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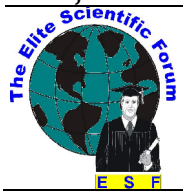

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Ergonomics and Occupational Health in Sugar Industry of Pakistan

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ABSTRACT
The present study was conducted in Sugar industry of Pakistan to analyze the ergonomics and occupational health status. Sugar industry is one of the major agro-based industries in Pakistan. There were frequent injuries and accidents in sugar industries but a little work had been done on ergonomics and occupational health of workers. For this purpose, questionnaires were prepared and surveys of different sugar industries were conducted to gather both qualitative and quantitative data. The modification in the existing design is also suggested in order to work at safe working level. The results showed that 15 to 20% workers were injured during the season in sugar industry of Pakistan. It is also observed that 40% of the total working staff was equipped with safety equipments. On an average, 85 to 112 dB noise levels were recorded in the sugar industry that affects human health very badly. It was found that about 50% of the workers were not equipped with safety measures. The results showed that working conditions existed in the sugar mills were not satisfactory regarding ergonomics and occupational health. The study suggests that there is need to recruit the skilled manpower to minimize the injuries in sugar industry of Pakistan.

INTRODUCTION

Sugar industry is one of the major agro-based industries which play a vital role in the development of our country. Sugar is produced in Pakistan predominantly from sugarcane which currently accounts for about 4.5% of the total cropped area and 11% of the total value added for overall crops. The industry contributes to GDP about four billion rupees and directly employs over 75,000 people including management experts, technologists, engineers, financial experts, lawyers and doctors in addition to skilled and semi skilled workers (Munir et al., 2003).

The workers on industrial as well as agricultural sectors suffer different kind of disorders due to poor working conditions. These figures vary from minor injuries to more severe and fatal injury. There is fundamental but un-quantified rate of pain, stress, and injury as a result of ergonomic problems due to poor working measures and conditions. In many industrial countries, accidents faced by workers due to hand tools and cutting instruments were most frequent (Melville, 1999).

In India, a study was conducted on ergonomics and occupational health and safety problems of workers in sugar mills in India. They reported that more than fifty industrial units' managers participated in this study. They also mentioned that about Forty-eight percent worker suffered from low back pain, 38% of fatigue, 34% of upper-body pain, 50% of stress and 45% of dissatisfaction. They also reported that fifty-seven percent of the managers recorded a hot environment, 37% a noisy environment, and 42% a lack of resources and conveniences for the workers. Similarly it was observed more than sixty percent workers had no knowledge or awareness about ergonomics issues and 65% of the managers did not carry out an ergonomic assessment of their production sectors. They applied a significant correlation ($p<0.01$) among ergonomics issues, safety measures and average injury rates. Finally they pointed out lack of skills in ergonomics, communication and resources were the major factors

contributing to the poor working conditions and subsequent increase in health and safety problems in sugar mills.

The purpose of occupational health and safety (OHS) is to secure the workers health and to identify, assess and prevent health disorder at the industrial level. Ergonomics is a science of designing of instruments used in the industries which are perfect to workers to improve the workers' efficiency and also reduced the injury rate at industry level. The purpose of occupational health and safety is to reduce the risk factors during working conditions in all type of industries. The important issues for many industrial countries were effects of poor health and lack of safety measures and non-ergonomics conditions existed in various industries which not only reduced the capacity of mill but also caused injuries (Ahasan, 2002).

The 1988, National Health Interview Survey reported that workers in production industries were mostly suffered to a variety of musculoskeletal injury hazards. An other analysis showed that the reported one year period prevalence rate of back pain among different individuals worker in production sectors or industries was about one and half times higher than the average for other US production sectors (Guo et al., 1999).

By keeping all the above facts in view, this study had been designed to assess the present status on ergonomics and occupation health in sugar industry.

MATERIALS AND METHODS

The proposed research work was conducted in different sugar mills of Pakistan. All the necessary information regarding machinery, equipment, working environment and health conditions of the workers at different sections were collected through questionnaire. The data were collected from different sugar mills like Shah Taj Sugar Mills Limited Mandi Bhaudin, Alhudah Sugar Mills Limited Sangla Hill Sugar Mills, Crescent Sugar Mills Limited Faisalabad, Hussain Sugar Mills Limited Jhranwala, Haseeb Waqas Sugar Mills Limited Nankana Sahib and Hunza Sugar Mills Limited Jhumra etc.

