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Assessment of Noise, Temperature, Light Intensity And Their Impacts on Workers In Footwear And Leather Products Industries of Bangladesh

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Abstract: *Noise, temperature and light intensity are invisible indoor environmental trepidations that affect the quality of life and productivity of the industries. The study was carried out in twenty footwear and leather products industries to reveal the current indoor environmental scenarios in Bangladesh. The noise level, temperature and light intensity were measured by digital sound level meter, temperature meter and digital lux meter respectively. An experiment was done over 280 workers to identify the disturbing level and types of annoyance due to noise, temperature and light intensity. The results revealed that the level of noise in the all sample factories exceeds the rational limit (75 dB) and it was found that the average noise level in the workplaces ranged between 78.55 dB and 102.77 dB. The result also proclaimed that the maximum temperature was found 36.4 ^{0}C at lasting department and minimum 31.5 ^{0}C at cutting department. The average light intensity was observed between 234.5 lux and 445 lux. In general, 86.43% and 38.93% of workers were annoyed from the noise and temperature in their workplaces while 23.21% of workers have complained about headache as a type of annoyance.*

Keyword: *Noise, Temperature, Light, Industry, Annoyance*

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I. Introduction

The indoor environmental factors in the footwear and leather products industries are noise, temperature and light intensity. Noise is an unwanted disturbing sound which can hinder the regular activities of human such as communication, conversation, sleeping and productivity. Noise is generally defined as the unpleasant sound which disturbs the human being physically and psychologically and pollutes the environment by destroying its ecosystem properties [1]. Noise is generated from various sources in the production floor such as cutting, sewing, roughing & scouring, lasting, and generator area of the footwear and leather product industries. Lighting is an imperative requirement both practical and aesthetic purposes which produces the visual sensation upon human eyes. Proper and adequate lighting in the industry improves the visibility of an object, enhance the work performance, job satisfaction and reduces loss and compensation payment due to accidents in the industry [2, 3]. In industry, Poor light level and work place can cause of eye strain, fatigue, stress, headaches and accidents. On the other hand, under too much light, "glare" can also cause health and safety problems. Both can lead to mistake at work, poor quality and low productivity [4]. Temperature is an important inside environmental factor which extensively influences the manufacturing output through its impact on workers and productivity. High temperatures may reduce manufacturing output by lowering worker productivity through heat stress [5]. At present most of the machineries and manufacturing processes in the footwear and leather products industries generate huge noise and temperature during the processing and fabrication of products. These pollutions such as extensive noise, light and temperature not only create adverse effects on workers' health but also deteriorate products quality and productivity. The psychological effects of noise are more common compared to the physical ones and they can be seen in the forms of annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception [6-8].

Footwear and leather products are subsectors of leather getting priority from the government as for their high value addition. The world renowned shoe and goods brands like Timberland, Hush Puppies, Hugo Boss, Bass, Picard and Armani etc. are sourcing their products from Bangladesh due to the best product quality with low production cost. The direct employment of these footwear and leather products industries is approximately 1,80,000 workers where 70% of the people are women. Most of the workers are leading to temporary and permanent hearing losses due to expose of high noise at the work places. Proper analysis is of utmost important to assess the indoor environmental pollution level of noise, temperature and light in the

footwear and leather products industries. Therefore, effective information is essential for the industry's to take proper action in preventing pollution by maintaining exact quality of products and good health of workers. In this research, the current indoor environmental (physical) factors such as noise, temperature and light intensity have been measured and determined the effects of these factors on workers.

II. Materials And Methods

The analysis and evaluation of noise level, temperature range and light intensity were measured in twenty (20) footwear and leather products industries during July to September 2017, in Bangladesh. The geographical location of these industries (A, B, C… S, T) is presented in figure 1.

Figure 1: Geographical locations of the study area

2.1 Instruments

Digital sound level meter (Model SM 100) was used to measure noise level with measuring range 30dB to 130dB, accuracy ± 1.5 dB. Digital lux meter (Model Lx1010BS) is a device that determined the amount of light level with the range of 0 to 100000 lux at operating temperature 0℃ to 40℃. Temperature meter with measuring range of -20℃ to 50℃ was deployed for assessing and recording temperature.

