

# **The Diamond Supply Chain**

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## **ABSTRACT**

A diamond in the rough is very valuable. The ending piece of diamond jewelry, the highly sought after product, is worth much more. Information about the secretive diamond industry is not well-known, nor is it well-understood how diamonds have become a source of great value. In order to transform the discovered diamond deposits mixed in with dirt and rock fragments, diamonds must go through a series of processes. Supply chain management is the integration of activities that procure materials, transform them into goods, and deliver them to customers. The diamond supply chain consists of the diamond exploration process, mining, sorting, cutting and polishing, jewelry creation, regulation, and the selling of the final product. This paper describes the supply chain of diamond industry.

**Keywords:** Supply chain, diamond

## **1. THE VALUE OF DIAMONDS**

For many centuries, diamonds have been talismans of magic, passion and success. They were once regarded as the "Tears of the Gods," and were thought to hold mysterious qualities and possess supernatural powers. Many myths and legends surround diamonds (De Beers, 2008). Diamonds are valued in almost every culture on the planet. They were first mined in India over four thousand years ago. "Indians thought they were formed by the goddess Indra, who sent them as bolts of lightning. During the Middle Ages, diamonds were used by doctors to help ward off illnesses. It was also during the Middle Ages that diamonds became highly valuable as jewelry (Koonar, 2006)." Diamonds are thought to be an ever-lasting sign of love that will never decrease in value. In the late 1940s, the De Beers Company, a leader in the diamond industry, created the advertising slogan, "A diamond is forever."

## **2. DIAMOND IN A ROUGH: WHAT IS IT AND HOW IT WAS FORMED**

Diamonds are made up of pure carbon and formed naturally as minerals within the rocks of the upper mantle of the Earth's surface at depths of up to 200 miles below the earth's surface, under pressures greater than 50,000 times our own atmospheric pressure, and at temperatures higher than 2500 degrees Fahrenheit ("Diamonds," 1999).

Diamonds are the hardest substance known on earth, so hard that the only material that can cut them is another diamond. The four main optical characteristics of diamonds are: transparency, luster, dispersion of light, and color. In its pure carbon form, a diamond is completely clear and transparent. As in all natural substances,

perfection is nearly impossible to find and inclusions of other minerals and elements in the diamond cause varying degrees of opacity. The surface of a diamond can be clouded by natural processes, such as the constant tumbling and scraping in the bed of a river (“Diamonds,” 1999).

One of the main optical characteristics, luster, includes the general appearance of the surface of a diamond crystal in reflected light, while another characteristic, dispersion, is the process of white light breaking up into the color spectrum. Transparency, luster, dispersion of light, and color vary from diamond to diamond and can either increase or decrease its value. Additionally, diamonds in their perfect form occur as eight-sided crystals. Many crystal variations occur in nature. Twelve-sided crystal shapes can even be found. Each diamond is unique, no two diamonds are exactly alike (“diamonds,” 1999 and “What..,”1999).

Diamonds exist in three main forms of deposits: kimberlite, lamproite, and placer deposits. Most form at a depth of about 90 miles beneath the surface of the earth. Volcanic activity carries these formed diamonds to the earth’s surface. A mixture of magma, minerals, rocks, and diamonds then create pipes shaped like cones as the mixture reaches the surface, which are called kimberlites. Kimberlite pipes, the main source of diamonds, occur in clusters and can be found directly beneath shallow lakes that were formed in inactive volcanic craters. Only one pipe in about two hundred will contain quality diamonds. Lamproite pipes are formed in the same way as kimberlite pipes, “except that boiling water and volatile compounds contained in the magma act corrosively on the overlying rock, resulting in a broader cone of eviscerated rock at the surface. This results in a martini-glass shaped diamondiferous deposit as opposed to kimberlite’s champagne flute shape (“Diamonds...” 2007).” Diamonds also exist as placer deposits, which were formed by the erosion of diamond pipes over millions of years. Placer diamond deposits can be found among river terrace sediments. These deposits are transported from their original location by seasonal flooding. Most diamonds today are found in Australia, Botswana, Zaire, South Africa, Russia, Angola, and Namibia (Diamond, Grolier Encyclopedia).

