# Occupational Health and Safety in Iran: Accident Cost Analysis and the Importance of Education in Accident Prevention

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# ABSTRACT

The goal of this study was to find the causes for industrial accidents in Tehran, associated costs of industrial accidents and explore the correlation of accidents to employee education level, work experience and job training certification.

We used surveys of employees and employers to collect information on the number of workplace accidents, the main causes for these accidents, the highest level of employee education, job training, work experience and direct and indirect cost of accidents.

Regression analysis and the fuzzy mathematical models were used to analyze the data and determine the main factors associated with occupational injury. These factors were used to recommend a model for injury prevention and predict a reduction in total cost of accidents. Employers surveys revealed 43% of workers had an accident in the workplace.

We found that the indirect cost of industrial accidents comprised a higher percentage of the total cost compared to direct costs. The indirect cost incurred by the studied industries ranged from 59.6% to 92.3% of the total cost. Experience and certificate of job training were found to be the main factors for accident prevention. Employees with no job training or younger than age 26 were more frequently involved in accidents than trained or older employees. Additionally, higher education level, work experience and training were associated with fewer accidents. The lack of

information was given as the main reason for accidents in the workplace. The improvement model applied show that investment in the training will drastically reduce the total cost of accidents in the workplace. The highest cost reduction was seen as 70% in the machine manufacturing industry. The average total cost reduction when all industries were considered was found to be 53%.

In conclusion, the high indirect cost of industrial accidents in manufacturing industries in Tehran may not be recognized by management. Job training can reduce occupational injuries. Companies should invest in pre employment training programs for workers and periodic training as long as they remain employed in order to prevent work related accidents and reduce total cost.

**Keywords**: Occupational accidents, injury, accidents prevention, job training, direct cost, indirect cost.

# ÖZ

Bu çalışmanın amacı Tahran'daki endüstriyel kazaların nedenlerini ve kazalarla ilgili masrafları tanımlamak ve çalışanların eğitim seviyeleri, iş deneyimleri, iş eğitimleri ile kazalar arasındaki ilişkiyi araştırmaktır.

İş kaza sayısı, kazaların temel nedenleri, çalışanların eğitim seviyeleri, iş deneyimlerinin olup olmadığı, iş eğitimi alıp almadıkları ile ilgili veriler, işveren ve çalışanlara yönelik anketler ile toplanmıştır.

İşci kaza ve yaralanmalarını önlemede önemli olan temel faktörleri ortaya çıkarmak için veriler regresyon analizi ve bulanık sınıflandırma modelleri ile analiz edilmiştir. Bulunan faktörler kaza önlemede kullanılacak bir model önermek ve kaza maliyetinin ne kadar azalacağını tahmin etmek için kullanılmıştır.

İşveren anketleri, çalışanların %43'ünün iş kazası geçirdiğini ortaya çıkarmıştır. Doğrudan kaza maliyetine kıyasla, dolaylı maliyetin, toplam kaza maliyetinin büyük bir oranını oluşturmakta olduğu bulunmuştur. Çalışmamızda incelenen endüstrilerin dolaylı kaza malıyetleri toplam maliyetin %59.6'sı ile %92.3'ü arasında değişmektedir.

Çalışanın iş deneyimi ve iş eğitim sertifikasının bulunmasının kaza önlemede en önemli faktörler olduğu bulunmuştur. Hiç iş eğitimi almamış veya 26 yaşın altında olan çalışanlar, iş eğitimi almış veya daha büyük yaşta olan çalışanlara oranla kazaya daha fazla maruz kalmışlardır.

Yüksek öğrenim seviyesi, iş deneyimi ve iş eğitimi daha az kaza ile ilişkilendirilmiş ve iş kazalarının en önemli nedeninin bilgi eksikliği olduğu rapor edilmiştir. Uygulanan iyileştirme modeli göstermiştir ki iş eğitimine yatırım yapmak toplam kaza maliyetini önemli ölçüde azaltacaktır. En yüksek toplam maliyet azaltımı %70 oranla makine üretimi endüstrisinde görüldü. Incelenen tüm sanayilere bakıldığında, toplam kaza maliyetinin ortalama olarak %53 oranında azaldığı bulunmuştur.

Sonuç olarak, Tahran üretim sektöründe iş kazalarının dolaylı maliyeti işveren tarafından farkedilmeyebilir. İş eğitimi iş kazalarını azaltabilir. Şirketler, iş kazalarını ve toplam kaza maliyetini azaltmak için, çalışanların iş öncesi eğitim programlarına ve çalıştıkları sürece periodic eğitim alacakları şekilde yatırım yapmalıdırlar.

**Anahtar Kelimeler:** Iş kazaları, yaralanma, kaza önleme, iş eğitimi, dolaylı kaza maliyeti, doğrudan kaza maliyeti, iş sağlığı ve güvenliği

This dissertation is dedicated to my parents especially to my mum, who insisted that I go to college even when I did not see the value in it and given me moral support and encouragement throughout my graduate studies. I am forever grateful.

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# Chapter 1

# INTRODUCTION

## 1.1 Occupational Health and Safety

Occupational health and safety is a vast field. It was introduced as industrial protection measures that set up principles and rules for increasing the employee efficiency. (Hammer, 1999).

With the development of industry in developed countries, occupational safety and health problems (OSH) became more apparent necessitating an increase in support by labor unions and government regulations. Laws and human resources and services were developed for improving occupational health and safety. According to Shirazeh Arghami(2009) the following principles need to be taken into account to improve workers health and safety.

1- Occupational safety and health education and training of workers including health and safety regulations related with their job.
2- Risk analysis in the work environment.
3- Renovation of facilities health and welfare of factories.
4- Implementation of pre-employment medical examination.
5- Prevention of work injuries and making first aid available.
6- Addressing employee (and family) medical and mental problems.

In industrial environments, despite plenty of machines and tools, often workers are exposed to various hazards. Risk and accidents has increased with increasing technological development and its increasing application in production.

According to Heinrich, H.W (1959), work safety is the prevention of accidents. Necessary measures should be designed to prevent the events in work environment. Various dangers in the workplace can be classified as (Sanders, M.S. 1987): physical dangers, chemical dangers, health hazards, mechanical dangers, biological dangers, social and psychological dangers. Any undesired event in the workplace brings an additional cost to the company.

Unexpected losses are caused by accidents due to failure in one or more system or process.

Loss is a broad concept and may be in different modes such as the loss of time, injured people, capital and loss of property and even environmental damage.

Some studies point out that OSH problems reported to management are mainly due to lack of resources and lack of awareness and knowledge of workers (Shikdar & Sawaqed, 2004).

## 1.2 Occupational Accident and Cost

Occupational safety and health is concerned with the number of accidents and disastrous events involving employees. Resources are used to prevent incidents and damages in the work environments. Another approach for the evaluation of occupational safety is the cost connected with incidents and damages.

Employees are interested in the cost of injuries as this can radically reduce earnings. Many managers do not understand accidents costs. In fact, all of the costs are not always clear. Attention to cost of accidents can improve the future of a company. Accidents have clear direct costs and higher indirect costs that are not realized by management. For instance, medical cost, insurance cost, equipment, product and all damage costs are insured costs. Most of the employers think that the accidents are not that much of a financial problem because they have insurance. They say insurance will pay if we have an accident but the insurance only covers direct costs, we will see that indirect costs comprise a larger proportion of total cost.

For instance, if an employee gets a shock from equipment and is seriously injured, all of the workers will stop working in that department, some workers will try to help by giving first aid to the injured workers and some of them will leave their work to call for help. When help arrives to the work environment, do workers immediately start their work? Not always. They may continue to help or remain their just to watch what is going on.

In this example, the work time of all these employees are included as part of total cost. Injured workers receive medical treatment, managers inspect the accident, all the time spent on analyzing accidents and writing reports is included in total accident cost. If the injured workers need to leave work for a short time, other employees make up for the production loss by working overtime, the costs for overtime increases total costs. If injured workers need to leave the work environment for a long time, employers hire and train a replacement worker. New employees are often less productive, adding further to total cost. Damaged equipment also add to cost. In

addition to all, special care should be exercised when re-using equipment that was involved in an accident. (WCF Safety Department, 2009).

**Direct cost**: can be determined more easily and include compensation for injuries, and the compensation for worker disability, medical expenses of the injured, treatment costs repair costs, renewal of machinery and tools and equipment damaged, waste materials, increase in insurance costs and fines.

**Indirect costs**: are more difficult to determine and include cost of reduction in employee efficiency and productivity, overtime, new employee training, capacity loss, increasing inventory, company reputation and employee morale. The last two are indirect costs that are most of the time calculated separately because they are more difficult to measure.

According to the National Safety Council (NSC), the cost of occupational accidents and death in 2004 was nearly $133 billion, $68 billion for lost payments and productivity, $24 billion for medical cost, $ 29 billion for administrative expenses and $ 7.5 billion for miscellaneous costs.

Activities brought attention to the high number of the accidents and death in the workplaces. (Rosner, 2000) It is known that preventing predictable accidents is ethically necessary but not possible without cost.

Employers must invest time and resources to make a work place safe. Which will in turn decrease cost by decreasing the number of occupational accidents. (Zaloshnja et

al, 2006). Employers can see their decreasing cost in increasing productivity and diminishing medical and insurance costs.

## 1.3 Risk and Accident

Bahr, N.J. (1997) points out that the scientific definition of risk differs from that viewed by the general of public. Risk is the concept of the people and view of science is different with each other. Of people view, risk means that the person to obtain what risk is faced. Estimate risk by the people generally annual death rates does not conform to the other factor, except the number of deaths of people mind effects. In other words, a science of view, death is death and only one death, but the tragic events of people, greater risks are allocated to science and of risk likely outcome is simply due to a threat. As mentioned the incident event that will cause losses. loss may be any shape and any size. Occupational accidents and financial losses and damage of human have a lot of looking primarily at workers and employers and then the country industry and economy and finally the whole society will suffer from them. In general, terms and conditions of different perspectives damage of occupational classified into different methods.

### 1.3.1 Risk and Accident Factors

Some studies point out that risk changes with gender. In most countries, researchers recognize men as having a greater risk than women when occupational accidents are concerned, although this was not adjusted for type of job (Layne and Pollack, 2004) and (Liao et al, 2001). ( Oigenblick and Goldberg, 2000) found that gender is not a consequential risk and accident factor. Saleh, Fuortes, Vaughn and Bauer (2001) found that women had a higher accident rate than men in a study of accidents in a large teaching hospital. This research did not adapt for job type because men are more inclined to work in high risk jobs, adjustment by job type made man identify

real gender specific risk. Smith, Huang, Ho and Chen (2006) stress the need to control industry specific dangers to avoid reaching false final conclusions. Park (2002) deduces that age, gender, seniority may be confounders or effect modifiers of unknown disclose.

Younger workers have higher rates of injury, and older workers are more likely to have fatal injuries. (Salminen and Smith, 2003) Compared with younger workers, old workers, have greater rates of reported mistakes, stumbles and falls (Kemmlert and Lundholm, 2001). Other studies suggest young employees have a decreased injury rate, and middle age employees have greater injury rate.(Saleh, Fuortes, Vaughn and Bauer, 2001).

Some studies mention a connection between occupational injury and shift work, night time work, and working over time (Frank, 2000). Llilley, Feyer, Krik and Gander (2002) assert longer work hours and shorter recuperation time may lead to reduced sleep time. In a Finnish steel mill they tried to help day work time workers to minimize tiredness by starting work one hour later(Rosa, Harma, Pulli, Mulder and Nasman, 1996). Although decreasing tiredness and drowsiness, enhance working conditions for day shift workers, it sabotaged workers working on evening and night shift.