2.2 Measurement of Noise

Noise level was measured in decibel, by holding the digital sound level meter at the height of 2 meter from various production floor such as cutting, sewing, soling, lasting, roughing, finishing and generator area respectively. Measurement was taken seven times at each section at different intervals of time from 9.00 am to 5.00 pm.

2.3 Measurement of Light

The light intensity of production floor in the footwear and leather products industries was determined in lux unit by holding the light meter at the height of 2 meter from production floor in individual experimental departments. The measurement was carried out seven times at each section at different intervals of time from 9.00 am to 5.00 pm.

2.4 Measurement of Temperature

The temperature range of the industries at different departments was measured in Degree Celsius maintaining the same procedures mentioned above at different intervals of time from 9.00 am to 5.00 pm.

2.5 Data Analysis

The measured data of noise, temperature and light was processed and analyzed with computer program Microsoft excels. The minimum value of an individual department was calculated by finding with the average value from all of observed minimum data. The maximum value of each department was also calculated following the same procedure mentioned above. The average value of an individual department was determined considering the minimum and maximum value.

A questionnaire was prepared to collect data regarding noise, temperature, and light related annoyances and type of annoyances. The number of workers from different departments participated in the interview were 280 and the resultant data was then analyzed and evaluated.

III. Results And Discussion

1.1. Noise Level

The industrial activities generate noise but it may differ from one department to another. The noise levels were measured in twenty footwear and leather products industries at different intervals of time in a day at different sections that are depicted intable1. Among the seven departments of the industries, the lowest average noise was found in the cutting department (78.55 dB) and the highest average noise level was found in the generator area and that was 102.77dB.

Table1: Noise level at different departments

Departments	Min (dB)	Max (dB)	Average (dB)
Cutting	74.13	82.98	78.55
Sewing	80.78	88.16	84.47
Soling	83.67	91.03	87.35
Lasting	84.45	91.52	87.98
Roughing	80.82	85.52	83.17
Finishing	76.43	81.86	79.14
Generator Area	100.08	105.47	102.77

The noise is produced from different sources within and across the footwear and leather products industries. The study found that the dominant sources of noise inside the industries were generators, compressors, hammering, roughing, sewing, skiving, toe lasting, seat and side lasting since many of the machineries used by the industries generated noise exceeding acceptable limits (75 dB) set by the Bangladesh's Department of Environment (DOE). Figure 2 shows the minimum and maximum values of individual departments and standard limits of noise level for industrial area. The standard limit of noise for industrial area is 75 dB at day time and 70 dB at night time. From the figure 2, it is clear that among the seven departments of the selected factories, the maximum noise (105.47 dB) generated in the generator area and minimum noise level (74.13 dB) was found in the cutting department. The noise pollution level at sewing and soling departments were compiled and it was found the maximum values 88.16 dB in sewing and 91.03 dB in soling department whereas the minimum values for these two departments were 80.78 dB and 83.67 dB respectively. Likewise, the noise pollution in both lasting and roughing departments were determined 84.45 dB, 80.82 dB as minimum and 91.52 dB, 85.52 dB as maximum values. On the contrary, the minimum and maximum noise pollution in the finishing department were noticed as 76.43 dB and 81.86 dB.