### **3. DIAMOND SUPPLY CHAIN DIAMOND EXPLORATION AND EXCAVATION PROCESS**

As diamond deposits are found across the globe, supply chain managers must carefully form strategies in order to find the fastest, most profitable way to reach the supply. When an industry spans across global markets, supply chain decisions become global strategic decisions. Managers must consider many issues and work to integrate all activities before the diamonds are removed from the earth so that the following interconnected activities work to produce the optimal outcome.

#### **3.1 DIAMONDS EXPLORATION AND EXCAVATION PROCESS**

The first activity in the diamond supply chain is the diamond exploration process. Geologists have identified the characteristics of the areas where diamonds can be found. Careful study, mapping, planning, observation, and testing are done before an area can be excavated. After diamond deposits are found during the exploration process of the supply chain, the next step consists of the mining of these areas. Diamonds are excavated from the earth via five main types on mining- artisanal mining, hard rock mining, marine mining, open pit mining, and placer mining. The diamond withdrawal methods vary depending on: (1) how the minerals are situated within the earth, (2) the steadiness of the material neighboring the preferred mineral, and (3) the nonessential damage done to the surrounding environment. Artisanal diamond mining, the most basic form of mining, involves digging and sifting through mud or gravel river-bank deposits. Very little equipment and no technology is needed to mine but hard labor, and long hours are necessary. “Diamond diggers” work with their bare hands, shovels, and sieves. Artisanal diamond mining is typically used in the poorer countries throughout the world since there are no associated equipment costs. It is used throughout West Africa, Angola, the Congo, and Liberia. This type of mining accounts for 90% of Sierra Leone’s diamond exports and is the country’s second largest employer after subsistence farming (“Diamond Mines...,” 2007).

The second form of diamond mining is called hard rock mining a technique in which miners build tunnel underground and create underground rooms held up by rock. A shaft and a decline are used to access the rooms (“Glossary...,” 2003). Hard rock mining requires more specialized equipment than artisanal mining.

The third diamond excavation technique, marine mining, is relatively new and has only been in use since the 1990s. “Marine diamond mining employs both vertical and horizontal techniques to extract diamonds from offshore placer deposits. Vertical marine mining uses a 6 to 7 meter diameter drill head to cut into the seabed and suck up the diamond bearing material from the sea bed. Horizontal mining employs the use of Seabed Crawlers (remotely controlled, CAT-tracked underwater mining vehicles) move across the sea floor pumping gravel up to an offshore vessel (“Diamond Mines...,” 2007)”. Marine mining requires still more specialized equipment than hard rock mining.

Another diamond extraction technique, open pit mining, involves extracting rock from the ground by taking away from an open pit or hole. Open pit mining is used when deposits of minerals are found near the surface or along kimberlite pipes. Open pit mining is used when the ‘overburden,’ or surface material covering the deposit, is relatively thin and/or the minerals are imbedded in structurally unstable earth that is not suitable for tunneling. ‘Pit lakes’ tend to form at the bottom of open-pit mines as a result of groundwater intrusion. Open pit mining is much less dangerous than hard rock and marine mining (“Glossary...,” 2003).

The final diamond excavation technique is called placer mining. Minerals are extracted from the surface of the earth. No tunnels are used. Placer mining requires that miners used water pressure, special surface excavating equipment, or digging by hand to excavate the diamonds (“Glossary...,” 2003).

The exploration, excavation, and mining process represent a highly specialized step in the diamond supply chain. New mining technology continues to be developed in order to make the exploration and mining process easier. Procuring raw materials (rough diamonds) represents a very important step in the supply chain process. The transformation of the raw materials into retail diamond jewelry depends on the quick retrieval of the diamonds from the ground. A successful end product requires successful material procurement.

