Occupational accidents due to personal factors and work factors in road work projects in the city of Lima Perú

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Abstract

The occurrence of accidents in the construction industry in Peru has been a great concern since they generate delays in the fulfillment, but above all, they generate justified absences to the injured workers, due to the medical breaks generated, In addition to not being able to perform their duties due to the acquired disability, this also affects the workers' daily life, since, being injured, they cannot perform activities ranging from helping with housework to healthy recreation with their families, such as playing with their children or enjoying a family outing. When an accident at work occurs, the investigation protocol is initiated to identify the root cause of the accident, generally identifying personal factors, since in every accident there are always personal factors and work factors present.

Keywords

Occupational accident, incident, occupational disease, unsafe act, unsafe condition, proximate cause, root cause, personal factor, work factor

1. Introduction

Internationally, there are several standards that ensure the protection of workers, who are committed to protection from the beginning of their work, being the main concern for their protection, assuming together with employers the commitment to prevent occupational accidents; construction projects have deadlines that are mostly met, due to the few delays caused during its development.

According to recent estimates published by the International Labor Organization (ILO), 2.78 million workers die each year due to occupational accidents and occupational diseases (of which 2.4 million are disease-related) and 374 million workers suffer non-fatal occupational accidents (ILO, 2019). Although the causes and consequences of occupational accidents are easily identifiable and reported almost immediately, the figures do not reflect the full regional picture, as they exclude the population not affiliated to social security systems, in addition to the fact that there is a high underreporting in each country (PAHO - WHO, 2015). Work accidents are one of the causes of work absenteeism, due to the medical breaks that they generate; affecting workers at work, since due to the incapacity generated by the work accident they cannot develop their work activities, in addition this incapacity prevents them from developing activities of a personal nature, the worker during the time of their rest will not have a normal life until their full recovery. Likewise, this absenteeism generates delays in compliance deadlines, and in the eagerness to meet the established deadlines, the pressure on workers increases, accelerating the activities and consequently the occurrence of new accidents that mainly affect the injured workers. In Peru, several construction projects are being developed in which accidents occur for various reasons, currently there is a Law of Safety and Health at Work which is based on nine principles for the protection of workers, however, there is no analysis of the causes of accidents that serves as a tool for accident prevention.

In the city of Lima, the development of several construction projects is being carried out, which are affected by the occurrence of work accidents, dangerous incidents and occupational diseases, which have an impact on the increased pressure to complete the mentioned projects or works, and thus to complete the deliveries of the same and in some cases avoid the payment of penalties, contractually established, for failure to deliver on the established date, thus generating the occurrence of unsafe acts and conditions, which result in work accidents. It is considered necessary to analyze the personal factors that influence the occurrence of accidents, since according to the studies carried out by Frank Bird (1986), the origin of accidents is the lack of control, since it is from the lack of control that two determining factors arise in the occurrence of accidents which are personal factors and work factors; being generally identified in practice the personal factors by their direct relationship with the worker, not taking into account in most cases the second one.

The Ministry of Labor and Employment Promotion is the institution in charge in Peru of preparing statistical reports on occupational accidents occurring at the national level, in which only information such as the number of accidents, fatal accidents, lost time accidents, occupational diseases and incidents occurring in the corresponding month is presented: number of accidents, fatal accidents, lost time accidents, occupational diseases, and incidents occurring in the period of the month corresponding to the publication, and from the information presented only referential tables are presented such as occurrences by regions, economic sectors, sex of the injured party, part of the body affected, causative agent, occupational category of the injured party, form of the accident (aggression with weapons, entrapment, running over, falls, among others), and the form of the accident (aggression with weapons, entrapment, falls, among others), In other words, this information is not necessary to carry out an adequate analysis that would allow the establishment of preventive measures to avoid new accidents, there is no classification in the notifications, such as the classification of accidents by root cause, or by type of basic causes, since it is by identifying the basic causes that the occurrence of new accidents can be prevented or avoided; All this added to the lack of accident notification by the companies, and even more, the scarce and almost non-existent notification and dangerous incidents.

