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Hazard Identification and Risk Assessment in Material Engineering Laboratory

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Abstract— The laboratory is a workplace where people are exposed to different levels of hazards, a place where a healthy and safe working process or procedures are required, safety is important as workers are liable to many risks due to the nature of the working environment. This study identifying potential hazards assessed the risk associated based on demographic features among students using Material Engineering. Hazards were identified and where assessed based on the Systematic random sampling technique. A sample size of 80 was considered due to a confidence level of 1.96 and a margin of error of 0.05. Knowledge, Attitude, and safety practices where collected based on age, gender, education level, and laboratory experience distribution among the 70 students and analyzed using Non-parametric analysis of variance test to see if there is a significant difference among the demographic features of users. Correlation between safety practices with attitude analyzed. Results show that age, educational level, and laboratory experience has a significant effect on the attitude, knowledge, and safety practice observed in the laboratory with p-values of 0.02, 0.044, 0.003, and 0.0001 respectively. Correlation between safety practice and both attitude and knowledge was positively related with correlation coefficient and p-value of rs =0.270 and p-value 0.024 and ra = 0.275 and p-value = 0.021 indicating a low Positive correlation between both knowledge and Attitude with safety practice, concluding that laboratory safety practice improves as knowledge toward hazards increases and good attitudes towards precautions improves.

Keywords— Hazard, Attitude, safety practice, Gender, education level, experience

I. INTRODUCTION

A place where Laboratory work is conducted exposes people to so many levels of hazards, a place where a healthy and safe working process or procedures are required, safety is important, as workers are liable to many risks due to the nature of the working environment. Due to the hazardous operation of the laboratory, it is exposed to accident and has potentials of injuries, illness, and damage [1]in present practice, hazard identification, risk assessment and preferring improvement and control are among the main component used to rate safety and health practice or assessment of health and safety management. Work safe plan is a verification and assessing the process, which can apply to measure safety and health management system. The safety of a workplace can be measured by the assessment and rate of the process. To comply with occupational safety and health act a safe workplace is required by the employer is important to develop a hazard report. All over the world, including our environment and our workplace hazard exist, but most importantly, identification and control measures to prevent any harm it can give rise to [2]. Using systematic approach hazard identification at the workplace can be managed and identified to ensure all hazards are noted without failure, once hazards are identified, need of conducting a risk assessment to determine the level of risk on the identified hazards, and come out with safe work procedure to reduce risk of the hazards.

The relationship between attitude and its influence on the safety of construction workers is of paramount importance. The management of safety needs the requirement of developing a culture of safety habits and attitudinal change. This attitude will be managed by a regulatory framework governing practicing of safety in the industry such as the construction industry [3]. Safety culture is the view and belief that organization members that are sharing risk, accident, and ill health [4]. Presently awareness of the labor force on a safer workplace has much room for improvement and requires more examination in a greater dimension. Basic lab risks and hazards are many but can be reduced or averted through education, a better attitude, and safe practice [5]. In today's world for any establishment, company, or industry to attain success it most not only meet production requirements but also attains operation and maintenance requirements for it to meet the specification or standard of occupation safety and health.

A risk assessment is simply assessing what would likely cause harm or accident to happen in our workplace, these assessments weigh up whether enough precautions are usually taken in preventing injury from occurring. Workers or workers at any workplace have the right to protection from any danger that may occur by failure to take precautions. The main problem where the lack of regular risk assessment in the laboratory for more than a year. This study is aiming at identifying potential hazards in the laboratory due to activity, process, or test. To investigate the relationship of safety practice concerning knowledge of students towards health and safety practice in laboratories and the influence of attitude toward safe practice.

