Impact of Air Pollution from Marble Industry on Health: A Case Study from Bajaur Agency, FATA

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DEDICATION

I dedicated this thesis to my prophet, ***HAZRAT MUHAMMAD (SAW),*** *for the path of virtue he showed.*

I dedicated this thesis to my ***Father****, for his passion towards my studies, my* ***Mother****, for her care, prayers and affections, my* ***brothers*** *and* ***sisters*** *for their unconditional love and my* ***Friends****, for lovely memories of life.*

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ABSTRACT

The present research work is based on assessment of impact of marble industries on human health and duration of workday's loss due to the sufferings from different diseases. Primary data was collected using both probabilistic and non-probabilistic sampling techniques. The total sample size is 346 respondents. The data was equally distributed among marble factory workers and non-marble factory workers i.e. 173 from marble industry workers and 173 non-marble industry workers from residential area near the vicinity of marble industries. Data was obtained through well-structured, pretested questionnaire. Multiple linear regression model (MLR) was used to estimate both number of workday's loss due to illness and total direct mitigation cost. Result revealed that there is significant number of workday's loss due to illness from dust. High correlation was observed between higher working hours and greater exposure to the dust particles. Marble factory workers are more exposed to the dust. Thus making them more ill compared to non-marble factory workers and results in more workday's losses as compared to the non-marble factory workers. Non-marble factory workers have option to live within limits of the factory or far away from the factory and would also use air cleaning machines or dust minimizing appliances. Negative and insignificant relationship of income with workday's loss have been found. The respondents were unaware about the adverse effects of marble dust on their health. This is mainly due to lack of education and awareness. On an average the marble factory workers were losing 30% of their working hours and 37% of their income due to health hazards. Policy recommendations were formulated.

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Chapter III: Status and Importance of Marble Industry in Bajaur Agency

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CHAPTER I

Introduction

1.1. Background of the Study

Pakistan is blessed with different types of natural resources and minerals such as marble, gypsum, silica, iron metal, rock salt, silver, precious stones, copper, coal, graphite and fire mud. Marbles industry contributed foremost to Pakistan Gross Domestic Product (GDP) and its methodology starts with the decision of unrefined material on stores concerning the essential of last thing's physical properties to the extent shading, surface, hardness thus on then it is removed in sort of pieces, then transported to process industry for cutting and evaluating those squares of rough material into finishing thing with specific estimation (Prentice, 1990 and Trade, 2010). The greater part of the marble holds in Pakistan are situated at Sawabi, Nowshehra, Buner and Mardan city of Khyber Pakhtunkhwa (KPK). Also marble reserves are located at Bajaur Agency and Mohmand Agency, Federally Administrated Tribal Area (FATA). The proportion of Bajaur Agency are 6% marble production and 8% chromate production for the year 2012-13 (PPAF, 2014).

1.2. Problem Statement

In tropical areas with dynamic mining, cyanide and mercury spillover from gold preparing into nearby water bodies regularly expands the pervasiveness of skin diseases, as individuals utilize water for every day necessities without treatment. Defilement realized by quarrying and affecting in open-pit mines augments not simply the dust particles detectable all around and the enveloping environment, furthermore progresses the spread of deadly chemicals. A percentage of the poisonous chemical residue are hazardous to the human health (Akabzaa, 2000).

Tuberculosis is an infectious disease brought on by Mycobacterium tuberculosis. Although all the organs in the human body are helpless to TB, the lungs are the essential organs that are most generally influenced. Tuberculosis as a rule influences the youth, poor and the frail who are as of now experiencing sicknesses, for example, HIV/AIDS, which weakens the resistant framework. Since TB is spread through the air, it transmits effectively in swarmed situations. Mineworkers work in close nearness to one another in an encased domain, for example, an underground mine, which permits the TB microscopic organisms to spread effortlessly. In South Africa, a main gold mining nation, tuberculosis is the third driving reason for death (Bradshaw et al., 2003).

Nearby groups can conceivably be influenced by dust particles up to 1 km from the industry, in spite of the fact that worries about dust are probably inside of 100 meters. Saved dust offers ascend to the best number of protests to quarries from nearby groups. Particulate matter may show up especially on clean surfaces, for example, cars, windows and window ledges, or surfaces that are for the most part expected that would stay free from dust. The impacts from quarrying activities on the individual's wellbeing are really basic as impacting vibrations have additionally brought about breaks in a few structures presenting the inhabitants to risk. The process of quarrying causes negative impact on floral development (Banez, et al., 2010).

Exposure to the dust particulates containing crystalline silica causing respiratory illness which is termed as silicosis (Choudhary and Mathur, 1996).

Dust originates from larger masses of same material through mechanical breakdown process such as cutting, explosion, strong friction between rocks. About 12% of the earth crust comprises of silica deposits. Silica containing particles causes hazardous ailment such i.e. silicosis (Chattopadhyay and Gangopadhyay, 2006).

Marble sludge subsequent to getting dried reasons air pollution issues for the occupants residing near the vicinity of marble industry. Transfer of sludge is a noteworthy ecological issue. Dust particulate affect plants by forming dust layer on their leaves and decreasing daylight penetration, which results in low vegetation. Moreover these particulates are also hazardous to aquatic life. Dr. Muhammad Zaman, told Daily Times that dust residue transmitted to air during marble processing were extremely harmful to one's health. He said, "Local community resident in vicinity of these industries are inclined to a respiratory infection called silicosis". This infection is incurable and it prompts respiratory system failure, leading to patient's death (Daily Times, 2008).

Employers of these industries are usually unaware of precautionary measures and threats of these hazardous pollutants (Fatusi and Erbabor, 1996).

Various reports show that the workers presented to stone dust generally encountering the lung illness which are joined with cardiovascular inconveniences, respiratory and liver ailments (Osorio et al., 1987).

As per Weber (2002), surface mining however less hazardous than underground mining, has a more prominent effect on surface scenes. Surface mining requires the evacuation of enormous measures of top soil keeping in mind the end goal to obtain entrance to the minerals, which can bring about disintegration, loss of living space, and dust pollution. It can bring about substantial metals to break down and saturate both ground and surface water in this manner emitting marine natural surroundings and crumble drinking water sources. Massive cultivating grounds are destroyed through marble processing, diminishing nourishment creation in the nation, and the salary hotspots for the individuals influenced. A cross-study investigation of ecological harms as a consequence of mining operation in 51 mining nations over the globe put around 60% of the occupants in these groups at danger.

Pneumonic illnesses are more across the board than related respiratory infection. Early acknowledgment of inappropriate respiratory functions will be of extraordinary clinical, social and preventive significance in industry laborers who always presented to air borne contamination. So the present study was led to focus the impact of marble and stone dust on works (Vyas, 2013).

1.3. Objectives

The general goal of this study is to demonstrate the impact of marble industry on health. In this consideration a case study from Bajaur Agency was taken. The particular targets are as follow:

- To figure out the status and importance of marble industry in the respective region.
- To estimate the direct mitigation cost and workday's loss due to health hazards cause by marble.
- To formulate policy recommendations for the reduction of air pollution in marble industry.

1.4. Research Question

- Does marble production affect workers health?

1.5. Hypothesis

- Better health will improve the quality of life of residents.
- Reducing pollution from marble industry will improve the community health.

1.6. Significance

Pioneer socio-economic and environmental study to interrogate the negative impacts of air pollution due to marble production process/ marble industry on health at Bajaur, FATA.

1.7. Organization of the Study

The study is organized into six chapters including chapter one. Part two gives a survey of related writing on the effects of marble and mining industry on health. Chapter three discusses the data and methodology employed for the study. Chapter four deals with status and importance of marble industry in the study area. Chapter five deals with empirical results and discussions of the findings of the research conducted. Chapter six covers a conclusion of the study, and appropriate recommendations.

