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Growth and Development of Agate Industry in Gujarat – A Case Study of Khambhat

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ABSTRACT

The paper looks at the growth and development of agate industry in the Khambhat area of Gujarat, India. The data collected for the understanding had use mix methodology which is explained in the paper below. The paper tries to understand the current situation of the agate industry in context of history, economics, environment and associated workers. The paper also explains the basic of agate and the manufacturing process that is used in the agate industry. The paper provides an insight to the current scenario of the agate industry in Khambhat area of Gujarat.

Keywords : Growth, Development, Agate, Industry, Khambhat

INTRODUCTION

Agates are basically hard semi-precious stones which are a different physical form of Chalcedony¹, a kind of silicon dioxide in the form of microscopic fibrous quartz crystals. It is used as a gemstone in ornaments and found all over the world in places including India, Asia, USA, Africa, Brazil, Germany, Mexico, Italy and Nepal. It is found in a variety of colours and gets formed in the cavity of host rocks. This leads to the concentric band kind of formation and appearance of these rocks (Changrani, 2016).

Agate is considered to be unique and different from other gemstones. Worldwide, agate is considered to have metaphysical properties. It is believed that it can enhance the quality of life or even prevent and cure psychological and mental disorders. People also believe that it can balance energies in the human body. Due to this, agates have been extensively mined, shaped, ground and polished multiple times into beads of all shapes and sizes. Agate's value was quite high in antiquity, when it was used as one of the main

¹ It is a fibrous microcrystalline type of silica which contains miniscule crystals of quartz. It is the family name which has many different gemstone varieties in it.

gemstones. Now its value is fairly low because of global competition around the world. Some 3000-3500 years ago the ancient, Egyptians sought colourful agates and other Chalcedonies from the Aghates River now called the Drillo River in Sicily. Consequently, many artefacts, jewellery, jewels were found in the tombs of Kings and Queens of ancient Egypt. (Agate, 2007) Agate rates a 6.5 to 7 on the hardness scale. The typical or more common colour of agate is a blue whitish grey. The most highly prized forms of agate are Cornelian, Chrysoprase, Jasper, and Sard. Carnelian is yellow-orange to orange red and translucent. Chrysocholla is an intense light blue or blue green. Chrysoprase is translucent, light to medium yellowish green, and was once considered to be prized form of Jade bloodstone is another version of agate, opaque and dark green with spots of dark red. Jasper can show various landscape-like patterns with the stone.

India's gems & jewellery sector is second highest contributor to the Indian commodity exports with a share of 13 %. The total exports of Gems and Jewellery for India in for year 2014-15 was around \$40 Billion out of which coloured Gemstones (Agate) was \$0.45 Billion. (Gujarat, 2017) However, it is to be noted that India has been the primary exporter of agate products world over and continues to dominate the same till date (PT, 2013).

✓ *Agate in India and the World*

Agate got its name from Greek philosopher and naturalist, Theophrastus. He named it so as he discovered it in between 3rd and 4th century, on the banks of the river Agates, which is in the city of Sicily, currently. The stone is being used from ancient times for hard stone carving. It has been recovered at many ancient sites including Knossos site in Crete, indicating its usage in Bronze Age. (Agate, 2007)

Currently, agate mines are prevalent all around the world. The important mines are in USA, Russia, Canada and Europe, apart from India. In the recent times, the industry has grown in strength in the South Dakota area of USA. It is called Fairbanks agate and is procured in the black hills. The stone has sharp bands that run parallel to each other. Deposits of agate are scattered across Arizona and Idaho as well. In San Luis Potosi and Aguascalientes states of Mexico, fire and multi-coloured agates are found. The apache agate, with floating red colour is a famous clear agate in this area. Laguna and Coyamito agates are banded agates which are less sharper found in proximity to Mexico. Agua Nueva, in the Mexican ranch is known for its vein agate.

In Oka River, 100 Km south of Moscow, one can find agate in limestone. In Nahe river valley in Germany, there have been traces of agate from 1497. The cutting centre here was called Idar-Oberstein. On discovery of rich agate deposits in Brazil in the 19th century, the cutters moved there after exhaustion of deposits in Idar-Oberstein. The second varieties of vein agates are found in Thunder Bay in Canada. Fire agates, quartz crystals and opal eggs are found in Opal mines in California.

Agate Creek in far North Queensland is the recognized Australian hotspot for appealingly designed agates that happen in and are weathered from amygdaloidal basalt of Carboniferous age. Agate Creek agates are famous both for the excellence and assorted variety of their alluring shading designs. It is a pity that agate from Agate Creek in North Queensland is minimal known outside of Australia, for this agate shows about each possible shading and example that is conceivable to see in agate.