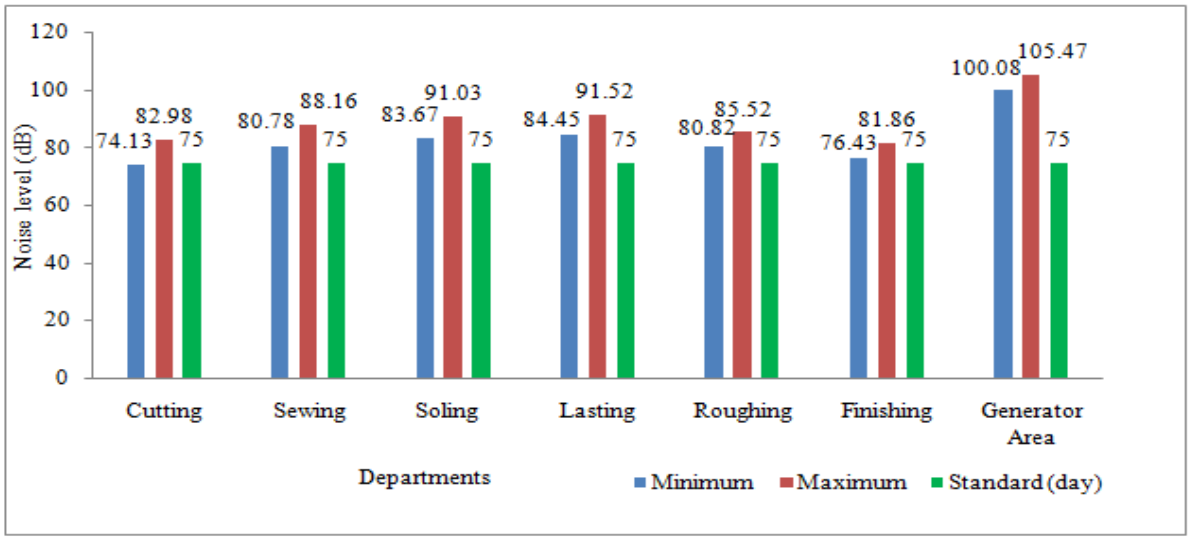

Figure 2: Noise level of different sections of footwear and leather products industries

1.2. Temperature

Temperature is a very critical pollution for the industry because higher temperature is hazard and hampers the regular activities and productivity. The recorded temperature ranges of the sample footwear and leather products industries are presented in the table 2. The lowest average temperature was found in finishing department (32.8 ^{0}C) and the highest average temperature was in the lasting section (34.9^{0}C).

Table 2: Temperature range at different departments

Departments	Min (^{0}C)	Max (^{0}C)	Average (^{0}C)
Cutting	31.5	34.7	33.1
Sewing	31.8	34.6	33.2
Soling	32.4	36.1	34.25
Lasting	33.4	36.4	34.9
Roughing	32.3	35.8	34.05
Finishing	31.9	33.7	32.8
Generator Area	32.5	34.8	33.65

The possible temperature sources in the industries were noticed and that were generated from heat setting, heat reactivation, lasting and few manufacturing machineries. The figure 3 indicates the minimum and maximum values of temperature for seven individual departments in the sample industries.

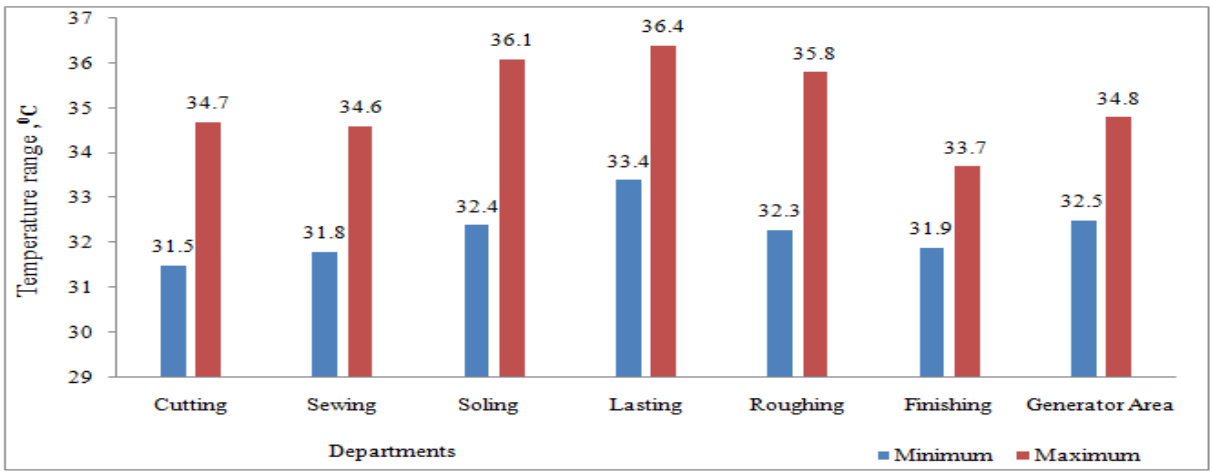

Figure 3: Temperature range of different sections of footwear and leather products industries

The minimum and maximum temperatures evolved in the cutting section were 31.5 ^{0}C and 34.7 ^{0}C successively while these values were 33.4 ^{0}C and 36.4 ^{0}C in the lasting department where lasted upper and bottom part attached together. Similarly, sewing, soling, roughing, finishing and generator departments discharges the minimum temperature of 31.8 ^{0}C, 32.4 ^{0}C, 32.3 ^{0}C, 31.9 ^{0}C and 32.5 ^{0}C and maximum of 34.6 ^{0}C, 36.1 ^{0}C, 35.8 ^{0}C, 33.7 ^{0}C and 34.8 ^{0}C respectively. Temperature range is a bit more in lasting department compared to the other departments of footwear and leather products industry.