CHAPTER II

Literature Review

Marble production method prompts development of dust particles which is suspended in air and afterward breathed in by the laborers. Epidemiological studies demonstrates that laborers exposed to marble dust stand an expanded danger of asthma signs, constant bronchitis, nasal irritation and impairment of lung function (Camici et al., 1977; Angotzi et al., 2005; Leikin et al., 2009) .

Inhalable diameter particulate matter (IPM) examining, with streamlined levels for zero - a 100 µm, is the environmental measurement which is probably the most intently predictive of the risk of creating nasal disease (Hinds, 1988) , it's the mass fraction of complete airborne particle which is inhaled by way of the nose and mouth (ISO, 1995).

Marble dust contains particles of calcium carbonate and silica. Exposure to respirable crystalline silica has long been known to cause of the most seasoned known occupational illnesses, silicosis (Pilkington et al., 1996; Tjoe-Nij et al., 2003).

Lung cancer (IARC, 1997), silicosis, respirable crystalline silica has been connected with immune system infection (Parks et al., 1999), non-harmful renal sickness (Steenland and Sanderson, 2001) and cardiovascular opestractive ailment (Hnizdo and Vallyathan, 2002). Health dangers are connected with exposure to the marble dust.

Marble is a transformative rock made out of recrystallized carbonate minerals, frequently calcite or dolomite (Kearey, 2001).

Air pollution affects the people directly due to the dust generated by mining activities. The health and well-being of the people especially, those living close to where toxic substances are generated is greatly affected. They suffer headache, skin rashes, diarrhea and vomiting,

etc. which are signs and symptoms of “mercury poisoning”. Mining also destroys many water bodies making it very difficult for the local people to get clean potable water for drinking, cooking, washing, bathing etc. In mining areas, there is always the tendency for prostitution, sexual abuse and drug addiction which also affects the health status of the people living in the respective communities indirectly. Due to the sexual abuse in those mining communities, there is increased incidence of HIV/AIDs and other Sexually Transmitted Diseases (STDs). There is also evidence of increase infant mortality rate in mining communities. People from both the western world and the third world are grappling with the negative social, environmental and health impact of mining. Those in the south are often delimited by poor environmental, health and safety standards. However mining companies operating in these communities are not putting in any strong or effective measures to comprehensively curtail these problems. While wellbeing, security and natural concerns are progressively on worldwide plan, numerous perspective those offenses against Indigenous (and other) individuals as an optional concern to the financial primary concern" (Whiteman and Mamen, 2002).

Stone and marble industries are viewed as of the principle monetary asset in Pakistan. These industries chiefly contributes to Pakistan economy. In addition, the principle material utilized in structural development area. These days, stones and marbles have been utilized for outside building furthermore for household inside designs. Around 40% of marble waste is produced world broadly in the coursework of marble processing prompting pollution i.e. land degradation, loss of soil quality etc. (Akbulut and Gürer, 2003; Çelik and Sabah, 2008).

Kitual (2005) demonstrated that local community health risks connected with marble processing causes accidents, health risks, and also around an expanded exposure to irresistible ailments and ecological issues. He takes note of that the quantity of injuries, accidents and fatalities in mining differs a lot between nations, basically relying upon mining

routines and innovations utilized, and whether minerals are mined in open pits or underground.

Mining is one of the most hazardous and risky occupation and during the period 1980-89, mining causes negative impact on health. Health impacts from mining can be divided into different categories: allergic rhinitis (including cough, fever, sneezing, flu etc.), cardiovascular diseases, respiratory illness and dermatological issues respectively.

Chemicals i.e. carbon monoxide (CO, CO_2), oxides of Sulphur (SO, SO_2), oxides of nitrogen (NO, NO_2) and fluorine compounds i.e. Chloro fluoro carbons (CFC's) causes air pollution and contamination to aquatic environment.

Biologically, microbial infections are common among employees due to lack of awareness, unhygienic living standards (Aswathanaryana, 2005).

As per Oppong (2005); mining areas may have a higher prevalence of specific ailments on the ground that mining changes the environment and permits infection bringing about pathogens and vectors to survive more openly than in different situations or environment. Malarial infection caused by female anopheles mosquito, the vector for illness and fever. These mosquitos are developed and survives well in warm and moist environment i.e. stagnant water. He also demonstrates that in addition intestinal sickness and malaria, some skin infections might likewise have a higher prevalence in mining territories.

Panday et al., 2005; assessed environmental degradation due to marble mining dust on the soil quality of Marrana, Nagaur (Raj.) India. In Marrana the essential driver of ecological contamination is industrial processing residue. Marrana exhibited salt-affected soil in light of the fact that the basicity (pH=8.4) and compelling sodium chloride (NaCl) region. Harvesting area near these industries show low advancement and production items. Subsequently, it is

suggested that the refinery profluent can be weakened to low concentration and used for farming.

It is disturbing that the greater part of the urban communities & commercial ventures of the urban areas and businesses in Pakistan are without wastewater treatment facilities. In Khyber Pakhtunkhwa, no fitting wastewater treatment facilities are realistic & the marble industries release their untreated wastewater into different water bodies bringing about surface & groundwater pollution endangering biodiversity & bringing down agriculture production (Nasrullah et al., 2006).

Aukour and Al-Qinna, (2008); indicated that, marble creation, as an industrial sector, needs to Jordanian economy because of extensive marble hold. Apparently extensive danger of such marble processing units on the ecological, which obliges consideration, alleviations, vindication and administration to secure the local community livings and common assets. Ecologically, it was demonstrated that every processing plant needs a serious assessment to choose the positive standards to manage their activity and to control the attainable effect delivered. However, new production lines must be set up inside the mechanical units to anticipate ecological group arches with better cure.

Then existing plants must acquaint relief activities to minimize gradually the environmental effects through providing proper managements and administrations relevant to environmental execution check. It is indicated that industrial foundations must be setup far from pedestrian city. As per site qualities during and after the coursework of industrial processing specifically harmed the land by interruption of urbanization & decrease of dazzling elements such as food production & mountains. Moreover, these industrial setup directly affect the local community residing near the vicinity of processing units. During the cutting stage water is being used for settling of marble dirt to minimize the air pollution. It also affect the soil quality upto five cm

due to discharge of harmful chemical waste. Precautionary measures are being used to avoid ecological and health risks by administrating safety gadgets, accumulation of created sludge should be properly disposed and dumped in artificial reservoirs.

The frequency of noise generated during marble processing is much higher than noise resulting from traffic movement. The disturbance level identified at the nearest neighborhood close marble fabricates did not achieve 60 dB (A), nonetheless, noise for all situation as yet irritating and disturbing individuals in local locations. Likewise, careful arrangement must be executed to control the sound and noise disturbance. As per transportation activity, the heavy vehicles affects the roads as well as the gases discharged from these vehicles are hazardous for human health. Marble processing units also provide the working opportunity to the local community.

Makin and Winder (2008); concluded that a viable safety program with provision of all safety equipments and trainings will diminish the possibilities of individual damage/ailment/death and help to enhance laborers productivity. It will help the laborers to work in successful and safe work environments with less opportunity to property crush. The Occupational Health and Safety administration plan of an industry makes the administration responsible for its workers good health and safety. The employers must furnish its workers with work environment conditions as indicated by the appropriate standards that should be free from the hazards that should bring about great damage/injury. The laborers for their sake are additionally in charge of their health and safety. Workers ought to be aware of their rights and commitments. They are obliged to understand and follow the guidelines that reduce the chances of hazards. If they didn't take after the suggestive measures they will be presented to the health and safety mishaps and misfortunes. OHS management process in the marble industries if appropriately actualized will help to distinguish the risks at prior. In this way, preventive measures can be received which reduces the occupational related dangers to the

workers and enhance the general coordination of aversion measures by using an incorporated methodology when contrasted with the customary alternatives of control; disposal, substitution, managerial controls, separation and individual protective equipment. It is considerably more imperative to handle the OHS issues in an appropriate way along their recognizable proof on a more extensive, authoritative connection.