In India, many varieties of agate are found such as the Jasper, bloodstone, chocolate stone, *maimariam*, azure, jet and *Pijora* varieties. These are found in parts of Bombay, Chennai and in the state of Orissa. However, it is found predominantly in Khambhat, in the western part of Gujarat. There are four types of agate found in this region. The first is the common agate which is of two types. The white, half clear stone is called *Dola*, and the cloudy, streaked one is called *Jamo*. The second is the moss type agate, which is from Tankara near Morvi known as *Suabhaji* and *Phatak*. The third variety is that of *Kapadvanj*, which is from the river bed of *Majam* known as *Kaiyu*, *Agiyu* and *Ratadiyu*. The most valued of them all is the veined variety of agate, called as the *Doradar*. India's export for last ten years (See Table 1) has been extremely profitable to the economy. It has made huge amount of contribution to the economy in the year 2012-13 during the export of coloured gem stones.

Table 1 India's Gross Exports (In Million \$) of Coloured Gemstones for last ten years (Source: GJEPC)

ITEMS	2007-08	2008-09	2009-10	2010-11	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Coloured Gem Stones	295	282	306	349	420	729	647	453	433	420

The predominant occupation of people here has been manufacturing and trading of the agate stones. There are many small industrial units in this region, which employ thousands of people and whole communities in cutting, drying, grinding and polishing of agates (PT, 2013). These communities were traditionally called Siddis and they had to take a lease to mine in this area from the government of India. Siddis were originally from Africa and were one of the first communities to start mining in the Rajpipla mines. Gori Pir was the name of the person who set up the first bead making workshop here and expand his business to other cities. Currently few of the descendants of Gori Pir or the Sidis are involved in agate trade (Possehl, 1981).

✓ ***Agate and Khambhat***

In Khambhat, stone bead-making is a cottage and household industrial activity, carried out in the house premises. They would fall under small scale industries, a self-sufficient and self-employed family unit. In these premises rough agate stones are transformed into various other products that are beautiful and smooth. But the fact is these industry is an oligopoly where only few individuals who own and other the business from various households (Intercultural Resources, George PT, 2013). A large majority of the small-scale units in the industry are not licensed and operate outside the industrial labour laws and

regulations. The lack of government involvement supervision of the working conditions of the units and unavailability of proper protective gears and mechanized tools expose agate workers to a variety of problems (Intercultural Resources, George PT, 2013). Due to this most of the workers employed in the industry do not have the benefits of organized industries.



Figure-I

One of the abundant rocks found in this area, which is also a result of the immense siltation in the gulf from immense catchment area such as the Narmada (Possehl, 1981). The author describes that the families work in extracting these rocks from the ground. Men would get into small holes dug to reach the rocks, which they brought out with their crude equipment's, which were then carried to storage spaces by women. They were then sorted again in the mines itself. These communities are called Siddhis and they had to take a lease to mine in this area from the Government of India.

Though few Siddhis are still involved in agate trade, many have adapted to the changing conditions and adapted new lifestyles, also because of the hazards related to the industry (Possehl, 1981). Before discussing them, it is important to understand the process of manufacturing and the end products of the agate industry.

✓ ***Basic of Agate***

Agates are formed in the holes in host rocks, which are filled up layer after layer. The arrangements, colours and patterns vary according to conditions such as pressure, temperature and mineral contents. The secondary deposits in the hollow cavities of igneous rocks often get transformed into agate over years. These empty cavities are filled with fluids which are often rich in suspended quartz and mineral impurities. When the concentration of the same gets super saturated and a gelatine like consistency is arrived at, miniature fibrous microcrystals are formed. Following this, contrasting bands are formed with repetitive patterns which are the agate rocks.

There are many types of agates. The common ones are:

- Fortification agate – one of the most common kinds of agate, which has bands crystallized in a concentric manner following the shape of the cavity.
- Water line agate – It is formed after the extra water in the silica settling layer by layer drains out. The orientation is controlled by gravity.
- Shadow Agate – It is an agate which has alternating translucent and opaque bands.
- Tube Agate – sometimes, tube like projections form in the silica gel, which weather away or leave hollow tubes that fill in with silica.
- Eye Agates – In some cases, the silica gel predominantly drains leaving only a droplet that beads up in the cavity, from which crystal growth further continues.
- Plume agate – these are filamentous growth that resemble feathers
- Geode agate – An agate with a hollow center and a crystalline outer fill.
- Moss Agate – it is a cluster of mineral inclusions which resemble landscape.
- Seam Agate – these form in cracks in host rock in parallel rows