“The effects of the liberalization and privatization of services are reflected in the increase of work accidents and occupational diseases. Moreover, there are indications that the incidence and severity of occupational accidents and diseases are approaching pre-1983 figures, which reflect a clear preventive setback" (Draft Law on Occupational Safety and Health, 2010).

1.1 Objetives

1.1.1 General Objetive

To establish whether personal and/or work factors influence the occurrence of accidents in Road Works Projects in the city of Lima in the Period 2017 - 2018.

1.1.2 Specific Objectives

- To establish whether personal factors influence the occurrence of accidents in Road Works Projects in Lima in the Period 2017 - 2018.
- To establish if work factors influence the occurrence of accidents in Road Works Projects in Lima in the Period 2017 - 2018.

2. Literature Review

2.1 Theoretical Framework

The most excellent awareness of the high incidence of accidents, injuries, illnesses, and deaths at work dates back to the Industrial Revolution, which took place in Europe, the United States, and some European colonies during the eighteenth and nineteenth centuries (ILO 2019). According to this reference, it is in the industrial revolution where the change in man's way of working takes place, with the mechanization of activities, the discovery of new work systems, and the invention of steam machines, the incidence of accidents due to work increases, since man faced machines with forces and capacities more significant than those he knew; with consequences that in many cases derived in amputations, this added to the extreme working hours, which on average exceeded twelve hours, left as consequences a high percentage of injured workers.

At the beginning of the 20th century, concern for the safety and health of workers arose, and institutions such as the ILO were formed, which is a tripartite agency of the UN. The ILO brings together governments, employers, and workers from 187 member states to establish labor standards, formulate policies, and develop programs to promote decent work for all, women, and men since it is worthy work that will provide workers with proper safety and health conditions for the development of their functions. The ILO, in its eagerness to watch over workers worldwide, has issued a series of

standards for the protection of workers, which are mandatory for the member countries of this organization, of which Peru is also a member and applies after ratification by the competent bodies according to the regulations of the Peruvian State.

Bird F. and Germain L. (1986), in their book entitled: Practical Leadership in Loss Prevention, establish the proportion of accidents (fig. 1), which is currently known as the Pyramid of Safety and is a referential relationship in all organizations that have an accident prevention service.

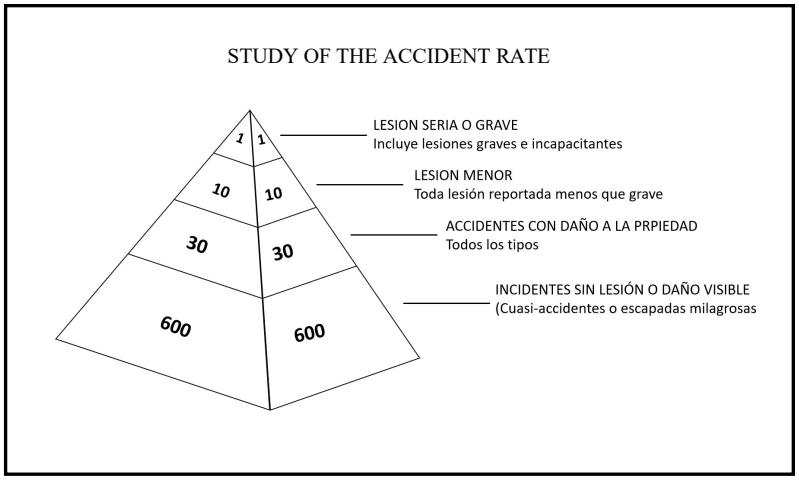

Figure 1: Bird's accident rate study
Source: Practical Leadership in Loss Control

It should be noted that the 1-10-30-600 ratio established in Figure 1 should be kept in mind that it represents the accidents and incidents that were reported, and not exactly the total number of casualties (Bird 1986).

