Mitigation of Accidents through Occupational Risk Assessment at Workplace: A Case Study in Lanka Sugar Company Private Limited, Pelwatte

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ABSTRACT

One of the most important aspects of any kind of business is occupational health and safety management. A healthy workforce contributes more to the success of a production. The sugar industry is one of the major risk-oriented, agro-based industry in Sri Lanka, though less concern on mitigation practices to minimize the risks of workplace. For this purpose, a questionnaire was prepared and gathered relevant data from workers as quantitative data. Qualitative data were collected from observations through the factory visit. All the observation-based risks and hazards identified were tabulated and the seriousness of risk was calculated, using the risk matrix tool. Using a risk matrix, appropriate mitigation methods were suggested and evaluated. Finally, it was evaluated the progress of mitigation methods by comparing the risk values at identification step and suggestion step. The ultimate objective of this research is to identify the workplace hazards frequently occurred in the Factory Department of Lanka Sugar Company Private Limited, *Pelwatte* and apply the risk assessment tool to the workplace to suggest appropriate mitigation measures, based on the risk assessment tool. The result of quantitative analysis showed that 54% of workers have lower levels of satisfaction about occupational health and safety conditions in the factory while 60% of them were not satisfied with the available occupational health and safety facilities. The research result showed that working conditions existed in the sugar mills were not at satisfactory level regarding employees' occupational health and safety. Also in this research, it was clearly identified that workers were not very much keen on safety during their work. Although, 26.5% eye injuries were recorded, but still the welders without safety goggles commonly observed during the factory visit. Even though the company arranged safety awareness programs frequently in higher risk-oriented sections only 56% of the labours had sufficient awareness on occupational health and safety while others suggest the programs should be practical oriented. The study suggests that there should be practical awareness programs on occupational health and safety, sufficient supply of personal protective equipment (PPE) relevant to the job performance and it highly recommended that there must be continued inspections of job performance and usage of safety precautions, for higher employee performance.

KEYWORDS: Health and safety, Risk matrix tool, Risks and hazards

Introduction

In Lanka Sugar (Pvt) Ltd, about 3900 employees working under five departments; Agricultural Department, Finance Department, Human Resource Department, Factory Department, and Distillery Department. Human Resource Department consists of nine sections; among those Safety Unit has the responsibility to protect every employee and asset in the company (Annual report, Lanka Sugar company *Pelwatte*, 2017). A number of accidents were reported in the workplace every year. In year 2017, total 308 accidents were reported (Annual report, 2017). To minimize those workplace accidents, it is important to gain a sound knowledge of occupational health and safety management together with risk assessment. In human concern, one of the valuable aspects is Occupational Health and Safety. It targets the adaptation of safety working environment to workers, for the encouragement and maintenance of the mental, physical, and social wellbeing in all occupations of workers (Berk, 2012). Most of the operations in the company are risk-oriented due to the higher usage of machine and electric current.

The significance of this occupational health and safety is, to assist and to develop effective and efficient workforce in the organization, to assist and improve employee performances on their field, to assist the increment of profits of the organization. Another significance of this study is; to understand the mutual relationship between health and safety management and risk management strategies, and to which extent *Pelwatte* Sugar Company Private Limited needs to meet the standard of due diligence. Also, this study will create awareness on occupational hazards and risks, helps to determine who are the parties that may be at risk and their level of risks and finally, it will help to determine what are the control measurements needed or whether the existing control measures are convenient.

Literature Review

Every year, industries have to face failures due to occupational diseases and accidents. Poor workplace environment and the lack of awareness on health and safety precaution is the reason for these failures (Fatima and Shahid, 2017). About 2.8 billion of the current global workforce, spend nearly one-third of their effective lifetime at workplaces (Munir et al., 2012). As a fundamental human right, all the employees expect a safer working environment. Due to lack of awareness about simple preventive measures and practices, there can be seen poor working conditions, most commonly in developing countries (Awan, 2007).

Depending on the magnitude of the organization, it will decide to what extent the action is needed (Oludare,2016). It is essential to deal with two aspects in a safety program, accident prevention and minimizing the resulting damages and losses to workers and property. The establishment of a healthy and safe workplace and elimination of hazards to the maximum scope are the responsibilities of every employee in an organization (Harry, 2011).