METHODOLOGY

Figure II Methodology's Work Flow

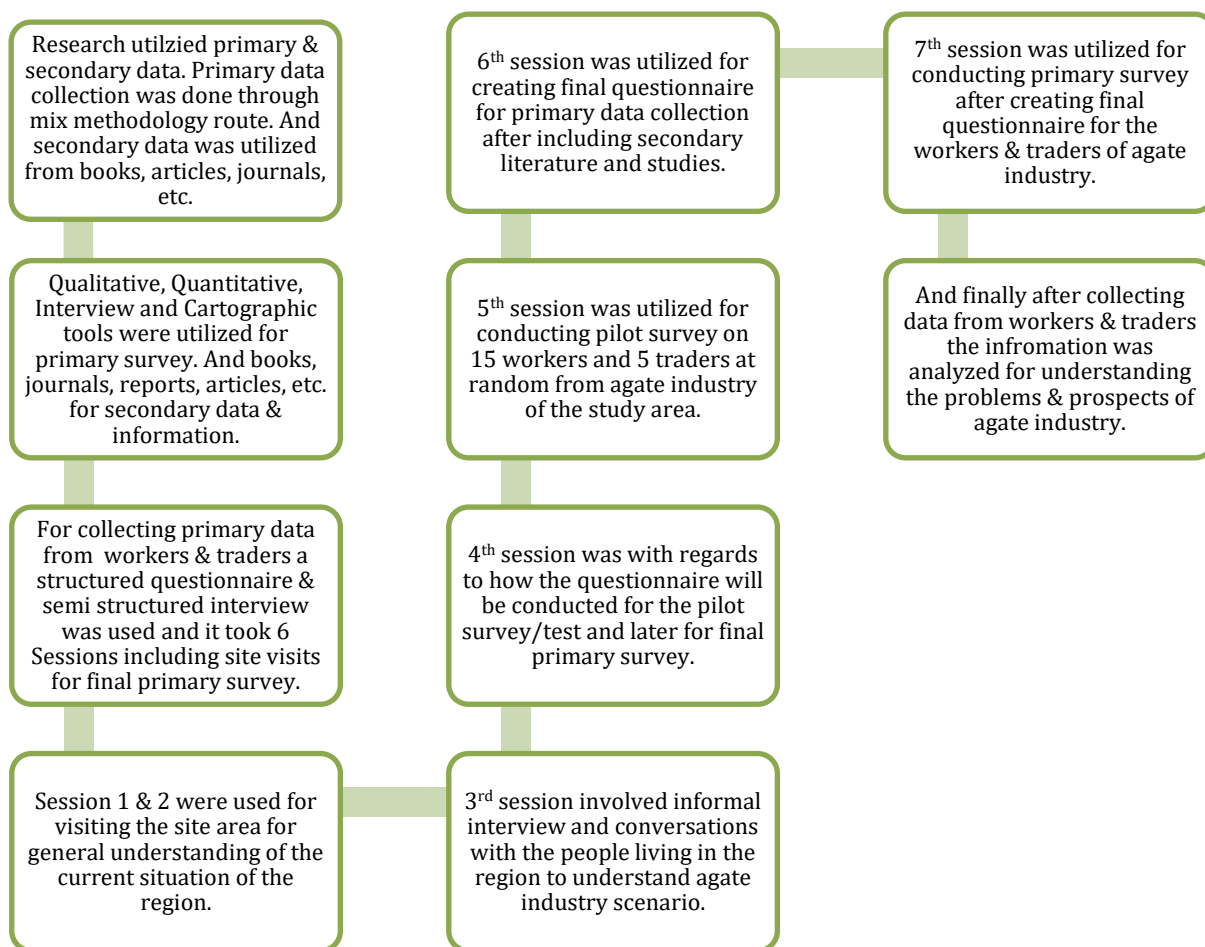


Figure III Process of Collection of Information from Workers

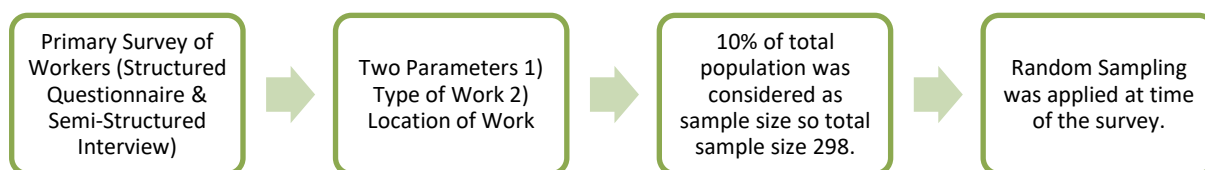
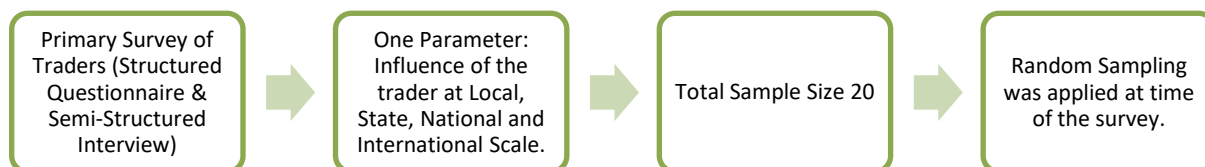


Figure IV Process of Collection of Information from Traders



RESULT AND DISCUSSION

1. *Agate Making Process*

The manufacturing process of agate includes steps such as sun drying, breaking larger stones into small sizes, slicing of the stones, rounding in a ball mill, shaping on grinding wheels, polishing, drilling holes, and assembling the final product. All of the mentioned steps are carried out by different sets of workers as for example, *fodia* (chipper) or *ghasiya* (polisher) etc.

