

# Analysis of Accidentality in an Industrial Sector Company between the Years 2016-2017

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## Abstract

### Summary

The objective of the present study is to analyze by statistics the behavior of the accident in the company of the industrial sector. This research had a descriptive qualitative approach that seeks to establish the conduct of the company in relation to its accident rate. For its realization, the administrative and operative processes were characterized allowing an approach to the present risks in the development of tasks of the organization through the matrix of hazard identification and risk assessment. Then we proceeded to describe sociodemographic characteristics of workers affected by the accident between the period 2016-2017 and recommendations were made for the prevention and protection of workers in order to reduce the accident rate. As a result, it was obtained that the company's own facilities and works in the client's company have the presence of hazards that trigger work accidents. The sociodemographic description of the injured workers that in their total were 13 people of which 9 are men and 4 women. With respect to the analysis of the events that occurred within the activities and / or tasks performed by the employee in their daily work activities should be taken into account training, inspection, signaling and protection elements as the main recommendations whose purpose would decrease the accident.

**Keywords:** Accident, risks, consequences, prevention, mitigation.

## INTRODUCTION

In the present investigation we sought analyze the accident of a company the industrial sector in the period 2016 to 2017. Responsible for providing timely services and supply of materials for thermal, acoustic and refractory insulation, well as assembly and repair of thermal insulation, acoustic and refractory supply and multidirectional scaffolding assembling and application of reinforced plastic fiberglass.

Among the activities performed by employees within companies, different situations and work areas that have hazards they are presented. Why if the worker is not prevented or not aware of its risks can materialize this causing an accident. Being an accident any sudden event which arises because or in the work, and the worker produces in an organic lesion, functional or psychiatric disturbance, disability or

death [1]. This means that an accident at work are unexpected or unwanted events that adversely affect those involved.

Said earlier accidents can occur because when the injuries suffered by the worker have direct origin in free business carried for benefit of a third party as indicated Bevilacqua et al, meaning that the cause is that mediate relationship between work, the harmful event and how to do it. And once when work creates the opportunity or the reason that that happens. (This refers to sudden event generated the accident) [2]. That is, when the worker at time of usual activities or own work tasks and an accident happens there a direct relationship to work, and this accident.

In studies of accidents in the Italian industry deal with all injuries, only in the industrial sectors is characterized by a high degree of concentration, finding a statistically significant correlation between the frequency index and the size of the company, while the frequency indexes of accidents involving permanent disability such as the frequency rate of fatal accidents decrease to a measure that increases the size of the company, even those with a low concentration index [3].

Similar to the previous investigation, characteristics of the accident rate are described and establish sources of accidents and determine the type of harmful events presented in the company under study [4]. Fatal accidents are up to eight times more frequent in small businesses and non-fatal injuries are up to 50% more likely to occur [5]. However, multinational companies introduce dangerous technological activities in less developed nations, which generates various risks and immediately endangers the workers involved [6]. Especially in high risk activities that require additional protection systems [7]. Participation in safety is conditioned by environmental conditions and occupational hazards, safety incentives and the support of co-worker [8]. It is the demands of work and the pressure of the accident generators themselves that need the support of the supervision directly associated with the physical and psychosocial safety behavior [9].

In the study by Christian, MS et al in 2009, it is mentioned that knowledge of safety and motivation of industrial safety and are closely related to safety behaviors and the best climate of psychological and group safety at work [10]. For the accident figures to decrease, it is necessary a greater participation of workers in the process of management of occupational risks and accidents at work and the corresponding communication [11]. Although the presence of safety management system practices is related to the reduction