A risk assessment matrix is a tool that is used in project management, which allows a quick review of the probable risk evaluation, in terms of probability and likelihood of the risk and the severity of all the consequences (Pike, 1996).

According to Raafat (1995), there are limitations in the risk matrix approach. In developing the risk evaluation using the matrix, it never provides an indication whether the risk is acceptable. Anyhow, the risk calculator also has limitations. Therefore, Woodraff (2005) identified the matters in risk estimation practices and suggested a methodology; in that, first identify the risk zone and then, to the risks in the tolerable zone apply a legal duty to reduce the identified risk (Woodruff, 2005). Targeted aim of OHS is to ensure the employee's safety and secure the employees' health and to identify, evaluate and prevent or minimize the health disorders within industrial environment. The purpose of OHS is to reduce or minimize the emerging risk factors in the working environment. Effects of non-ergonomic conditions, poor health, and reduction in safety measures reduced the mill capacity and caused a number of injuries (Munir et al., 2012).

Importance of Risk Assessment and Risk Mitigation Measures

Risk assessment is an important aspect of the decision-making process. It is important to know that all sources of uncertainty need growth in risk assessment (Hallenbeck, 1993).

Several risks are neither touch well nor use at all, by currently using quantitative risk assessments such as human errors occurred during accident conditions, digital software failures, safety culture and manufacturing errors (Thakur, 2015).

According to Papadopoulos, working time, work organization, years of employment, type of employment contracts and working conditions affect noteworthy changes in the working environment. These changes open path to the human biological rhythm disruptions, increment in workers' fatigue, job insecurity, occupational stresses which seriously impact on workers' health and it may result a rapid increase in occupational accident (Papadopoulos et al., 2010).Traditional safety analysis also deals with probabilities, but unlike in quantitative risk analysis, the probabilities never quantified in any manner (Apostolakis, 2003).

Risk identification techniques include questionnaires, brainstorming, business studies that describe both internal and external processes, industry benchmarking, risk assessment workshop, scenario analysis, auditing and inspection, incident investigation, hazard, and operability studies.

Risk analysis methods and techniques are consisting with upside risks; as a market survey, test marketing, prospecting, business impact analysis, research and development, and downside risks; threat analysis, fault tree analysis, failure mode and effect analysis (Jain et al., 2016).

Occupational health and safety preventive activities include occupational medicine, ergonomics, industrial hygiene, psychology as well as it covers all the scientific disciplines (Hasle & Limborg, 2006). Occupational health and safety research needs to focus in different angles: behavioural-based safety, legal prospectus, medical, socio-cultural, economic and cyber safety in terms of safety performance (Oludare, 2016). Occupational risk assessment methods can vary from simple to complex methods.

Output data of the above method can be quantitative when it is expressed as an index of risk levels, also they can be expressed in quantitative form such as recommendations. Commonly used industrial occupational risk assessment methods include, EA, FTA, HAZOP, FMEA, Deviation Analysis, Event tree analysis, cause consequence diagram, reaction matrix, technically oriented methods such as consequence analysis model, human-oriented methods such as human reliability assessment, THERP, human error identification, CREAM task analysis, such as operator action event tree, operational sequence diagram, decision action flow diagram, management-oriented methods such as MORT, ISRS, SHE, SCHAZOP, accident investigations such as AEB, STEP, change analysis, multi-linear events sequencing, coarse analysis, such as check-list, PHA (Nunes, 2011).

Identification of Types of Hazards in Sugar, Distillery, and Co-Generation Plant (HAZID)

Hazards in Sugar Mill, distillery and Co-generation plants occur due to; Fire in electrical panels, oil rooms and alcohol storage, Explosions in the boiler house, Electrocution, Cleaning of barrels, which held chemical substances, and Fall of material. The potential hazardous areas and the likelihood of the accidents with the concerned area have been listed below.

