Policy Article

Economic Impacts of Work Accidents and Occupational Diseases: The Deep Economic Cost of the Invisible Burden

ABSTRACT

As in all processes involving human and machine elements, it is expected that unexpected events or developments will occur in business life and that these events will lead to unforeseen results. These unforeseen results will definitely have economic effects. These effects will occur at the micro level as well as at the mezzo and macro levels. In other words, a work accident or occupational disease concerns not only the worker or his employer, but also everyone from the end consumer to other companies; from social security institutions to private health insurance institutions. The aim of this study is to analyze the cost of work- related accidents and diseases. For this first we will define work-related(occupational) accident and diseases. Then we will demistify their direct and indirect costs. Then we will offer some basic precautions to avoid these costs.

Keywords: ***Work-related accident, work- related diseases, accident theory, direct cost, indirect cost***

1. INTRODUCTION

As in all processes involving human and machine elements, it is expected that unexpected events or developments will occur in business life and that these events will lead to unforeseen results. These unforeseen results will definitely have economic effects. These effects will occur at the micro level as well as at the mezzo and macro levels. In other words, a work accident or occupational disease concerns not only the worker or his employer, but also everyone from the end consumer to other companies; from social security institutions to private health insurance institutions.

Many countries have been paying close attention to occupational accidents and diseases for over a century. Industrialized countries in particular have developed comprehensive laws and regulations to ensure that workers are protected from these risks (Spreewer, 2008, 7-9, cited in Hamalainen, 2010, 15). These countries meticulously monitor the levels of occupational accidents and aim to keep these phenomena under control. In recent years, both countries and companies have increased their interest in such events. An important reason for this interest is the increasingly noticeable economic costs of accidents and diseases (Hamalainen, 2010, 15).

The acceleration of industrialization and the complexity of business processes have made occupational accidents and diseases not only individual grievances but also a wide-ranging issue with economic, social and institutional effects. In this article, the multidimensional economic effects of occupational accidents and diseases will be discussed in detail, direct and indirect costs will be analyzed, and solution suggestions will be presented.

2. DEFINITIONS AND MAJOR THEORIES

It is not possible to analyze economic costs by making superficial definitions without giving a detailed definition of occupational accidents and diseases. Definitions made without going into detailed definitions in this way lead to both underestimating the costs and not being able to take the right measures to reduce these costs. Therefore, a detailed conceptualization has been made especially regarding occupational accidents and their causes.

Work(-related) Accident

Before defining a work accident, it would be appropriate to examine how an accident is defined. In English, "accident" is defined as follows (dictionary.cambridge.org):

"*Something bad that happens that is not expected or intended and that often damages something or injures someone*"

"*An event not intended by anyone but which has the result of injuring someone or damaging something*"

"*Something that happens unexpectedly and unintentionally "*

If we pay attention, the first element of an accident is that it is an unexpected situation or event. The second element is that it causes damage. The third element is that it is not planned in advance. However, accident theory has presented different approaches and has gone on to make a more detailed analysis. The most general theories developed to explain the causes of accidents are: Domino Theory, Human Factors Theory, Swiss Cheese Model, Accident/Incident Theory, Epidemiology Theory, System Theory and Combination Theory (Dizdar, 2001, 28). In this paper, we focus on Domino Theory, Human Factors Theory and Swiss Cheese Model.

The Domino Theory was put forward by Heinrich. Heinrich is an important figure who pioneered in determining the causes of accidents. He comprehensively presented the theory of the causes of accidents, the interaction between man and machine, the dynamics of the frequency and severity of accidents, the causes of unsafe behaviors, managerial responsibilities in preventing accidents, the economic costs of accidents, and the effect of safety on productivity (Hagan et al., 2001 as cited in Hosseinian et al., 2012, 54). Based on statistical data based on accident reports, Heinrich determined that 88 percent of accidents were caused by unsafe behaviors of workers, 10 percent by unsafe environmental conditions, and the remaining 2 percent by external factors such as natural events. Heinrich defined an accident as "an unplanned and uncontrolled event that results in individual injuries or the possibility of such injuries as a result of the action or reaction of an object, substance, person or radiation" (Abdelhamid and Everett, 2000, as cited in Hosseinian et al, 2012).