1.3. Light Intensity

Proper lighting is essential for the production floor to perform visual work efficiently and enhance the productivity by maintaining product quality. The light intensity of production floor at different departments in footwear and leather products industry is described in the table 3. It is observed that among the seven departments of the industries, the lowest and highest average light intensity were recorded in cutting department and generator area; and the value were found to be 234.5 lux and 445 lux respectively. According to Bangladesh National Code 2011, standard light intensity for shoe manufacturing (Leather) industry is 450 lux for sewing, soling, roughing and generator area;

Table 3: Light intensity at different departments

Departments	Min (Lux)	Max (Lux)	Average (Lux)
Cutting	275	615	445

Sewing	217	408	312.5
Soling	213	360	286.5
Lasting	227	495	361
Roughing	248	405	326.5
Finishing	225	480	352.5
Generator Area	179	290	234.5

600 lux for lasting and finishing section [09]. The figure 4 exhibits the minimum and maximum values of individual departments and standard limit of light intensity for shoe manufacturing (Leather) industry. The minimum light intensity of individual departments such as cutting, sewing, soling, roughening, finishing and generator area were found 275,217, 213, 227, 248, 225 and 179 lux respectively. The maximum light intensity was recorded 615 lux in cutting department, 408 lux in sewing, 360 lux in soling, 495 lux in lasting, 405 lux in roughing, 480 lux in finishing and 290 lux in generator area. Hence the highest and lowest light intensities are found in the cutting section and in the generator room successively.

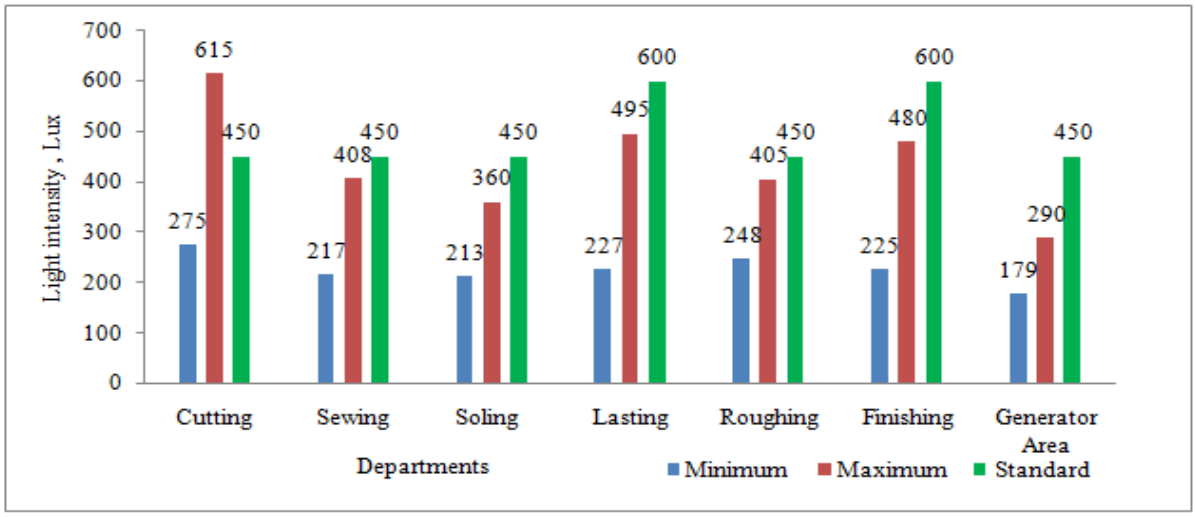

Figure 4: Light intensity of different sections in footwear and leather products industries

3.4 Annoyances from Noise and Temperature

Noise and temperature are the major pollutants for the footwear and leather products industries that can interfere workers efficiency and productivity and eventually deteriorate health of the worker both physically and psychologically. The levels of disturbances from industrial noise are given in table 4. In general, about 86.43% workers (among 280 participants) have complaint about high level of noise in the production floor. When all the departments are considered individually; a relationship can be established between the annoyance and exposure to noise in the workplaces. It has been observed that all 20 participants complained against the over sound of generator area and this was quoted 102.77 dB. The minimum sound (78.55 dB) was found in cutting department and the complaints were also comparatively less than that of other departments.