### **3.2 DIAMOND SORTING PROCESS**

After the mining process, diamonds are sold to wholesalers, who sort the rough diamonds based on 16,000 individual categories of shape, color, size, and carat (Koonar, 2006). Diamond shape refers to the general appearance of the rough diamond. Some of the most common diamond shapes are round, marquise, emerald, princess, pear, oval, and heart (De Beers, 2008). In terms of color, most diamonds appear colorless but may actually be slightly yellow or brown. The closer the stone is to colorless, the more valuable it is. The GIA Color Scale has been developed in order to detect the actual diamond color. The scale ranks a diamond’s color on a scale from D (colorless) to Z (heavily tinted). Diamonds may also be red, blue, green, and bright yellow. These colored diamonds are called “fancy” diamonds (“Glossary...,” 2003). Diamonds which are blue, black, pale green, pink, violet, and red are very rare. The Hope Diamond, which is the world’s most famous blue diamond, was mined in Colorado, a 45.5 carat diamond, now on display at the National Museum of Natural History in Washington, D.C (“Diamonds,” 1999).

Carat, another sorting category used by wholesalers, refers to the weight of the diamond. “Although the definition of a carat has changed over time, since 1913 the international standard has been 200 milligrams, or 1/5 of a gram. Often, jewelers describe carats in 1/4 increment. In jewelry pieces with more than one diamond, the carats may be described in terms of total carat weight (TW) (“Glossary...,” 2003).” Diamonds can be found in numerous sizes ranging from a fraction of a carat to several carats. Because large diamonds are much rarer than small diamonds, the price increases greatly as diamonds increase in size.

The sorting process, like all processes in the diamond supply chain, represents a valuable step in the creation of retail diamond jewelry. The wholesalers select diamonds based on demand and these four sorting categories. Good choices in the diamond materials now translates into good, quality piece of diamond jewelry further along the supply chain.

### **3.3 DIAMOND CUTTING AND POLISHING**

The extreme hardness of diamonds requires that no other material, except other diamonds, can cut a diamond. Thus, diamond cutting calls for highly specialized artisans, tools, equipment, and techniques. There are very few places in the world that specialize in the cutting and polishing of diamonds. The main diamond cutting centers are found in Antwerp and Amsterdam, The Netherlands, Johannesburg, South Africa, New York, the United States, and Tel Aviv, Israel. Due to the low cost of labor, diamond cutting centers have also been set up in China, India, and Thailand. The cutting center in Gujarat, India handles a large number of small diamonds due to the cheap labor costs. Large diamonds in smaller quantities are most likely to be sent for cutting and polishing in Europe and North America (Diamond, Wikipedia).

As cutting changes a rough diamond into a processed gem, ready for placement in jewelry, any mistakes at this point of the supply chain will lead to serious repercussions in profitability and supply. Thus, the planning stage of the diamond cutting process is more important than the actual cutting of the diamonds. A skilled cutter gets very few chances to make the right cut. Scanning devices take pictures of the rough diamond, and the shape is transmitted into a 3-D computer analyzing program. The diamond shape is scanned into the computer and the shape is then analyzed. The program helps the cutter determine the optimal shape for the diamond and the best way to go about cutting it. The diamond's natural shape and the market demand for certain shape are considered when cutting the diamond. As larger diamonds are more expensive and gain a higher profit, cutters desire to produce very little waste during the cutting process. Once a plan is in order, the rough diamonds go through a process called cleaving when a rough diamond is separated into smaller diamond pieces, to be finished separately. A diamond saw can be used to cleave a rough diamond. Bruiting phase where two diamonds are set onto spinning axles turning in opposite directions to grind against each other to shape each diamond into a round shape follows cleaving. The facets are then cut into the diamond and the entire diamond is polished, cleaned in acids, and inspected for quality (Diamond Cutting, Wikipedia).

Diamonds must present the perfect cut, as the cut adds a great deal of value to the diamond. This highly specialized stage in the supply chain represents the last stage in the processing of the raw materials. At this point, the diamonds must now be distributed to wholesalers and from there to retailers.

### **3.4 DIAMONDS EXCHANGES-BOURSES**

Once the diamonds have been properly cut and polished, the diamonds are then sold on diamond exchanges called bourses. There are currently 28 registered bourses in the world. The diamonds may be sold as loose diamonds or as diamonds already set in jewelry.