The rising dangers to the wellbeing of the workers and residential area close to the marble quarries in Pakistan, and the local inhabitants residing in industrial zone are inclined to an illness referred to as silicosis, whereby breathed in marble soil harms the cells of the respiratory system (Zaman, 2008).

Marble has been frequently utilized as a part of the molding of statues, the development of structures and landmarks since the old times. It is a material utilized as a part of tiles, ledges and indoor deck. The waste residue comprising of dust particulates contributes natural issues far and wide (Corinaldesi et al., 2010).

Adewole and Adesina, 2011; surveyed effect of marble mining and soil properties in separated of Guinea Savanna zone of South Western Nigeria. As indicated by them, particulates from marble mining have degradable impact on soil physiochemical properties & these are added weight to micro availability of soil properties of the study area. Nitrogen & phosphorus; of the major plants supplements decreased in fixations inside of the mining territory & these expanded in focus with separation, far from the mining regions. The natural carbon that the CEC rely on upon additionally reduced within the mining territories. All these may prompt low crop yield because of marble particulates that get stored on soil & vegetation of the zone. Aside from the soil health that would be in risk because of soil-supplement imbalance that may set in because of marble particulates, the wage of the subsistence

agriculturists in the study zone may be unfavorably influenced additionally because of lessened crop yield they may encounter.

Ahmed et al., 2011; coordinated study on the effects of marble dust on differing pneumonic parameters in marble industry workers. They assessed that generally workers are habituated to smoke amid their working hours. The smoking habit and moreover exposure to the marble dust impacts the pneumonic parameters. The consequences of the study exhibits that there was a discriminating and direct effect of marble dust on pneumonic parameters on workers who are working always in marble processing plants with smoking habits. It likewise presumes that marble dust moreover impact the group who were abiding near the zone of marble processing plants. As a result of inhalation of marble dust through breath which may be causes lung infections. It is recommended that if marble handling plants workers use masks to cover their nose and mouth they can shield themselves from exposure to the dust.

In 2011, a study was driven for the examination of defilement weight in industrial profluent & groundwater of marble business tries in District Buner, Khyber Pakhtunkhwa. The unserious behavior of near to marble industry proprietors & wrong waste of the abuses/calcium of marble industries in Buner has not exactly endangered & debilitated the oceanic biodiversity of neighborhood streams however up to some degree the life of people and scenic beauty & field crops. The Industrial effluents is the major source of surface and ground water spoiling. This loss of water quality is hazardous for health. These issues are a direct result of waste water treatment facilities, lack of awareness, nonappearance of budgetary resources and inefficient environmental laws (Khan et al., 2012).

Dev (2013); assessed that the mining causes deforestation, loss of soil quality, decrease of ground water level and the natural beauty of the region being crushed. The horticulture harvest yield has likewise diminished unfathomably and the region is continuously changing

into barren land. He analyzed that the quantity of mining commercial ventures has discovered diminished in 2012, yet the ecological effects have discovered expanded. The rock, sand and stone creations are to be gone through the method for Chapagaon, so the earth of Chapagaon has corrupted even in the wake of moving the mining commercial ventures from Chapagaon.

Occupation related pneumonic ailments are common than whatever other group of work related infection in form of respiratory illness. Continuous working hour's causes lung infections in occupants. The study demonstrates a significant to highly significant decrease in lung parameters in workers of marble cutters and stone cutters when exposed to air toxins/pollutants as silica dust coming about into pneumonic brokenness. The distinction is measurably critical showing that the air contamination at work site quickened decrease in lung capacities. So appropriate exposure measures are to be produced to minimize the results of silica dust in these workers (Vyas, 2013).

Zahra et al., 2014; conducted the occupational health and safety issue in the marble industry and their potential measures. As per their studies, the level of occupational health and safety administration relies on upon the extent of the business as it fluctuates as per the capacities and scale. Planning the occupational health and safety administration technique for the small scale businesses is more troublesome because of their restricted assets and different imperatives. The fundamental foundation for the correct usage of occupational health and safety administration strategy in any of the business is based on hazard identification method in connection to the general technique. The strategy not just help to comprehend the seriousness of these dangers additionally fitting control measures can be proposed in like manner. In Pakistan, occupational health and issues of safety of workers is among of the principle territories that are confronting the carelessness of government. This area needs exceptional center in small scale commercial enterprises which are regularly unregistered and not a part of standardized social security method created by government. This potential and

observational study focused on the workers employed in the marble commercial ventures who have been exposed to distinctive sorts of occupational related risks at the work environment. The study incorporates the identification of occupational health and safety dangers and suggests potential measures to lessen the related dangers. In view of the perception it is uncovered that workers in the marble industries are not equipped with the personal protective equipments and are at risk to different occupational health and safety hazards which should be alleviated/mitigated.

2.1. Research Gap

The impact of marble industry is still under debate in academic and industrial community. Previous literature illustrates the impact of marble industry and mining on human health and environment using chemical methods. So most of the studies are chemically oriented. There is no Pakistan specific study that examines social perspective in context of air pollution from marble industry and its impact on health. This is the first ever study conducted in Bajaur Agency, Federally Administrated Tribal Area (FATA), Pakistan. We were also unable to find any econometric models used in the previous studies, that examines socio-economic factors and diseases with the dependent variable.

The impact of marble industry on local community residing near the vicinity of marble industry and respondents working in marble industry was assessed on the basis of number of workday's loss due to health issues. Moreover, mitigation cost as well as number of workday's loss due to air borne diseases were also studied using multiple linear regression (MLR) model.

CHAPTER III

Status and Importance of Marble Industry in Bajaur Agency

Geographically, KPK is the littlest province of Pakistan covering 74,521 sq. Km It comprises 24 regions which are furtherly partitioned into 43 sub-divisions, 47 Tehsils and 957 union councils.

3.1. Federally Administered Tribal Area (FATA)

FATA covered 27,220 sq. km. The estimated population of FATA for the year 2008-09 is 4.02 million. Officially, FATA incorporates seven Tribal associations together with Bajaur, Mohmand, Khyber, Orakzai, Kurram, North Waziristan and South Waziristan and six Frontier districts together with Peshawar, Kohat, Bannu, Tank, Dera Ismail Khan and Lakki Marwat. FATA works underneath the Federal government's Ministry of States and Frontier Regions (SAFRON), assigning the Governor of KP as its operators. The Governor proceeds over the organizations through Political advisors depending wide political, authoritative, and legal forces. FATA has been upheld with its Civil Secretariat in Peshawar as FATA Secretariat, which is driven with the guide of the extra Chief Secretary.

3.2. Bajaur Agency

Before 1960, Bajaur Agency endured a semi-impartial region and used to be viewed as a distant range. The entire subject was below the have an effect on of quite a lot of Khans i.e. The Khans of Khar, Nawagai, Pashat, and so forth. In 1960, Bajaur was subdivision of Malakand agency and an Assistant Political Agent used to be working with his central station at Munda, Dir district. In December 1973, Bajaur was declared as a part of FATA area. It covers 1,290 square kilometers of total area.

The respective region is located at the Himalayan assortment which makes vulnerability in storm downpours from month to month and year to year. Rabi plants have a good hazard of achieving maturity, but variations within the timing and amount of precipitation create risks and lead to variable yields. The food production region receives annual rainfall of about 800 mm.