of incidents and may represent a necessary first step in the prevention of accidents, safety performance may also depend on mediation through cognitive and emotional commitment focused on the safety of workers [12-13-14]. The concept of an industrial safety culture must be integrated with behavioral characteristics to strengthen the development and implementation of safety management systems [15]. The analysis of the personal factors identified statistically significant relationships between the work accident of the electric type, sex, age, experience, nationality and the occupation of the workers. compliance with the applicable legislation in terms of protection against direct and indirect electrical contact is required [16]. In different sectors such as agriculture, the causes of non-fatal accidents are analyzed, where risk factors vary and accidents have different consequences, all avoidable [17]. while in the construction and industry union, workplace accidents tend to occur during the first day of the worker in the workplace, when the project or plant has little or no management of health and industrial safety, when the company did not provide equipment of personal protection to workers or when it was not used correctly and workers ignored safety instructions [18]. The frequency of accidents in the industry has a growing trend, with fires and explosions being the main type of accidents that occurred in 2014 [19]. Groups of ages between 46-50, have shown 1 to 2 years old tenure in the workplace with injuries due to tension and fractures, slips, falls or trips and injuries in the lower extremities as the type of accident suffered by the groups of identified risks [20]. The three main categories of work injury injuries in the wood sector were characterized by saw injuries were fracture (35.8%), open wounds (29.6%) and amputation (14.8%)[21, 22]. Risks in the workplace, when combined with demanding tasks, organizational factors, work environments, personal factors and external factors, can produce safety risks [23] and unacceptable illnesses for personnel and personal injuries in the workplace [24]. Shift workers have been identified compared to workers who did not work shifts, present a 2.7 and 1.7 times higher risk of work-related injuries [25]. It has been found that foreign workers have a shorter survival caused by injuries labor that native workers tend since the latter tend to suffer fatal injuries at older ages after prolonged exposure at work [26]. A recent study reveals that although they are mostly competent people used to carry out industrial operation activities, inadequate training and fatigue of operators are one of the main reasons that cause safety problems and occupational accidents [27].

In a study carried out in Colombia, affected workers were found in assistant plant positions with 33% and apprentice 22%, where 75% of those affected belong to the company and the remaining 25% are contractors, the upper and lower extremities being the most affected areas of the body [28]. Most critical accidents.

In sectors of metalworking and gas industry could be avoided with the use of corrective actions for prevention. the events that occurred in the accidents of these areas were characterized by slips and trips caused by floors, corridors, steps or surfaces of earth and excessive effort and bodily reaction and the inadequate posture adopted by the worker[29]. In a study on serious and fatal accidents in Spain

it is indicated on the occurrence of 212 accidents (serious or fatal) where it is necessary to analyze and investigate the causes of this high rate, taking into account that this study only covers 20 years, that is 10.6 per year [30]. In cities such as Hong Kong, the ratio of fatal accidents per thousand workers increases with the gross value of work performed per worker over a period of 21 years between 1995 and 2015. There were more deaths when workers worked more. The majority of the victims were workers aged 45 or older, reflecting acute problems of aging work and shortage of skilled labor, most workers died on hot and humid days in the summer after working for 2 hours in the morning or 1 hour after lunch [31].

## METHODOLOGY

Type of descriptive qualitative research because it seeks to specify the important properties of individuals, groups, communities or any other phenomenon that is subject to analysis of accidents. The aim was to measure or evaluate the various aspects of the phenomenon with the purpose of identifying hazards and assessing risks when handling the data related to the reported accident through the collection of data.

The accidents were verified, plus the identification of the matrix and the environmental aspect, different accidents that the workers had during their work activities and some tasks at risk, which is the probability of occurrence of accidents in the period 2016 to 2017. To achieve this, first, the administrative and operational processes that allow an approach to the risks involved in the development characterize the tasks of the organization, through the identification of the matrix and environmental aspects. To then describe the sociodemographic characteristics of workers affected by the accident during the 2016-2017 season and subsequently the statistical behavior of the accident in the company under study was determined, together with the recommendations for the prevention and protection of workers in order to reduce the accidents that occurred.

Population and sample: the company studied 13 accidents in workers, of which 9 affected men and 4 women.

Data collection instrument: for the realization of the accidents of the research formats, in order to establish the statistical data that were used. In addition, the aspects of the matrix and environmental impacts were used, in order to facilitate the characterization of business processes.

## RESULTS

**Characterization of administrative and operational procedures of the company that allows an approach to the risks present in the development of the tasks of the organization.**