In Peru, in 1964, the first occupational health and safety regulation was promulgated, D.S. 42-F Reglamento de Seguridad Industrial (Industrial Safety Regulation), and later in 1965, D.S. N° 29/65 D.G.S. Reglamento para la apertura y control sanitario de plantas industriales (Regulation for the opening and sanitary control of industrial plants) was published. In 2005 D.S. 009-2005-TR Reglamento de seguridad en el trabajo was published, which was modified in 2007 by D.S. 007-2007, and in 2005 D.S. 015-2015-SA Reglamento Valores permisibles para agentes químicos en ambientes de trabajo was also published.

In 2001, the International Labor Organization (ILO) published the document: "Guidelines concerning the management of occupational safety and health ILO-OSH 2001", which arise from the concern about the increase in accidents and work-related diseases, being a reference document for the management of occupational safety and health at a national level, that is, to serve as a guide to countries wishing to apply these guidelines on a voluntary basis, It establishes guidelines to be followed for the implementation of a management system at national level, establishing suggestions from the principles that the national policy should contain, continuing with the organization, planning and application, evaluation and actions for improvement, that is, with the "continuous improvement" cycle, similar to the guidelines used in the OHSAS 18001:2007 and ISO 45001:2018 model management systems: 2007, and ISO 45001:2018, with the difference that while in the OHSAS and ISO model management systems the word "must" is used, i.e. mandatory, in ILO-OHS the word "should" is used, since, as indicated in the aforementioned document, they are only suggestions to be followed, and can be applied at the national and organizational level, unlike the OHSAS and ISO management systems that only apply to organizations. It also states for national guidelines: "There should be consistency between ILO guidelines, national guidelines and specific guidelines, with sufficient flexibility to allow direct application or specific application at the organizational level" (ILO-OHS 2001).

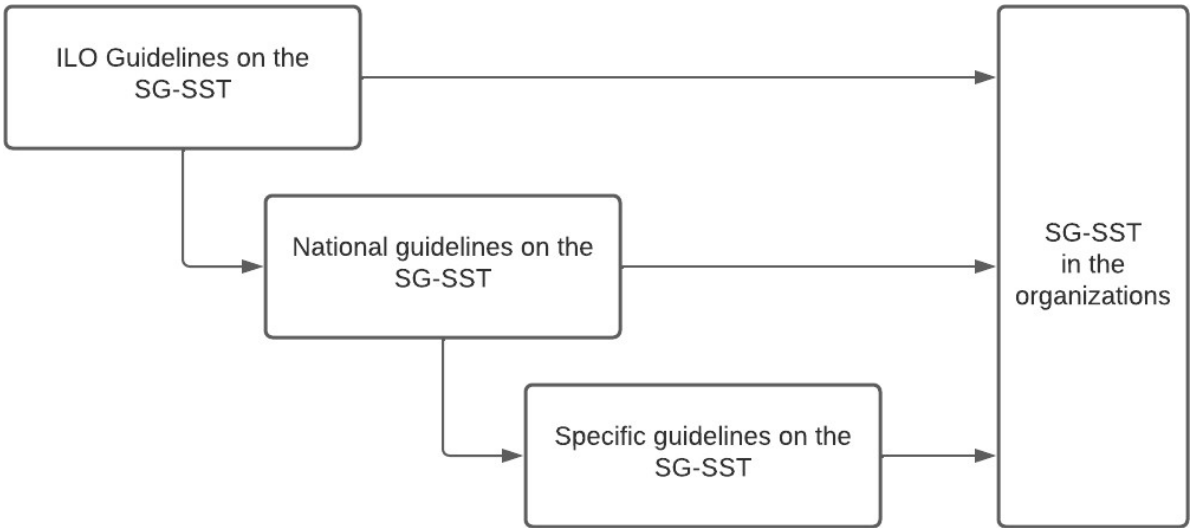

Figure 2. Elements of the national framework for occupational safety and health management systems. Source: OLO-OHS 2001