Heinrich's Domino Theory is a classic theory developed to get to the root of occupational accidents and provide a framework for preventing such incidents. Published in 1931, this theory suggests that accidents are not simply the result of physical events, but rather occur through the interaction of a series of sequential and interdependent factors. Each factor triggers another in a chain reaction of domino effects, leading to the accident. This theory takes a deep approach that explains occupational safety not only through individual errors, but also through organizational and environmental dynamics.

Heinrich's Domino Theory was designed as a five-step process (Heinrich, 1931):

1. **Bad Human Behavior (First Domino):** The basis of accidents is factors such as employees not following safety rules, carelessness, inadequate training or lack of safety awareness. This first stage is considered the most effective factor in the occurrence of accidents and occupational safety violations usually start here.
2. **Adverse Human Conditions (Second Domino):** Adverse conditions such as individuals' habits, lack of attention or inadequate knowledge and skills about safety are important risk factors that pave the way for accidents to occur. This stage is aimed at understanding the interaction of worker behavior and environmental conditions.
3. **Machinery and Environmental Conditions (Third Domino):** In addition to human factors and personal behavior, environmental factors such as dangerous machinery, faulty equipment, poorly organized work areas, and lack of safety precautions in the workplace also play a role in accidents. This stage explains how the physical environment and technical structures lead to accidents.
4. **Accident Event (Fourth Domino):** Eventually, this chain reaction turns into an accident event. With the combination of human errors, environmental factors and dangerous conditions, accidents occur in a concrete way and cause injuries and damages.
5. **Consequence (Fifth Domino):** As a result of the accident, serious consequences such as personal injuries, disabilities or death may occur. At the same time, material losses in the workplace, decrease in production efficiency and general economic losses are also inevitable.

Heinrich argues that the first domino, that is, correcting worker behavior and establishing a safety culture, is critical in preventing accidents. In this context, he emphasizes that regular training should be provided to workers, safety precautions should be increased, working conditions should be improved, and organizational responsibilities should be strengthened. The Domino Theory states that accidents are not only caused by physical factors, but also by psychological, organizational, and environmental factors.

As a result, Heinrich's Domino Theory has become a fundamental reference point in the field of occupational safety and has had a great influence on the formation of today's safety practices. This theory demonstrates that not only individual behaviors but also organizational structures, environmental conditions and managerial measures in the workplace play an important role in preventing accidents.

Although Heinrich's Domino theory is considered one of the most understandable and clear theories to explain accident processes, it had some weaknesses in the context of application. These weaknesses emerged due to the effects of elements such as the theory's excessive attribution of blame to individuals, the disregard of managerial and organizational errors, and the assumption that accidents

are due to only one cause. As a result, the deficiencies of this theory revealed both a narrow perspective resulting from the emphasis on individual errors and an understanding that complex accidents based on multiple causes should be reduced to a single cause, which led to the theory being reviewed and reshaped (Sabet et al., 2013, 73).

There have been many criticisms of the approach developed by Heinrich, which places human error at the root of every accident. One of these criticisms was put forward by Petersen and eventually led to the definition of a new model as the “Multiple Causation Model”. In his work titled “Safety Management Techniques” (Petersen, 1971), Petersen introduced a management model that was not based on dominoes. In this model, it is emphasized that more than one factor, cause and sub-cause plays an important role in the occurrence of accidents, and the theoretical framework of this situation is defined as “multiple causes”. Petersen argued that accidents cannot be reduced to a single cause; on the contrary, various factors come together randomly and cause accidents to occur. In this context, he suggested that these multiple factors that cause accidents should be determined and targeted during the accident investigation process (Abdelhamid and Everett, 2000, 53).