The respective area is inhabited nearly completely by means of Tarkani Pashtuns. Salarzai is the prominent tribe of the agency.

The region is divided into seven tehsils i.e. Barang, Nawagai, Khar, Mamund, Salarzai, Utmankhel and Chamarkand.

The wintry weather season begins in November and lasts as much as March. Winters are tremendously cold and often from December by means of February the temperature plunges beneath freezing factor. According to the census of 1998, Bajaur population 595,227 people that gives it the very best population density. The estimated populace of the agency for 2014 was once 1,167,431.

Table 3.1: Demography of Bajaur Agency

Demographic Indicators	**Number's**
Projected Population – 2014 (thousand)	1,167,431
Population Density (Persons per Square Kilometer)	909
Percentage of Rural Population	100
Percentage of Female Population	49
Sex Ratio (Males per 100 Females)	114
Average Percentage of Children (Less than five years)	17
Average Percentage of Active Population (15-64 years)	56
Average Household Size	9

Source: PPAF, 2014.

The common resources vary in types, deposits, points, and characteristics from one country to the other as these resources were geologically formed over a long time in distinctive conditions. Normal resource economics may be very major in studying the shortage and efficient allocation of normal resources. Moreover, it develops the satisfactory approaches and items for extracting, producing, and drinking the typical resources in methods that take into consideration the significance of sustainability of the natural assets for the future generations.

3.3. Marble

The expression marble originates from Greek word Mamaros which implies that sparkling stone. Chemically marble is composed of calcite ($CaCO_3$), dolomite (Ca Mg $(CO_2)_3$). It is used for architectural purpose (TDAP, 2010).

3.4. Life Cycle Flowchart of Stone and Marble

Given flow chart shows the complete lifecycle analysis of the stones as construction material.

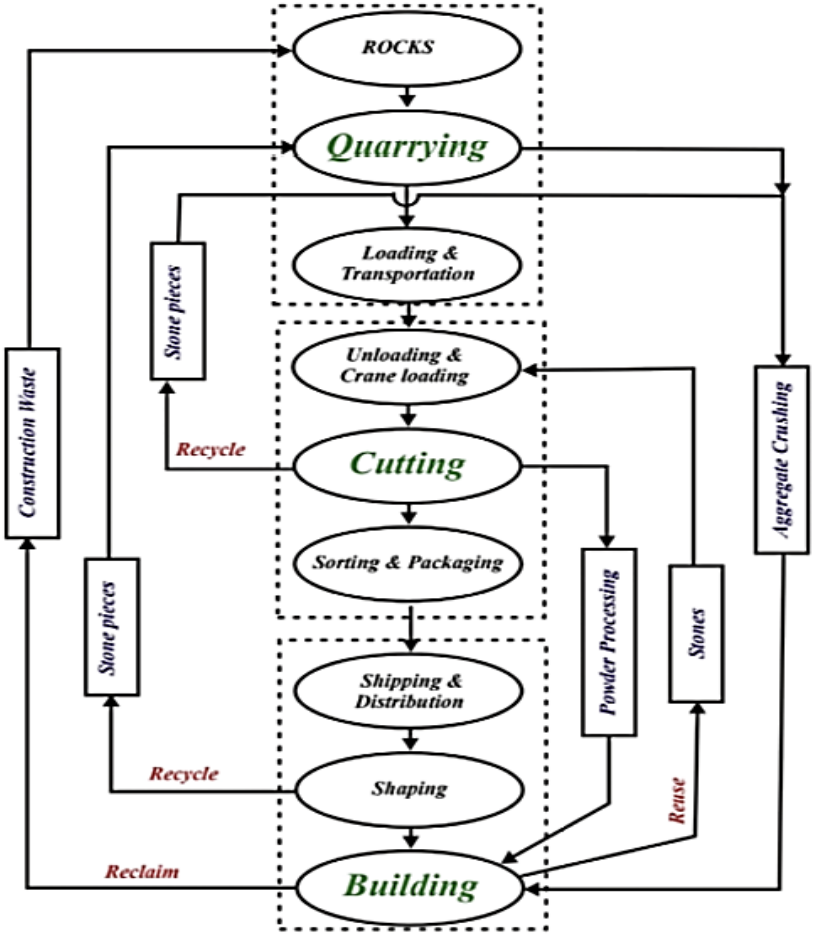

Figure 3.1: Life cycle flowchart of Stone and Marble (Hanieh et al., 2014)

3.5. Marble Resources in Pakistan

Pakistan comprises primary stone extracts with variety of colorations and designs. Marble reserves are found in various regions of Baluchistan, KPK, FATA, Punjab and Sindh. Fewer marble industries are presently using modern techniques and equipments for marble processing. Our country possess vivid potentialities of settling up joint ventures in marble sector.

3.6. Current Status of Marble Resources in Bajaur Agency

About 5,850 million tons of marble deposits exist at Nawagai, Inzerai, Kawtaro Kandao in Bajaur Agency, from which about an average of 40200 tons marble blocks are annually extracted through operational mines.

Overall there are 89 marble factories in Bajaur agency. Forty eight of those marble factories received damage in the course of military operation "Sher Dill" carried out within the agency. Due to high mining cost 17 mines were closed at Inzerai Tehsil Khar. A part from that 19 marble factories are non-operational due to power shortage. About 25 persons benefited from each mine. Additionally, truck-owners also benefited from these mines. Shutting down of those local marble industries brought about unemployment. 80% increase in sales is anticipated after utilizing the latest technology. The proportion of Bajaur Agency in Federally Administered Tribal Area (FATA) are 6% and 8% for marble and chromate for the year 2012-2013 respectively. Because of traditional mining approach, 50% of the stone goes vain/damaged. While 50% is transported to marble factories for additional processing. After the implementation of cutting-edge technology, the percentage of the broken stone will go down to 20%.

Mineral Production [2012-13]

Table 3.2: Mineral Production in Bajaur Agency

Minerals	**Tones**	**As Percent of FATA**
Marble	3089	6.1
Chromate	2773	8.0

Source: PPAF, 2014

3.7. Types of Marble in Pakistan

Table 3.3: Types of Marble in Pakistan

Color	**Area**	**Specification**
Black	Bajaur Agency	With lighter and dark patterns.
White, Green, Pink, Grey, Brown, Yellow, Green	Other districts of KPK and FATA regions.	With various coloration, patterns, patches and designs.

Source: TDAP, 2010

3.8. Problems faced by Marble Industry

Bajaur Agency is a backward area and marble mines are privately owned. The owner of the marble industry are unable to generate enough profit to afford latest technology and equipment for extraction of marble. Thus following problems are faced by marble industry.

- Problems in material shipping in various cities due to political restrictions.
- They are non-renewable and are being depleted rapidly due to non-efficient techniques of mining.
- Most of latest devices and machines are manufactured abroad. These are expensive and most of the mine owners are unable to use due to lack of financial resources. It also creates complications when need for repair and preservation arises.

3.9. Environmental Challenges

Marble processing has extreme ecological impacts. As it adversely affects air, water and soil quality.

To control the dust, water is used which results in formation of mud basins. Cutting procedure is noisy and for this reason reducing workshop ought to be placed away from

neighborhood residential clusters. Dust is one of the main contributor of ailment which affects respiratory system.

The items in observe impacting atmosphere stated previously solved with the aid of given systems.

Table 3.4: Environmental impact and remedy practices

Environmental impact	Remedy practices
Air, water and soil contamination	Filtration techniques and isolated cabins are used to avoid the dust
Noise Pollution	Modern techniques and machinery are used to overcome the noise pollution

Source: Hanieh et al., 2014

3.10. Social Challenges

Stone and marble enterprises are owned by private owners. The social affects of marble enterprise with causes and remedy practices are discussed as comply with.