Data Acquisition

The data were collected in Cane handling units, Mills house, Process house, Boiler house, Power house and Workshop. The data covered all the sections of sugar mills with the detail of each machine/equipment under the existing condition of the plant. The detailed information and data were collected about critical shortfalls in the existing design of machinery and suggestion to overcome the shortfall at each section of sugar mill, Noise level at different sections of sugar mills, number of injuries of workers at each section, percentage of workers provided safety equipments at each section and total number of worker, skilled workers, semi skilled workers and un-skilled workers at each section of mill. Sugar industry is basically seasonal in nature and operates only for 120 to 150 days in a year (normally mid November to mid April).

Assessment of working environment

In order to assess the safe working environment, pH meter, Carbon Monoxide detector, Noise meter, Oxygen (O_2) detector and Hardness Test Kit were purchased and used. To assess the quality of water, a pH meter was used. This pH meter is a handheld device which test water for its level of acidity. If water is equally acidic and alkaline, it registers as neutral on a pH meter. The pH meter utilizes a standard pH scale for measuring these aspects of quality. Carbon monoxide (CO) detector was used to detect the presence of carbon monoxide gas (CO), so that protection equipments can be provided to the workers. A sound meter was used to measure noise and sound levels in a specified manner. The meter includes a microphone, amplifier, an output meter and frequency weighting networks. Noise is defined as unwanted sound and the impact of noise may cause permanent hearing loss due to the exposure to noise levels exceeding 90 dB (where dB is the noise measurement unit). In industries, the exposure of high noise level is the key cause of human mistakes leading to increase accident rate. Digital sound meter was used to measures the noise levels at industries level. Oxygen (O_2) detector is an electronic device that measures the proportion of oxygen (O_2) gas by volume in air. It was used in sugar industry to measure the proportion of oxygen (O_2) at different sections of industry. In sugar industries; workers suffer different respiratory and asthma problems due to deficiency of oxygen in the air. Hard water has high concentrations of Ca^{+2} and Mg^{+2} ions. Hard water is generally not harmful to one's health but can pose serious problems in industrial settings, where water hardness is monitored to avoid costly breakdowns in boilers, cooling towers, and other equipment otherwise it leads toward injuries of the workers and major break down in machinery.

Data Analysis

The data of noise level at different sections of sugar industries were collected and analyzed as suggested by Montgomery (2009) using PROC GLM (General linear Model) procedure of SAS Institute. The least significant difference LSD ($\alpha = 0.05$) approach was used to compare the mean values of results for comparison of different treatments.

RESULTS AND DISCUSSION

The proposed research work was conducted during the cane crushing season 2010-11 in different sugar mills of Pakistan. All the necessary information regarding machinery, equipment, working environment and health

condition of the workers at different sections were collected through questionnaires. The results obtained during the study are discussed as under:

Injuries of Workers in Sugar Industries of Pakistan

Keeping in view the importance of the workers as the real backbone of industry, it was planned to conduct face to face interviews of injured victims to record their injuries faced during working in sugar industries. Table 1 shows the detail of injured victims at different sections of sugar mills and causes of injuries during cane crushing season 2010-11.

Musculoskeletal disorders (MSDs) symptoms in workers in Sugar Mills

Musculoskeletal disorders (MSDs) are a leading cause of occupational injury and disability in the developed and industrially developing countries. The economic loss due to these disorders affects not only the individual but also the organization and the society as a whole. Poor working conditions and the absence of an effective work injury prevention program in industrially developing countries has resulted in a very high rate of MSDs. Risk factors of WMSDs include workplace activities such as heavy load lifting, repetitive tasks, and awkward working postures. In sugar-producing factories, workers are directly involved in the production process. In these mills, physical activities such as manual material handling (e.g., heavy load lifting, lowering, carrying, pulling, and pushing) and awkward working postures were very common. In this situation, a high rate of WMSD is expected (Vanwonterghem, 1996). During survey of sugar industries of Pakistan it was conducted that 437 workers were suffering from musculoskeletal disorders symptoms in different body regions. Figure 1 shows the musculoskeletal disorder symptoms in different body regions of the workers during the working hours. The workers' knees, lower back, shoulders, and upper back were most commonly affected.

Effect of noise level

The statistically analyzed results of noise level at two distance (5m, 10m), five sections of six Sugar Mills are shown in Table 2. The effects of sections, Sugar Mills and their interaction on noise level were found highly significant ($P<0.05$), which mean that all treatments are significant. The significant interaction indicates that the main effects as such do not have much meaning.