Table 4: Annoyance from noise at different departments in the industries

Departments	Annoyance from noise						
	Participants	Yes	%	No	%	No Opinion	%
Cutting	60	47	78.33	3	5.00	10	16.66
Sewing	60	52	86.66	2	3.33	6	10
Soling	40	38	95.00	2	5.00	0	00
Lasting	40	37	92.5	0	00	3	7.50
Roughing	30	29	96.66	1	3.33	0	00
Finishing	30	19	63.33	7	23.33	4	13.33
Generator Area	20	20	100	0	00	0	00
Total	280	242	86.43	15	5.36	23	8.21

The level of annoyance due to the temperature is shown in table 5 and it is found that 38.93% of workers had complaints about high level of temperature in the production floor. The highest level of complaint came from generator room (75.93%) and about 70% workers' complaints from the roughing department (as shown in table 5).

Table 5: Annoyance from Temperature at different departments in the industries

Departments	Annoyance from Temperature						
	Participants	Yes	%	No	%	No Opinion	%
Cutting	60	09	15.00	33	55.00	18	30.00
Sewing	60	13	21.66	38	63.33	9	15
Soling	40	25	62.50	10	25.00	5	12.5
Lasting	40	24	60.00	8	20.00	8	20.00
Roughing	30	21	70.00	4	13.33	5	16.66
Finishing	30	2	6.66	22	73.33	6	20.00
Generator Area	20	15	75.00	3	15.00	2	10.00
Total	280	109	38.93	118	42.14	53	18.93

The workers had been asked about their type of annoyance such as headache, nervousness, insomnia and eye strain. 23.21% of workers responding to this question have complained about headache. Roughing is identified as the most vulnerable department in the footwear and leather products industries since 53.33% complaints has arisen due to headache from this department. From the following data in the table 6 it was revealed that 17.50% workers have complained about nervousness, 13.57% about insomnia and 13.92% about eye strain respectively.

Table 6: Annoyances observed by workers in footwear and leather products industries

Departments	**Participants**	**Headache**		**Nervousness**		**Insomnia**		**Eye strain**	
		N	%	N	%	N	%	N	%
Cutting	60	11	18.33	7	11.66	12	20	3	5
Sewing	60	10	16.66	7	11.66	6	10	6	10
Soling	40	7	17.5	8	20	6	15	8	20
Lasting	40	12	30	10	25	4	10	5	12.5
Roughing	30	16	53.33	5	16.66	4	13.33	11	36.66
Finishing	30	5	16.66	7	23.33	3	10	6	20
Generator area	20	4	20	5	25	3	15	0	0
Total	280	65	23.21	49	17.50	38	13.57	39	13.92

IV. Conclusion

Noise, extensive temperature and improper light intensity are imperceptible enemies for the footwear and leather products industries and most of the industries are not concerned about these complications. This study results disclosed that the existing noise pollution levels in the footwear and leather products industries far exceeds the standards limits (75 dB) set by Bangladesh's Department of Environments (DOE). During analyzing the data, it was found that the average noise level in the workplaces was between 78.55 dB and 102.77 dB and 86.43% of workers in the industries were annoyed from the noise in their workplaces. It was also unfolded that the temperature was more than the normal room temperature (25^0C) and light intensity was lower than the standard limits for the shoe and leather goods manufacturing industry. The maximum temperature was found 36.4 ^{0}C at lasting department and minimum 31.5 ^{0}C at cutting department; and 38.93% of the workers in the workplaces were disturbed by the effect of high temperature. The average light intensity was observed between 234.5 lux and 445 lux in the working floor. These factors caused the problem of headache on 23.21% workers. These are the indoor environmental scenarios of footwear and leather products industries in Bangladesh which are great threats to workers health, productivity and product quality. The impacts of the indoor environmental factors should immediately be addressed and proper mitigation must be taken to improve the health condition of the workers and productivity as well.

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