Petersen's model is a much broader perspective that argues that it is insufficient to attribute accidents to a single cause in the field of occupational safety. This model is built on the idea that accidents occur as a result of a complex interaction of a number of factors and causes that are independent of each other but affect each other. Petersen emphasizes that these multiple factors inherent in accidents include a variety of elements, from workplace conditions to employee behavior, from equipment failures to environmental factors.

The basic principle of the model is that accidents do not occur as a result of a single factor or cause, but rather as a result of a combination of factors. These factors may not be directly related to each other, but they result in accidents as a result of a certain combination and sequence. The "multiple cause" approach recognizes that accidents are a dynamic and multi-layered process, and that this process develops under the influence of not only individual errors, but also organizational structures, safety culture, management policies and environmental factors.

Petersen's approach shows that accidents are too complex to be explained by individual errors alone, and that a large number of factors must be taken into account to get to the root of the accident. Therefore, from the perspective of occupational safety management, this model allows for the development of more comprehensive and holistic strategies for preventing accidents. Identifying the multiple causes behind accidents makes it possible to take specific measures against each of these factors, thus contributing to the strengthening of the general safety culture.

Another contribution to the domino model was made by Weaver. Weaver attributed the accidents to managerial deficiencies. Weaver(2006,49) clearly stated the effects of safety management and organizational deficiencies in the following paragraph:

“But is it the function of safety to "locate and define operational errors" that result in rejects, contaminated batches, badly served customers and similar snafus? Clearly, these are beyond the scope of safety, so we must modify our definition. The function of safety management is "to locate and define the operational errors that can produce the symptoms we call an accident and/or injury." So modified, the definition suggests the scope of the safety function and indicates the safety director's role as a manager. The role of a manager is to harness and improve the supervisory/management skills of an organization to achieve safety objectives. No organization is perfect; “all have strengths on which to build, and weaknesses to buttress in an ever-shifting process of change”

Another model put forward to define the role of management in accidents is the model of Bird and Loftus. Bird and Loftus (1976) revealed the direct results of managerial effects on accidents and incidents through the Lost Cause Model and in this context, they added another domino to the Domino Theory and included managerial errors in the theoretical framework. With this addition, they founded the idea that accidents can be prevented if errors at the management level are eliminated (Bird and Loftus 1976 as cited in Uslu and Dönmez, 2018, 292). Bird and Loftus' approach emphasizes that accidents should be evaluated as the final result of a chain of interrelated causes rather than being individual events. Managerial errors are positioned as the most critical link in this chain and it is considered essential to systematically analyze administrative processes in order to prevent accidents. In this context, it is stated that the disruptions in the management's planning, organization and decision-making processes play a critical role as the first domino of the chain. The idea that a mistake in administrative processes could create a chain reaction and ultimately lead to an accident places this theory in a different position from other accident theories of the period.

While the analysis that began with the Domino Theory mostly takes into account institutional interactions and sociocultural variables, there are also approaches that include the psychological dimension in the analysis. The most important of these is the Goals Freedom Alertness Theory (Kerr 1957). This approach is a pioneering approach that aims to analyze the relationship between motivation and individual performance and sheds light on the dynamic nature of human behavior. This theory deeply examines how individuals' goal-setting processes and the attention and alertness they show towards achieving these goals are shaped by their perceptions of freedom. Kerr's theory has an innovative paradigm in the motivation literature in that it draws attention to the decisive effect of not only individual goals but also the individual's environmental and psychological perception of freedom on performance.

In this context, the theory claims that the sense of freedom acts as a catalyst in increasing the efforts of individuals towards determined goals. The individual's feeling of being free from environmental limitations directly affects their ability to shape their own goals and focus their attention on these goals. The approach put forward by Kerr does not only consider the sense of freedom as independence from physical obstacles; it also emphasizes the individual's capacity to overcome mental, emotional and social boundaries. Freedom is evaluated as a performance trigger and an indispensable prerequisite for the realization of individual potential within this framework. The view that having a wide area of freedom in determining goals, when associated with reasonably achievable goals, coincides with high-quality work performance is the basic basis of this theory. In this context, the theory considers an accident as only a low-quality work behavior and defines it as a "waste" situation that happens to an individual rather than an object. While increasing the quality of work necessitates raising the level of awareness, such high awareness can only be sustained when the psychological environment in which the individual is located provides a satisfactory reward system. Accordingly, individuals being in an environment enriched with different reward opportunities, both economic and non-economic, increases their awareness levels and therefore brings about a noticeable increase in work quality. In this context, improving the quality of individuals' work behaviors should not be limited to efforts aimed at increasing their awareness levels; reward mechanisms should also be structured in a way that encourages high-quality work behaviors. This multi-layered relationship is considered as the basic elements that optimize the individual's performance (Kerr, 1957, 5).