In 2011, Law 29783, the Occupational Safety and Health Law, was enacted in Peru (Figure 2). When referring in the explanatory memorandum to the national regulatory framework, it states that "At the sectoral level, the situation is more dispersed. The provisions related to Occupational Safety and Health have been spreading, with a greater or lesser degree of regulation, without a general framework or a framework law to regulate them". In addition to the scope of application includes in the amending complementary provisions, the inclusion in the Criminal Code of Article 168-A entitled "Attempt against the conditions of safety and health at work", included in Chapter VII - VIOLATION OF FREEDOM OF WORK, amended in 2,013, by Law 30222, Law amending Law 29783 Law on Safety and Health at Work, and amended again in 2,019 by Emergency Decree N° 044-2019; currently Article 168-A of the Criminal Code cites the following: "Whoever, deliberately, in violation of occupational safety and health standards and being legally obliged, puts in imminent danger the life, health or physical integrity of his workers in a serious manner, shall be punished with imprisonment of not less than one nor more than four years. If, as a consequence of the deliberate non-observance of the norms of safety and health at work, the death of the worker or third parties is caused or serious injury is produced, and the agent could foresee this result, the prison sentence shall be not less than four nor more than eight years in case of death, and not less than three nor more than six years in case of serious injury".

On April 24, 2012, D.S. 005-2012-TR, Regulation of Law 29783, Law of Safety and Health at Work, was approved, establishing in said regulation the guidelines to be followed for the compliance of Law 29783, serving as a guide for the implementation of the referred Law; in 2012, D.S. 011-2019 was published. 011-2019-TR, Supreme Decree that approves the Safety and Health at Work Regulations for the Construction Sector, establishing a Sectoral Standard for Construction activities, being also adequate or aligned with Law 29783, Law on Safety and Health at Work, which in the first of its Final Complementary Provisions indicates that "the ministries, public institutions and decentralized public bodies shall be responsible for the implementation of the regulations, Since the Ministry of Housing does not have a sectorial regulation, it is the Ministry of Labor that issues the aforementioned regulation through a Supreme Decree with the characteristic of a Supra-sectorial norm, that is to say, it covers construction activities, regardless of the economic or industrial sector where they are carried out. However, this has not allowed the reduction of accidents in the Construction Sector, in the last five years, being on the contrary the year 2019, the year in which the highest number of accidents reported to the Ministry of Labor and Employment Promotion is registered as shown in the figure 3 and figure 4 below:

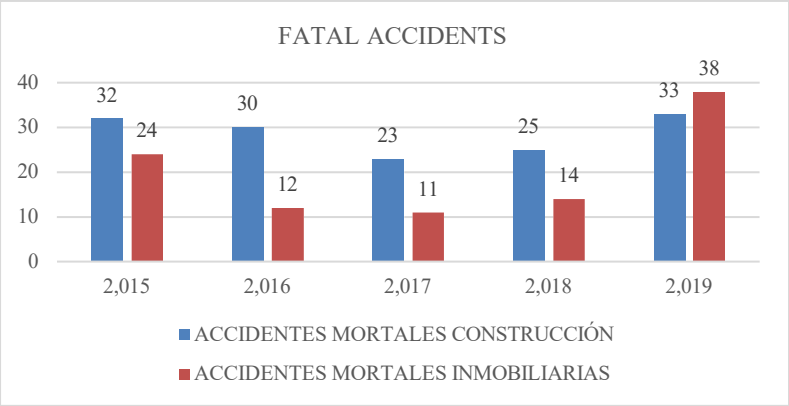

Figure 3. Fatal accidents in the construction and real estate sectors

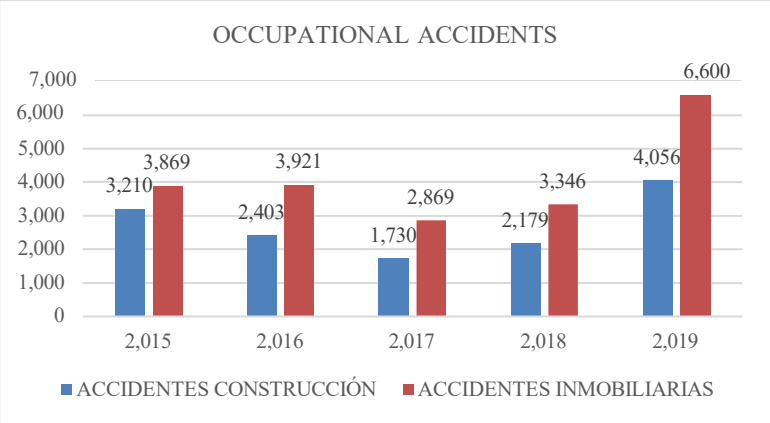

Figure 4. Occupational accidents in the construction and real estate sectors

3. Method

The present research is carried out in a construction site of a road project developed in the city of Lima (Table 1). It corresponds to the level of analysis of the causes of accidents according to the findings of the different investigations of causes that gave rise to the occurrence of accidents in the mentioned project, being an applied and non-experimental type of research.

Table 1. Data summary

Main Problem	Secondary problems	Hypothesis
To demonstrate that personal factors and work factors influence the occurrence of accidents in road works projects in the city of Lima in the period 2017 - 2018.	To what extent do personal factors influence the occurrence of accidents in Road Works Projects in the city of Lima in the Period 2017 - 2018?	H1
		Personal factors do influence the occurrence of accidents in Road Works Projects in the city of Lima in the Period 2017 - 2018.
	To what extent the work factors influence the worker in the occurrence of accidents in Road Works Projects in the city of Lima in the Period 2017 - 2018?	H0
		Work factors do influence the occurrence of accidents in Road Works Projects in the city of Lima in the Period 2017 - 2018.

The main topic of study is how personal factors and work factors influence the occurrence of occupational accidents. The project has two variables that we will seek to relate, these are: personal factors and work factors (independent variable), and work accidents (dependent variable). However, the primary objective of this research project is to demonstrate that our hypothesis is true.

The methodology of our research project consists of the relationship between two variables, for which the analysis of accident causes was carried out according to the findings of the different accident investigations, as well as the analysis of safety inspection reports.

4. Data Collection

This study includes all workers who had work-related accidents with lost time during the period indicated, so the target population is the total number of workers who suffered accidents with lost time during the development of the project.

The data used in this study corresponds to the detailed information of the reports of work accidents that occurred during the execution of the project in the identified period, in addition to reports of safety inspections in which unsafe acts and conditions in which some workers performed their work were identified; with this information, the data was prepared for the respective analysis.

For data analysis, descriptive statistics were used, inferential tables were used and the relationship between variables was determined by means of comparative tables.

5. Results and Discussion

The present study was conducted based on the information obtained in the period between the months of January 2017 and July 2018, in a road construction project in the city of Lima; it takes as reference the accidents that occurred in the development of the project, which began in 2013; the project had a cumulative frequency rate in the period equal to 2.62, and in the periods of 2017 and 2018 the frequency rates resulted in 1.26 1.08 respectively as shown in the table below (Table 2)

Table 2. Frequency rate and severity rate in the project by year and accumulated

Year	Average Workers	Maximun Workers	Man hours (thousand)	ASTP	ACTP	Fatal	Days Lost	Total Accidents	IF	IF Accum.	IS	IS Accum.
2013	2,839	3,159	11,626	0	40	0	238	40	3.44	3.44	20.47	20.47
2014	2,633	3,697	7,779	3	18	0	167	21	2.31	2.99	21.47	20.87
2015	1,321	1,701	2,870	1	11	1	10,145	13	4.18	3.14	3,535	473.64
2016	714	1,397	1,903	4	8	0	127	12	4.20	3.23	66.72	441.60
2017	3,071	4,597	8,732	11	9	0	125	20	1.03	2.64	14.32	328.23
Jan – Jul 2018	1,051	2,289	1,851	1	2	0	0	3	1.08	2.56	0.00	310.75
Grand Total	1,938	4,597	34,761	20	88	1	10,802	109		2.55		310.75