Table 3 shows that statistically greatest values of noise level were recorded in sugar mill number 5, 4 and 1 at section 1, in mill 5, 6 and 4 at section 2, in 6, 5 and 4 at section 3, in mill 6 and 5 at section 4 and in mill 6 at section 5. On the other hand significantly lowest values of noise level were found in mill 3 at section 1, in mill 1 at section 2, in mill 1 at section 3, in mill 4, 3, 2 and 1 at section 4 and mill 2 and 1 at section 5. Sugar mill 1 had significantly greatest noise level at section 2 and lowest at section 3. Sugar industry 3 had significantly greatest noise level at section 2 and lowest at section 3. Sugar mill 4 had significantly highest value of noise at section 2 and lowest value at section 3. Sugar mill 5 had significantly highest value of noise at section 2 and lowest value at section 3. Sugar mill 6 had significantly highest value of noise at section 2 and lowest value at section 3. In all sugar mills, section 2 had significantly highest valves of noise and section 3 lowest valves. The reasons of highest noise at boiler house were due to

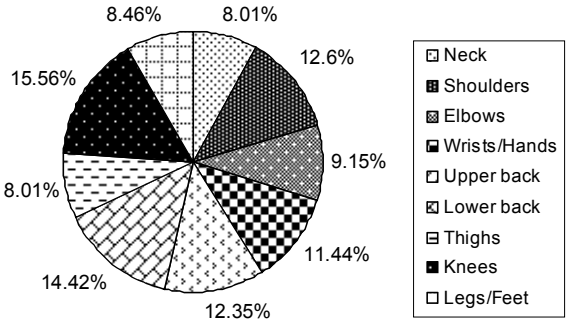

Fig. 1: Percentage (%) of Musculoskeletal Disorder symptoms in different body parts of workers

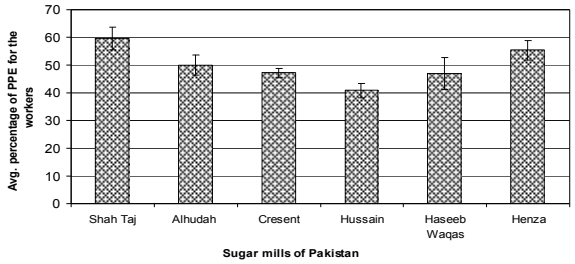

Fig. 2: Average percentage of personal protective equipments provided to the workers in different sugar mills of Pakistan (Error bars indicate standard error)

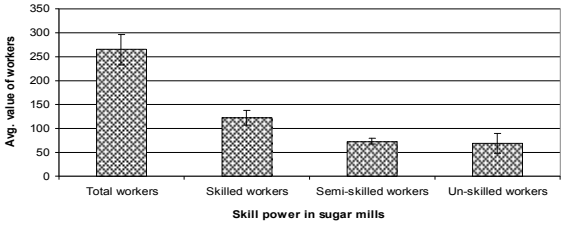

Fig. 3: Determination of skill power of the workers in sugar mills of Pakistan (Error bars indicate standard error)

Table 1: Details of injured victims at different sections of sugar mills and causes of injuries during cane crushing season of 2010-11

Sugar Mill Sections	No. of victims	Age limit (years)	Injuries on Body part	Machine parts Causing injury	Causes of injuries of workers
Cane Handling Unit	11 8 8 3 2	16-25 26-35 36-45 46-55 >55	Right hand elbow, left and right hand fingers and face injured etc.	Belt and Pulley, broken Guide Pulley, leakage of lubricant from Turbine	Safety equipments not provided to worker
Mill House	13 8 9 6 4	16-25 26-35 36-45 46-55 >55	Right hand elbow, Left and Right hand fingers, Right hand arm etc.	Cane Cutter, Cane Leveler, Auxiliary Cane carrier, Motor Belt and Pulley	Safety equipments not provided to worker, no proper awareness and education provided about machinery operation
Boiler House	19 11 9 8 3	16-25 26-35 36-45 46-55 >55	Left and Right hand, Legs injured face problem etc.	Chain broken, Boiler tubes leakage, breakage Belt and Pulley, Foundation Bolts broken	Safety equipments not provided to worker, lack of preventive maintenance of the equipments at boilers
Process House	8 4 3 2 1	16-25 26-35 36-45 46-55 >55	Left and Right hand, Legs and Face injured etc.	Vacuum Filter, Centrifugal Machine and tubes leakages etc.	Safety equipments not provided to worker, excessive vibration and noise of the equipments at process house
Power House	4 2 1 1 0	16-25 26-35 36-45 46-55 >55	Human body injured etc.	Turbines Plates damage, Electric shock etc.	Safety equipments not provided to worker, lack of knowledge about precautions at power house
Workshop	20 8 5 4 1	16-25 26-35 36-45 46-55 >55	Left and Right hand injured, Legs and Face injured etc.	Lathe, Drill, Milling and Grinding Machines etc.	Safety equipments not provided to worker, no proper training and education etc.

