiation R&D requirements (both current and recurrent) to the national ten year plan for science and technology	• Support and develop competitive technologies
Inadequate skills	• Align the beneficiation skills pipeline to the National Skills Development Strategy and the Sector Skills Plans for required skills • Promote skills development and partner with the relevant SETA's and institutions o	• Investment in Human Capital Development • Co-operate with government to leverage and enhance the National Skills Development Strategy and the Sector Skills Plans for required skills
Access to international markets	• Review existing and ensure that future trade agreements adequately support the beneficiation intent (FDI and market access) • Take advantage of the Comprehensive Strategic Partnership with China to support investment in beneficiation in South Africa as well as access to markets in China	• Leverage on trade agreements

Table 1: Cross Cutting Activities and Interventions (Department of Mineral Resources, 2011)

Export Ban

Processing and further refinement of ore means moving up to higher value chain. The minerals are in a form closer to its end use, thereby increasing its value. Some countries like South Africa, Indonesia implemented mineral export ban to develop value-adding processes. The policy effectively compels mining companies to invest on additional smelters and refineries on the control of economic viability.

For instance, the demand of steel in the country is high and because nickel is a requirement in the production of steel, it is probably wise to put nickel on the list. China, a top importer of nickel, is also one of the major producers of Scandium, a rare earth element that is highly-valued. With the geology of China, it is doubted that the Scandium is indeed from their lands. Allegations have been circulating that these Scandium actually constitute the nickel ores that are imported from the Philippines. Further research must be done to determine if presence of this REE in our nickel deposits is significantly high to drive more investments on the processing facilities.

However, in the case of the Philippines, we have to remember that there are several challenges in tailing value-adding processes. Technicalities and industry cost such as power and transportation, as discussed above, are some of the constraints. Case studies have to be done to determine if building smelters and refineries are cost-effective or if such investment will generate poor returns. Export ban can be possibly promoting the advancement on value chain for some minerals only. Probably, a better approach than a sweeping export ban on unprocessed minerals would be a selective policy, aimed at downstream processing in specific minerals with profitable investment profiles and with some competitive promise in raising export earnings.

If downstream processing is to be pursued as a policy it should be (1) selective and (2) based on "first-best" economic principles to avoid collateral damage. That is, if downstream processing in a particular mineral looks profitable and has promise in raising export earnings, then the "first-best" economic policy would be to target policy interventions on the problem of processing this mineral directly, rather than using indirect restrictions on all exports of unprocessed minerals to subsidize downstream processing of it via falling domestic prices of inputs (U.S. Agency for International Development, 2013).

The country has to "focus on fiscal policy rather than the production side of the minerals industry. In general, the best thing for policymakers to do to get more out of the country's natural resource endowments is to focus on fiscal policy rather than the production side of the minerals industry where distortions can be costly. Changes in the royalty and income tax regime would appear to be the most effective, least costly policy approach" (U.S. Agency for International Development, 2013).

There has emerged speculation that Indonesia may not fully implement its ban on exports of concentrates (partially processed metals) in 2017. This controversial ban, part of the country's 2009 Mining Law, aims to boost domestic processing facilities and reduce the country's dependence on raw commodity exports. The ban was originally implemented in January 2014. However, as there was insufficient domestic smelting capacity full implementation would imply a huge revenue loss (Indonesia - Investments, 2016).

The slumping nickel price has hurt producers in Indonesia. Tsingshan Bintangdelapan Group, a Chinese-Indonesian venture that built a smelter after the ban on ore exports, has said it is making a loss of $2,000 on every ton. Plans for new smelters will be put on hold if rates stay where they are now, according to Chief Executive Alexander Barus (Rusmana & Wulandri, 2016)

Role of Women

Mining is an industry which has always been male-dominated, regardless of geographical location. There have been positive steps which have helped to integrate women into the industry, but females continue to be under-represented and mining is still largely a man's domain.

In a study published early in 2013 and conducted by Women in Mining (UK) and Price-Waterhouse Coopers, stated that the mining industry has the lowest number of women on company boards of any industry group worldwide. South Africa is one country which is leading the rest in terms of employing women in the mining and minerals sectors (Women in Mining & Price-Waterhouse Coopers, 2013).