Table 3.5: Social impact and remedy practices

Social Impact	Reasons	Remedy Practices
On site accident	Not following the precautionary measures	Use of safety helmets, Shoes, Gloves.
Respiratory / ENT diseases	Inhalation of particulate polluted air	Use of masks to avoid hazardous gases and polluted air
White finger disease or blood vessel blockage	Not using modern equipments	Use of automated equipments and machinery
Unemployment, poverty, low salary packages, non-skilled labour	Fewer opportunities, dense population, inavailabity of local business for local people	Better employment opportunities for local people

Source: Hanieh et al., 2014

CHAPTER IV

Data and Methodology

This chapter presents the methodology that was employed in conducting the study. It discussed the source of data, econometric model which is used, research design and instruments, sampling method, and methods of data collection and analysis.

4.1. Theoretical Framework

Bajaur Agency is underdeveloped area of FATA, Pakistan. Due to lack of awareness, resources, financial capacity and modern techniques/equipments, marble industry as its stake. In marble industry, work is done manually because the equipment and machinery used are imported from foreign countries which are costly and creates complications when need for repair and maintenance arises.

Many accidents occurred either in quarries or in cutting workshops due to lack of awareness of safety rules and their enforcement. Most of these accidents occurred due to discarding the importance of using safety shoes, gloves and helmets.

Workers are subject to respiratory, lung diseases, asthama due to inhalation of particulate polluted air. Cardiovascular disease specifically silicosis, due to hypertension caused by noise from quarrying and cutting. Allergic rhinitis and dermatological issues are caused during marble processing and polishing. Due to illness, worker's faces workday's loss.

For treatment of illness, worker's usually bear direct mitigation cost which is combination of travel cost, number of visits to the doctor, cost on medicines and cost on diagnostic tests. This results in relatively low salaries and increase poverty in marble industry workers.

This poverty can be avoided by increasing skills of these workers thus increasing their productivity and consequently increasing their salaries and improving their standard of living (PFI, 2009).

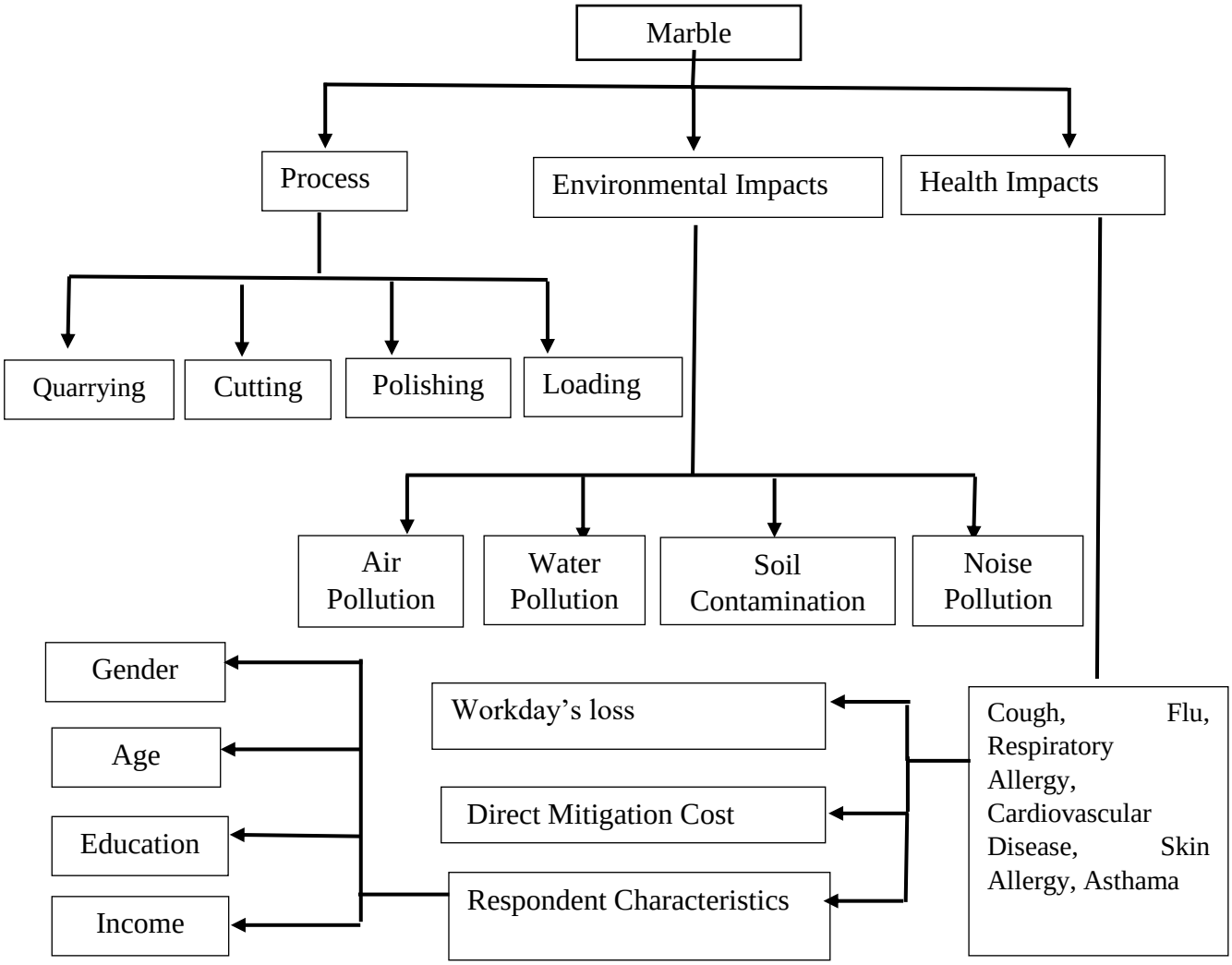

Figure 4.1: Diagrammatical Representation of Conceptual Framework

4.2. Multiple Linear Regression Model

We use multiple linear regression model in our study. Linear regressions are intend to quantify a relationship between variables: those that take linear form. The assumption is that for every one-unit change in the independent variable, there will be a consistent and uniform change in the dependent variable. In a multiple linear regression model (MLR), more than one independent variable is included in the regression model.

Formally, the model for multiple linear regression, given n observations, is:

$$\mathbf{Y_i} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \ldots\ldots\ldots + \beta_k x_{ki} + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(i)}$$

4.3. Econometric Model

Econometric model was utilized for the investigation of two major objectives, i.e. number of workday's loss due to illness and direct cost of mitigation.

4.3.1. Number of workday's loss due to illness

Multiple linear regression models are used to estimate the number of workday's loss due to illness. In our study, number of workday's loss due to illness and total cost of mitigation are dependent variables. H represents number of workday's loss due to illness. In equation (ii) age, education, monthly income, marble factory workers/non-marble factory workers, cough, fever, respiratory allergy, cardiovascular disease, skin allergy and asthama are independent variables.

$$\boldsymbol{H} = \alpha_0 + \beta_1 A + \beta_2 E + \beta_3 hhY + \beta_4 MFW/NMFW + \beta_5 Cough + \beta_6 Fever + \beta_7 RA + \beta_8 CV + \beta_9 SA + \beta_{10} Asth + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(ii)}$$

Where:

H = number of workday's loss due to illness

A = age of the respondent

E = number of years of education of the respondent

hhY = monthly income of the household

MFW/NMFW = marble factory worker and non-marble factory worker

Cough = disease experienced by respondent

Fever = disease experienced by respondent

RA = respiratory allergy

CV = cardiovascular disease

SA = skin allergy

Asth = asthama experienced by respondent

4.3.2. Total direct cost of mitigation

Multiple linear regression model is being used to assess the relationship between dependent and independent variables. Here, M is dependent variable which represent the total mitigation cost acquired due to health hazards cause by marble industry. Direct mitigation cost is combination of cost on medicines, fee paid to the doctor, cost on diagnostic tests, travel cost to the doctor's clinic etc., per person, per week.