These tables indicate that during the development of the project, it starts with an average of more than three workers with accidents per million man-hours worked, exceeding four workers with accidents per million hours in 2015 and 2016; when permanent inspections are applied in 2017, this average drops to just one worker with an accident per million man-hours worked, the relationship established between minor accidents (ASTP), disabling, ACTP and fatal accidents is shown in graph 2.

To determine the FI it is necessary to have the calculation of man-hours worked and the number of accidents that occurred in the period:

$$AF = \frac{N \times 1'000{,}000}{\text{Man-h}}$$

Where:
AF: Accident Frequency Rate
N: Number of accidents during the period
Man-h: Number of man-hours worked in the period

According to the calculation of the accident frequency rate, with the information shown in the preceding graphs, we obtain the evolution of the frequency rate during the development of the project (figure 5).

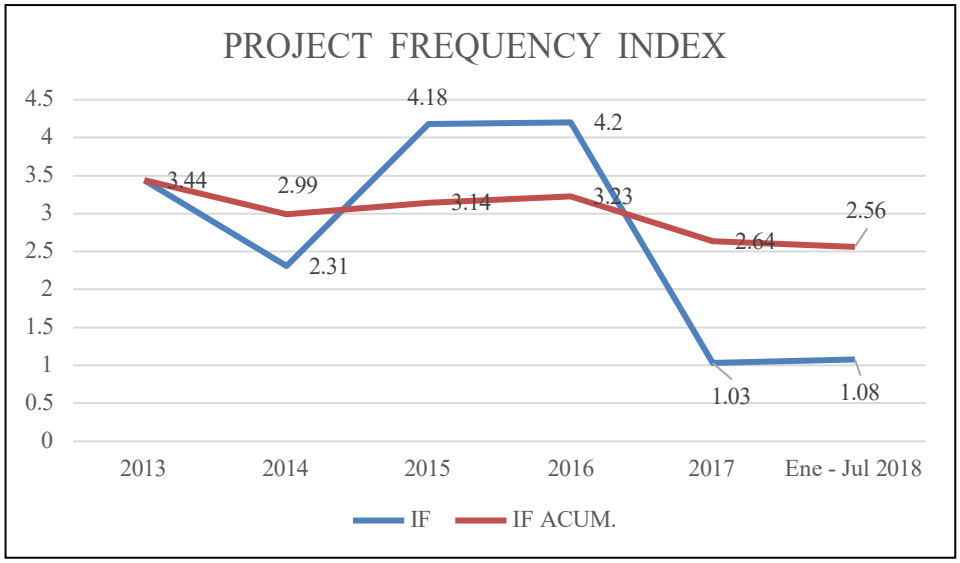

Figure 5. Frequency Index Evolution

5.1 Numerical Results

H1: Personal factors and work factors do influence the occurrence of accidents in road works in the city of Lima in the period 2017 - 2018.
H0: Personal factors and work factors do not influence the occurrence of accidents in Road Works in the city of Lima in the Period 2017 - 2018.

Table 3: Summary of the model

Model	R	R-square	R-square adjusted	Standard error of the estimate
1	,620[a]	,384	,076	5,62884

According to the R (0.620) is a moderate value indicating that the independent variables are explained by the dependent variable by 62% which is moderate (Table 3).

Table 4. Anova test

Model		Sum of squares	gl	Mean square	F	Sig.
1	Regression	78,979	2	39,490	1,246	,380[b]
	Residue	126,735	4	31,684		
	Total	205,714	6			

According to the P-value (0.38) is greater than 0.05 then the null hypothesis is not rejected, and it is concluded that the model in general is not significant (Table 4).