Primary size reduction job is done by chippers. A pointy iron rod is implanted in the ground at a certain angle. A stone is then held against the rod by hand and is struck with a hammer made of animal horn example cow's horn, so that the stone is chipped into small pieces. The chipper must break the stone while keeping in mind the final product which is to be created hence this job requires skills for work.

Rounding and process of reduction of the size is sometimes done in a drum made of wooden planks – a sort of a barrel of ball mill, powered through an electric motor. The process is very dusty and noisy. Many people especially the men of the working class who employees other workers, but many also work alongside the workers to build walls around the mill to prevent silica dust from spreading everywhere in the work environment. The walls also help to reduce the noise pollution created by the ball mill machine.

Polishing or Grinding is done by polishers or grinders. These people are the most vulnerable to exposure of silica dust. Polishing is done in various ways depending on the final product. For creation of certain products, a horizontal wooden bench with a vertical moving emery wheel powered by an electric motor is commonly used. Polishing done by hand is done dry, though many workers have started to adapt wet methods for polishing the stone. For shaping spherical beads, polishers use a rectangular wooden plank of about 6-8 inches wide and 2 – 3 feet long. Several rounded grooves are etched into one end of the plank to hold the stones in place, and matching set of grooves is chipped into the emery wheel. Rough agate stones are arranged on the etchings and pressed against those grooved emery wheel. Lubricants are utilized at the time of revolving process for the purpose of shaping the surface of the stone.

Giving the smooth lustful polish requires various methods for the process. The most popular of them all is to tumble the stones in metal drums with water, aluminium oxide and emery dust. When required the stone slicing is done by a specialized machine. Small and medium size machines are now available for slicing of the agate stones. Stone slicing is done in an enclosed machine using kerosene as a coolant. In other places it is done through dry process the process is noisy and dusty.

Drilling used to be done manually, creating ergonomic problems at time of creation of the final products. Electric drilling machines are instead utilized for the purpose thereby reducing the error in the process and the assembly of the whole product is still done manually till date.

Agates are chipped into barrel shapes, long faceted beads and rectangular shape which are common (Patel & Robbins, 2011). They are first chipped for a rough shape, then for a finer shape. They are then smoothed and polished for primary finish. Following this, they are drilled to create holes in the centre and sent for the final polishing. After this, the beads are again sorted for quality (Possehl, 1981).

It is to be noted that the process has been redundant without much of technological intervention except the electric grinders. This dry grinding process releases fine dust which accumulates little by little in the lungs of the workers, leading to the fatal disease of silicosis.

2. Growth and Development of Agate Industry

The pure handicraft and art-based industry expanded and mechanized after the induction of electricity in the manufacturing process. Grinding the agate stones at high speed produces a large amount of dust. The particles are 2-5 microns in size and settle in layers in the alveoli. An exposure of 5-10 years to this dust has proven to be fatal. When continuously exposed to silica dust, the lungs gradually over the course of time gets filled with the dust particles. Whole families have been wiped out due to this disease. In the month of September, 2014 two people became victim of the deadly occupational disease of silicosis, in the Khambhat region. The number of deaths because of silicosis in the state of Gujarat reached to 19 people, this is the highest ever in a single year.

There is also a severe social stigma associated to these workers as nobody wishes to marry them or their children due to their short lifespan. Though silicosis is a compensable disease in India's workmen's compensation act, agate workers never claim the same. This is more since they are declared as self-employed and lack rights to claim compensation. The others do not have the awareness for the same. The cost to file the claim, and the duration of the process prove to be very expensive for the workers. Doctors hardly diagnose the same and even the workers do not care as it makes no difference to their lives. They work till they die (Patel & Robbins, 2011).

Back in the 1980s itself, extensive research was done on silicosis among agate workers in Khambhat by Industrial Toxicology Research Centre (ITRC), Lucknow. It proved that 63% of the workers suffered from lung diseases. A public interest petition was filed in Gujarat High Court. The High Court set up an inquiry commission. The National Institute of Occupational Health (NIOH), as a part of inquiry commission, carried out a survey. They installed exhaust system to measure the dust level. NIOH submitted report to the High Court but no action was taken. NIOH carried out an environmental epidemiological study during 1999-2004. It also studied the Silica dust in the environment and recommended the exhaust system with better design. The study has conclusively shown that it is the serious major environmental problem. As the workers are directly exposed to deadly Silica dust. Not only workers, but their family members including children are also affected (PUCL Gujarat, 2007). Regular exposure to even 25-27 micrograms per cubic centimetre of air can have devastating consequences on the workers' health. Even non-workers who are exposed to this dust are equally vulnerable to silicosis (Intercultural Resources, George PT, 2013). Another

study in 2007, 123 subjects were studied out of which 70% were reported to have silicosis. The study showed an alarming fact that with every year of exposure, the probability of getting silicosis increased by 12%. Only the workers are not exposed to this, but their children, neighbours and whole villages are affected by the dust (Patel & Robbins, 2011).