Table 2: Analysis of Variance Table for effect of Noise level

Source	DF	MS	F-Value	Prob
Block	1	387.20		
SM	5	37.89	45.49**	0.0024
B*SM	5	1.843	2.21**	0.0024
Sections	4	1908.46	2291.15**	0.0001
SM*Sections	20	3.92	4.71**	0.0002
Error	24	0.833		

** = Highly significant (P<0.05) where, SM= Sugar Mills

more friction between moving parts of Induced Draft (ID) and Forced Draft (FD) fans, excessive vibration of machines parts, low lubrication and maintenance of the machines. Sugar mill 6 and 5 were producing more noise than other sugar mills. In these sugar mills, the reasons of high noise expose were the old technology to extract cane juice, most of the machines had completed their life span, low lubrication of machines and no preventive maintenance of machines.

Determination of Water Parameters in Sugar Mills

Drinking water quality is the major priority for health. For this purpose, hardness test kit and pH meter were used to analyze the water quality at the site. The analysis has shown that some of the mills have pH out of the permissible range which ultimately affects the health of the workers adversely. Hardness of drinking water of most of the mills was giving the alarming figures. High hardness levels of water were causing the kidney and other stomach problems. The weak health of the workers was the clear indication of bad water quality for drinking purposes. Nevertheless, the water quality test for disinfection was not carried out during the research. The values of water hardness and pH of different sugar industries are given in Table 4.

Determination of Safety Equipments for workers

It was observed that most of the workers in different sugar mills in Pakistan were not equipped with safety measures due to which many workers got injured. It was observed from Figure 2 that the average percentage of personal protective equipment (PPE) provided to the

Table 3: Effect of Sugar Mills, Sections and there interaction on Noise level (dB)

Sections	Sugar Mills						Mean	LSD (0.05)
	SM_1	SM_2	SM_3	SM_4	SM_5	SM_6		
$Section_1$	93.75^{a}_{c}	93.33^{ab}_{c}	92.00^{b}_{c}	93.75^{a}_{c}	94.67^{a}_{c}	94.00^{a}_{cd}	93.58^{c}	1.53
$Section_2$	106.58^{e}_{a}	107.33^{d}_{a}	108.00^{c}_{a}	108.25^{c}_{a}	110.58^{a}_{a}	109.00^{b}_{a}	108.29^{a}	0.52
$Section_3$	87.58^{c}_{d}	91.08^{ab}_{d}	90.50^{b}_{d}	90.50^{b}_{d}	92.50^{a}_{d}	92.50^{a}_{d}	90.78^{d}	1.66
$Section_4$	100.75^{b}_{b}	100.33^{b}_{b}	100.92^{b}_{b}	101.25^{b}_{b}	103.08^{a}_{b}	104.08^{a}_{b}	101.74^{b}	1.53
$Section_5$	92.67^{b}_{c}	92.75^{b}_{c}	92.83^{ab}	93.08^{ab}_{c}	94.33^{ab}_{c}	94.50^{a}_{c}	93.36^{c}	1.69
Mean	96.266^{c}	96.964^{bc}	96.850^{bc}	97.366^{b}	99.032^{b}	98.816^{a}		
LSD(0.05)	1.67	1.19	0.97	1.57	1.68	1.54	97.550	-

where, SM_1 = Shah Taj Sugar Mill, SM_2 = Ahudah Sugar Mill, SM_3 = Crescent Sugar Mill; SM_4 = Hussain Sugar Mill, SM_5 = Haseeb Waqas Sugar Mill, SM_6 = Hunza Sugar Mill and $Section_1$ = Mill House, $Section_2$ = Boiler House, $Section_3$ = Process House; $Section_4$ = Power House, $Section_5$ = Workshop; Super scripts show horizontal comparison; Sub scripts show vertical comparison; Same alphabetical superscripts and subscripts show no significant difference at $\alpha = 5\%$

Table 4: Drinking water parameters of different sugar mills in in Pakistan

Parameter	Sugar Industry					
	Shah Taj	Alhudah	Crescent	Hussain	Haseeb Waqas	Hunza
pH value	7.2	7.95	7.79	8.3	9.2	8.9
$CaCo_3$ (ppm)	132	159	153	159	162	156

workers at different sections was varied from 40.8 to 59.6 in Hussain sugar mill to Shah Taj sugar mill. Statistical analysis was carried out and the values of standard errors varied from 1.714 to 5.744 respectively. These values were found in low range showing that less than 50% workers were equipped with safety measures at different sections of sugar mills. It was observed that no attention was being paid on this very important issue in most sugar mills in Pakistan. Number of injuries of workers can be reduced by providing appropriate safety equipments to the workers.