Process	Zone / Locale		aspects	
own company premises	Warehouse	Receiving the materials	Generation Ordinary Solid Waste	
		Delivery of materials	Energy consumption	
		Material storage	Fire	
		cleaning materials in stock	Generation of micro particles dispersed in the air	
		Maintenance equipment stock to keep your lifetime	leak or dumping of grease or lubricants	
	Management	Activities office		power consumption
				water consumption
				employment generation
				Generation printed paper
				Using toner
				generation fluorescent tubes
	Patios	vehicle maintenance		Fuga or dumping of greases, lubricants or oils
				domestic solid waste generation
				employment generation
				power consumption
				water consumption
				Generation of micro particles dispersed in the air
	works in customer business	customer company	Cleaning materials in stock	Generation of micro particles dispersed in the air
own works Activities				Generation of industrial solid waste (plastic aluminum cans of paints, cables, cardboard, polypropylene)
			Generation of micro particles dispersed in the air	
			vapor generation, dispersed gases in the Air	
			consumption energy	
			consumption water	
			Noise Generation	
			domestic solid waste generation	
			Fire	

This company has two processes: one of the company's own facilities and another with facilities in client companies.

In the process of the company's own facilities, different activities are carried out in different areas within the company. In the storage activities are the receipt of materials,

then the delivery of these, then the storage of materials within the company is given, the cleaning of materials in stock continues and finally maintenance is carried out on equipment to maintain its useful life. Aspects related to risks in areas are the generation of ordinary solid waste, energy consumption, fire, generation of dispersed micro particles in the air, leakage or shedding of fats or lubricants, demonstrating the existence of risks for humans and the environment ambient.

In the administrative area, office activities are carried out, such as customer service, reporting, archiving documents, among others. Its aspects are the consumption of energy and water, generation of printed paper, use of toner and last generation of fluorescent tubes. And finally in the area of yards are performed different tasks of vehicle maintenance which aspects are leaking or shedding of fats, lubricants or oils, generation of domestic solid waste, generation of employment, energy consumption, water consumption, generation of micro particles scattered in the air

**Description of the sociodemographic characteristics of the workers affected by the accident in the company during the period 2016-2017**

#	Sex		Age (years)	Occupation	Work Experience (in years)	Seniority in the office (in years)	Type of Injury by Accident	affected body part
	M	F						
1	x		48	Insulation Official	15	15	nose Trauma	Head
2	x		32	Assistant	3	3	ankle sprain G2	Pie
3	x		31	Insulator	2	3	Blow	hand
4	x		27	Helper	2	2	Injury hand	hand
5	x		23	shipowner	1	1	Hit	Bag
6		x	26	HSE	2	0	Contusion	Trunk
7	x		24	shipowner	2	1	wound	Head
8		x	23	Engineer	0	0	Strike	Arm
9	x		21	Assistant	1	1	Wound	Eye
10	x		24	Insulator	1	0	Contusion	Back
11	x		23	Assistant	3	3	Injury	Head
12		x	32	Engineer	1	1	Sprain G1	Shoulder
13		x	27	HSE	0	0	G2Sprain	Arm

This table shows the sociodemographic description of the injured workers that in their total are 13 people 9 men and 4 women. In the first place we have a male worker with 48 years of age, his occupation is of isolation officer with a work experience and a seniority in his trade of 15 years, with a type of injury due to the trauma of the nose where the part of the affected body is head-nose; second of it has a male worker with 32 years of age, assistant of work with 3 years of work experience and seniority in his trade, with a type of injury due to the sprained accident in the ankle grade 2 and the part of

the affected body is the left foot. Third, we have a male worker with 31 years of age, his occupation is thermal insulator with a work experience of 1 year and 9 months and a seniority in his trade of 3 years and 4 months, the type of injury suffered by the accident presented, it is blow and the part of the affected body is the index finger of his right hand. In the fourth place we have a male worker with 27 years of age, isolation assistant, with 2 years of work experience and seniority in his trade, the type of injury from the accident is a wound on the finger left with nail damage. In the fifth place is a male worker with 23 years of age and his occupation is of scaffolding, with a work experience of 9 months and a seniority in his trade of 7 months, the type of injury presented is a blow and the part of the affected body is the finger of the left hand in the little finger. In the sixth place we have a female worker of 26 years of age, with the occupation of inspector of HSE with 2 years of work experience and a seniority in his office of 3 months, the type of injury caused by the accident is of contusion and the affected part of the body is the left side. In the seventh place we have a male worker, with 24 years of age and his trade is a scaffold with 1 year and 9 months of work experience and a seniority in his trade of 1 year, the type of injury caused by the accident is injured and the affected part of the body is the head (front).