In the survey conducted by Philippine Statistics Authority last April 2015, there are around 3,100 female workers under mining and quarrying sector (Philippine Statistics Authority, 2015). Three possible involvements of women in this sector are in mining proper, metallurgical processing and administrative works.

Mine sites are usually situated in poor and rural areas. In these places, mostly women were not able to go to schools. Development of mines includes construction of community –hospitals, schools and other necessary forms. With this, people are given the opportunities to learn and work. Women, in particular, are trained to give aid in the hospitals, simple clerical and administrative works in offices.

Women often miss out on the potential benefits of the extractive industries and bear an unequal share of its burdens. Employment and income are largely captured by men, with formal unemployment rates for women in mining communities as high as 90 percent. Simultaneously, the environmental and social risks of mining tend to fall upon women through the loss of productive agricultural land, marginalization and an increase in health risks, including HIV/AIDS.
In July 2007, Lonmin, a primary producer of Platinum Group Metals, together with International Finance Corporation (IFC), a member of World Bank group, collaborated to produce a conceptual framework of integrating women in mining industry (Lonmin Plc. & International Finance Corporation, 2009). The partnership seeks to promote the employment and retention of women in Lonmin's workforce. They have identified driving forces in asserting women in mineral sector.

- **Legislative**: This is the case when government regulations mandate a certain percentage of women participation.
- **Business case**: There is growing evidence that integrating women into the workforce leads to an increase in productivity, efficiency, profitability and reliability for mining companies.
- **Corporate social responsibility**: Employing women can lead to communities becoming more prosperous and help break cycles of poverty by contributing more towards household welfare and increasing the level of skills in the community

The manual is written with an emphasis on women in mining, but it can be applied to other extractive sectors and other heavy industries.

The key departments necessary for the WIM program are: Program Leadership, Operations, Engineering, Medical, Human Resources, and Training, Culture Change & Communications.

Given that the Operations Department has first-hand contact with all workers and therefore with potential women recruits, its responsibility is to prepare for, recruit and retain women with support from and in coordination with the program leadership and other departments. In that sense, there is a constant feedback loop between the Operations Department and other departments, with the program leadership simply playing the role of a facilitator.

Process/ Department	Program Leadership	Engineering	Medical	Human Resources	Training, Culture Change & Communication
Prepare	Step 1: Secure management commitment and set incentives Step 2: Audit current status and climate	Step 1: Prepare the physical environment	Step 1: Conduct health risk assessments for women on all jobs Step 2: Categorize all jobs by physical requirements	Step 1: Develop Women in Mining Policies Step 2: Develop a recruitment action plan for women	Step 1: Prepare workforce through sensitization training
Recruit	Step 3: Develop overall plan and management structure		Step 3: Conduct gender-neutral strength and health assessments	Step 3: Recruit women	Step 2: Conduct induction on sexual harassment and maternity policies

Retain	Step 4: Monitor and continuously improve program			Step 4: Provide career development support Step 5: Provide lifestyle support Step 6: Develop an alternative placement system for pregnant and breastfeeding	Step 3: Provide sexual harassment training and preparedness Step 4: Provide ongoing communications and training events to support women

Table 2. Women in Mining Manual (International Finance Corporation, 2010)

A significant advance in the mining industry is the **South African Mining Charter**, adopted in 2004 which must be commended. The Charter requires mining industries to actively change the demographic profile of their employees and to ensure that they have plans in place to achieve the target of 10% participation of women by 2009 (Zungu, 2011).

For the case of Lonmin, it is actually a legislative requirement of the government of the country of operation mandates a certain percentage of women participation in the company. In 2011, Lonmin recruited 473 women of whom twenty joined our management team. They employ 2,073 women, representing 7.46% of our employees with approximately 52% of those (1,071) working in core operations (Lonmin Plc, 2011).

In Ghana, Newmont Gold is taking similar steps to encourage women into its mines or to take up jobs associated with its mining operations. IFC has helped Newmont employ more women in its operations in roles ranging from dump-truck drivers to metallurgy specialists (International Finance Corporation, 2010).

Lu Zungu stated that some amendments to the Mining Charter have to be introduced, focusing on the promotion of health and safety needs of women especially those who are working underground.

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