Table 1: Possible hazardous location onsite

No.	Hazardous Area	Likely Accident
1	Boiler Area	Explosion
2	Electrical room	Lose fitting
3	Electrocution	Fire and electrocution
4	Transformer Area	Fire and electrocution
5	Storage Yard (coal)	Sliding, fall of material

Source: Risk Assessment. Flood Ready Sugar Cane Farming (Chulen, 2013)

Because of destitute working environmental conditions, workers suffer diverse kind of health problems. Because of poor working conditions and ergonomic problems, it results in pain, stress and injury (Munir, Awan, Hensel, & Iqbal, 2012).

According to Ahasan *et.al* (2001), the research highlights the percentages of workers suffering from different kind of work stress disorders. In addition, it observed that 42% of workers suffered from lack of resources and facilities. As well as more than 60% of workers had no or little awareness about ergonomic problems and 65% of managers were able to carry out any kind of ergonomics assessment their production sectors. To find out the ergonomic issues they applied specified correlation ($p < 0.01$) and then finally they had pointed out that lack of knowledge on ergonomics, communication and needful resources were the primary facts that were contributing to create unsafe working environments and health problems in sugar mills.

Table 1: Identified disorders

Disorder	Percentage
Low back pain	85%
Fatigue	38%
Upper body pain	34%
Stress	34%
Dissatisfaction	50%
Hot environment	57%
Noisy environment	37%

Source: Safety Problems in the Sugar Industry (Ahasan et.al, 2001)

Purpose of Occupational Health and Safety

Targeted aim of OHS is to ensure the employee safety and secure the employees' health and to identify, evaluate and prevent or minimize the health disorders within industrial environment. The purpose of OHS is to reduce or minimize the emerging risk factors in the working environment. Effects of non-ergonomic conditions, poor health, and reduction in safety measures reduced the mill capacity and caused a number of injuries (Munir et al., 2012). Ergonomics is the science, which deals with designing instruments and tools used in different industries in a way that makes them perfect to the worker to improve the working efficiency and reduce the rate of injury (Munir et al., 2012). The OHS problems are definitely manageable problems and if they are not managing in proper manner they will become cost burden to working operations that can be easily reduced. According to Sabine (1998), 11 billion productive hours of labour were cost in American factories. Reports proved that 17000 deaths and it included from 60,000 to 93,000 disabilities. On behalf of that, the number of temporary disabilities was over 1,250,000 per day.

According to the National Safety Council, in 1998, a cost of six billion dollars for workplace accidents and almost 32 million dollars' amount was paid only to cover the eye injuries. In every year an average of 75 workers, lose their sight of both eyes, while 2000 other workers lose one eye because of workplace accidents (Sabine, 1998).

Methodology

Among the 570 workers in factory department, the sample was selected consisting 100 workers. According to the stratified sampling method, the department workers were randomly selected. The final sample consisted of 26 from mill and boiler section, 27 from process house, 5 from quality control, 25 from factory workshop, 13 from power generation and electrical maintenance, and 4 from factory lab.

Primary data were collected through field observations and discussions with workers. After identifying the hazards through past incident, questionnaire, and worksite

inspection survey, risks were assessed. In that case, the risk-rating matrix was used. Then using the risk calculator, seriousness of risk was calculated.

The Seriousness of Risk = Likelihood * Consequences

Then according to the risk level rating, it was decided that what are the required actions and what time do they need to apply. Then using the evaluation of control effectiveness table each risk was estimated individually and it also allowed to determine if any additional requirements were necessary to apply. As the next step, preventive measures were implemented. Always, this on-going process was monitored to measure the progress of the risk assessment procedure.

Results and Discussion

According to data, 50% of employees were permanent, 20% temporary, and balance 30% are contract workers. The company should always focus on workers' job satisfaction. If the employee turnover rises due to unsafe working environment it will harm the company's reputation. According to the employees' viewpoint, 49% accidents occurred within workplace, while 51% were ensured their safety at workplace. About 10% of accidents were hand injuries, 6% of accidents were leg injuries, 13% of accidents were eye injuries, 6% of accidents were head injuries, 5% have complained about back pains, 2% have complained about chest pains, 6% complained about electric shocks and 1% of employees were faced to skin burns.