In eighth place we have a female worker with 23 years of age, with an occupation of engineering works without work experience and no seniority in their trade, the type of injury caused by the accident are blows and the affected body part is the arm, shoulder and left leg. In the ninth place we have a male worker with 21 years of age as an isolation assistant with 1 year and 7 months of work experience and seniority in his trade, the type of injury caused by the accident is a wound and the of the affected body is the head. In the tenth place we have a male worker with an age of 24 as thermal insulator with a work experience of 1 year and 3 months, no seniority in his trade, the type of injury caused by the accident is contusion (physical injuries not penetrating (closed) and the affected part of the body is the back (lower left side), then we have a male worker with 23 years of age, as an isolation assistant, with 3 years of work experience and seniority in his job, type of injury caused by the accident is injured and the part of the body affected is the head. Then we have a female worker with 32 years of age, is an operations engineer with 1 year of experience and seniority in his trade, the type of injury caused by the accident is sprain and twisting of the joints and the affected part of the body is the neck, right shoulder, right elbow and leg. Finally we have a worker of feme sex Child with 27 years of age, HSE practitioner, without work experience and without seniority in his occupation, the type of injury caused by the accident is sprain and twisting of the shoulder joints and the affected body part is the left arm.

**Behavioral statistics of accidents in the company under study.**

**Table 1. Number of accident in the years 2016-2017**

accident No.years	f	fr	F	Fr
2016 -I	1	8%	1	8%
2016 -II	1	8%	1	15%
2017 -I	5	38%	4	31%
2017-II	6	46%	7	54%
$\Sigma$	13			100%

year	No accident
2016 -I	1
2016 -II	1
2017 -I	5
2017-II	6

In this table you can see how, as the years go by, the accident rate increases. In 2016-I the accident rate was 8% and in 2016-II it remains at 8%. However, as of 2017-I it increases with 38% of accidents, in 2017-II it increases even more with 46% of accidents within the company. That is why workers are not taking into account the dangers and / or risks in which they are exposed and work in such a way that they expose their integrity to unforeseen events that can change their lives in a negative way.

**Table 2. Ages People Ragged**

Li	Is	Ni	f	fr	F	Fr
21	28	25	9	69%	9	69%
28	36	32	3	23%	12	92%
36	43	40	0	0%	12	92%
43	51	47	1	8%	13	100%
$\Sigma$			13			

range	4
min	21
Max	48
amplitude	7

It has most of the roughest staff during these years is 21 to 28 years with 69%, which have less experience in the workplace, followed with 23% staff from 28 to 36 years, without But workers who have age of 43 to 51 years who have extensive experience in their profession and / or in the workplace is 8%, which is the least eventful age. Why it implies that workers from 21 to 28 years need more training about the risks to which they are exposed in their work.

Table 4. Type of accident

type of accident	f	fr	F	Fr
Traditional work		92%	12	92%
Transit	0	0%	12	92%
Violence	0	0%	12	92%
Sports	1	8%	13	100%
Σ	13			

This table is expressed that accidents presented during these years (2016-2017) were own work and that 92% of injured workers were for the basic and immediate causes possessing activity I tasks performed the employee within Business. However 8% was sports type. The type of event that occurred was severe.

## CONCLUSION

Accident affectation in this study has mostly involved male gender workers, being the most common events of work and work activity. It remains to determine in depth whether the inappropriate use of personal protection elements has a direct impact with accidents. It continues to be indispensable to develop previous training activities in industrial safety, inspection of areas and equipment, signaling and prevention to reduce accidents in the industrial sector.

### Recommendations for prevention and protection of workers in order to reduce the accident.

Regarding the analysis of events that has been presented in the activities and / or tasks performed the employee in their daily work activities should take into account the following recommendations will aim reduce the accident:

#### Training:

The personnel in the first instance must receive training and training in the functions that must be fulfilled during their working day. Train workers about the risks to which they are exposed and emphasize the importance of maintaining order and cleanliness in the work areas, since according to the literature consulted many of these accidents occurred due to the lack of order and cleanliness in the workplace..

#### Inspections:

Periodically inspect workplaces, in addition to the machinery and tools used by workers to detect any risk that could undermine the integrity of the worker and the company.

#### Signaling:

Is also recommended establishing signage in the area where the work is being done, especially recommended mark and clear the work area being carried work at height and hot work;

to mitigate the risks of accidents where a second person involved.