If a person gets ill from such disease i.e. chronic illness, allergic rhinitis and dermatological issues, he/she would have to visit doctor for cure of illness. Travel cost is one of the major component of the mitigation cost. When patient gets ill he would have to make round trip, i.e.

To and from the doctor. In such case he would either walk if the hospital or clinic is nearby and or if worker is capable of walking and in case of utilizing his own vehicle, public transport or taxi, he will anchor travel cost for making round trip.

If a person gets ills, he would have to visit doctor for cure of illness and doctor prescribed him/her to do some tests to diagnose the disease. Various sources could be used for detection of chronic illness and allergic rhinitis ranging from x-rays, Chest CT scan, Ultra sound, ECG etc. which may results in additional cost.

The doctor prescribed medication to the respondent who gets ill from various diseases caused by marble industries. Such treatment will anchor additional cost.

While in equation (iii) age, education, monthly income, marble factory workers/non-marble factory workers, cough, fever, respiratory allergy, cardiovascular disease, skin allergy and asthama are independent variables.

$$\boldsymbol{M} = \gamma_i + \delta_1 A + \delta_2 E + \delta_3 hhY + \delta_4 MFW/NMFW + \delta_5 Cough + \delta_6 Flu + \delta_7 RA + \delta_8 CV + \delta_9 SA + \delta_{10} Asth + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(iii)}$$

Where:

M = total direct mitigation cost

Age = age of the respondent/worker

Edu = number of years of education of the respondent/ worker

hhY = monthly income of the household

MFW/NMFW = marble factory worker and non-marble factory worker

Cough = disease experienced by respondent

Flu = disease experienced by respondent

RA = respiratory allergy

CV = cardiovascular disease

SA = skin allergy

Asth = asthama experienced by respondent

4.4. Description of Independent Variables

Description of independent variables are:

4.4.1. Age of the respondent

This alludes to the age of an occupant. With ageing, the wellbeing stock decays and along these lines inclination to ailment and alleviating exercises increment. All those people residing in vicinity of marble industries i.e. Site areas, marble factories etc., either they are professionals or not are suffering from such diseases i.e. chronic illness, allergic rhinitis and dermatological issues.

4.4.2. Marble factory worker and non-marble factory worker

To analyze the relationship of workday's loss with marble factory worker and non-marble factory worker, we use marble factory worker and non-marble factory worker as independent dummy variable. In order to compare their relationship with workday's loss.

4.4.3. Education of the respondent

This refers to the education of the respondent. It is expected that an educated occupant would be more aware of the wellbeing results of the reduction of air contamination and will attempt to minimize it. It means when education increases, the individual get more concerned about his health and brings change in his behavior, thus takes precautionary measures to avoid illness and thus workday's loss decreases.

4.4.4. Monthly income of the household

This refers to the income of the respondent or household. When salary or wages of factory workers increases, it motivates him to spend more time on working and less on leisure. In case of marble factory worker, if the workers would spend more time in working, they will expose themselves more to dust and polluted environment of the factory. Thus making them ill and would result in increase in workday's losses. On the other hand, the local residents (non-workers of marble industry) do not live within a confined area like a factory and they have the option to live within limits of the factory or far from factory. And also priorities changes with increase in income. As, higher income households like to live in a clean dust free environment. Thus minimizing risks from ailments and workdays losses from ailments. It means that when Income increases workday's loss decreases.

4.4.5. Chronic illness

This refers to the chronic illness such as Respiratory Allergy, Tuberculosis, Blood Pressure, Cardiovascular disease and Asthama. This variable records for the occupant's wellbeing stock. A person who has constant sickness or illness is more helpless to the particulate matters and is likely to have higher mitigation cost and number of workday's loss.

4.4.6. Allergic rhinitis

This refers to the allergic rhinitis such as cough, runny nose, fever, sneezing, wheezing and influenza etc. A person who has an allergic rhinitis is more helpless to contamination introduction and is liable to have higher restorative costs and number of workday's misfortune.

4.4.7. Dermatological issues

This refers to the skin allergies. Mostly marble industry workers have skin allergies because they are more defenseless to contamination presentation and is liable to have higher medicinal costs and number of workday's misfortune.

4.5. Data and its Sources

Primary data have been gathered with the end goal of the study through well-structured questionnaire. Both probabilistic and non-probabilistic sampling techniques are used. In probabilistic sampling, we use simple random sampling technique. In non-probabilistic sampling, we used focus group discussion and key informant survey.

4.5.1. Data Collection Technique and Instruments

Following techniques were used for the accumulation of essential information.

4.5.1.1. Non Marble Industry Survey

It was directed to assemble more data about the effect of marble processing units. Different data with respect to the contamination and different effects was gathered through questionnaire.

4.5.1.2. Marble Industry Survey

Different data with respect to the contamination from marble industries and its affect on employees was gathered through well-structured questionnaire.

4.5.1.3. Focus group discussion

Focus group discussion was carried out in order to explore the area and people perception concerning with the affects of marble processing units on health.

4.5.1.4. Key Informant Surveyors

Some proficient persons such as doctors, marble industry owners, and group based delegate work force, instructors and neighborhood pioneers were chosen as key sources to complete examination.

4.5.1.5. Method of Data Analysis

The gathered information were coded, ordered and organized for information accumulation. The quantitative data have been introduced in simple factual programming known as statistical package for the social sciences (SPSS) being used for data analysis.

4.6. Study Area

Bajaur Agency covers 1,290 square kilometers of total area. Assistant political agent (APA) is hired to operate the political issues. Overall there are eighty nine marble production factories in Bajaur Agency. The proportions of Bajaur Agency in FATA are 6% and 8% for marble and chromate for the year 2012-2013 individually. Around 25 persons benefited from every mine and additionally truck-proprietors. We select seven distinctive marble production plants/mines i.e. small, medium and large in Nawagai, Loesum, Mandal, Jaar and Anaat Kalley, Bajaur Agency, FATA. The working hours for marble workers are 8hr's. There are three shifts in large scale, two shifts in medium scale and one shift in small scale production plants/mines.

4.7. Population

As per the census of 1998, Bajaur population was 595,227 persons that gives it the highest population density. The estimated population of the agency for 2014 is 1,167,431.

The population development rate in the respective region is much higher than the FATA midpoints. The population density per person is 909 sq. km. The average household size is 9.

4.8. Sample Size

The sample size was determined through online sample size calculator using confidence level of 95%, confidence interval as 7.4 (CRS, 1982). Accordingly, the sample size of 346 respondents were used. This sample size was distributed equally among marble factory workers and non-marble factory workers i.e. 173 respondents from marble factory workers and 173 from non-marble factory workers.

Table 4.1: Number of workers randomly selected from marble industry

Marble Industry Name	Area	Size	Number of Workers	Working Hour's	Number of Shifts
Haji Gulab Marble Industry	Nawagai	Large	60	8	3
Bajaur Mable Industry	Loesum	Medium	42	8	2
Said Arif Ali Marble Industry	Anaat Kalley	Medium	35	8	2
Kohinoor Marble Factory	Mandal	Small	22	8	1
Hassan Marble Factory	Jaar	Small	14	8	1
Total			173		

The sample size of 173 respondents were selected randomly from non-marble factory workers.