The identified main reason for the higher number of accidents was the carelessness of workers. They did not follow safety precautions when handling machinery. When operating grinders, it is necessary to wear gloves, but most of them wilfully back out this. Also in the welding process, it is necessary to wear safety clothing, goggles, hand gloves, helmet and overall. Nevertheless, most of them did not use goggles; it was the main cause of eye injuries. The company deals with sugar production where the floors are always wetted with slides (oil), to prevent that it needs to wear boots in the factory section. However, most of them wear slippers, which are easily slipped when contracted with wet floor. This may cause leg injuries. Back pains and chest pains are common due to most of them avoid practicing ergonomic modifications, such as loading and unloading tasks. Skin burns happened due to handling chemicals without wearing safety coat, welders without wearing without safety cloth. Head injuries happened due to falling down of hard materials from upstairs, building constructing areas. Care should be immediately taken to prevent such kind of accidents.

16.5% of workers were exposed to both heat stress and noise. In the boiler section, 24 hours the steam is generated to supply power to rotate the turbines. Therefore, in this section workers always exposed to higher heat. On the other hand, in boiler section frequency of noise is very high due to usage of higher machinery. 5.5% of workers were having the risk of the stress due to vibration of machinery in boiler section. 6.1% of workers were having the risk of lighting, while engaging tasks such as welding. 4.9% workers were exposed to harmful chemicals at the laboratory section and in

operating section. 0.6% percentage of workers was having the risk of radiation effects in the laboratory section. 3.6% of workers had ventilation effects in their sections, 15.9% of workers complained about lack of ergonomics structures within working environment. About 3.6% of workers mentally dissatisfied with their job, causing occupational stress, during the work.

According to the employees' viewpoint, 15% experiencing very low and 13% experiencing low risks associated with their environment. Workers engaged with light works and office work belongs to this category. Majority of 59% of employees experiencing risks at moderate levels, such as welders, fitters. Machine operators, laboratory workers, boiler section workers, technicians, and electricians experienced about 6% of high and 7% of critical risks.

According to the one-way ANOVA in Table 3, the F value is 0.237 and significance value is 0.789 between education level and seriousness risk level. Therefore, it can be clearly observed that there was no statistically proven significant relationship between education level and seriousness of risk level.

Table 3: Effect of education level on seriousness risk level

One-Way ANOVA

	F Value	Sig.
Between Groups	.237	.789

The significance level is 0.05

Source: Author's own data, (2018)

According to the one-way ANOVA results in Table 4, the F value is 3.511 and significance value is 0.001 between designation and seriousness risk level. Therefore, it can be clearly observed that there was a statistically proven significant relationship between designation and seriousness of risk level.

Table 4: Effect of designation on seriousness risk level

One Way ANOVA

	F Value	Sig.
Between Group	3.511	.001

The significance level is .05

Source: Author's own data, (2018)

According to the post hoc test (Table 5), three homogenous designation groups were identified. First category, quality controllers, and clerks identified as low-risk level jobs. Second category labour, fitter, lab assistants, and welder identified as moderate risk level jobs. Third category technician, electrician, and Forman identified as higher risk level jobs.

Table 5: Post hoc test of designation on seriousness risk level

Designation	N	Subset for alpha = 0.05		
		1	2	3
Quality controller	2	1.00		
Clerk	4	1.25		
Tool keeper	6	4.50	4.50	
Machine operator	17	6.24	6.24	6.24
Labor	13		8.67	8.15
Fitter	6		8.80	8.67
Lab assistance	5		9.17	8.80
Welder	6			9.17
Technician	19			10.74
Electrician	12			10.92
Forman	30			11.10
Sig.				0.122

There were 3 Homogenous designation groups

Based on the results of the one-way ANOVA test in Table 6, the F value is 5.412 and significance value is 0.000 between section and seriousness risk level. Therefore, it can be clearly observed that there was a statistically significant relationship between section and seriousness of risk level.

Table 6: Effect of designation on seriousness risk level

One Way ANOVA

	F Value	Sig.
Between Groups	5.412	.000

The significance level is .05

Source: Author's own data, (2018)

The results of post hoc test in Table 7 show that there were two homogenous sections were identified. First category the quality control section identified as a low-risk level section while in second category process house, factory workshop, power generation, factory lab and mill and boiler and as higher risk level sections. According to the selected sample of workers, 56% of them were having sufficient knowledge/ awareness about occupational health and safety precautions.