Altering work time and the consequence interruption of the circadian cycle is harmful to comfortable sleep, and influences more than 23 million workers in the US (Connor et al. 2002). According to researches, shift work affects sleep confusion score, and the working time changes with quantity and quality of sleep (Garbarino et al., 2001). Since many jobs and industries, employ shift work it remains a risk and

accident factor. Moreover, working for long hours on a concentrated schedule brings the need for going to holidays. Employee can work on a concentrated schedule at the first time of period but could not continue to end of the period without any vacation. (Epstein, Tsischinnsky, Herer and Lavie,2001).

Hearing loss can increase the risk of accidents. Noise Induced Hearing Loss (NIHI) can be distinguished from other hearing loss.

When aim listening is needed, employees with hearing loss may be more exhausted. Exhausted employees have more occupational injury risk than non-exhausted employees. Therefore employees with hearing loss may have more incidents than employees with normal hearing. Moreover, employees hearing defictis may miss caution sirens, which can result in accidents (Moll van Charante and Mulder 1990).

## 1.4 Literature Review

Recent literature was reviewed on the effectiveness of OSHA, the background of OSHA and a summary history of occupational health and safety in IRAN and Europe.

The rates of accidents are growing in current society. The European agency estimated 4.6 million occupational accidents happen every year in the EU resulting in 146 million lost working hours (EUOSHA, 2001). The occupational safety and health initiative has come a long way since the industrial revolution. These days, there is a requirement to provide a safe and healthy work environment. One way of reducing accidents in the workplace is by increasing safety and applying penalties for non-adherence to safety standards. However, penalties are often a topic of intense

debate as to whether they are effective in diminishing occupational injuries, sickness and fatalities.

( Davidson, Worrel and Cheng, 1994). Suggested that enforcements or OSHA fines may result in changes to improve the safety of the work environment.

(Mendeloff and Gary, 2005), showed how inspection and fines decreased the number of occupational regulation violations. Managers fear from inspection and try to comply with the OSHA standards.

A study on occupational injuries in Tehran, took place by collecting data from six hospitals, more than 8400 patients went to these hospitals during a 13 month period. 14% of these patients had occupational injuries out of these 95% of them were males. Adults between 19-39 years of age comprised 63% of the patients. 11% of the patients were less than 18 years old. More than 60% of the patients did not have any type of insurance.(Bahman Sayyar Roudsari, Mohammad Ghodsi, 2003).

Cost benefit and productivity analysis in occupational health and safety showed that safe and efficient workplaces have an important financial role. The methods described in this study can be applied to both service and manufacturing industries. By using this method we can estimate the cost of occupational health and safety for different types of tasks in the workplace and can relate to productivity. Additionally this approach helps understand at risk places in the work environment. Here the researcher described hidden costs as overtime, extra staffing, training, supervision, labor turnover, waste and rework, lost of production time and reduced productivity and underlines that warranty costs, maintenance, product and plant damage and

equipment downtime due to accidents can be significant in some situations (Oxenburgh and Marlow, 2005).

Shalini (2008), studied occupational accidents in a small island Maruitius and tried to find relationship of cost and OSH awareness. In this study they analyzed the difference between the economic costs of accidents by using both quantitative and qualitative methods. The results show costs of accidents were estimated as $168 billion in large part due to loss of productivity. They found that small businesses had the highest rate of accidents. Younger workers were more likely to be involved in occupational accidents due to lack of knowledge and risk awareness. They also found that 4% of employers understood that investment in safety and health is essential for supporting a good business. They concluded that increased awareness of both employees and employers of practical health and safety systems would help prevent accidents. (Ramessur Taruna Shalini, 2008).

In another study by (J. Nouri, et al., 2007). The goal was to assess workers safety behaviors in an Iranian gas treatment company. Their methodology was based on the Safety Behavior Sampling (SBS) technique. After observing the safe and unsafe behaviors during this study they saw that 26.7% of workers behaviors were unsafe. The main reason of workplace injuries were clumsy workers accounting for 13.1% of total workplace injuries. The results show that there is meaningful relationship between age and job experience on work accidents. The connection between the work injuries and the number of prior work injuries was also found important. The last results of research show that a great number of workers behaviors were unsafe that each of them had major prior industrial accidents.

(Gavious, 2009), calculated direct and indirect accident costs associated with industrial accidents. They also started the difficulty in calculating indirect cost and suggested a model for calculating the real cost of industrial accidents.

(Arshi, 2006). collected data related with injuries at home. 59.4% of the injured were found to be females. Mean of the age of those injured was 22.3 ± 19 years in female and 13.6 ± 17 years in male. The large majority of burns were at home and the main reasons were hot liquids or steam.

Shali J. Butani (1988). Office of mines calculated a survey to evaluate the behavior of the workers in industry workplace. They show that usage of demographics survey data to confirm variables for accidents in the industry that connected with age and experience in the firms. This research found that accidents alter with experience than by age. It means that the workers with experience had accident less than workers without experience.

Study shows that the number of injured workers in workplaces was 22134, in 2008, The number of events decreased about 8 percent compared to the past year. Most number of incidents were caused by work in 2008 respectively related to the offices of the city of Tehran and khoozestan.

The rate of 98 percent of the incidents caused by men during the year and 1.8 percent by women. The main reason for this difference is the number of men and women workers. Men are in the majority in heavy industry. The female workers usually work in jobs that are less dangerious.

75 percent of the incidents are caused by married workers are related to and 24.8 percent related to the bachelors.

Workers of age between 25-29 years got involved in accidents more with 28.1 percent than those between 30-40 years of age with 19 percent. The main reasons of the accidents were found to be careless work.

### 1.4.1 Occupational Health and Safety Regulation in Iran

There are some regulations in Iran about health and safety in the work place. Which are necessary for protection of human resources and material resources in the country. The OSH regulations in Iran can be summarized as: ( Habibi, 2004).

1- The employment of people will age less than 15 years has been banned.
2- Labor force between 15 to 18 years of age is considered teenager and the employer is required to initiate a medical evaluation by social security organization prior to employment.
3- Employers should repeat medical test at least once a year and document must be saved in their employee file.
4- Hours of work for teenager workers are half an hour less than normal workers.
5- Any kind of extra work, work at night and handling material at a weight more than permitted without using material handling equipment are forbidden.
6- All the mobile pieces and all parts of dangerous machines in the company must have suitable and save guards.
7- Automatic machines should not work when save guards are open.
8- Workers with responsibility of lubricating machines should not use the paths that workers use in the production workshop. In order to prevent accidents due to oil spillage.

9- When foreign individuals (visitors, workers from other companies) enter the workplace they should be briefed about the possible dangers in the work environment.

Personal Protection Equipment (PPE) must be provided to workers and should be used whenever necessary these can be:

1- Work clothes
2- Safety hat
3- Safety shoes
4- Safety gloves
5- Some equipment for eyes protection
6- Some equipment for ear protection
7- Safety belt
8- All kinds of respiratory masks

Nobody is allowed to use other means of shielding the person, except for common use equipment already in use. For example seat belt

All companies are required to have shielding equipment needed to protect and empower people.

Protective equipment should be made of different material appropriate for the type of work. The use of PPE in different phases of work is recommended by an employee responsible for occupational health and safety. These steps identify and provide necessary staff training. Shielding devices purchased by individual companies need to pass inspection before entering the workplace.

Management is responsible for the use of safety devices. Additionally, all clients and visitors of the plant must also use safety equipment.

All PPE must be provided by management together with guidelines on how they are used. Work clothes winter and summer must be prepared and provided to employees. These should be at an appropriate size. If the work requires employees to continuously roll up their sleeves, employees should wear short sleeved clothes in workplace.

Helmet use when there is traffic in the work place is mandatory for all employees. Helmets must be made of non-combustible materials it should be shock resistant and moisture impenetrable.

Strips and the leather of hats should be easily replaceable. Before using the hat that belonged to someone else it should be cleaned and the leather and bands should be changed.

The use of safety shoes in the workplace when walking in an industrial environment is mandatory for all employees. Safety shoes must be made of steel or other refractory metal to protect toes.

The safety shoes of employees working with electricity or in a workplace where sparks are likely to be created should be without any nails.

Safety gloves should be selected to match the risks of work.

Employees should use work gloves in all activities in which they have probability for skin injury. Those working with caustic, acid and bases must use chemical gloves. In all activities likely to damage the arm, gloves long enough to cover the arms should be used.

All employees involved in activities that could cause eye injury should use eye shielding devices. If workers need to use glasses, those with vision problems should use their glasses with goggles. Glasses should be clean from any air bubbles, cracks, waves or any other flaw.

Welding glasses should be selected in such a way that waves passing rate is reduced to a rate much lower than recommended values.

Employees working in environments with noise levels above the permissible limits should use suitable ear protection equipment.

Those who are working at a height 2 m or above and without safe guards to prevent them from falling should use safety belts.

Safety belts and shoulder straps that are placed on belts should be made of hemp or other suitable material and should have enough strength.

Cracked or ruptured belts should be replaced quickly. If there are a probability for dumped, molten, caustic or corrosive chemicals workers must use gaiter for feet

Gaiters should be able to cover legs and shoes completely.

They must be made in a way allowing workers to easily bring them down in an emergency situation.

Workers should use breathing masks in places when doing activities where congestion and air pollution is more than the recommended amount authorized.
Breathing masks should be appropriate for different types of work and should have a good seal (fit).

Employees should be trained on the proper use and maintenance of respiratory masks. Oxygen air breathing mask is prohibited with the use of mechanical filters for protection against harmful gases and vapors at low concentration.

## 1.5 Aim of The Study

The main goal of this study is to define the different types of industrial accidents in Iran, the main reasons for accidents and the cost associated with accidents. Our secondary goal is to identify any correlation between work experience, training, education level and accidents in an effort to produce guidelines for prevention.

## 1.6 Scope and Limitation of Thesis

The study was restricted to industrial companies in Tehran. The researcher had practical constraint of time and money. Data related with accidents and medical expenses were also going to be collected from the hospitals near the factories. It was realized that the company did not prefer closest hospitals and sometimes the injured person did not mention that it was an occupational injury. Therefore the hospital records were not useful for this study.

The second limitation was that some of the training institutes, did not keep record and did not give certificate to some workers at the end of the training period understanding the number of trained employees in our study. Another limitation was about collecting accident information from companies, some workers were scared of top management in other words they had a fear of losing their jobs. Extra time was spent to explain that the information collected would not be shared with management or any other party and data collected will only be used for research and will help to improve their work environment. Those that were convinced participated in the survey, here and some did not because of fear, limiting the data collected.

On the other hand, some companies did not report accidents to government because they did not want to pay fines. Therefore, labor office records did not reflect the real number of accidents in companies. But it is believed that management also included these unreported accidents when answering the survey questions.

# Chapter 2

# STUDY DESIGN

## 2.1 Setting

### 2.1.1 Selection of sampling sites

There are different types of industries in Tehran. In the last study of the Ministry of Industry it was reported that there were 23 general categories of products manufactured in Tehran as seen in table 2.1(Ministry of Industry, 2010)

Table 2.1: Categories of products manufactured in Tehran

| Number | Product Name |
|---|---|
| 1 | Nutritional Products and Drinks |
| 2 | Textile Products |
| 3 | Clothes |
| 4 | Leather Products |
| 5 | Wood Products other than furniture |
| 6 | Paper and Pulp Products |
| 7 | Stamp and Publishing |
| 8 | Oil Products |
| 9 | Raw material and Chemical Products |
| 10 | Plastic and Tire Products |
| 11 | Non- metal Mineral Products |
| 12 | Basic Metals |
| 13 | Basic Metals Products |
| 14 | Machine production |
| 15 | Accounting and Clerical Plant and Computer |
| 16 | Electric Systems and Plant |
| 17 | Radio and Television and related parts |
| 18 | Medical Devices |
| 19 | Traffic Products |
| 20 | Transportation Equipment |
| 21 | Furniture |
| 22 | Recycling |
| 23 | Computers |

The 23 categories were collapsed into nine categories by grouping similar industries as shown in table 2.2.