Table 4.2: Population wise sample size determination

Name of Village	Population	Number of Households	Sample Size
Jaar	9009	1001	60
Loi Sam	27981	3109	20
Anaat Kalley	3627	403	10
Nawagai	23529	2614	23
Smsai	9072	1008	60
Total		8135	173

4.9.Research Design

The research methodology comprises data evaluation of marble industries Bajaur, FATA. It is based on investigating the ecological impact of these marble and its impacts on industrial occupants as well as local residents who are residing near the vicinity of marble industries.

4.10. Limitation of the study

Due to financial, social and cultural constraints we were unable to motivate some people for participation in survey. Some people were also reluctant to participate in survey due to the law and order situation.

CHAPTER V

Results and Discussion

This chapter deals with the presentation of results and discussion. Questionnaires were administered to local community, marble industry workers and other relevant stakeholders. The questionnaire sought to unveil negative impacts of marble industry pollution on human health. Data collected from the exercise were analyzed using the Statistical Package for Social Sciences (SPSS) and results presented below:

5.1. Frequency Distribution Tables of Various Variables used in the Study

Many variables were used in the study, detail of which are given as follow.

5.1.1. Age wise distribution of the respondent

Frequency table of the respondent shows that approximately 47.9% are between 16 to 30 years of age, followed by the age group of between 31 to 45 years age and the less workers are in age group of greater than 45 years (Table 5.1).

Table 5. 1: Age wise distribution of the respondent

Age	Frequency	Percent
1-15	38	11.0
16-30	163	47.9
31-45	115	32.4
46-60	22	6.4
61-75	8	2.3
Total	346	100

Source: Field observation

5.1.2. Education wise distribution of respondents

The table shows that almost 41.6% of the respondents haven't attendant any educational institute in the past. Almost 26% of the respondents have primary education and 26.3% of the respondents have education between sixth and 12th class. And low number of respondents were having education greater than intermediate (Table 5.2).

Table 5. 2: Education wise distribution of respondents

Education Level	Frequency	Percent
Not Attended	144	41.6
Primary	90	26.0
Secondary to Intermediate	91	26.3
Higher than Intermediate	21	6.1
Total	346	100.0

Source: Field observation

5.1.3. Frequency table regarding ailments faced by respondents

Frequency table regarding diseases shows that respiratory allergy is more prevalent among the respondents. Followed by coughing, asthama, fever, skin allergy and cardiovascular diseases (Table 5.3).

Table 5. 3: Frequency Table regarding ailments faced by respondents

Illness due to disease	Frequency	Percent
Cough	66	22.5
Fever	57	15.3
Respiratory Allergy	103	32.7
Cardiovascular Diseases	19	1.00
Skin allergy	39	7.4
Asthama	62	21.1
Total	346	100

Source: Field observation

5.2. Empirical Results and Discussion

The empirical results and discussion of the relevant study are given as followed.

5.2.1. Number of workday's loss due to illness

The table shows the response of the different variables to the workday's losses of respondents.

As the dependent variable in this model is continuous one, then in this case it is better to utilize multiple regression model to figure out the relationship of independent variables with dependent variables. Among the independent variables like marble factory workers/ non-marble factory workers, flu/fever, respiratory allergy, cardiovascular disease, skin allergy and asthama are dummy variables. While age, education and income are continuous variables. For workday's loss of the respondents, result of the study shows that out of ten explanatory variables only seven are positively significant i.e. Marble factory Worker/ Non-Marble Factory Workers, Cough, Flu/Fever, Respiratory Allergy, Heart problem, Skin Allergy, and Asthama. The diseases like Flu/Fever, Respiratory Allergy, Heart Disease, Skin Allergy, and Asthama are significant at 1% and Cough is significant at 5%. Thus, it is quite evident that with ailments like above, the deterioration of health occur which ultimately results in workday's loss.

So far, the comparison of the variable of the marble factory workers and non-marble factory workers with the dependent variable of workday's loss is concerned, marble factory workers spend time in working in marble factories. They expose themselves more to the dust and the polluted environment of the factory. Thus making them ill and results in increase in workday's losses. That's why workday's losses occur more among marble factory workers compared to non-marble factory workers. As non-marble factory workers are not that much exposed to the dust and also they have the option to live far away from the marble factories. That's why proportion of illness among non-marble factory workers

is less than marble factory workers. So workday's losses occurs less compared to the marble factory workers.

While the income of the respondents have negative association with workday's loss. It's so because higher income households would not like to live with in remits of the factory and would also use air cleaning machines. Thus minimizing risks from dust and workdays losses from ailments. Such phenomenon is according to Engel's Law. According to which when income increases, expenditure on food items increases less, proportional to increase in income. It means higher the increase in income, less would be increase in expenditure on necessities (food items). On the other hand more of the amount is spent on luxurious items as compared to food items. But here the relationship of income with workday's loss is insignificant.

The results further indicates that age and education of the respondents have negative but insignificant association with the workday's loss. So far education is concerned, it means when education increases, the individual get more concerned about his health and bring change in his behavior, thus takes precautionary measures to avoid illness and thus workday's loss decreases.

So far, age is concerned, the current study shows that age has negative relationship with workday's losses. It is so because when age increases the immunity also improves. So the people get less affected by diseases and workday's losses decreases. Though in current study, insignificancy of results shows that Age and Education have very much less contribution in minimizing workday's losses of the respondents.

The overall goodness of fit of model is represented by R square, which is 0.618. It means that 62% of change in the dependent variable has been explained by the independent variables. The significance of the F statistic of the model indicates, that the model is fit.

Dependent Variable: Numbers of workday's loss due to illness.

Independent Variable: Age, Education, Income, Marble Factory Workers/Non-Marble Factory Workers, Cough, Flu, Respiratory Allergy, Heart Disease, Skin Allergy and Asthama.

Table 5. 4: Number of workday's loss due to illness

Variables	**Unstandardized Coefficient**	**Standard Error**	**T**	**P- value**
Constant	0.598	0.370	1.616	.107
Age	-0.059	0.107	-0.554	.580
Edu	-0.161	0.098	-1.641	.102
Income	-0.097	0.070	-1.380	.168
MFW/NMFW	2.326*	0.209	11.131	.000
Cough	0.479**	0.195	2.464	.014
Fever	1.367*	0.190	7.197	.000
RA	1.437*	0.256	5.624	.000
CV	3.538*	0.406	8.725	.000
SA	1.599*	0.235	6.801	.000
Asth	2.095*	0.291	7.190	.000
Goodness of Fit Statistic				
R Square	0.618	F Statistics	54.098	.000
Adjusted R Square	0.606			

Note *, **, *** shows level of significance at 1%, 5% and 10% respectively.

5.2.2. Direct mitigation cost

Here the dependent variable is direct mitigation cost which is the combination of number of visit to the doctor, Travel Cost, Total cost on Medicines and Total Diagnostic Test Cost. If a person gets ill, he/she would have to visit doctor for cure of illness and so would anchor travel cost, cost on medicines and diagnostic test cost.

The results showed that there is a direct and significant relationship of direct mitigation cost with marble factory workers/non-marble factory workers, cough, fever, respiratory allergy, cardiovascular diseases, skin allergy, and asthama.

So far the education of the respondents is concerned, it shows negative relationship with the direct mitigation cost. It is so because when a person attains education he/she become more awared about the consequences of dust and other forms of pollution. Thus educated people will try to adopt precautionary measures to minimize threats or diseases from dust or other forms of pollutions. But in the study area people are less educated due to which the relationship of education with direct mitigation cost is negative and insignificant.

The relationship of age with direct mitigation cost was also found to be negative and insignificant, which means that age has very minimal effect in reducing direct mitigation cost.

The relationship of income with direct mitigation cost is negative and insignificant. It's so because the higher income household would acquire air cleaning machine or may live far away from marble factory and will minimize the threats from exposure to dust.