The World Federation of Diamond Bourses (WFDB) was founded in 1947 to unite and to provide bourses trading in rough and polished diamonds and precious stones, with a common set of trading practices. As stated on the World Federation of Diamond Bourses website, the purpose of the WFDB is as follows:

“The purpose of the WFDB is to promote understanding and closer co-operation between peoples all over the world who earn their livelihood in the diamond and precious stones trade. Furthermore, it is the aim of the WFDB to encourage the establishment of bourses with a view to eventual affiliation. The World Diamond

Council, which is the body set up by the World Federation, works hand in hand with over 35 Governments, the European Union and the United Nations to rid the Industry of the scourge of conflict diamonds (“World...,” 2008).”

Either before or after the diamonds are sold on the diamond exchanges, the diamonds are set into fine pieces of jewelry. This highly specialized job requires great craftsmanship, equipment, and tools. Before a piece of jewelry can be created, the design must be created. An artist or craftsman renders designs on paper. Once all the details have been worked out and all the measurements have been taken, a wax mold is created to be used to for the production of the jewelry piece that is later polished. Diamond designs and embellishments are then added to the metal pieces (“How...,” 2001).

### **3.5 DIAMONDS IN RETAIL STORE**

Retailers may purchase loose diamonds directly from the bourses or diamonds may be purchased after they have been set into jewelry. Jewelry has become a leading retail industry. The jewelry industry is split up into five different categories: bridal jewelry comprises 30% of the market, fashion jewelry is 22%, watches make up 18%, precious stones make up 15%, and precious metals comprise the last 15%. Jewelry stores throughout the world account for \$27 billion annually in sales, with 15% of sales in the U.S. Jewelry has a direct correspondence to economic conditions. If economic times are good, then people are more willing to spend money on jewelry. Purchasing jewelry today is not limited to in-store shopping. Jewelers have expanded their stores to the Internet. Consumers may purchase and customize jewelry online. Jewelry sales also are affected by the season. Forty percent of sales are accounted for in the fourth quarter.

On the market side of the diamond distribution, Switzerland, Japan, and Thailand make up the three largest exports for U.S precious metals. The United States is the largest purchaser of jewelry. Over 70% of the diamond market is controlled by the De Beers Company that has production and purchase agreements with most of the diamond producing countries (Gotlieb, 2006). Over the last 140 years De Beers managed to keep diamonds an expensive luxury product through hoarding diamonds or buying up supplies from other mines to keep them off the market and strategically suppressing production. In recent years Indian jewelers are the world’s biggest source of polished diamonds. India exports 80 percent of diamonds quantity that accounts for 55 percent of dollar value of the polished diamond market (Kaufman, 2002). Diamonds and jewelry are demanded globally, and managers must make sure that all members in the supply chain perform their job.

## **4. CREATING MORE ETHICALLY RESPONSIBLE DIAMOND SUPPLY CHAIN**

The heightened awareness in recent years of the serious nature of the conflict diamond matter has led global efforts to ensure that the diamonds on the market are true fair trade diamonds.

In recent years, the world has learned of despicable and dangerous activities in the diamond supply chain as described above. The Kimberly Process has been formed in response to this activity.

The Kimberly Process (KP) is a joint governments, industry and civil society initiative to stem the flow of conflict diamonds – rough diamonds used by rebel movements to finance wars against legitimate governments and has fuelled decades of devastating conflicts in countries like Angola, Cote d’Ivoire, the Democratic Republic of the Congo, and Sierra Leone. The Kimberly Process Certification Scheme (KPCS) imposes extensive requirements on its members to enable them to certify shipments of rough diamonds as ‘conflict-free’. Under the terms of the KPCS, participating states must meet ‘minimum requirements’ and must put in place national legislation and institutions; export, import, and internal controls; and also commit to transparency and the exchange of statistical data. Participants can only legally trade with other participants who have also met the minimum requirements of the scheme, and international shipments of rough diamonds must be accompanied by a KP certificate guaranteeing that they are conflict-free. As of September 2007, the KP has 48 members, representing 74 countries, with the European Community and its Member States counting as an individual participant (“The Kimberly...,” 2008).