Table 2.2: Nine Categories of products manufactured in Tehran

| Number | Product Name |
|---|---|
| 1 | Nutritional Products and Drink |
| 2 | Textile Products |
| 3 | Wood Products other than Furniture |
| 4 | Paper and Pulp Products |
| 5 | Raw materials and Chemical Products |
| 6 | Plastic and Tire Products |
| 7 | Machine Production |
| 8 | Radio and Television and Related parts |
| 9 | Furniture |

### 2.1.2 Specific Characteristics of Sampling Sites

Table 2.3: Specific Characteristics of Companies from Nine Categories of Products

| **Nutritional Products and Drinks** | | | | |
|---|---|---|---|---|
| **Name** | No Worker | Production Rate | | Products |
| **A** | 30 | 300 | ton/yr | Catch up, Gherkin, Jam |
| **B** | 30 | 600 | ton/yr | Macaroni |
| **C** | 47 | 1000 | ton/yr | Sausage, Salami, Kabob |
| **D** | 60 | 1000 | ton/yr | Juice Fruit, Cream, Yoghurt, Cheese |
| **E** | 36 | 420 | ton/yr | Ice cream, Sweets, Milk powder, Biscuit |

**Textile Products**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 32 | 66 ton/yr | Sock, Towel, String |
| **B** | 48 | 43 ton/yr | Carpet |
| **C** | 29 | 12 ton/yr | Cloth |
| **D** | 51 | 58 ton/yr | Cloth |
| **E** | 29 | 21 ton/yr | Rug, Blanket, Cloth |

**Woody Products other than Furniture**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 18 | 2000 number | Door and Window |
| **B** | 14 | 3000 number | Door and Window |
| **C** | 19 | 200000 number | Door and Window |
| **D** | 12 | 296000 number | Wooden Cabinet |
| **E** | 12 | 245000 number | Wooden Cabinet |

**Paper and Pulp Products**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 31 | 2000 ton/yr | Paper |
| **B** | 10 | 16 ton/yr | Catalogue |
| **C** | 49 | 1500 ton/yr | Album |
| **D** | 21 | 615 ton/yr | Cardboard |
| **E** | 17 | 814 ton/yr | Paper, Carton |

**Raw material and Chemical Products**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 23 | 641 ton/yr | Shampoo, Cream, Glass cleaner, Wax |
| **B** | 93 | 2241 ton/yr | Soap, Hair Gel, Perfume |
| **C** | 200 | 9085 ton/yr | Shaving Cream, Lipstick, Nail Polish |
| **D** | 32 | 1980 ton/yr | Toothpaste, Shampoo |
| **E** | 32 | 6200 ton/yr | Plastic color, Oil Color, Anti Freeze |

**Plastic and Tire Products**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 17 | 485 ton/yr | Melamine, Dish, Pipe, Glove |
| **B** | 25 | 300 ton/yr | Rubber, Tire |
| **C** | 18 | 900 ton/yr | Protective Tire |
| **D** | 11 | 163 ton/yr | Tire |
| **E** | 12 | 290 ton/yr | Melamine |

**Machine Manufactring**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 26 | 3000 number | Gear |
| **B** | 21 | 2620 number | Shield |
| **C** | 40 | 13000 number | Engine |
| **D** | 39 | 40000 number | Gear Box |
| **E** | 48 | 5200 number | Differential |

**Radio and Television and Related Prats**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 672 | 3781000 number | Lamp, Radio, Television |
| **B** | 234 | 200000 number | Monitor, Computer |
| **C** | 661 | 97000 number | Loud Speaker, Telephone, Antenna |
| **D** | 10 | 90000 number | Modem |
| **E** | 17 | 40000 number | Thermal Elements, Thief Hunter |

**Furniture**

| Name | No Worker | Production Rate | Products |
|---|---|---|---|
| **A** | 15 | 25 ton/yr | Furniture |
| **B** | 41 | 41 ton/yr | Furniture |
| **C** | 10 | 10 ton/yr | Furniture |
| **D** | 20 | 20 ton/yr | Furniture |
| **E** | 18 | 18 ton/yr | Furniture |

# Chapter 3

# METHODOLOGY

## 3.1 Data Collection

Data was collected from employer and employees using carefully designed surveys (Appendix 1), one to one interviews and on site direct observations. Data could not be collected from labor offices or hospitals as mentioned in the limitations section of this thesis, because companies did not want to report all accidents to government. Therefore, hospitals besides confidentiality, they were not able to give correct information about number of accidents in each firm. Therefore, questioners were designed; employer and employee assured content validity (Appendix 1).

To collect data many related different types of costs after an accidents happens in the firm. In addition to write questions the researcher had observations and oral communication with employers and employees from different industries, labor offices and training institutes.

### 3.1.1 Employer Survey

The employer survey questions was designed to collect data related with accidents over a one year period. The data collected with employer survey included total number of accidents, cost of product and equipment damage cost, medical expenses, fines, increase in insurance, contract cancellation, decrease in the number of customers, penalties due to delay, decreased production, employee replacement, training new workers for the job, lost work days for the injured workers.

### 3.1.2 Employee Survey

The employee survey collected information on education level (including training and experience), types of accidents and risks in the work environment, cost of the direct accidents to the employee and days of work loss due to accidents. Beside this it was aimed to collect information related with how long work stopped just after an accident took place in the work environment.

## 3.2 Methods

### 3.2.1 Method Used for Accident Related Cost Calculations

The total cost in an industrial accident includes direct costs, indirect costs, payment and immeasurable costs. According to Corcoran, (2002) it can be calculated as shown in equation 3.1

Total cost = $C_{direct} + C_{indirect} + C_{payment} + C_{immeasurable}$ (3.1)

Equations 3.2 and 3.3 can be used to calculate the direct cost and indirect cost.

$C_{direct} = C_{damage} + C_{medical} + C_{fine} + C_{insurance}$ (3.2)

Where

$C_{damage}$= the damage of product, machinery and equipment. Most of the time, an accident not only has cost for the worker, but also it has damage of products, equipments and machinery. Damage cost includes, the damage caused to machinery, raw materials, other equipments and the price of cleaning the work area.

$C_{medical}$= costs of medical treatment. This cost includes, cost of bringing workers to the hospital after an accident, hospitalization, medical care after the accident.

$C_{fine}$= this includes fines paid to the government for any violation of occupational rules and regulations.

$C_{insurance}$= supplementary charge of increasing insurance. The annual wage a company pays as an insurance cost is determined by the estimated number of days that workers will not come to work, how many days they will stay in hospital. The insurance cost will be different from year to year according to the events in the previous year. The difference between the previous insurance cost and new cost for insurance can be related as a direct cost.

$$C_{indirect} = C_{capacity\ lost} + C_{schedule} + C_{recruit} + C_{work\ time} + C_{wip} + C_{mang} \tag{3.3}$$

$C_{capacity\ lost}$= This cost arises from capacity loss. An accident can cause slowdown in production or a hault in production for a short time, or production will continue at low capacity which has a cost to the company. The equation used to calculate capacity loss is given below 3.4.

$$C_{capacity\ lost} = \int_0^{t_1} ufh_{old}\, Prdt + max\left(\int_{t_1}^{t_2} (ufh_{old} - ufh_{new}) Prdt, 0\right) + Re\ Cre \tag{3.4}$$

$t_1$- This time after accident, from when production line stops and resumes after an accident.

$t_2$- The time between the production line start after accident and production line arrive to last production rate.

$P_r$- Beneficial of per product.

$ufh_{old}$- Production rate before accident.

$ufh_{new}$- Production rate after accident.

$Re$- Amount of product damaged in the accident which can be repaired.

$Cre$- The cost for the produce damaged products.

$C_{schedule}$= when an accident happens in the company, product may not reach the customer on time. This can cause contract cancellation or a demand to get products late at a lower price. In some cases the company can also buy from others at a higher price to meet the schedule of product delivery. All additional costs are included in schedule cost of equation 3.3 and can be calculated as shown below in equation 3.5.

$$C_{schedule} = F_0 Nco + F_a Nca + K \sum_{i=1}^{Nol} d_i + Q(P - M) \quad 3.5$$

$F_0$- Penalty of canceling order.

$F_a$- Penalty of canceling agreement.

$Nco$- Amount of order canceling.

$Nca$- Amount of agreement canceling.

$K$- Penalty to postpone in deliveries.

$Nol$- Amount of requests that had delay in deliveries.

$d_i$- Amount of day of lateness for request.

$Q$- Amount of products they got from another producer for satisfying contract.

$P$- Cost of products for another producer.

$M_a$- Cost of material for products.

$C_{recruit}$= this includes the cost of replacing injured workers including the time for orientation and training. Equation 3.6 can be used to calculate the recruit cost.

$$C_{recruit} = W_1(r + l) \quad (3.6)$$

$r$- Hiring cost for worker.

$l$- Cost of training for new workers.

$W_1$- Number of new workers.

$C_{work\ time}$= this is the cost of time managers spend for looking into the accident, and the supplemental work hours needed to replace the injured worker.

$$C_{work\ time} = \sum_{i=1}^{n} T_i C_i + \sum_{i=1}^{l} \sum_{j=1}^{k} P_i H_{ij} \quad 3.7$$

$T_i$- Amount of hours the employers spent for responding to injured workers.

$C_i$- Cost of $T_i$.

$P_i$- Cost of overtime for $T_i$.

$H_{ij}$- Amount of overtime hours.

$C_{wip}$ = when an accident happen, it makes a new bottleneck, as a consequence, the inventory start to grow and obviously the cost of it grows as well. Managers should find a way to adapt the inventory to the new bottleneck. This will have a high cost and is included in $C_{wip}$.

$C_{mang}$= the cost connected to the CEO time. The CEO time is very costly and wasting time can cause the company to lose sales.

$$C_{mang}= \begin{cases} \frac{T_p}{P_1} \times T \times C \ if\ management - controlled\ firm \\ \frac{T_p}{P_2} \times T \times C \ if\ externally - controlled\ firm \end{cases} \quad (3.8)$$

$T_p$- Percentage of time spent for the accident by the CEO.

$T$- Percentage of benefit from last year sales.

$C$- Net profit from last year sales.

$P_1$ - The percentage increase in the CEO payroll, for every percent.

The payment cost in equation 3.1 can be calculated as seen in equation 3.9

$$C_{payment} = M(Pay_{new} W_1) + \sum_{i=1}^{W_2} B_i - NI \times W_2 \quad (3.9)$$

This is the payment for injured workers including the pay for replacing the worker during the period of leave. The formula comprises of:

$Pay_{new}$- The payroll of a new employee.

M- Number of months the injured worker is replaced.

$W_1$-number of workers replacing the injured workers

$W_2$- Number of injured workers

$B_i$- Compensation given to injured worker. Every worker is eligible for different compensation appropriate for the degree of injury.

NI- National insurance refund.

The final cost in the total cost calculation equation 3.1 is the immesurable cost which is the summation of company reputation and worker morale costs as seen in equation 3.10.

$$C_{immeasurable} = C_{reputation} + C_{morale} \quad (3.10)$$

$C_{reputation}$= includes damage of the company reputation and the cost of customers preferring competitors products.

$C_{moral}$= Influences the cost of bad worker morale caused by accidents. Reduction in the motivation of workers due to accidents reduces productivity and even sometimes causes some employees not to want to go to work.