Another psychologically based approach is “Human Factor Models”. Ferrel’s theory comes first among these approaches. Russel Ferrel (1997) developed his theory based on a series of human factor sources for the occurrence of accidents and argued that the most basic causes of accidents are human errors. The main factors affecting the occurrence of these errors are as follows (Abdelhamid and Everett, 2000; Taylor et al., 2004; Jha, 2011 as cited in Hosseinian et al., 2012, 57):

i. **Overload** : The overload factor refers to the incompatibility between the load that an individual can carry and their physical and psychological capacity. This incompatibility can cause the individual to experience situations such as anxiety, pressure, and fatigue; these effects can be further deepened by the physical conditions (dust, light, noise, smoke, etc.) present in the working environment.

ii. **Wrong Reaction** : The person's wrong response in a way that is incompatible with the working conditions he is in is largely related to the negative effects of environmental factors on the individual. This situation leads to the person's responses being misdirected.

iii. **Wrong Activity** : Another important factor that increases the risk of an accident is when an individual performs a certain activity incorrectly, either because they do not have the appropriate knowledge or by deliberately taking risks. This situation can result from both unconsciousness and carelessness in the person's approach to their work.

Another important theory is the “Swiss Cheese Model”. Developed by James Reason, **the Swiss Cheese Model** is an effective framework that explains the mechanism of accidents and errors, especially in the context of safety management and risk analysis. This model takes its name from a series of holes in layers that resemble a structure similar to Swiss cheese. Each layer represents the defense mechanisms, processes or controls that exist in an organization. However, the holes in these layers represent the flaws or weaknesses of the system. The Swiss Cheese Model argues that accidents cannot be attributed to a single cause, but rather occur as a result of the sequential combination of multiple flaws and deficiencies. In this context, the basic elements of the model can be listed as follows (Reason, 1990, 28):

1. **Layered Defense Mechanisms** :
   Organizations have a number of layers of defense to ensure security. These layers include policies, procedures, technological controls, and human interventions. However, these mechanisms are never perfect and each has certain weaknesses or "holes."
2. **Latent Errors** :
   Latent errors are defects or deficiencies that persist in the system for a long time without being noticed. These errors are usually caused by upper management decisions, design flaws or systematic inadequacies. On the contrary, such errors are generally considered to be the main reasons that pave the way for accidents.
3. **Active Errors** :
   Active errors are errors that directly cause an accident, usually attributed to the actions of individuals. For example, an operator pressing the wrong button or performing a procedural action would fall into this category. However, the Swiss Cheese Model states that these types of errors are often the result of deeper, latent faults in the system.
4. **How Accidents Happen** :
   As the model visualizes, when holes in the defense layers align with each other, accidents are inevitable. This refers to the "error chain" that occurs when individual and system errors combine. In this respect, it is necessary to prevent these holes from aligning in order to prevent an accident.

As a result of all these evaluations, a work accident can be defined as a sudden and unexpected event that causes physical or psychological harm to an employee at work or during an activity related to the work place, and has social, cultural, economic and physical consequences. The following criteria stand out in defining work accidents:

- **Time and Place**: The accident must occur during business hours or in an environment connected to the workplace.

- **Cause-Effect Relationship**: The employee must be harmed while performing a work-related activity.
- **Physical and Psychological Effects**: May result in injury, death or trauma.