Usually, it takes some years for the symptoms of silicosis to show up. Lack of early detection, unavailability of the treatment with added layer of malnutrition proves fatal for the workers. Most of the victims of silicosis come to know about it only in the later stages. During the process because of lack of strength they continuously fall ill with severe cough, fever and many other symptoms. Unable to do any physical labour, they stay at home, chained to perennial poverty and illness, always weak, struggle to breathe. And the trap continuous to take life out of them and they die a premature death (Intercultural Resources, George PT, 2013).

On the issue of silicosis in the Khambhat region, for a long time, in the absence of proper diagnosis, many cases of silicosis have been recorded as cases of tuberculosis, making the morbidity figures very inaccurate right at the outset (PUCL Gujarat, 2007). Several silicosis patients have also died either without proper diagnosis or with treatment only for tuberculosis. Different reports show different figures. Some reports show the total number of people affected by silicosis in Khambhat to be around 50,000, while some others show a figure of 30,000. Government officials give a totally different picture, denying these figures and reducing the number to around 5000. Thus, it's a difficult task to give an accurate figure of people affected by silicosis (Intercultural Resources, George PT, 2013).

The government of Gujarat has not acted proactively in this issue. Though the central government's factories act deems the exposure to more than 5% of silica as hazardous, this has not been implemented by the state government. Rather, amendments to the state act have been carried out which have reduced the permissible workers per factory. The government has not focused on improving the condition of work places, providing exhausts, lowering the incidence of occupational diseases or installation of new advanced equipment in these factories. They have been declared as cottage industries which do not fall under the factories act as well. In Khambhat area in 2009, 21 gemstone workers died of silicosis (The National Labour Committee, 2010).

This is seen by many researches as a major threat to the industry as the workforce is reducing day by day due to the health issues and new workmen are difficult to find given the hazardous exposure of the industry. The disease can be preventable by very simple measures with occupational safeguards, which would serve as an advantage to the growth of the industry on the whole.

3. Current Workers Scenario in the Industry

In order to understand the caste, religion and other demographic profiles of the region, various forms of data were collected at the time of the survey.

The total population of family members on average was 4.97 per family. The maximum number of family identified was 15 members in a family. The lowest is one. The mean of educated members is 2.96. Per family the average children recorded is 2.35. The maximum children recorded in a family are 10. Among the children how many children went to the school on average is 1.88. Out of average family of 4.97, the members working in the family is 2.18 and out which only 1.60 members work in agate industry.

57.4% of the respondent were male and the remaining 42.6% people belong to the female. On average 1.66 males are in to agate work from the family, and similar to that female are 1.51. The average age of experience of male workers in agate work is 15.68 years where as for the female it comes to 13.55 years. Exposure to more than 5 to 10 years of experience in agate industry can lead to serious exposure to silicosis. The (Figure 4) portrays that there are 5 caste that have highest percentage of involvement in the agate work industry. The Thakor caste is the highest found at the time of the survey (23.8%), followed by Chunar caste (15.1%). Baraiye caste has 11.4% people working in the agate industry. Malek and Shekh caste are around 10.4% and 10.7% respectively. The other workers come from various different castes from the society across the whole Gulf of Khambhat region.