About 35% of them were lacking in proper knowledge/ awareness, while 9% of employees did not have sufficient knowledge/ awareness. In most sections, especially where it reported higher frequency of accidents, safety awareness programs, workshop organized every year. Around 46% of employees were satisfied with the available awareness programs. Fifteen percent of them suggested that the programs should be modified/ developed, while 39% of employees' viewpoint was that, the available programs were not effective/ successful. Fifteen employees have not enough knowledge,

19 of them have not enough practical knowledge while seven of them complained that there were no awareness programs while three employees comment that the programs were not successful.

Table 7: Post hoc test of section on seriousness risk level

Section	N	Subset of alpha = 0.05	
		1	**2**
Quality control	04	1.00	
Process house	23		7.13
Factory workshop	22		7.14
Power generation	20		8.40
Factory lab	05		8.80
Mill and boiler	26		11.77
Sig.		1.00	0.53

Note:There were 2 Homogenous designation groups

Forty six percent of employees were satisfied with facilitated occupational health and safety within the factory, 51% of employees syncretized that they can be satisfied up to somewhat extended by the occupational health programs. Seventeen percent of employees were satisfied with the available occupational health and safety equipment while 23% of employees' opinion was available occupational health and safety is not 100% sufficient it should be further developed. On the viewpoint of remaining majority of 60% employees, the available occupational health and safety facilities were not at satisfactory level. As they were explained, they were ill equipped, especially in sections like boiler, quality control unit and factory lab. They had to wait for new boots, safety shoes, overall and gloves when they were damaged. Sometimes welders were not provided with quality goggles.

One-way ANOVA test in Table 8 show that the F value is 4.801 and significance value is 0.010 between satisfaction level and seriousness risk level. Therefore, it is clear that there is a statistically proven significant relationship between satisfaction level and seriousness of risk level.

Table 8: Effect of the satisfaction level on seriousness risk level

One Way ANOVA

	F Value	**Sig.**
Between Groups	4.801	.010

The significance level is 0.05

Source: Author's own data, (2018)

According to the one-way ANOVA in Table 9, the F value is 4.289 and significance value is 0.016 between satisfaction about sufficient facilities and seriousness risk level. Therefore, it can be clearly observed that there was a statistically proven

significant relationship between satisfaction about sufficient facilities and seriousness of risk level.

Table 9: Effect of the satisfaction about sufficient facilities on seriousness risk level

One Way ANOVA

	F Value	Sig.
Between Groups	4.289	.016

The significance level is 0.05

Sources: Author's own data, (2018)

Conclusions

In this study, it was recognized that 49% of the employees in the factory department had met with accidents during their working hours. The highest number of accidents were reported in the factory department were eye injuries. The main reason for this, that the welders were neglected to wear personal protective equipment during the operations.

According to the Monthly Reports (2018-January, February, March), number of major injuries was reduced and only reported minor injuries. The main causes for those types of accidents were employees' carelessness and the company was unable to provide sufficient amount of safety materials. In case of non-occupational diseases, considerable portion of employees were suffering from high blood pressure, cholesterol, diabetics like non-contagious diseases. The company needs to take some actions to increase the employees' fitness such as morning exercise programs. When it comes to the occupational health and safety problems, 26% dust-related problems, 16.5% heat stress and noise problem or vibrations the major impacts. As well as there were reported higher portion of ergonomics issues. When it considered the seriousness of the risks, 59% per cent of risks are categorized into a moderate level. Seriousness level of risk was always dependent on the designation, section, and employee satisfaction about sufficient facilities. Higher risk-oriented jobs that were identified are electricians, technicians, and formans. Higher risk-oriented sections that were identified are mill and boiler, factory lab and power generation. Most of workers were well aware of occupational health and safety measures, but they were not practically using those in their day-to-day life. Most of employees were satisfied with the overall health and safety within the factory, but they were not satisfied with the individual health and safety aspects in the factory. Ill-supplementation of personal protective equipment was highly dominated for the poor performance of employees. Employees' satisfaction level was depending on seriousness level, sufficient facilities, and sufficient awareness about occupational health and safety.

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