### 3.2.2 Accident Analysis with Safety Behavior Sampling SBS

Safety behavior sampling method was used to analyze accidents in this study."SBS is a technique of measuring unsafe acts and is based on the laws of probability"(Armitage & Conner, 2001). There can be only two conditions safe and unsafe behavior with a total probability of 1 or 100% which was modified having or

not having an accident in this study. The probability of not having an accident (safe behaviors) $p$ and $q = (1 - p)$ the probability of not having a safe behavior (having an accident), the total number of workers response to our survey n, and $(p + q)^n = 1$,

The distribution is binomial with mean "$np$" and standard deviation $\sqrt{np(1-p)}$. When "n" is a large number and neither "$p$" nor "$q$" is close to zero, the mean and standard deviation are acquired by sample mean = $\frac{np}{n} = p$, and sample standard deviation= $\frac{\sqrt{np\,(1-p)}}{n} = \sqrt{\frac{p\,(1-p)}{n}}$.

This technique has beneficial thing for apprising unsafe behavior. In the survey we collect unsafe behaviors for the workers with interview with managers and check the documents in office related with work injures and ask workers in their own survey.

Total number of act of looking prepared ( $N_1$). Number of act of looking in which work injury was studied ( $N_2$ ). Thus, the dimension of work injury is $P = \frac{N_2}{N_1}$

If S is longed for preciseness, N the total number of acts of looking required and K the value acquired from standardized normal tables for a given level of confidence, then the total number of safety acts is extracted from. (Raouf & Dhillon, 1994).

$$N = \left(\frac{K}{S}\right)^2 p(1-p).$$

For K confidence level, we can read it from standardized normal table. For 95% confidence, K is 2, and for 99% confidence, k is 3. Confidence level means that the final decision will be characteristic of the true population 95% of the time. 5%

accuracy with 95% confidence level is the number of things combined often used in SBS. SBS should be considered randomly. Since the character of human will be change from time to time, the acts duration has a necessary role in accuracy of the consequence. Therefore the same shift workers were randomly chosen for collecting the data and 450 acts were considered.

### 3.2.3 Logistic Regression Model

Logistic regression suitable for predicting a categorical variable from a set of predictors variables with a absolute dependent variable, function analysis is usually activated if all of the forecasting are successive and well distributed. Analysis is usually activated if all of the factors are definite. Logistic regression is often selected if the forecaster variables are a mix of successive and definite variable and if they are not well distributed. Logistic regression has been particularly famous with medical research or another research in which the dependent items.

### 3.2.4 Fuzzy Classification Rules

In the application of fuzzy classification rules the regulation is a fuzzy description in the many and enormous data and the regulation of results is a crisp.$\{1,2,\dots,N_c\}$

$R_i: if\ x_1 is\ A_{i1} and \dots x_n is\ A_{in} then\ g_i = p_i, i = 1,\dots,M$(3.11)

n is symbolize the number of special data, $x = \{x_1, x_2, \dots, x_n\}^T$is the data, $g_i$is the result of the $i$th and $A_{i1}, \dots, A_{in}$are something which precedes fuzzy sets. The model allows for reciprocal action between the theory in precedes data. The rank for making active for data calculated as:

$B_i(x) = \prod_{j=1}^{n} A_{ij}(X_j), i = 1,2,\dots,M$ (3.12)

The results for output will be determined by choosing the maximum number of activation: $y = g_i *, i *= are \max B_i, 1 \leq i \leq M$ (3.13)

In the next step the next item for output will again be determined by choosing the maximum answer obtained. ( Roubos and Setnes, 2002).

$CF = B_i */ \sum_i^M B_i$ (3.14)

Fuzzy classification rule model was used to find the most important component for reducing occupational accidents in the workplace.

### 3.2.5 Cause and Effect Diagram

Cause and effect analysis help identify main risk factors for accidents. Management can use this information to address problem areas.( Amitava Mitra, 1998).

SPSS, Microsoft Excel and Minitab software packages were used for data analysis.

# Chapter 4

# DATA ANALYSIS

## 4.1 Accident Related Production Cost Calculation and a Model for Improvement

A well designed management safety system can help reduce accidents and diseases, as well as costs. In addition, a good management system aims to increase efficiency, improve productivity, improve morale, quality of products and decrease legal issues. Management should pay attention to health and safety of employees and related costs. They have to understand that costs are not just direct expenses related with an accident but also cover indirect expenses which increase the price of the product or service in their organization. In this section, data collected from the selected companies (as mentioned in section 3) were analyzed with the main aim of showing how accidents can increase production cost and how labor training can help reduce the costs which are often not apparent to managers.

### 4.1.1 Direct Cost of accidents

The calculated costs, do not reflect the amount of pain and suffering of the individual injured. Events are much more expensive than managers understand, because there are many hidden costs that are not immediately apparent. Direct costs are comprised of work men compensation, medical expenses, insurance coverage and all types of damage cost and fines.

Table 4.1 and figure 4.1 shows the direct cost of accidents calculated for each group of company categorized by their products. Equation 3.2 was used to calculate direct cost of accidents over a one year period for the 9 industries analyzed.

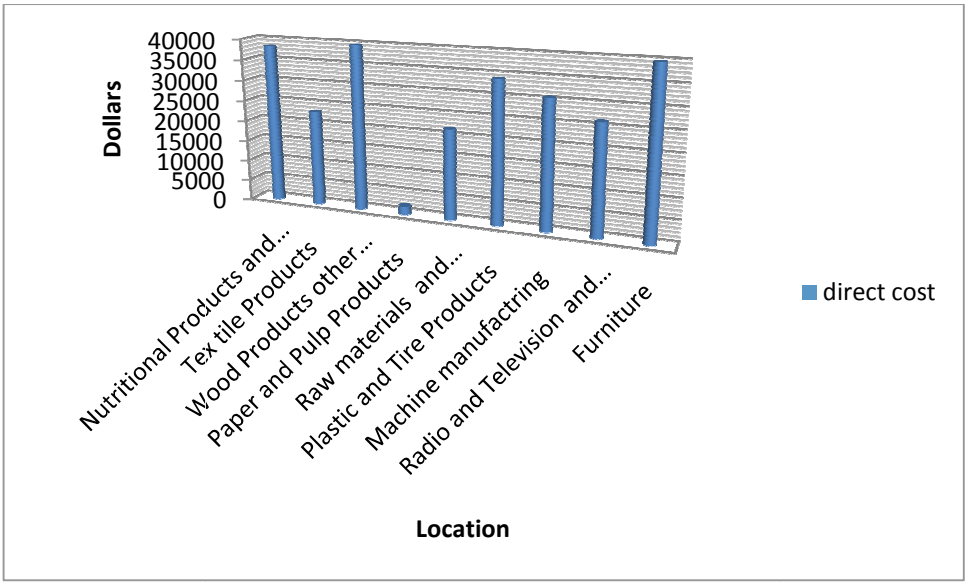


Figure 4.1 Direct cost of accidents in different industries

Table 4.1 Direct cost of accidents in different industries

| Industry | Direct Cost $ |
|---|---|
| Nutritional Products and Drinks | 38270 |
| Tex tile Products | 23070 |
| Woody Products other than Furniture | 39650 |
| Paper and Pulp Products | 1990 |
| Material make and Chemical Products | 21700 |
| Plastic and Tire Products | 34040 |
| Machine manufacturing | 30600 |
| Radio and Television and Related products | 26220 |
| Furniture | 39730 |

As seen in figure 4.1 some industries have high direct cost which can be because they have expensive product and equipments and / or due to higher accident risk.

### 4.1.2 Indirect Cost of accidents

There are some costs that are less visible. These are indirect costs. Indirect costs were calculated by using equation 3.3 and is made of different types of costs as explained in detail in section 3.2.1

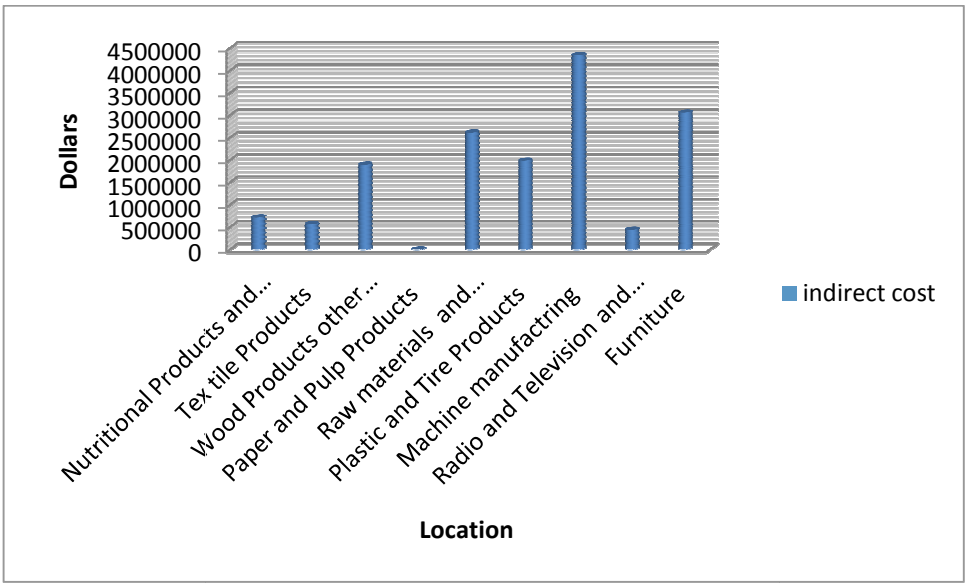


Figure 4.2 Indirect cost of accidents in different industries

Table 4.2 Indirect cost of accidents in different industries

| Industry | Indirect Costs $ |
|---|---|
| Nutritional Products and Drinks | 714520 |
| Tex tile Products | 568460 |
| Wood Products other Furniture | 1894880 |
| Paper and Pulp Products | 1545 |
| Raw materials and Chemical Products | 2613370 |
| Plastic and Tire Products | 1986100 |
| Machine Manufacturing | 4345350 |
| Radio and Television and Related Products | 440420 |
| Furniture | 3060300 |

The indirect costs calculated for different industries are shown in figure 4.2 and table 4.2. Machine production companies have high indirect cost compared to other types of companies. The main reason for this is that the machine industry is a heavy

industry with high accident risk and enough care is not given to employee job training and special training on how to operate machines before starting to work with them. Also it is realized from the results that periodic OSH training is not activated in most of the companies in Iran and this is causing accidents and hence high indirect costs.