Determination of skilled manpower of the workers in Sugar Mills

It has been seen in sugar mills that most of the workers were untrained at the time of joining the mills, so they got injuries during working hours. It was responsibility for the sugar mills managers to provide a training and education program to the workers. During visiting of sugar mills, the data were collected about skilled, semi-skilled and un-skilled workers. It was observed from Figure 3 that at an average, 265 workers worked in each sugar mill of Pakistan in which 123 workers were fully trained, 73 workers were semi-skilled and 69 workers had no training and education about their profession. Statistical analysis was carried out and the values of standard errors were found 31.52 for total workers, 15.75 for skilled workers, 6.31 for semi-skilled and 19.92 for un-skilled workers. Finally it had been observed that most of the workers at different sections of the sugar mills were semi-skilled and unskilled. Unskilled manpower not only adversely affected the capacity of the sugar mills but also caused the injury to the workers. A proper training and education program for workers in each year before starting of cane crushing season can increase the capacity of mill and more skill power in industry.

The data were covered all the sections of sugar mills with the detail of each machine/equipment under the existing condition of the plant. It was found that the number of victims in sugar industry of Pakistan were on higher side. Most of the victims were from lowest age group (16-25). This was due to the reason that the labor class of this group was not trained and educated properly. It was also found that the boiler section was the main dominant section with reference to maximum injuries. Infact, boiler is the most sensitive station in a sugar mills which need constant monitoring of skilled manpower. Deputation of untrained and skilled manpower was the problem of serious injuries at boiler section.

The reasons of high musculoskeletal disorders symptoms in different body regions of workers were poor working conditions and the absence of an effective work injury prevention program, heavy load lifting, lowering, carrying, pulling, and pushing in sugar mills. These musculoskeletal disorders symptoms in different body regions of workers can be minimized by providing effective work injury prevention program and rails system for the carrying the heavy loads.

It was found that mills house and boiler house were producing the high noise levels. On fact most of the machines in these sections were old and running without proper preventive maintenance measures. Moreover, improper lubrication, excessive vibration and friction of the moving parts were the reasons of high noise levels. In boiler house, leakage of steam from different places was one of the reason of noise pollution at boilers.

Poor quality of drinking water and dusty environmental in sugar industry had affected the health of the workers adversely. It was also found that about half of the workers in sugar industy of Pakistan were not equipped with safety measures which were the major cause of injury at different sections of the sugar industry. Finally results have shown that the injuries in Sugar Industry of Pakistan can be reduced by organizing proper training program at the industry. The prevention of work related injuries, illnesses, and fatalities were important to an organization and had been taken into consideration in the design of a management system.

Conclusions

The injuries of workers in sugar mills resulted due to lack of safety measures, no proper training and education program. Most of the machines were not provided with the safety covers to the rotating machine parts which was one of the cause of injuries. Excessive noise and vibration of machines parts, poor ventilation and lighting during working hours had adverse effects on workers health. Tests have shown that the quality of drinking water was not of good quality. Leakage of different lubricant on the workplace of the workers causes the frequent slippery problems. In most of the mills, there was no first aid facility. No preventive maintenance staff was deputed at the sensitive sections of sugar mills. In sugar mills of Pakistan, workers injuries can be reduced by adopting the basic safety measures and modifications in the existing design according the ergonomics and occupational health standards.

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REFERENCES

Ahasan M, 2002. Occupational Health, Safety and Ergonomic issues in small and medium-sized enterprises in developing countries, ISBN 951-42-6812-1 (URL: http://herkules.oulu.fi/isbn9514268121).

Guo H, S Tanaka, W Halperin and L Cameron, 1999. Back prevalence in US industry and estimates of lost workdays. American Journal of Public Health, 89: 1029-1035.

Melville H, 1999. Environmental science and pollution research, Journal of Earth and Environmental Science, 6(3): 175-182.

Montgomery DC, 2009. Design and analysis of experiments. Arizona state university, USA. ISBN: 978-0-470-12866-4.

Vanwonterghem K, 1996. Work-related musculoskeletal problems among workers in Iranian Sugar Production Industry: some ergonomics considerations. Journal of Human Ergology, 25(1): 5-13.

Munir A, AR Tahir and MS Sabir, 2003. Optimization of milling performance of sugar plant by using linear programming technique. Pakistan Journal Agricultural Science, 40(1-2): 87-92.