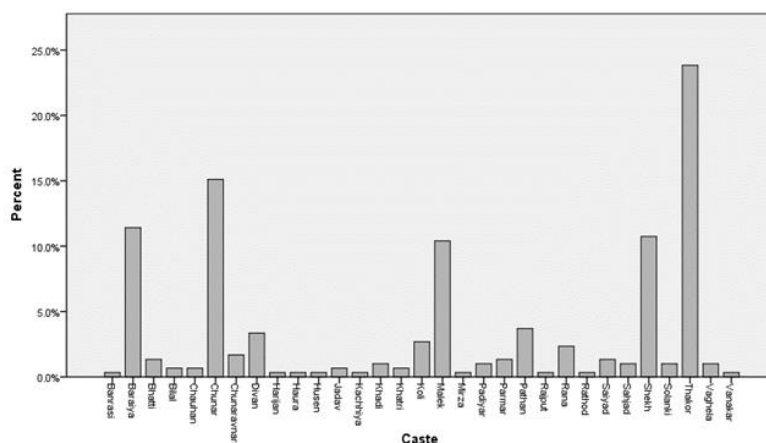


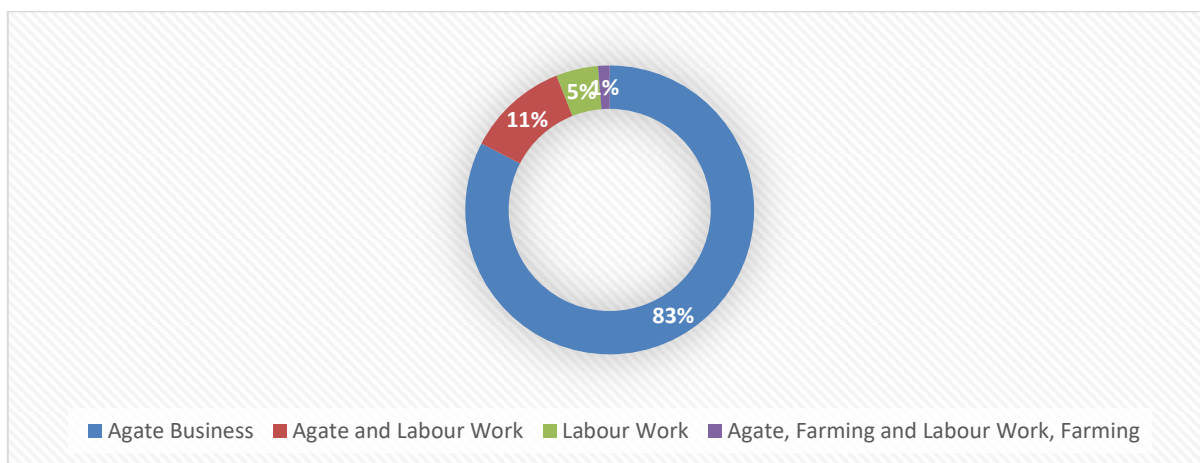
Figure V. Caste Based Distribution among Agate Workers

The religion based demography of worker force shows majority are Hindu (65.1 %) followed by Muslim (33.6%) people from the total sample survey size of 298 agate workers. People from other religious group such as Sikh, Christians, etc. have never been found during the time of survey. Many in their research have acknowledged that Hindus and Muslims have been part of the agate industry since couple of century. Though there haven't been many studies on the subject. The marital status of this worker was largely divided into 4 categories in Descending order of the distribution. Married workers were the highest at 77.9%, followed by 16.8% workers were unmarried. Widow and Widower turned around to be at 4.7% and 0.7% respectively among the sample size. 84.3% of the agate workers had primary education. Followed by Secondary education at 14.7% and Higher Secondary education was merely 0.7%. 0.3% is the lowest percentage belonged to Graduation and Post-Graduation education level in the agate workers. Education is

getting costlier thus the workers are struggling to provide education even for their children. Silicosis on the other hand eats up larger share of their income; there is merely small amount of money left with the worker to support his or her children’s education. The total monthly income is utilized largely for food and other household expenses.

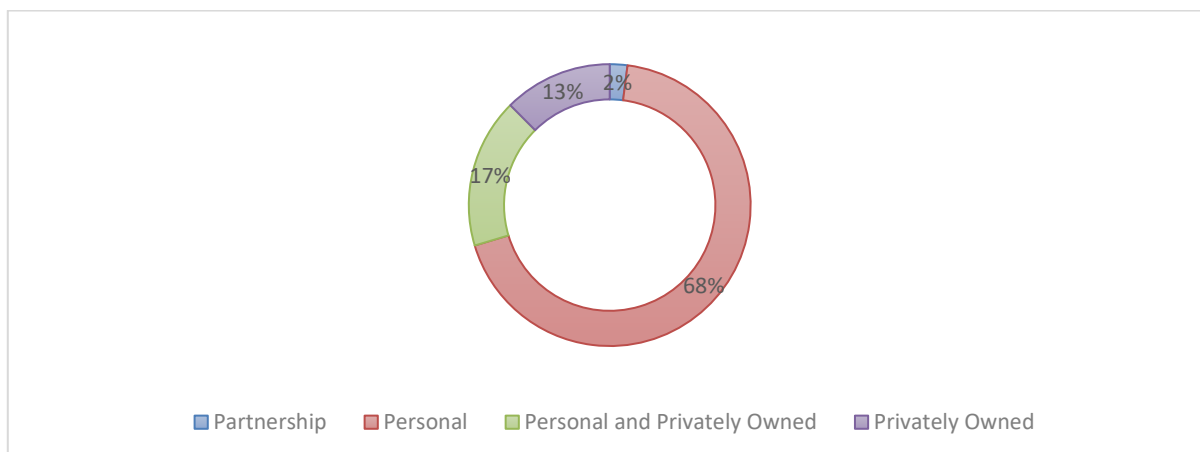
Majority of the people (82.6%) agate workers had their major family source of income from agate work. Few worked with a combination of Agate work and Labour work (11.4%). The remaining major source of family income was observed among agate business, farming, and labour work. See Figure (VI) for more details.