#### Personal protection equipment:

Depending on the task or work activity, using protective equipment. In the case of this company, you should use:

Safety helmet.

Hearing protection if there is noise in the work area.

Safety glasses

Gloves against mechanical attack.

Industrial thermal boots.

Supply for assembly of multidirectional scaffolds:

Safety harness

Industrial boots

Industrial rescue equipment

## REFERENCES

- [1] Bevilacqua, M., & Ciarapica, F. E. (2018). Human factor risk management in the process industry: A case study. *Reliability Engineering and System Safety*, 169, 149-159. [10.1016/j.res.2017.08.013](https://doi.org/10.1016/j.res.2017.08.013).
- [2] Bevilacqua, M., Ciarapica, F. E., & Mazzuto, G. (2012). Analysis of injury events with fuzzy cognitive maps. *Journal of Loss Prevention in the Process Industries*, 25(4), 677-685.
- [3] Fabiano, B., Currò, F., & Pastorino, R. (2004). A study of the relationship between occupational injuries and firm size and type in the italian industry. *Safety Science*, 42(7), 587-600.
- [4] Ciarapica, F. E., & Giacchetta, G. (2009). Classification and prediction of occupational injury risk using soft computing techniques: An Italian study. *Safety Science*, 47(1), 36-49. [10.1016/j.ssci.2008.01.006](https://doi.org/10.1016/j.ssci.2008.01.006).
- [5] Tremblay, A., & Badri, A. (2018). Assessment of occupational health and safety performance evaluation tools: State of the art and challenges for small and medium-sized enterprises. *Safety Science*, 101, 260-267. [10.1016/j.ssci.2017.09.016](https://doi.org/10.1016/j.ssci.2017.09.016).
- [6] Baram, M. (2009). Globalization and workplace hazards in developing nations. *Safety Science*, 47(6), 756-766. [10.1016/j.ssci.2008.01.008](https://doi.org/10.1016/j.ssci.2008.01.008).
- [7] Goh, Y. M., & Guo, B. H. W. (2018). FPSWizard: A web-based CBR-RBR system for supporting the design of active fall protection systems. *Automation in Construction*, 85, 40-50. [10.1016/j.autcon.2017.09.020](https://doi.org/10.1016/j.autcon.2017.09.020).
- [8] Fernández-Muñiz, B., Montes-Peón, J. M., & Vázquez-Ordás, C. J. (2017). The role of safety leadership and