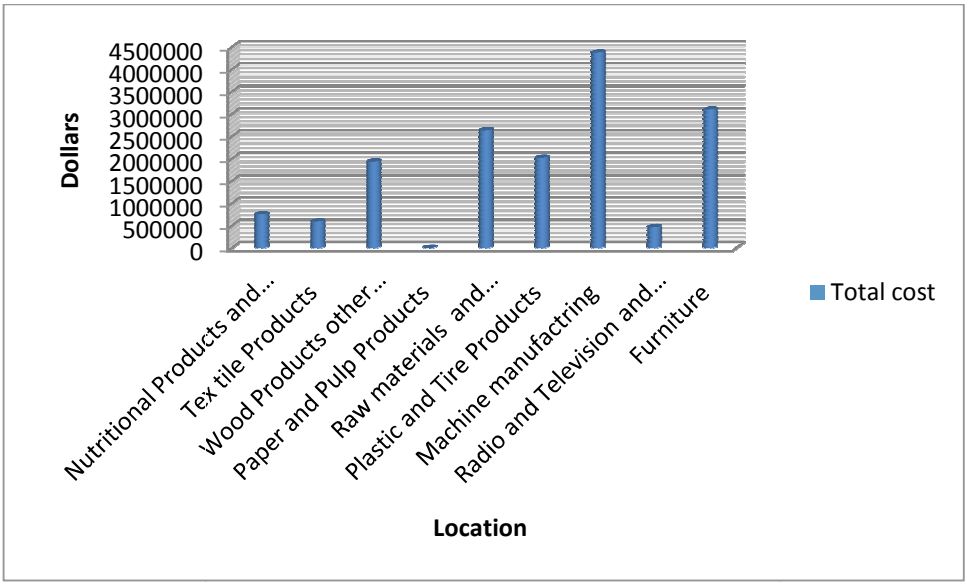


Figure 4.3 Total cost of accidents in different industries

Table 4.3 Total cost of accidents in different industries

| Industry | Total Cost $ |
|---|---|
| Nutritional Products and Drinks | 752790 |
| Tex tile Products | 591530 |
| Wood Products other than Furniture | 1934530 |
| Paper and Pulp Products | 3535 |
| Raw materials and Chemical Products | 2635070 |
| Plastic and Tire Products | 2020140 |
| Machine Manufacturing | 4375950 |
| Radio and Television and Related Products | 466640 |
| Furniture | 3100030 |

We saw that direct cost for most of the companies were approximately the same because this was mostly comprised of employee medical costs which does not differ much as industry or type of injury changes. Figure 4.2 and 4.3 illustrates that indirect

cost of accidents comprise the majority of total costs. Most of the managers will not pay attention to this part after an accident because they are just thinking about injured workers and government office reports. We must try to reduce the accident rate in companies and knowing the main reasons for these accidents becomes important.

## 4.2 Relation Between the Main Factors of workers and accident

### 4.2.1 Age of worker and accident

After cost analysis the main factors resulting in accidents were indentified. So, that actions can be taken to prevent work injuries. Amount of 450 respondents acts were considered in thesis. From the total acts 197 were found unsafe with a percentage of 43.7%. Most of the accidents occurred in the 18 to 26. The age group 26 to 40 age group was found to act safe compared to others. We can see that after age 40 the rate of accidents increased possibly because workers were tired of doing the same job, those workers who changed their job position after 40 did not have accident but those who continued with their current work had an increased risk for injury. The relationship between age and accidents can be seen in figure 4.4 and table 4.4 shows the percentage of workers involved in an accident in each industry analyzed. Table 4.5 helps understand the age distribution of work force in all industries and table A1 in appendix shows this for each industry separately.


Figure 4.4 the relation between age and accident

Table 4.4 Percentage of accidents in different industries

| **Industry** | No of employees | No of accident in the past year | % of workers who had an accident |
|---|---|---|---|
| Nutritional Products and Drinks | 203 | 33 | 16.26% |
| Tex tile Products | 189 | 26 | 13.76% |
| Wood Products other thanFurniture | 75 | 43 | 57.33% |
| Paper and Pulp Products | 128 | 5 | 3.91% |
| Raw materials and Chemical Products | 380 | 50 | 13.16% |
| Plastic and Tire Products | 83 | 42 | 50.60% |
| Machine Manufacturing | 174 | 78 | 44.83% |
| Radio and Television and Related Products | 1594 | 20 | 1.25% |
| Furniture | 104 | 57 | 54.81% |

Table 4.5 Age distribution of workforce in all industries

| Total Factory | | |
|---|---|---|
| AGE | Number | Percentage |
| Below 18 | 0 | 0 |
| 18-25 | 116 | 26 |
| 26-30 | 192 | 43 |
| 31-35 | 73 | 16 |
| 36-40 | 46 | 10 |
| 41-45 | 19 | 4 |
| 46-50 | 1 | 0 |
| 51-55 | 3 | 1 |
| above55 | 0 | 0 |
| | 450 | 100 |

Table 4.6 the relation between age and not having an accident

| | **Total Factory** | |
|---|---|---|
| AGE | No accident | Percentage% |
| Below 18 | 0 | 0 |
| 18-25 | 86 | 44 |
| 26-30 | 68 | 35 |
| 31-35 | 26 | 13 |
| 36-40 | 11 | 6 |
| 41-45 | 5 | 3 |
| 46-50 | 0 | 0 |
| 51-55 | 1 | 1 |
| above55 | 0 | 0 |
| | 197 | 100 |

Table A2 in appendix shows the relationship of age and frequency of accidents for all 9 industries separately.

### 4.2.2 Education level and Accident

The next item after age for preventing accident is education. We can see in Figure 4.5 that the rate of accidents decrease with higher levels of education. Table A3 in appendix show the education level and frequency of accidents sector wise.

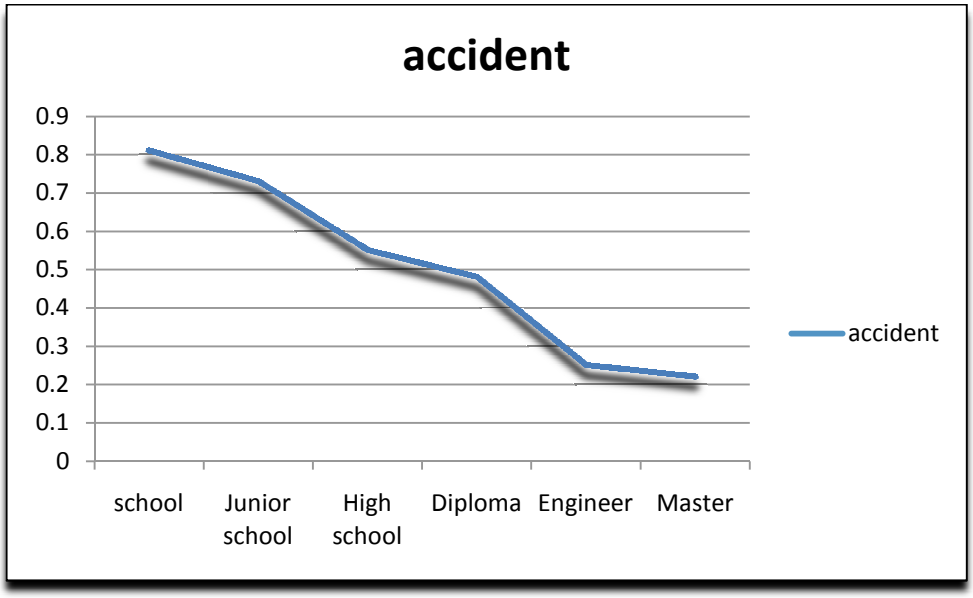


Figure 4.5 the relation between education level and accident

Table 4.7 the relation between education level and accident

| Total Factory | | | |
|---|---|---|---|
| education level | No of workers | No of accidents | % of accidents |
| primary school | 15 | 0 | 12 |
| Junior high school | 26 | 0 | 19 |
| high school | 58 | 0 | 32 |
| Diploma | 193 | 18 | 95 |
| university degree | 141 | 2 | 35 |
| master degree | 17 | 0 | 4 |
| Total | 450 | 20 | 197 |

The results in figure 4.5 show that accident rate and educational level are related. Workers with school level education had more accidents then workers with master education. Generally, less educated workers have more stress in work environments. Less education is a cause for work injuries and we can reduce accidents with increasing educational level in factories. But this is not practically possible since the work done does not need a college or university degree.

### 4.2.3 Experience and Accident

In Figure 4.6 we can see the relation between the experience and accidents. Workers with experience have lower workplace accidents.

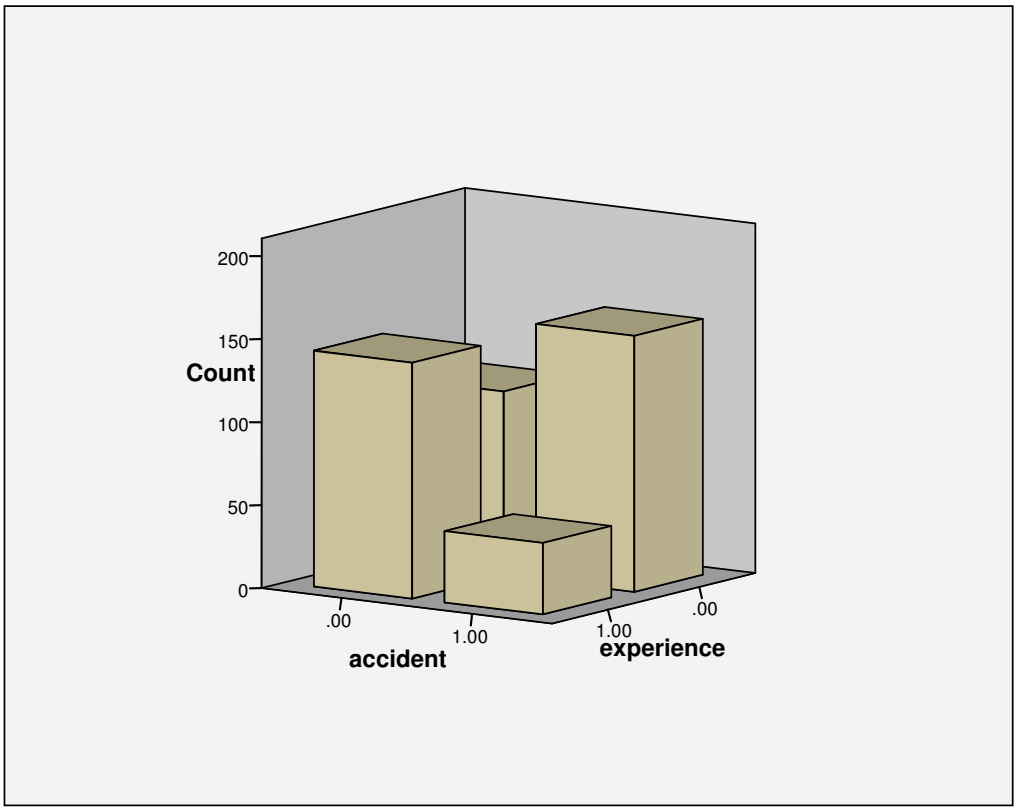


Figure 4.6 the relationship between experience and number of accident

Work experience is protective against workplace accidents.

### 4.2.4 Certificate and Accident

Certification and workplace training reduces the likelihood of accidents in industries analyzed as seen in figure 4.7.

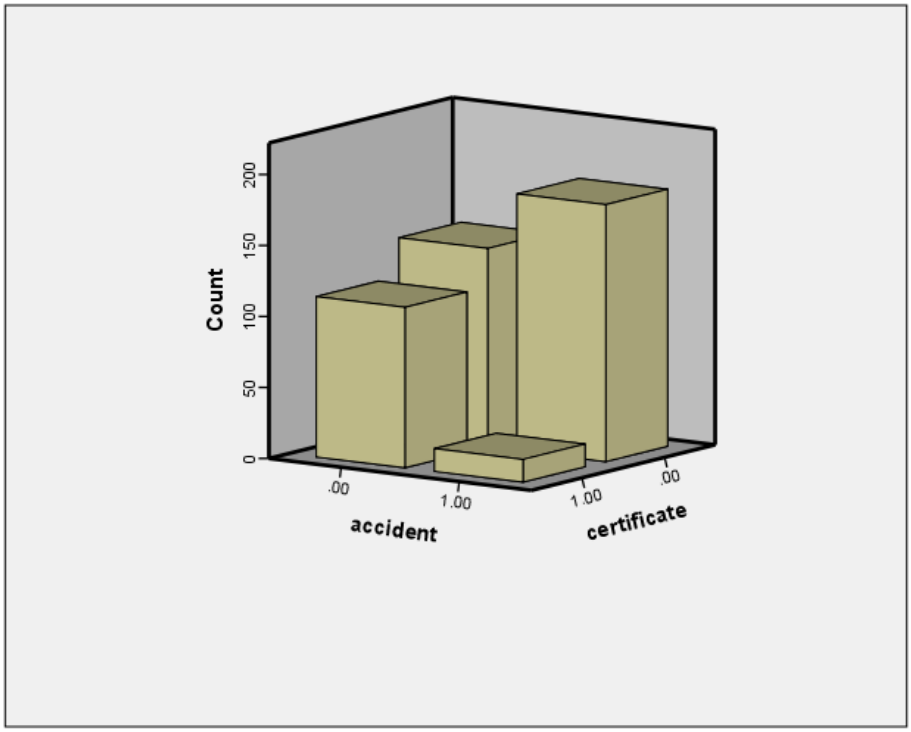


Figure 4.7 the relation between certificate and accident

Certification of job training was found to be more protective than work experience in preventing workplace accidents. Fewer accidents were observed among employees with certificate or job training than those with job experience.