Work accidents constitute a problem that deeply affects the social structure and continues to increase every year. Published statistical data reveal that such incidents have reached alarming levels in terms of both frequency and severity (Niza et al, 2008, 959). Work accidents are a process that occurs under the influence of multiple factors and has humans at its center. This process, whose most important subject and most important object is humans, leads to human injury or death, work stoppage, and machinery and equipment failure or becoming unusable. Therefore, it is a process in which the worker, the worker's family, the employer, other workers, customers, intermediaries and suppliers all suffer losses. It is a complex process involving social, economic and environmental factors and elements.

Occupational Disease

Work-related diseases include all diseases in which work has a direct and significant effect on etiology, course or prognosis (Rantanen and Kauppinen, 2006,98). In order to express the concept of occupational disease more clearly, it would be appropriate to use a perspective that includes the concept of epidemiology. Epidemiology is an interdisciplinary branch of science that examines the distribution and frequency of diseases, health-related events and conditions that affect public health, and the factors affecting these phenomena in detail. In this context, it provides a basic scientific framework for protecting and improving public health, as well as for creating strategies for disease prevention.

Epidemiology is not limited to the study of infectious diseases; on the contrary, it is closely concerned with a wide range of issues concerning public health, from chronic diseases to environmental and occupational risks, from injuries to lifestyle factors, and even the effectiveness of health services. From this perspective, epidemiology is an indispensable scientific tool in understanding the complex structure of health problems and in developing effective policies for these problems (WHO, 1989, 8).

Occupational diseases are health problems that occur over time due to physical, chemical, biological or ergonomic risk factors that employees are exposed to at work. The main characteristics of occupational diseases are:

1. **Long-Term Exposure**: The worker must be exposed to harmful effects continuously or repeatedly.
2. **Relationship to a Specific Occupation**: The disease must be caused by the characteristics of the job performed by the employee.
3. **Tendency to Become Chronic**: Occupational diseases generally lead to health problems in the long term.

3. **Categories of Economic Burden**

Costs of work-related accidents and diseases can be analyzed under three major highlights. The direct costs, the indirect costs, the social costs. We will analyze these concepts below.

3.1.Direct Economic Costs

Direct costs, which are the most obvious element of the economic effects of occupational accidents and diseases, generally include compensations, treatment expenses and rehabilitation expenses. These costs can be examined under the following headings:

1. **Medical Expenses** : Costs of health care services such as treatment, surgery, medications and physical therapy after an accident or illness.
2. **Compensation** : Legal compensations paid for damages suffered by employees.
3. **Insurance Premiums** : Premium increases requested by insurance companies after work accidents.

According to the International Labor Organization, 2.34 million people die each year worldwide due to work-related causes. Of these deaths, 321,000 are attributed to occupational accidents, while 2.02 million deaths are due to occupational diseases. This represents an average of more than 5,500 deaths per day (Yokoyama et al., 2013, 459). When non-fatal accidents are added to these numbers, the number increases dramatically. According to the data of the International Social Security Association, 270 million people encounter non-fatal occupational accidents and 160 million new cases of occupational diseases are reported each year (Yokoyama et al., 2013, 459).

It is often difficult to make direct calculations regarding medical costs. Some health expenditures are not reflected in the calculations even though they are related to work accidents or occupational diseases. For example, Leigh (2011, 729-730), who evaluated the studies conducted for the USA, determined the following:

1. Workers' compensation records exclude 23% to 53% of nonfatal injuries requiring medical attention (Bonauto et al., 2010).
2. At least 91% of occupational disease deaths are not detected by the workers' compensation system (Leigh and Robbins, 2004).
3. The national injury estimates produced by Corso and colleagues for the year 2000 do not distinguish between whether these injuries are occupationally related or not.
4. Biddle (2009) provided estimates of the costs of fatal occupation-related injuries, but did not consider costs associated with non-fatal injuries and occupational diseases.
5. The NSC excludes assaults, homicides, and all illnesses when calculating the costs of occupation-related injuries.
6. National cost estimates of diseases such as circulatory diseases, cancer, and chronic obstructive pulmonary disease (COPD) do not include the proportion of these diseases that result from occupational exposures.