Table 5. Coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	(Constante)	6,018	3,916		1,537	,199
	Personal Factor	-,614	,616	-,406	-,998	,375
	Work Factor	1,374	,953	,586	1,442	,023

From the results of the coefficients (Table 5), we can observe that the P value (0.199) associated with the personal factor is greater than 0.05, indicating that the variable is not significant in the model; however, the P value (0.023) associated with the work factor is less than 0.05, indicating that the work factor variable is significant in the research.

H1: Personal factors do influence the occurrence of accidents in road works in the city of Lima in the period 2017 - 2018.
H0: Personal factors do not influence the occurrence of accidents in Road Works in the city of Lima in the Period 2017 - 2018.

Table 6. Summary of the model

Model	R	R-square	R-square adjusted	Standard error of the estimate
1	,252[a]	,064	-,124	6,20663

According to the R (0.252) is a low value indicating that the independent variables are explained by the dependent variable by 25.2% which is low (Taable 6).

Table 7. ANOVA TEST

Model		Sum of squares	gl	Mean square	F	Sig.
1	Regression	13,103	1	13,103	,340	,585[b]
	Residue	192,611	5	38,522		
	Total	205,714	6			

According to the P-value (0.585) is greater than 0.05 then the null hypothesis is not rejected, and it is concluded that the model in general is not significant (Table 7).

Table 8. Coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	(Constante)	9,739	3,248		2,998	,030
	Personal Factor	-,382	,655	-,252	-,583	,585

From the coefficient results we can observe that the P value (0.585) associated with the personal factor is greater than 0.05, indicating that the variable is not significant in the model (Table 8).

H1: Work factors do influence the occurrence of accidents in road works in the city of Lima in the period 2017 - 2018.
H0: Work factors do not influence the occurrence of accidents in Road Works in the city of Lima in the Period 2017 - 2018.

Table 9. Summary of the model

Model	R	R-square	R-square adjusted	Standard error of the estimate
1	,480[a]	,231	,077	5,62607

According to the R (0.48) is a moderate value indicating that the independent variable is explained by the dependent variable by 48% which is low (Table 9).

Table 10. ANOVA TEST

Model		Sum of squares	gl	Mean square	F	Sig.
1	Regression	47,451	1	47,451	1,499	,275[b]
	Residue	158,263	5	31,653		
	Total	205,714	6			

According to the P-value (0.275) is greater than 0.05 then the null hypothesis is not rejected, and it is concluded that the model, in general, is not significant (Table 10).

Table 11. Coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	(Constant)	4,729	3,695		1,280	,257
	Work Factor	1,126	,920	,480	1,224	,025

From the coefficient results, we can observe the coefficient results show that the P-value (0.025) associated with the personal factor is less than 0.05, which indicates that the variable is significant in the model (Table 11).

6. Conclusions

The immediate causes for all accidents are unsafe acts and unsafe conditions; that is, the occurrence of an accident is because the worker is committing an unsafe act, related to a dangerous condition, there is no accident in which only the worker has performed a hazardous act without being under a hazardous situation.

The elimination of unsafe acts and unsafe conditions is an effective tool to avoid accidents, the base on which the pyramid of the proportion of accidents indicates that the bottom is the incidents without injury or visible damage because this base is supported by unsafe acts and unsafe conditions, which are the immediate causes of accidents, which is why by eliminating the primary reasons are avoided possible accidents. In this study, it is demonstrated how, with the elimination of immediate causes, accidents were reduced in significant proportion in the years 2017 and 2018. Leadership is the main link in preventing accidents; the leader's motivation to his workers serves as a guide to do things the right way, complying with the established work standards. Above all, this motivation will drive the worker to follow the leader's example.

Supervision is an effective tool for eliminating immediate causes; therefore, it is the primary tool for accident prevention. Personal factors are the ones that cause the worker to commit unsafe acts, while work factors affect in an underlying way the decisions that the worker makes to commit a dangerous act.

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