The Kimberly Process has not been free of criticism by human rights activists. Michael Rapaport, a central figure in the fair trade jewelry movement and one of the key figures in the initiation of the KPCS called the KP a “sham”. For the last two years, fairjewelry.org argued that KP “...is a shield that deceives the consumer and should never be criteria for ethical sourcing. KP does not address human rights, labor, or environmental issues. Anyone interested in ethically source diamonds, whether jewelers or consumers, must not rely on KP. The issue is mine to market custody, which KP does not address sufficiently (Choyt, 2010).”

The Responsible Jewelry Council (RJC), (formerly The Council for Responsible Jewelry Practices) was founded in 2005 by a group of fourteen large companies and trade groups in the jewelry sector aims at reinforcing confidence in the diamond and gold supply chain by having its members adhere to “responsible ethical human rights, social and environmental practices in a transparent and accountable manner...(Choyt, 2009).” Now RJC has about 140 members from various stages of the supply chain (mining, retail, gold hedging, assaying). RJC’s certification scheme for gold and diamond supply chain was finalized in December 2009. Certification will show that a company’s diamond and gold operations comply with the RJC’s code of principles (“Jewelry...,” 2010).

In order to further ensure that the diamonds being sold are not conflict diamonds, individual countries, companies, and retailers have voluntarily set up additional regulation and certification systems. The Canadian Government has created the Canadian Diamond Code of Conduct, which establishes a set of standards to be followed by Canadian diamond retailers. Certified Canadian diamonds are able to be traced back to both the mine and the retailer. Diamonds that are not certified are easily able to be identified (“Canadian...,” 2007). Zales Jewelers, North America’s largest specialty jeweler, “participates in a voluntary program of self-regulation to complement the KPCS in cooperation with the leading organizations in the jewelry industry, including the World Diamond Council and Jewelers of America”. Zales has created a compliance program that requires all vendors to continually recertify compliance to KPCS and to provide proof of warranty from their diamond suppliers (“Glossary...,” 2003).

## **5. RECENT TRENDS IN THE DIAMOND SUPPLY CHAIN**

According to Daniel White, UK business director of Diamond Trading Company, the world’s supplier of diamonds the trend in the diamond industry is to shorten the supply chain between the rough coming out of mine and shop window. Companies are realizing it makes sense financially to consolidate the pipeline and take part in more of the process. For example Lev Leviev, chairman of the Leviev group of companies controls the biggest private mine, is the world’s largest polisher and cutter of diamonds, and owns Leviev boutique in London to be followed by one in New York. DeBeers owns diamond only shops in London, Paris, Tokyo, and Los Angeles (Doutton, 2006). Tiffany & Co for the last 172 years avoided sourcing, cutting, and polishing its own diamonds. The company decided to move backward in the supply chain and in 2002 began opening cutting and polishing plants in Canada, Belgium, South Africa and Vietnam adding operations in China and Mauritius in the last two years (O’Connell, 2009). Harry Winston Diamond Corp. now owns 40% interest in Davik Diamond Mine in Canada and retail stores in New York, Paris, Tokyo with plans to open many others in the US, Beijing and Hong Kong. This has given the company access to the more profitable ends of the diamond supply chain -the rough-cut wholesale and retail business (Covert, 2007).

## **6. CONCLUSION**

The tiny size of a diamond is misleading, as its small size does not offer any hints about the numerous steps involved in the process of turning it into a retail diamond. As new mining technology and new exploration techniques are discovered, more steps and links may need to be added to the supply chain. In addition, new consumer trends and designs in the jewelry industry will alter the fair trade diamond supply chain. There is no

shortage in the demand for diamonds. Successful supply chain management in the diamond industry provides for higher profitability. Managers, given current social-cultural trends in societies, must carefully integrate the activities that procure materials and services, transform them into goods, and deliver them to customers in ethically responsible way.

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