Figure VI Major Source of Family Income



Type of business ownership was highly skewed towards personal work that the workers did. 68.1% of the workers had their own personal work for agate. There were small amount of workers who worked personally but also owned the business in person (17.1%). Only two percent of the workers worked in partnerships (See Figure VII for more details).

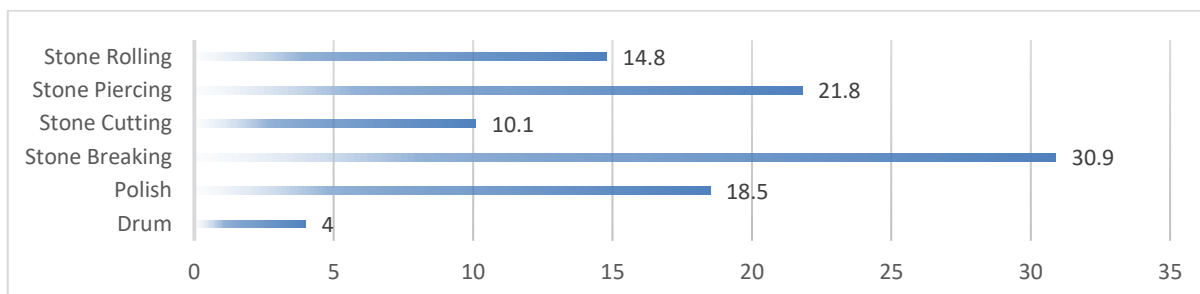
Figure VII Type of Business Ownership



More than quarter of workers (30.9%) worked in stone breaking work at the time of the survey, followed by 21.8% of people in stone piercing work. And polishing worked stood at 18.5%. The work distribution

identifies the work opportunity the workers have but on the other hand the industry is requires skill worker with enough experience to work in particular type of agate work. For more details (See Figure8). On average the worker spends around 7.14 hours a day in their work. The minimum hours recorded at time of the survey was 4 hours. Majority (69.1%) of the workers work from morning 10:00 hours to evening 18:00 hours. Almost 8 hours a day.

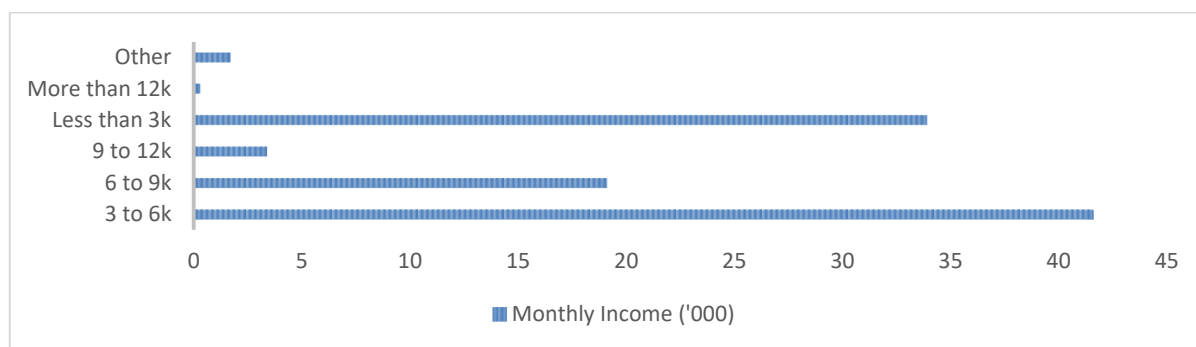
Figure VIII Type of Agate Work (%)



More than 1/3rd (41.6%) of the workers fall under the income bracket of ₹3000 - ₹6000. Followed by workers who have monthly income of less than ₹3000 (33.9%). There are very few workers who are paid more than ₹12000 a month. For more details of monthly income of workers (See Figure9).

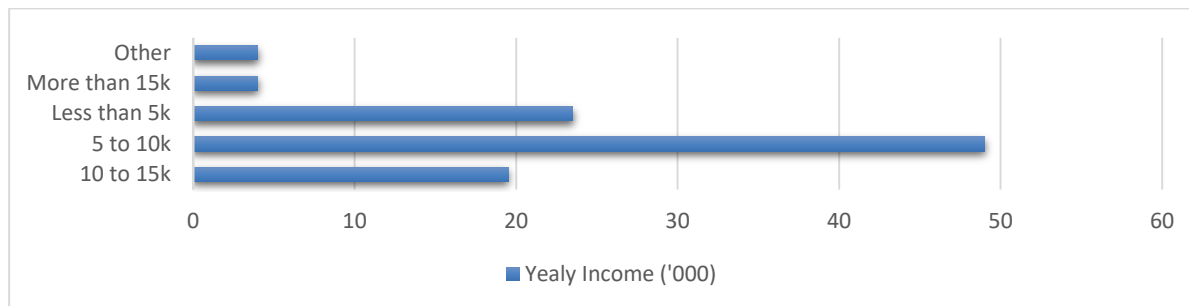
The workers are paid based on piece they create on daily basis and also on type of work they hold onto. The workers are not allowed to work for other workers. So, it is tough for them to create a new source of income apart from agate work. The agate work pays of their daily bills thus many families prefer to stay in agate industry and also allow their children to follow the same path.