- working conditions in safety performance in process industries. *Journal of Loss Prevention in the Process Industries*, 50, 403-415. 10.1016/j.jlp.2017.11.001.
- [9] Bronkhorst, B. (2015). Behaving safely under pressure: The effects of job demands, resources, and safety climate on employee physical and psychosocial safety behavior. *Journal of Safety Research*, 55, 63-72. 10.1016/j.jsr.2015.09.002.
- [10] Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, 94(5), 1103-1127. 10.1037/a0016172.
- [11] Castro, I., & Ramos, D. G. (2017). Understanding the management of occupational health and safety risks through the consultation of workers. Paper presented at the Occupational Safety and Hygiene V - Proceedings of the International Symposium on Occupational Safety and Hygiene, SHO 2017, 17-22. 10.1201/9781315164809-5.
- [12] Wachter, J. K., & Yorio, P. L. (2014). A system of safety management practices and worker engagement for reducing and preventing accidents: An empirical and theoretical investigation. *Accident Analysis and Prevention*, 68, 117-130. 10.1016/j.aap.2013.07.029.
- [13] DeJoy, D. M. (2005). Behavior change versus culture change: Divergent approaches to managing workplace safety. *Safety Science*, 43(2), 105-129. 10.1016/j.ssci.2005.02.001.
- [14] Gillen, M., Baltz, D., Gassel, M., Kirsch, L., & Vaccaro, D. (2002). Perceived safety climate, job demands, and coworker support among union and nonunion injured construction workers. *Journal of Safety Research*, 33(1), [d] 33-51.
- [15] Guldenmund, F. W. (2010). (Mis) understanding safety culture and its relationship to safety management. *Risk Analysis*, 30(10), 1466-1480. 10.1111/j.1539-6924.2010.01452.x
- [16] Castillo-Rosa, J., Suárez-Cebador, M., Rubio-Romero, J. C., & Aguado, J. A. (2017). Personal factors and consequences of electrical occupational accidents in the primary, secondary and tertiary sectors. *Safety Science*, 91, 286-297. 10.1016/j.ssci.2016.08.021.
- [17] Campos, C., Santos Baptista, J., & Oliveira, M. J. (2015). Non-fatal accidents at work in the farming sector—a short review. Paper presented at the Occupational Safety and Hygiene III - Selected Extended and Revised Contributions from the International Symposium on Safety and Hygiene, 131-135.
- [18] Cheng, C., Leu, S., Lin, C., & Fan, C. (2010). Characteristic analysis of occupational accidents at small construction enterprises. *Safety Science*, 48(6), 698-707. 10.1016/j.ssci.2010.02.001.
- [19] Calvo Olivares, R. D., Rivera, S. S., & Núñez McLeod, J. E. (2014). Database for accidents and incidents in the biodiesel industry. *Journal of Loss Prevention in the Process Industries*, 29(1), 245-261. 10.1016/j.jlp.2014.03.010.
- [20] Ramaswamy, S. K., & Mosher, G. A. (2018). Using workers' compensation claims data to characterize occupational injuries in the biofuels industry. *Safety Science*, 103, 352-360. 10.1016/j.ssci.2017.12.014.
- [21] [21] Beery, L., Harris, J. R., Collins, J. W., Current, R. S., Amendola, A. A., Meyers, A. R., . . . Bertke, S. J. (2014). Occupational injuries in ohio wood product manufacturing: A descriptive analysis with emphasis on saw-related injuries and associated causes. *American Journal of Industrial Medicine*, 57(11), 1265-1275. 10.1002/ajim.22360.
- [22] Bedoya-Marrugo, E. A., Severiche-Sierra, C. A., Sierra-Calderon, D. D., Jaimes-Morales, J., Marrugo-Ligardo, Y. A., & Espinosa-Fuentes, E. A. (2017). Conditions of work and dermatitis in workers exposed to chemical risks by cement. *International Journal of Applied Engineering Research*, 12(22), 12119-12126.
- [23] Karakhan, A., & Gambatese, J. (2018). Hazards and risk in construction and the impact of incentives and rewards on safety outcomes. *Practice Periodical on Structural Design and Construction*, 23(2)10.1061/(ASCE)SC.1943-5576.0000359.
- [24] Sierra-Calderon, D. D., Severiche-Sierra, C. A., Bedoya-Marrugo, E. A., & Meza-Aleman, M. (2017). Occupational implications by exposure to industrial noise: A review. *International Journal of Applied Engineering Research*, 12(21), 11424-11431.
- [25] Ryu, J., Jung-Choi, K., Choi, K. -, Kwon, H. -, Kang, C., & Kim, H. (2017). Associations of shift work and its duration with work-related injury among electronics factory workers in south korea. *International Journal of Environmental Research and Public Health*, 14(11)10.3390/ijerph14111429.
- [26] Byler, C. G., & Robinson, W. C. (2018). Differences in patterns of mortality between foreign-born and native-born workers due to fatal occupational injury in the USA from 2003 to 2010. *Journal of Immigrant and Minority Health*, 20(1), 26-32. 10.1007/s10903-016-0503-2.
- [27] Bamfo-Agyei, E., & Atepor, L. (2018). Assessing the safety use of tower cranes on construction sites in central region of ghana10.1007/978-3-319-60525-8\_50.
- [28] Bedoya-Marrugo, E. (2015). Behavior of the accident rate in a metalworking company in Cartagena, Colombia. *Nova*, 13(24), 93-99.
- [29] Kim, J. N., Jeong, B. Y., & Park, M. H. (2017). Accident analysis of gas cylinder handling work based on occupational injuries data. *Human Factors and Ergonomics in Manufacturing*, 27(6), 280-288. 10.1002/hfm.20711.

- [30] Sanmiquel, L., Freijo, M., Edo, J., & Rossell, J. M. (2010). Analysis of work related accidents in the spanish mining sector from 1982-2006. *Journal of Safety Research*, 41(1), 1-7. 10.1016/j.jsr.2009.09.008.
- [31] Chiang, Y. -, Wong, F. K. -, & Liang, S. (2018). Fatal construction accidents in Hong Kong. *Journal of Construction Engineering and Management*, 144(3)10.1061/(ASCE)CO.1943-7862.0001433