In the model, marble factory worker and non-marble factory worker have been included as dummy variable i.e. (marble factory worker = 1, non-marble factory worker = 0). This variable shows positive and significant relationship with the direct mitigation cost. Because marble factory workers are more prone to factory dust. That's why become more ill compared to non-marble factory worker. Thus the positive and significant relationship

of marble factory worker / non-marble factory worker with direct mitigation cost shows that marble factory workers anchor more mitigation cost compared to non-marble factory worker.

Here the value of R-Square is 0.441, which means that 44% of the variation in the dependent variable is being explained by the independent variables. F-statistic is significant, which means that model is valid.

Dependent Variable: Direct mitigation cost

Independent Variable: Age, Education, Income, Marble Factory Workers/Non-Marble Factory Workers, Cough, Flu, Respiratory Allergy, Cardiovascular Disease, Skin Allergy and Asthama.

Table 5. 5: Direct mitigation cost

Variables	**Unstandardized Coefficient**	**Standard Error**	**T**	**P- value**
Constant	238.667	190.008	1.256	.210
Age	-22.816	54.917	-.415	.678
Edu	-68.795	50.315	-1.367	.172
Income	-88.185	36.053	-2.446	.615
MFW/NMFW	805.113*	107.268	7.506	.000
Cough	50.080*	99.880	.501	.000
Fever	143.605*	97.492	1.473	.000
RA	702.581*	131.159	5.357	.000
CV	1787.087*	208.141	8.586	.000
SA	540.873*	120.666	4.482	.000
Asth	509.887*	149.538	3.410	.001
Goodness of Fit Statistic				
R Square	0.441	F Statistics	26.378	.000
Adjusted R Square	0.424			

Note *, **, *** shows level of significance at 1%, 5% and 10% respectively.

5.3. Findings of the Focus Group Discussion

Focus group discussions were conducted with different stakeholders who are directly or indirectly affected by the marble industry of Nawagai. The stakeholders / participants includes adult labor, children working in marble sector, doctors, on job officers, imam masjid and retired persons living in Nawagai.

Multiple sessions were conducted with labor working in marble industry and the conclusion of the discussions is that they cannot afford to either go or to send their children to schools due to financial constraints. However, almost 80 percent of the participants expressed their wish to attend school. Those who studied some classes are also working in the marble industries/quarries because they could not find appropriate jobs. The reason for discontinuing studies was to sustain their family and lack of resources to finance studies. All of them agreed that their elders are not against education but they have their own compulsions for involving their children in labor.

While interviewing the children working in marble industry often (10) children to various queries told that approximately 30% children are involved in highly risky and hazardous tasks such as cutting, polishing and loading. Those children also reported that employers are rude and doesn't compromise over any mistake and even sometimes results in physical torture. Further they earn enough money to fulfill their daily needs and that income is handed over to the eldest member of the family.

About 70% of the participants who are working in marble industry/quarries said that their earnings are used to fulfill daily expenses on food items, repay various loans, commodities and sometimes livestock for additional benefits.

During discussions on health with employees working in marble industry we have come to know that employer is not responsible for any kind of treatment in case of injury or illness.

Series of sessions were also conducted with doctors serving in different hospitals of Nawagai to get the information regarding health condition of both peoples working in marble industry and people living in the locality of industry. We have come to know that various common diseases that are found in labor working in marble industry are headache, diarrhea, vomiting and skin diseases. They have also reported deterioration of health and mentioned some symptoms relating their eyes: such as redeyes, skin blackening, cough, fever, fatigue and depression. According to them marble factory workers are residing near the vicinity of the industry and due to lack of education, people are not aware about the adverse effects of marble dust on health. Labors are not using precautionary measurements i.e. safety helmets, shoes, gloves and masks to avoid hazardous gases and polluted air. Marble dust is the main source to pollute the air which has adverse effects on human health and causes allergic rhinitis, cardiovascular disease and dermatological issues.

Focal group discussion with community members was organized in Jirga Hall of Khar, Bajaur Agency. Ten community members who attended the meeting said that maximum of population is bound to work in marble industry/quarries as there is no alternative source of income for them.

Literacy rate is at very lower side because of limited financial resources. Explosives are used for blasting procedure which is harmful for human health as well as for infrastructure. Cutting process is noisy and for this reason workshops ought to be placed far away from residential areas/clusters. Marble industry is not using modern equipments as they are reluctant to invest more.

CHAPTER VI

Conclusion and Recommendations

This portion was divided into two sub sections, i.e. Summary/conclusion of the study and policy recommendation on the basis of our research work.

6.1. Conclusion

The research work is based on assessing the impact of marble industries on human health. The research work have two aspects. First, to assess the impact of pollution from marble industries on number of workday's loss due to illness of such disease like chronic illness, dermatological issues and allergic rhinitis. Second, to estimate the direct mitigation cost when the patient or respondent gets ill from such disease like chronic illness, dermatological issues and allergic rhinitis.

Different techniques were adopted to collect the primary data i.e. household survey, marble industry survey, focus group discussion and interview with key informant survey. For research 173 marble industry workers and also 173 respondents from non-marble factory workers residing near the vicinity of marble industries were randomly selected and data was obtained through well-structured questionnaire.

In the research, Multiple Linear Regression model was used for assessing the number of workday's loss due to illness and the direct mitigation cost. The dependent variable was number of workday's loss due to illness and the independent variables were age, monthly income, education, marble factory workers/non-marble factory workers, cough, fever, respiratory allergy, cardiovascular disease, skin allergy and asthama. In second equation, the dependent variable was direct mitigation cost and independent variables were age, monthly income, education, marble factory workers/non-marble factory workers, cough, fever,

respiratory allergy, cardiovascular disease, skin allergy and asthama. The total mitigation cost includes number of visits to the doctor, travel cost, total cost on medicines and total cost on diagnostic tests.

For number of workday's loss due to illness shows the significant results at 1%. It is quite evident that when the respondent or patient gets ill, the number of workday's loss increases. Marble factory workers expose themselves more to the polluted environment of the factory which results in increase in workday's loss. That's why workday's loss occur more among marble factory workers compared to non-marble factory workers.

While the income of the respondent have negative association with the workday's loss. Because higher income households would not like to live near the vicinity of marble factories and would also utilize dust minimizing appliances.

So far education is concerned, it means when education increases, the individual get more concerned about his health and bring change in his behavior, thus takes precautionary measures to avoid illness and thus workday's loss decreases. As most of the respondents especially in FATA region are less educated, so it has no significant contribution in increasing or reducing work days losses.

Workday's loss due to illness of such diseases i.e. chronic illness, allergic rhinitis and dermatological issues shows the significant results. While estimating direct mitigation cost including chronic illness, allergic rhinitis and dermatological issues also shows the significant results.

6.2. Recommendations

In order to control the air pollution from marble industry, the following recommendations are useful to reduce the impact of marble industry on workers, local community and respondents.

i. An effective safety program with provision of all safety equipments and trainings will reduce the chances of personal injury/disease and help to improve the workers productivity. It will help workers to work in effective and safe workplaces.

ii. Industry is responsible for the good and safe health of its workers. The employer's must provide the protective gadgets to the workers at quarry site.

iii. The workers on their behalf are also responsible for their safety and health. This is in view of the fact that most workers consider wearing protective gadgets while at work an unnecessary burden. Use of protective gadgets by workers while at work should be enforced by the health and safety unit or the management.

iv. Marble industry need to use the environmental friendly equipments.

v. Awareness should be created among the industrialists, workers and the local community.

vi. It is strongly recommended that tree plantation programme should be conducted from industrialists and local people. It may be undertaken to reduce pollution.

6.3. Future Research

The area of study can be enlarged to draw a better picture of the situation. In this respect, local and multinational NGOs and government agencies should focus.

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