Figure IX Monthly Income of Agate Workers



For around 49% of the families of the agate worker the whole family earns between ₹5000 - ₹10000 a month. Close to quarter, 23.5% families earn less than ₹5000 a month. Income segregation is seen because of the type of work the workers are involved into (See Figure10).

Figure X Total Family Income (Per Month)



CONCLUSION

Agate workers associated with this business have asymmetrical distribution and have faced prosecutive behaviour. 54.7% are the men that engaged in this occupation. Based on caste 23.8% comes from Thakor, 15.1% comes from Chunara caste, 11.4% Baraiya Caste. Distribution based on religion 65.1% are Hindu, 33.6% are Muslim that means only people from two religions are working in this industry. 77% people are married besides the widow 4.7%. (Whose husbands died at early age due to Silicosis). Percentage of people involved in higher education is extremely poor it is just 1%. 82.6% of the families that are involved in this business has agate work as their only major source of income and out of which only 68% of the people owns those business. 30.9% of the people are involved in the stone breaking work and the lowest percentage of work belongs to drum i.e. 4%. 41.6% people who are involved in the business have monthly income in range of ₹3000 to ₹6000, 49% has monthly income in range of ₹5000 to ₹10000.

The ancient identity of the Khambhat region is associated with industrial landscape of agate industry. Agate Industry even though being one of the ancient and heritage industry the growth and development of the industry in the region is comparatively slower than other industries. This research through its finding has helped to understand the problems and obstacles face by people associated to agate business in the Khambhat region. People who are working in Dry Polish and Drum Polish have been most affected by Silicosis disease. The prevention of health hazards from the work environment, providing exhausts for lowering the incidence of occupational diseases or installation of a new technologically & advanced equipment in the factory are some of the required useful steps towards the overall development of the Agate Industry.

REFERENCES

1. Agate, A. C. (2007, July 16). *Gem*. Retrieved February 24, 2018, from Agate Creek Agate: <https://web.archive.org/web/20070716052933/http://www.gem.org.au/agate.htm>
2. Changrani, R. (2016, March 9). *Jewelinfo4u*. Retrieved February 24, 2018, from Jewelinfo4u website: <https://www.jewelinfo4u.com/important-agate-mines-in-the-world>

3. Department of Ocean Development, G. (2002, May). *Critical Habitat Information System for Gulf of Khambhat - Gujarat*. Chennai, Tamil Nadu, India: Government of India (GOI), Integrated Coastal and Marine Area Management.
4. Gujarat, V. (2017, January 10). *Vibrant Gujarat*. Retrieved February 24, 2018, from <http://vibrantgujarat.com>: <http://vibrantgujarat.com/writereaddata/images/pdf/gems-jewellery-sector.pdf>
5. Intercultural Resources, George PT. (2013, June 12). *The Silent Killer: Agate Workers in Khambhat Fight against Silicosis*. Retrieved March 12, 2018, from ritimo.org: <https://www.ritimo.org/The-Silent-Killer-Agate-Workers-in-Khambhat-Fight-against-Silicosis>
6. Patel, J., & Robbins, M. (2011). The Agate Industry and Silicosis in Khambhat, India. *New Solutions: Journal of Environmental and Occupational Health Policy*, 117 - 139. Retrieved from <http://journals.sagepub.com/doi/abs/10.2190/NS.21.1.1?journalCode=newa>
7. Possehl, G. L. (1981). *Cambay Beadmaking - An ancient craft in modern India*. Ahmedabad: Expedition.
8. PT, G. (2013, June 12). *Ritimo*. Retrieved February 24, 2018, from ritimo.org: <http://www.ritimo.org/The-Silent-Killer-Agate-Workers-in-Khambhat-Fight-against-Silicosis>
9. PUCL Gujarat. (2007, November 1). *Silicosis: A Death Trap for Agate Workers in Gujarat*. Retrieved March 11, 2018, from countercurrents.org: <https://www.countercurrents.org/pucl021107.htm>
10. The National Labour Committee. (2010). *Hearts of Darkness*. Ahmedabad.
11. Vincent, D., & Gupta, G. (2002). *Critical Habitat Information system for Gulf of Khambhat-Gujarat*. Chennai: GoI Department of Ocean Development.