The goals of education can be the goal of social security, the goal of an organization, the aim of the staffs, changes in policies and programs and the guidelines of the organization.

All kinds of educational programs are apprenticeship, knowledge has judged and training. The effective of training are the employees are learning in all the time, proper training increase job satisfaction of personnel and director. Proper training to the personnel like entering a new blood to vessels of the organization.

### 4.2.5 Relation between Experience and Certificate with Accident

Data given in table 4.8 was analyzed using SPSS to find how having a job training certificate and experience relates with accident rate. It is clearly seen in figure 4.8

that having a certificate/ job training and experience is effective in reducing occupational accidents. The results show that workers with experience and certificate or job training have the lowest rate of accidents.

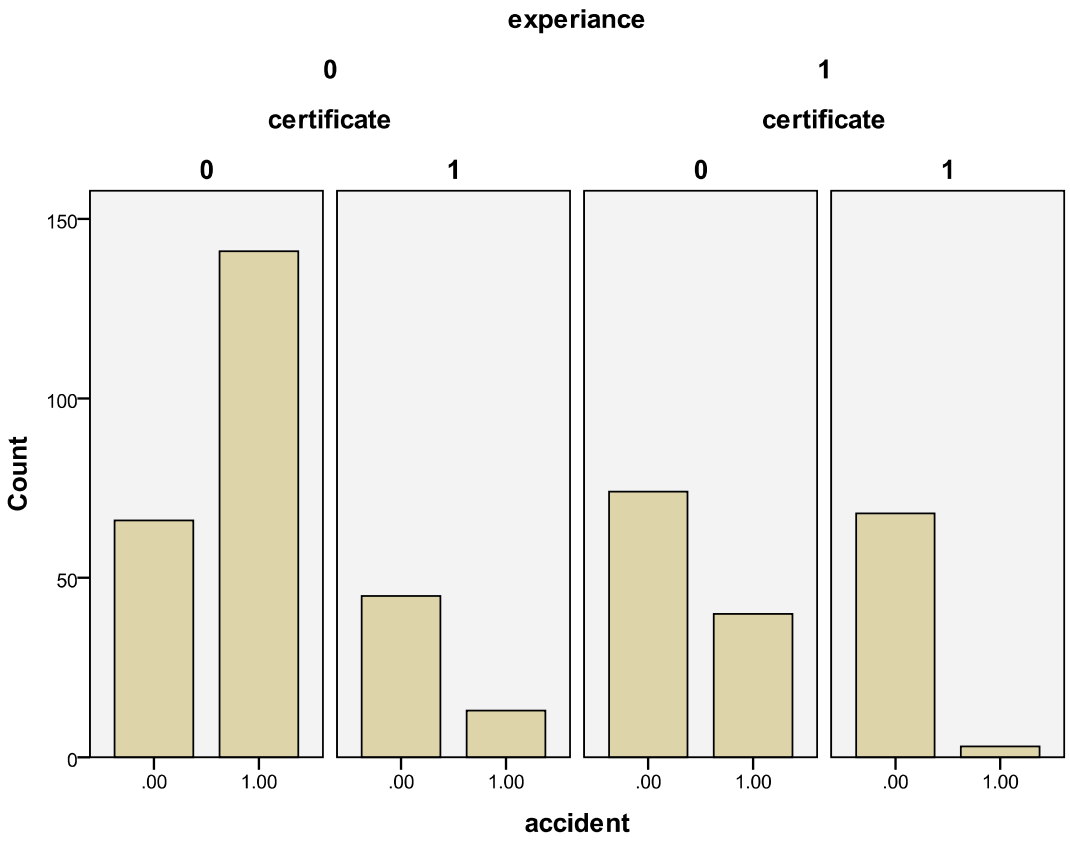


Figure 4.8 the relation between certificate and experience with accident

| Total Factory | | | |
|---|---|---|---|
| accident based on experience and certificate | | | |
| Labor with | No of worker | No of accident | % of accident |
| Experience | 114 | 40 | 20.30457 |
| Certificate | 58 | 13 | 6.598985 |
| Experience and certificate | 71 | 3 | 1.522843 |
| no experience and no certificate | 207 | 141 | 71.5736 |
| Total | 450 | 197 | 100 |

Table 4.8 frequency of accidents based on certificate and experience

## 4.3 Regression Model Analysis

Binary logistic regression analysis was used to determine predictors for safe acts. As defined before safe act stands for the case of not having accident.

Our dependent variable is accident and independent variables are experience, job training certificate and education level.

A total of 250 survey respondents data were included( table 4.9.)

Table 4.9 **Case processing summary**

**Case Processing Summary**

| Unweighted Cases[a] | | N | Percent |
|---|---|---|---|
| Selected Cases | Included in Analysis | 250 | 100.0 |
| | Missing Cases | 0 | .0 |
| | Total | 250 | 100.0 |
| Unselected Cases | | 0 | .0 |
| Total | | 250 | 100.0 |

a. If weight is in effect, see classification table for the total number of cases.

Table 4.10 **Predicted outcome coding**

**Dependent Variable Encoding**

| Original Value | Internal Value |
|---|---|
| no | 0 |
| yes | 1 |

Table 4.10. shows the outcome coding of the program; 1 represents having an accident and 0 not having an accident.

Table 4.11 **Omnibus tests of model coefficients**

**Omnibus Tests of Model Coefficients**

| | | Chi-square | df | Sig. |
|---|---|---|---|---|
| Step 1 | Step | 124.393 | 3 | .000 |
| | Block | 124.393 | 3 | .000 |
| | Model | 124.393 | 3 | .000 |

Tables 4.11 and 4.12 show that the model fits and the classification (table 14.3) shows its accuracy.

In this model chi-square is 124.393, Df is 3 and Sig is 0 showing the model is the model is significant.

Table 4.12 **Model summary**

**Model Summary**

| Step | -2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
|---|---|---|---|
| 1 | 211.285[a] | .392 | .531 |

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 4.13 **Classification table**

**Classification Table[a]**

| Observed | | | Predicted | | |
|---|---|---|---|---|---|
| | | | accident | | Percentage Correct |
| | | | no | yes | |
| Step 1 | accident | No | 75 | 24 | 75.8 |
| | | Yes | 25 | 126 | 83.4 |
| | Overall Percentage | | | | 80.4 |

a. The cut value is .500

The accuracy of predicting no accidents is 75.8% and 83.4% for the case having an accident (yes) and the overall accuracy is found to be 80.4%.

Table 4.14 **Variables in the equation**

**Variables in the Equation**

| | | B | S.E. | Wald | Df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | experience | -1.979 | .355 | 31.106 | 1 | .000 | .138 |
| | certificate | -2.940 | .439 | 44.823 | 1 | .000 | .053 |
| | education | -1.401 | .400 | 12.243 | 1 | .000 | .246 |
| | Constant | 2.571 | .329 | 61.158 | 1 | .000 | 13.081 |

a. Variable(s) entered on step 1: experience, certificate, education.

The negative B values seen in the table 4.14 show that having no accident is higher than having an accident for each variable analyzed.

All variables were found to be significant after controlling for the other predictors. This is consistent with other analysis in our study. It is clearly seen that education and being trained for the job reduces the number of accidents.

## 4.4 Classification Rules Model Results

The classification rules model helped us find the main item for preventing occupational accidents, the items considered include experience, certificatione and education level, with equations 3.14 and 3.15 were used. The approach was based on not having accidents and the output gives the most important among the items listed above.

Experience Yes 142/186=0.76

Experience No 111/264=0.42

Certificate Yes 113/129=0.87

Certificate No 140/321=0.44

Education Yes 115/154=0.75

Education No 139/296=0.47

We then chose the highest values, represented by workers with job training certification and compared it with other factors.

If certificate Yes experience Yes 68/113=0.60

If certificate Yes experience No 45/113=0.40

If certificate Yes education Yes 30/113=0.26

If certificate Yes education No 83/113=0.73

Here the highest value occurred for uneducated workers with job training certificate. In the final step the importance of experience among uneducated workers with certificate was analyzed.

If certificate Yes education No experience Yes 52/83=0.62

If certificate Yes education No experience No 31/83=0.73

The main factors for preventing accidents are certification and job experience.

## 4.5 Improving Model

In regression model and fuzzy classification rules we saw that certification and experience are main factors in accident prevention, therefore managers certification for all employees. Investing in pre-employment and periodic job training programs will be beneficial. In table 4.15 we will see the reduction in total cost after instituting the employee training program.

Table 4.15 Total cost reduction after instituting employee training program

| Industry | Total Cost1 | Total Cost2 | % Total cost Reduction |
|---|---|---|---|
| Nutritional Products and Drinks | 752790 | 370271 | 50.81 |
| Tex tile Products | 591530 | 351780 | 40.53 |
| Wood Products other than Furniture | 1934530 | 600100 | 68.98 |
| Paper and Pulp Products | 3535 | 2921 | 17.37 |
| Raw materials and Chemical Products | 2635070 | 895923 | 66.00 |
| Plastic and Tire Products | 2020140 | 868660 | 57.00 |
| Machine Manufacturing | 4375950 | 1312785 | 70.00 |
| Radio and Television and Related Products | 466640 | 291980 | 46.00 |
| Furniture | 3100030 | 992009 | 30.10 |

Here total cost 1 is the total costs calculated for the current situation based on survey response. Total cost 2 is the expected total cost after applying the improvement

model. It is for the case where all companies implement a job training program with the aim of training all employees. As known there cannot be a zero risk environment therefore no zero accidents expected but reducing number of accidents is possible. The total cost as seen in the table 4.15 has reduced drastically with the expected reduction of number of accidents. Additional training and other related costs were also included to total cost 2.

# Chapter 5

# DISCUSSION

This study shows that accident related indirect costs are high. Besides the workers wellbeing, accidents should be prevented for the companies wellbeing as well. The main factors that should be taken into account for accident prevention was found as experience and job training certification. Regression fuzzy classification rules and other statistical analyses carried out with SPSS and MS Excel gave the same results. The main reason for accidents as reported by 60% of respondents was found to be lack of information. This is consistent with our findings. An improvement model was used to calculate how job training can reduce the number of accidents and hence total cost. The additional expenses like trainer salary and employee work time was also reflected in the new total cost. The nature and benefit of educational programs are further discussed in the following sections.

## 5.1 Safety Education

We saw that educated workers had lower workplace accident rates. Prevention of accidents depends on proper execution of a job. As long as people learn necessary training for doing their jobs well, they will observe safety regulations. This means that those responsible from safety should know how to teach workers about safety guidelines, including how to learn from accidents and how to respond to an emergency.