The financial burden caused by occupational accidents and diseases, when calculated based on costs such as compensation, health services, rehabilitation and disability, corresponds to 4% of the gross domestic product (GDP) worldwide. This rate is particularly dramatic for developing countries; in some countries, the cost can reach up to 10% of GDP (Yokoyama et al., 2013, 459). If policy makers, employers and other relevant public institutions and organizations in countries do not take the necessary measures to combat occupational accidents and diseases, this burden will gradually increase. The Canadian Central Conference's study titled "Costs of Injuries and Accidents in Canada", which was conducted with the support of the Public Health Agency of Canada in 2015, analyzed the economic effects of injuries and accidents across the country in detail. According to the research findings, there was an increase of approximately 35% in injury costs examined in 2015 compared to 2004. In this context, if current trends continue, these costs are expected to increase dramatically by 180% by 2035 (Seryasat and Haddadnia, 2018; Antti-Poika and Laitinen, 2004 as cited in Rahmani et al, 2021, 2653).

3.2.Indirect Economic Costs

Indirect costs, although less visible than direct costs, can result in greater economic losses in the long run. These include:

The main components of indirect costs can be divided into four broad categories (Sun et al., 2006 as cited in Jallon et al., 2011,150):

1. **Legal and administrative costs**: The employer must allocate human and financial resources for tasks such as creating and following the file, entering data into the accident record, compiling accident statistics, and preparing reports.
2. **Productivity costs**: An accident can disrupt the balance in the workplace and affect productivity through work stoppages, overtime, production delays, etc.
3. **Replacement costs**: In order to maintain productivity, a departing employee must be replaced by a new one. This process incurs costs for transferring, hiring, and training personnel.
4. **Investigation costs**: This includes the costs incurred in investigating the cause of the accident and completing the relevant legal and administrative documentation.

> Indirect effects of occupational accidents and diseases are important in all economies, whether developed or underdeveloped. For example, Santana et al. (2006, 2) presented a series of important findings in their study in 2006: The total cost of losses in productivity and production, compensations, wage payments and other indirect costs for the USA was calculated as 96.2 billion US dollars. This study revealed that the total cost of occupational accidents and diseases is higher than health problems such as AIDS or Alzheimer's disease; it is even comparable to the costs associated with cancer. Similarly, other studies conducted in countries such as China and Lebanon have also revealed the high costs of occupational accidents. However, it is difficult to compare these results because the procedures and unique structural features of each country are different. Although the effects of occupational accidents and diseases are important for both groups, the effect is evaluated to be greater especially in underdeveloped countries. The significant difference in occupational accident rates between developed and developing countries constitutes a striking problem in the context of occupational health and safety. While businesses in developed countries generally adopt the "zero accident" policy as a basic goal, rapidly increasing infrastructure projects and industrialization processes in developing countries create new and complex risk scenarios. In this context, it is seen that businesses in developing countries are not sufficiently equipped to effectively identify and manage potential hazards. Moreover, multinational companies operating in more than one geography due to the impact of globalization have to take cultural differences into account in their strategies to prevent occupational accidents. Therefore, it is essential that occupational health and safety management systems in the institutional context are designed and implemented by taking into account the variability originating from different cultures (Hamalainen et al., 2006, 138).

Manuela (2011, 39) reached the following findings as a result of her literature review:

•The Business Results Through Health and Safety Guidebook, from Canadian Manufacturers and Exporters (Ontario Division) and Workplace Safety and Insurance Board (2001) “demonstrates the business case for workplace health and safety and reflects the experience of Ontario businesses.” The publication states, “The average workplace lost-time injury in Ontario costs over $59,000. The average losttime workers' compensation claim cost is over $11,771.” (Note: Round $11,771 to $11,800, and one finds that a 4-to-1 multiplier was used to get to $59,000. The guidebook recommends a 4:1 ratio within a cost computation system provided for employers to use.)