Safety education must be ac-companied with job training. Educational programming started with needs assessment. Needs assessment will serve two purpose; first, is there any need to train workers on a special topic? Second did workers learn about that topic before? For this work, we should assess employee skills and experience. By revising their records and by observing their performance at work. Iinterviews and questionnaires can be used to assess their practical knowledge and skills. I believe that the implementation of educational programs is essential in some cases. For example, training of new workers and workers that have been assigned new jobs in factories or when new equipments is introduced at work. Educational programs can also be used when they change or update work processers when they want to give new information to workers and when performance of workers should be improved.

### 5.1.1 Goals of Program

Educational programs must be based on specific goals. These goals should be planed carefully and prioritized. The learning objectives for the educational programs should clearly state the educational needs that will be met by attending the training session and how to apply that information.

Unfortunately, there are no single program that will meet educational needs in all factories. Each factory or company should provide educational programs specific ti their work environment and needs. These programs should be controlled by safety managers and should be approved by senior management. One of the main duties of managers is the prevention of workplace injuries by enforcing safety guidelines in the work environment. When proper work methods are enforced and well known. workers will do very well. Unfortunately accidents often occur due to unsafe

methods in the workplaces. Study of accidents reveal that there are no instruction on safe work standards often do not exist and only after an accident has occurred The accident risk will be apparent.

Training programs cannot be fully successful without management support and contribution. Therefore managers should also pass through OSH training which can be organized as workshops or periodic seminars. This will increase their participation in the prevention of occupational accidents by helping understand regulations, safety standards and main causes of accidents. Managers will feel more responsibility in solving workplace safety problems after such a training.

## 5.2 Employee Training in the Workplace (or on job)

This method is a flexible and good method of education. Trainees will improve their skills in a job position. The person teaching workers must be completely familiar with the job, kind and at the same time patient. The advantages of educational system are as follows:

Workers get more motivation for learning because one person guides them.

Teachers can observe employees and give feedback for improvement. Training will be more effective since its taking place with real equipment in the trainees own work environment.

Education is real and practical and can be done in a timely fashion whenever necessary at different levels.

## 5.3 Pre-employment Training

A new employee starting work without training will increase the risk of accidents not only for their self but at the same time for their co-workers. The management will have no control on accident prevention if the new employee learns by trial and error in the work environment. Employers must ensure that the new employee gets training for safety in the workplace. Safety instruction should start during pre-employment training. Educational videos highlighting important safety points can also be an effective method for training.

# Chapter 6

# CONCLUSIONS

Our study presented the importance of understanding work accidents, their causes and associated costs. It is important to assess work environments for accident risk and make necessary corrections to reduce risk. Applying credible method for assessing the cost of work injuries is very important.

Our study of nine types of companies in Tehran demonstrated that the 43.7% of employees had accidents. This percentage was less to compare with another company in Iran. For instance, metal company had 59.2%. (Azadeh, 2000).

Accidents in the workplace depend on different factors such as age, experience, training certification and level of education. Work experience and certification of job training are correlated with the least accidents.

Most accidents were due to lack of knowledge about workstations and proper use of equipment. Employees were assigned to workstations without proper assessment of their abilities. Knowledge of the work environment, training on proper equipment use and safety guidelines are essential for accident prevention.

High indirect cost of industrial accidents in manufacturing industries in Tehran may not be recognized by management. Job training can reduce occupational injuries and therefore their indirect costs. Companies should invest in pre-employment training

programs for workers and periodic training as long as they remain employed in order to prevent work related accidents and reduce total cost.

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# APPENDICES

## Appendix 1: Employer Form Survey

Factory name: Product name:

1- How many accidents did you have in your company in the past one year?
2- Did you have damage of products or equipment and machinery in the accident? If yes give the information about cost of damage and related cost?
3- Did you pay any money for medical cost? If yes give the information about cost?
4- Did you pay any fines for example because you did not train the worker for the job? If yes, give the information about cost?
5- How much did the insurance cost increase because of previous year accident?
6- Did you have any accident that caused a contract cancellation or decrease in the number of customers? If yes, give the information about the cost?
7- Did the accident cause a slowdown in production for a period of the time? If yes, give the information about duration of slowdown and related costs.
8- How much do you pay for hiring workers and training for new workers?
9- Did you have any meeting about accidents or did you pay money for visiting your workers after accident? If yes give the information about cost?
10- How much did you pay for injured workers stay away from work?
11- How much salary did you pay for injured workers?
12- Did you replace the injured worker with a new worker during their days away?
13- If yes, how much salary did you pay for new workers replacing the injured worker?
14- If no, who did the injured workers job, how much did it cost?

15- Give the approximate amount of cost about your reputation damage in your company?

16- Give the approximate amount of cost about impact on the morale of the workers?

## Appendix 2: Employee Form Survey

Education level age:

1- How long you have been working in this company?

2- Did you have any work experience before working in this company?

3- Did you get Fani and Herfee certificate before starting to work in this firm?

4- Does your employer pay insurance for you?

5- Did you have any accident in the company until this time?

6- Did you go to hospital after the accident?

7- Did your company pay for your hospital expenses?

8- How much was the hospital expenses?

9- How much did you pay?

10- Does work stop when a worker has an accident in your company?

11- Give an approximate number of min you stop working after an accident?

12- What was the main reason of accident in your opinion?

13- What type of risk do you have in your work environment?

Table A1 Age distribution of labor force in different industries

| **Nutritional Products and Drinks** | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0.00% | |
| 18-25 | 14 | 28.00% | |
| 26-30 | 27 | 54.00% | |
| 31-35 | 7 | 14.00% | |
| 36-40 | 2 | 4.00% | |
| 41-45 | 0 | 0.00% | |
| 46-50 | 0 | 0.00% | |
| 51-55 | 0 | 0.00% | |
| above55 | 0 | 0.00% | |
| Total | 50 | 100% | |
| **Tex tile Products** | | | |
| AGE | Number | Percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 9 | 18 | |
| 26-30 | 24 | 48 | |
| 31-35 | 9 | 18 | |
| 36-40 | 4 | 8 | |
| 41-45 | 4 | 8 | |
| 46-50 | 0 | 0 | |
| 51-55 | 0 | 0 | |
| above55 | 0 | 0 | |

| **Wood Products other than Furniture** | | | |
|---|---|---|---|
| AGE | Number | Percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 14 | 28 | |
| 26-30 | 20 | 40 | |
| 31-35 | 9 | 18 | |
| 36-40 | 5 | 10 | |
| 41-45 | 2 | 4 | |
| 46-50 | 0 | 0 | |
| 51-55 | 0 | 0 | |
| above55 | 0 | 0 | |

**Table A1 continued**

| Paper and Pulp Products | | | |
|---|---|---|---|
| AGE | Number | Percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 1 | 2 | |
| 26-30 | 27 | 54 | |
| 31-35 | 8 | 16 | |
| 36-40 | 6 | 12 | |
| 41-45 | 5 | 10 | |
| 46-50 | 1 | 2 | |
| 51-55 | 2 | 4 | |
| above55 | 0 | 0 | |

| Raw materials and Chemical Products | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 9 | 18 | |
| 26-30 | 24 | 48 | |
| 31-35 | 13 | 26 | |
| 36-40 | 3 | 6 | |
| 41-45 | 1 | 2 | |
| 46-50 | 0 | 0 | |
| 51-55 | 0 | 0 | |
| above55 | 0 | 0 | |

| Plastic and Tire Products | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 23 | 46 | |
| 26-30 | 19 | 38 | |
| 31-35 | 4 | 8 | |
| 36-40 | 4 | 8 | |
| 41-45 | 0 | 0 | |
| 46-50 | 0 | 0 | |
| 51-55 | 0 | 0 | |
| above55 | 0 | 0 | |

**Table A1 continued**

| Machine Manufacturing | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 15 | 30 | |
| 26-30 | 18 | 36 | |
| 31-35 | 6 | 12 | |
| 36-40 | 10 | 20 | |
| 41-45 | 1 | 2 | |
| 46-50 | 0 | 0 | |
| 51-55 | 0 | 0 | |
| above55 | 0 | 0 | |

| Radio and Television and Related Products | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 7 | 14 | |
| 26-30 | 17 | 34 | |
| 31-35 | 12 | 24 | |
| 36-40 | 10 | 20 | |
| 41-45 | 3 | 6 | |
| 46-50 | 0 | 0 | |
| 51-55 | 1 | 2 | |
| above55 | 0 | 0 | |

| Furniture | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 24 | 48 | |
| 26-30 | 16 | 32 | |
| 31-35 | 5 | 10 | |
| 36-40 | 2 | 4 | |
| 41-45 | 3 | 6 | |
| 46-50 | 0 | 0 | |
| 51-55 | 0 | 0 | |
| above55 | 0 | 0 | |

**Table A1 continued**

| All Factories | | | |
|---|---|---|---|
| AGE | Number | percentage | |
| Below 18 | 0 | 0 | |
| 18-25 | 116 | 26 | |
| 26-30 | 192 | 43 | |
| 31-35 | 73 | 16 | |
| 36-40 | 46 | 10 | |
| 41-45 | 19 | 4 | |
| 46-50 | 1 | 0 | |
| 51-55 | 3 | 1 | |
| above55 | 0 | 0 | |
| | 450 | 100 | |

Table A2 Age and Frequency of accidents in Different Industries

**Nutritional Products and Drinks**

| AGE | Number of accidents | percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 4 | 20 |
| 26-30 | 13 | 65 |
| 31-35 | 3 | 15 |
| 36-40 | 0 | 0 |
| 41-45 | 0 | 0 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 20 | 100 |

**Tex tile Products**

| AGE | Number of accidents | percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 5 | 33 |
| 26-30 | 5 | 33 |
| 31-35 | 2 | 13 |
| 36-40 | 1 | 7 |
| 41-45 | 2 | 13 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 1 | 100 |

**Table A2 continued**

**Wood Products other Than Furniture**

| AGE | Number of accidents | percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 7 | 25 |
| 26-30 | 14 | 50 |
| 31-35 | 5 | 18 |
| 36-40 | 1 | 4 |
| 41-45 | 1 | 4 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 28 | 100 |

**Paper and Pulp Products**

| AGE | Number of accidents | Percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 0 | 0 |
| 26-30 | 1 | 50 |
| 31-35 | 0 | 0 |
| 36-40 | 0 | 0 |
| 41-45 | 0 | 0 |
| 46-50 | 0 | 0 |
| 51-55 | 1 | 50 |
| above55 | 0 | 0 |
| | 2 | 100 |

**Raw materials and Chemical Products**

| AGE | Number of accidents | Percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 7 | 23 |
| 26-30 | 15 | 50 |
| 31-35 | 8 | 27 |
| 36-40 | 0 | 0 |
| 41-45 | 0 | 0 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 30 | 100 |

**Table A2 continued**

**Plastic and Tire Products**

| AGE | Number of accidents | Percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 18 | 64 |
| 26-30 | 7 | 25 |
| 31-35 | 2 | 7 |
| 36-40 | 1 | 4 |
| 41-45 | 0 | 0 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 28 | 100 |

**Machine Manufacturing**

| AGE | Number of accidents | Percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 11 | 31 |
| 26-30 | 16 | 46 |
| 31-35 | 2 | 6 |
| 36-40 | 5 | 14 |
| 41-45 | 1 | 3 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 35 | 100 |

**Radio and Television and Related Products**

| AGE | Number of accidents | Percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 1 | 11 |
| 26-30 | 4 | 44 |
| 31-35 | 2 | 22 |
| 36-40 | 2 | 22 |
| 41-45 | 0 | 0 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 9 | 100 |