•The Spring 2006 issue of ASSE's Journal of SH&E Research contains the article, "A Survey of the Safety Roles and Costs of Injuries in the Roofing Contracting Industry" Choi (2006). The author writes, "Traditionally indirect costs are measured as being four times the direct costs (Heinrich, 1941), but the indirect costs of injuries may range from two to 20 times the direct costs."

•US Fish and Wildlife Service, Division of Safety and Health, offers this: "For every dollar spent on direct costs, $4 to $10 are spent on indirect costs."

•Western National Insurance says, "Most experts estimate that the indirect costs are 3 to 10 times the direct costs of an accident."

•North Carolina Industrial Commission (2007) states, "Many seasoned experts estimate that the indirect costs of an accident are three to 10 times the direct costs."

•International Labor Organization's Introduction to Occupational Safety and Health training module states, "It has been estimated that the indirect costs of an accident or illness can be four to 10 times greater than the direct costs, or even more."

•International Safety Equipment Association (ISEA, 2002) says, "Reliable estimates place them (indirect costs) at up to 30 times the direct costs."

•OSHA (2007) indicates that "studies show that the ratio of indirect costs to direct costs varies widely, from a high of 20:1 to a low of 1:1."

3.3. Social Economic Costs

The economic effects of occupational accidents and diseases extend beyond individuals and businesses to society. Social costs include:

- **Public Health Expenditures** : The burden of treating illnesses and accidents on public resources.
- **Social Security System Burden** : Increased demands for social assistance in the event of long-term disability.
- **Decreasing Tax Revenues** : Decreasing tax revenues due to lower employee productivity.

Long-Term Dynamics of Occupational Diseases

The economic effects of occupational diseases are generally long-term and affect more than one economic system. The main effects are:

1. **Permanent Disability** : Conditions such as musculoskeletal disorders, respiratory diseases, and chemical exposures that permanently reduce the productivity of workers.
2. **Long-Term Treatment Expenses** : Costs of treatment and care processes for chronic diseases.
3. **Financial Pressure on the Family** : Family budgets suffer due to loss of income for employees.

Analyzing the social effects of occupational accidents and diseases is relatively more difficult than analyzing their effects on workers and employers. It is difficult to make a clear calculation due to the limitations that arise both in terms of methodology and data. One of the most fundamental difficulties encountered in evaluating the economic consequences of occupational injuries and diseases is determining the appropriate time dimension for the analysis process. Because some economic effects occur immediately; for example, traumatic deaths can be precisely determined at the time they occur and the results related to this can be evaluated in that time period. However, the results of exposure to toxic substances in the

workplace can lead to physical problems after a long period of time. In this context, the diagnosis of a disease may not represent the starting point of the economic effects of that disease. Similarly, the initial return of an individual to work in the event of an injury may not be a definite indicator of long-term and permanent reintegration into the labor market. In this respect, addressing the economic effects of occupational risks necessitates a multi-layered time perspective (Weil, 2001, 419). The calculation becomes increasingly difficult as we go down to the lower layers of data. For example, it is very difficult to calculate the opportunity cost of the returns a child loses due to the loss of income suffered by a parent.

One way to overcome the limitations related to data and methodology is to use the concept of "attributable fractions". AFs aim to measure the proportion of work-related diseases and deaths that can be directly attributed to working conditions. In this respect, although comprehensive studies on AFs have been conducted in developed countries, it is seen that such data are quite limited in developing countries. The mortality rate tables presented by the World Health Organization (WHO) for different regions provide background data and provide approximate estimates of mortality rates for each disease or disease group by adding AF rates to these data in percentiles. It should also be noted that these data are updated at regular intervals. The main AF values used in the studies conducted by the ILO can be summarized as follows:

1. It was found that work-related cancer cases accounted for 8.4% of total cancer deaths; this rate was 13.8% for men and 2.2% for women.
2. In asbestos-related lung cancer and mesothelioma cases, the AF rate was determined as 12.2%; a distribution of 14.0% in men and 0.6% in women was observed.
3. In lung cancer and circulatory system diseases caused by passive smoking, AF rates range from 3.0-2.0% for lung cancer.
4. In circulatory system diseases, the AF rate was 12.4% in total, recorded as 14.4% in men and 6.7% in women.
5. In respiratory system diseases, the AF rate is 4.1%; it was found to be 6.8% in men and 1.1% in women.
6. In infectious diseases, the AF rate is 8.8%. While this rate is 4.8% in men, it has reached a high level of 32.5% in women due to occupational infections in the health sector. However, since health sector exposure is lower in developing countries compared to risks in agriculture and other sectors, this rate has been adjusted to take into account factors such as tropical diseases, bacteria, viruses and vector-borne infections (Takala et al., 2014, 327).

Studies have shown very different figures. One study shows that the United States allocated $250 billion to costs related to medical expenses and lost productivity in 2007 alone. Another study conducted an analysis using the monetized quality-adjusted life years method to assess the deterioration in the general health status of the working population between the ages of 18 and 88. In this context, it was determined that the annual economic burden in the mining sector reached a significant level of $340 billion, while this cost in the service sector increased to a huge level of $14.8 trillion (Schulte et al., 2017, 1051).

4. Solutions and Policy Recommendations

It is not possible to eliminate the negative effects of occupational accidents and diseases on workers, employers and the country with reactive measures. The important thing is to prevent these costs by taking proactive measures. For this, it is necessary to create social awareness as well as individual

awareness. In this context, animation and awareness training should be organized, and the society should be constantly kept alert by using elements such as public service announcements. Occupational Health and Safety training, regular trainings for employees and employers are one of the basic tools for preventing occupational accidents and occupational diseases. In order for these trainings to be effective, Risk Awareness (such as training programs that develop employees' ability to detect potential hazards in advance); s sector-based trainings (such as special content targeting occupational safety needs specific to each sector) should be implemented as a priority. In addition, technological investments can be included. Technology plays a critical role in preventing occupational accidents and occupational diseases:

1. **Automation** : Performing risky work with automatic systems.
2. **Sensor-Based Monitoring Systems** : Technologies that shorten intervention time by detecting dangers early.
3. **Artificial Intelligence and IoT** : Systems that constantly monitor the work environment and provide security through instant data analysis.

Legal control and sanctions are another element that needs to be carefully considered. The state must strictly monitor occupational health and safety standards and apply deterrent sanctions to violations.In this context, the recommended policies are **:**

1. **Strengthening Inspection Mechanisms** : Detecting violations in workplaces through more frequent and comprehensive inspections.
2. **Deterrent Penalties** : Sanctions that encourage employers to invest more in safety measures.

Improving the Working Environment is another argument that should be used to eliminate the economic negative effects of work accidents and occupational diseases.Improving physical and psychological working environments is an important factor in reducing work accidents and occupational diseases:

1. **Ergonomic Designs** : Arranging work areas to protect the health of the musculoskeletal system.
2. **Psychological Support Programs** : Applications that help employees cope with problems such as stress and burnout syndrome.

4. CONCLUSION

The economic effects of occupational accidents and diseases occur at micro, mezzo and macro levels. Both direct and indirect costs are very high. In statistical studies and modeling, it is not possible to measure these costs completely and accurately under any name. At this point, under current conditions, what needs to be done is to use the right methods and methods in the selection and evaluation of the data. Companies, employees and public authorities should be encouraged in terms of data collection. Considering the views and suggestions of different social parties in all these stages will make things easier. However, what needs to be done is to take the necessary measures to achieve the perfect situation in terms of occupational accidents and diseases. Although it has not been tested as a subject of a study in itself, the cost of the measures taken is smaller than the effect of the damages incurred. Therefore, it is necessary to focus on these measures.

Work accidents and occupational diseases have profound economic consequences that affect not only individuals but also businesses and society. Solving these problems requires comprehensive and multi-dimensional strategies. Approaches such as education, technology, inspection and improving the work environment are the most effective ways to reduce economic costs and increase the well-

being of employees. Investments in occupational health and safety are not a choice but a necessity for a sustainable workforce and economic growth.
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