**Table A2 continued**
**Furniture**

| AGE | Number of accidents | percentage |
|---|---|---|
| Below 18 | 0 | 0 |
| 18-25 | 15 | 50 |
| 26-30 | 11 | 37 |
| 31-35 | 2 | 7 |
| 36-40 | 1 | 3 |
| 41-45 | 1 | 3 |
| 46-50 | 0 | 0 |
| 51-55 | 0 | 0 |
| above55 | 0 | 0 |
| | 30 | 100 |

Table A3 Education Level and Frequency of Accidents in Different Industries

| Nutritional Products and Drinks | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 0 | 0 | 0 |
| Junior high school | 0 | 0 | 0 |
| high school | 3 | 0 | 0 |
| Diploma | 37 | 18 | 90 |
| university degree | 10 | 2 | 10 |
| master degree | 0 | 0 | 0 |
| Total | 50 | 20 | 100 |

| Tex tile Products | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 0 | 0 | 0 |
| Junior high school | 1 | 0 | 0 |
| high school | 5 | 0 | 0 |
| Diploma | 21 | 9 | 60 |
| university degree | 19 | 4 | 26.66 |
| master degree | 4 | 2 | 13.33 |
| Total | 50 | 15 | 100 |

**Table A3 continued**

| Wood Products other than Furniture | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 0 | 0 | 0 |
| Junior high school | 0 | 0 | 0 |
| high school | 7 | 4 | 14.28 |
| diploma | 28 | 17 | 60.71 |
| university degree | 14 | 6 | 21.42 |
| master degree | 1 | 1 | 3.57 |
| Total | 50 | 28 | 100 |

| Paper and Pulp Products | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 0 | 0 | 0 |
| Junior high school | 0 | 0 | 0 |
| high school | 0 | 0 | 0 |
| Diploma | 8 | 0 | 0 |
| university degree | 38 | 2 | 100 |
| master degree | 4 | 0 | 0 |
| Total | 50 | 2 | 100 |

| Raw materials and Chemical Products | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 3 | 0 | 0 |
| Junior high school | 3 | 2 | 6.66 |
| high school | 5 | 5 | 16.66 |
| diploma | 21 | 14 | 46.66 |
| university degree | 17 | 9 | 30 |
| master degree | 1 | 0 | 0 |
| Total | 50 | 30 | 100 |

| Plastic and Tire Products | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 2 | 2 | 7.142 |
| Junior high school | 12 | 10 | 35.71 |
| high school | 8 | 4 | 14.28 |
| Diploma | 20 | 12 | 42.85 |
| university degree | 6 | 0 | 0 |
| master degree | 2 | 0 | 0 |
| Total | 50 | 28 | 100 |

**Table A3 continued**

| Machine Manufacturing | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 10 | 10 | 28.57 |
| Junior high school | 3 | 3 | 8.57 |
| high school | 15 | 12 | 34.28 |
| Diploma | 10 | 5 | 14.28 |
| university degree | 11 | 5 | 14.28 |
| master degree | 1 | 0 | 0 |
| Total | 50 | 35 | 100 |

| Radio and Television and Related Products | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 0 | 0 | 0 |
| Junior high school | 0 | 0 | 0 |
| high school | 9 | 1 | 11.11 |
| Diploma | 23 | 7 | 77.77 |
| university degree | 16 | 1 | 11.11 |
| master degree | 2 | 0 | 0 |
| Total | 50 | 9 | 100 |

| Furniture | | | |
|---|---|---|---|
| Education level | No of workers | No of accidents | % of accidents |
| primary school | 0 | 0 | 0 |
| Junior high school | 7 | 4 | 13.33 |
| high school | 6 | 6 | 20 |
| Diploma | 25 | 13 | 43.33 |
| university degree | 10 | 6 | 20 |
| master degree | 2 | 1 | 3.33 |
| Total | 50 | 30 | 100 |

Table A4 Frequency of Accidents Based on having Experience / Certificate

| Nutritional Products and Drinks | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 11 | 4 | 20 |
| Certificate | 7 | 2 | 10 |
| Experience and certificate | 6 | 0 | 0 |
| No experience and No certificate | 26 | 14 | 70 |
| Total | 50 | 20 | 100 |

| Tex tile Products | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 18 | 5 | 33.33 |
| Certificate | 6 | 3 | 20 |
| Experience and Certificate | 9 | 0 | 0 |
| No Experience and No certificate | 17 | 7 | 46.66 |
| Total | 50 | 15 | 100 |

| Wood Products other than Furniture | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 13 | 6 | 21.42 |
| Certificate | 2 | 0 | 0 |
| Experience and Certificate | 11 | 1 | 3.57 |
| No Experience and No certificate | 24 | 21 | 75 |
| Total | 50 | 28 | 100 |

| Paper and Pulp Products | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 7 | 0 | 0 |
| Certificate | 16 | 0 | 0 |
| Experience and Certificate | 11 | 1 | 50 |
| No Experience and No certificate | 16 | 1 | 50 |
| Total | 50 | 2 | 100 |

**Table A4 continued**

| Raw materials and Chemical Products | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 14 | 6 | 20 |
| Certificate | 7 | 4 | 13.33 |
| Experience and Certificate | 8 | 0 | 0 |
| No experience and No certificate | 21 | 20 | 66.66 |
| Total | 50 | 30 | 100 |

| Plastic and Tire Products | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 15 | 7 | 25 |
| Certificate | 1 | 1 | 3.57 |
| Experience and Certificate | 10 | 0 | 0 |
| No experience and No certificate | 24 | 20 | 71.42 |
| total | 50 | 28 | 100 |

| Machine Manufacturing | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 10 | 6 | 17.14 |
| Certificate | 7 | 2 | 5.71 |
| Experience and Certificate | 6 | 1 | 2.85 |
| No experience and No certificate | 27 | 26 | 74.28 |
| total | 50 | 35 | 100 |

| Radio and Television and Related Products | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 15 | 2 | 22.22 |
| Certificate | 5 | 1 | 11.11 |
| Experience and Certificate | 4 | 0 | 0 |
| No experience and No certificate | 26 | 6 | 66.66 |
| Total | 50 | 9 | 100 |

**Table A4 continued**

| Furniture | | | |
|---|---|---|---|
| Number of accidents based on experience and certificate | | | |
| Labor with | No of workers | No of accidents | % of accidents |
| Experience | 11 | 4 | 13.33 |
| certificate | 7 | 0 | 0 |
| Experience and Certificate | 6 | 0 | 0 |
| No experience and No certificate | 26 | 26 | 86.66 |
| Total | 50 | 30 | 100 |

Table A5 Frequency of Accidents based on number of years on job

| **Nutritional Products and Drinks** | | |
|---|---|---|
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 8 | 40 |
| 6_10 | 12 | 60 |
| 11_15 | 0 | 0 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 20 | 100 |
| **Tex tile Products** | | |
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 8 | 53.33 |
| 6_10 | 6 | 40 |
| 11_15 | 1 | 6.66 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 15 | 100 |
| **Wood Products other than Furniture** | | |
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 14 | 50 |
| 6_10 | 13 | 46.42 |
| 11_15 | 1 | 3.57 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 28 | 100 |

**Table A5 continued**

| **Paper and Pulp Products** | | |
|---|---|---|
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 1 | 50 |
| 6_10 | 0 | 0 |
| 11_15 | 0 | 0 |
| 16_20 | 1 | 50 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 2 | 100 |
| **Raw materials and Chemical Products** | | |
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 17 | 56.66 |
| 6_10 | 12 | 40 |
| 11_15 | 1 | 3.33 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 30 | 100 |
| **Plastic and Tire Products** | | |
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 17 | 60.71 |
| 6_10 | 9 | 32.14 |
| 11_15 | 2 | 7.14 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 28 | 100 |
| **Machine Manufacturing** | | |
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 26 | 74.28 |
| 6_10 | 9 | 25.71 |
| 11_15 | 0 | 0 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 35 | 100 |

**Table A5 continued**

| **Radio and Television and Related Products** | | |
|---|---|---|
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 4 | 44.44 |
| 6_10 | 4 | 44.44 |
| 11_15 | 1 | 11.11 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 9 | 100 |
| **Furniture** | | |
| Total # of years working | No of accidents | % of accidents |
| 0-5 | 26 | 86.66 |
| 6_10 | 3 | 10 |
| 11_15 | 1 | 3.33 |
| 16_20 | 0 | 0 |
| 21_25 | 0 | 0 |
| 26_30 | 0 | 0 |
| Total | 30 | 100 |

Table A6 Frequency of Main Reason of Accidents in Different Industries

| **Nutritional Products and Drinks** | |
|---|---|
| Main reason of accidents due to respondends | Type of Frequency |
| Lake of information | 5 |
| equipment problem | 3 |
| not running system correctly | 4 |
| quality of material | 2 |
| lack of control | 3 |
| Taking break | 1 |
| Sleepy on job | 2 |
| **Tex tile Products** | |
| Main reason of accidents due to respondends | Type of frequency |
| Lake of information | 7 |
| equipment problem | 3 |
| Not taking safety precautions | 3 |
| not running system correctly | 2 |

**Table A6 continued**

| **Wood Products other than Furniture** | |
|---|---|
| Main reason of accidents due to respondends | Type of Frequency |
| Lack of information | 4 |
| lack of safety issues | 4 |
| not running system correctly | 4 |
| lack of control | 8 |
| Co-worker not taking safety precautions | 5 |
| Stress | 3 |
| **Paper and Pulp Products** | |
| Main reason of accidents due to respondends | Type of Frequency |
| Lake of information | 1 |
| quality of material | 1 |
| **Raw materials and Chemical Products** | |
| Main reason of accidents due to respondends | Type of Frequency |
| Lake of information | 9 |
| equipment problem | 3 |
| lack of experience | 3 |
| lack of safety issues | 6 |
| Co-worker not taking safety precautions | 4 |
| Sleepy on job | 3 |
| stress | 2 |
| **Plastic and Tire Products** | |
| Main reason of accidents due to respondends | Type of Frequency |
| Lake of information | 7 |
| lack of safety issues | 6 |
| Doing work in a hurry | 6 |
| cold weather | 1 |
| Taking a break | 2 |
| Co-workmate not taking safety precautions | 2 |
| quality of material | 4 |
| **Machine Manufacturing** | |
| Main reason of accidents due to respondends | Type of Frequency |
| Lack of information | 17 |
| lack of safety issues | 10 |
| lack of control | 6 |
| quality of material | 1 |

**Table A6 continued**

| **Radio and Television and Related Products** | |
|---|---|
| Main reason of accidents due to respondends | Type of Frequency |
| Lack of information | 10 |
| equipment problem | 12 |
| lack of experience | 2 |
| lack of safety issues | 5 |
| Taking a break | 1 |
| **Furniture** | |
| Main reason of accidents due to respondends | Type of Frequency |
| Lack of information | 4 |
| lack of safety issues | 3 |
| Co-workers not taking safety precautions | 2 |

Table A7 Frequency and Percentage occurance of Reported Reasons of Accidents in all industries analyzed

| **All factories** | | |
|---|---|---|
| Main reason of accidents due to respondends | Type of frequency | percentage |
| Lack of information | 64 | 32.48 |
| equipments problem | 21 | 10.65 |
| Not taking safety precautions | 3 | 1.52 |
| lack of experience | 5 | 2.53 |
| lack of safety issues | 34 | 17.25 |
| Not running the system correctly | 10 | 5.07 |
| Doing work in a hurry | 5 | 2.53 |
| lack of control | 18 | 9.13 |
| Taking a break | 4 | 2.03 |
| C0-worker not taking safety precautions | 13 | 6.59 |
| cold weather | 1 | 0.50 |
| quality of material | 9 | 4.56 |
| Sleepy on job | 5 | 2.53 |
| Stress | 5 | 2.53 |
| | 197 | 100 |