II. RELATED WORK

Hazard identification and assessing risk is an important factor in preventing any harm and fulfilling job safety contract among workers. [2] observed that in this daily practice, hazard identification, risk assessment, improvement, and control are among the main component used to rate the safety and management of health or audit assessment. The audit assessment tool was used in their work to rate safety and health hazards management system, they were able to identify 10 potential hazards that involve physical hazard, radiation hazard, chemical hazard Fire hazards, confined spaces, and heavy machinery hazards. [6] in their work identified hazards in hematology, microbiology, chemistry virology, and histopathology laboratory among laboratory attendants and technicians. It was identified that 61% of the sample experienced injuries and frequent needle stick hazards. They suggested that there was a need for controls on exposure to hazards and concluded that emphasis should be more on the knowledge and attitude of workers towards observing hazards and control. [7] Also conducted a study to identify hazards and assess risk in foundry operations through generating a checklist and conducting an interview with workers using the quantitative technique. They suggested that measures that there should be the prevention of the re-occurrence of such hazards.

Experts from safety established that bad attitude plays the most significant role in accidents.[8] While Analysing Heinrich Accident-causing Theory and the Factors of Safety Ideology showed that most important activities that bring about the industrial accident are unsafe behavior. [9] Advised that there should be a concentrate on people as an agent of accidents, considering safe workplace but without workers having knowledge, attitude, and behavior toward health and safety may fail to exist. [10] Evaluated the knowledge, attitude, and behavior concerning safety in a safe working environment, and found out that 90% of injuries are associated with knowledge, attitude, and behavior of workers in terms of health and safety. According to [11], [12] medical care services account for large waste and side effect that requires safety in handling and disposing of encountering waste product will bring about ill effects. Medical care organization is more concerned this day on hazardous waste management. When measuring the level of knowledge among medical health practitioners, the report shows a significant difference when observed. Considering enlightenment in BMW among lab technicians. The current research measures knowledge in terms of BMW and awareness level also it measures knowledge in terms of needle sticking injuries using a closed-ended questionnaire

III. METHODOLOGY

Study Design

To investigate the hazard identification in the material laboratory the study adopts interviews for data collection. A knowledge, attitude, and practice survey questionnaire were used to collect data about safety laboratory practices. The questionnaire was made up of four units in which unit one comprises of socio-demographic information with four (4) questions, the unit two will deal with the knowledge of activities when expose may pose risk ten (10) questions. The third unit will deal with the attitude towards activities when exposure may pose risk nine (9) questions. The fourth unit will deal with safe practice towards activities when expose may pose risk ten (10) questions

Study Sample Size

The Hazard identification was determined using a structured questionnaire that was administered to three laboratory technicians of the three sections of the laboratory, which are the strength of material lab, metal forming lab, and cad and cam laboratory. The questionnaire for Knowledge, Attitude, and safety practice for risk assessment was administered based on some students using the laboratory. 43 (Forty-three) questions were asked to identify the physical hazards as indicated in Table 1. A sample size of 80 (eighty) was considered because a confidence level of 1.96 and a margin of error of 0.05 is required according to [13]. Figure 1. Shows the total number of students using the material engineering Laboratory. The quantitative technique was used to consider the consequence and the potential harm that may result from the hazards because of its accuracy and reliability. Factors to be considered are Knowledge as independent variable and safety practice as the dependent variable. Attitude as independent variable and safety practice as the dependent variable. The data were subjected to Non-parametric analysis of variance due to the non-normality of the data using SPSS version 20 software.

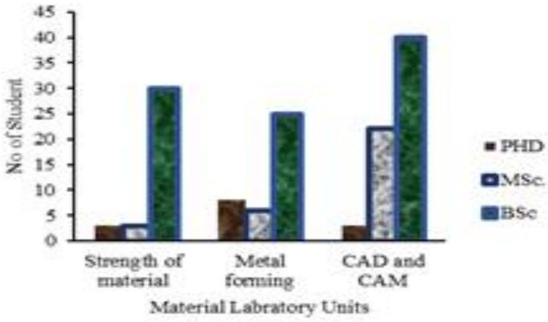

Figure 1. Number of Students Using Material Engineering Laboratory

Results and Discussion

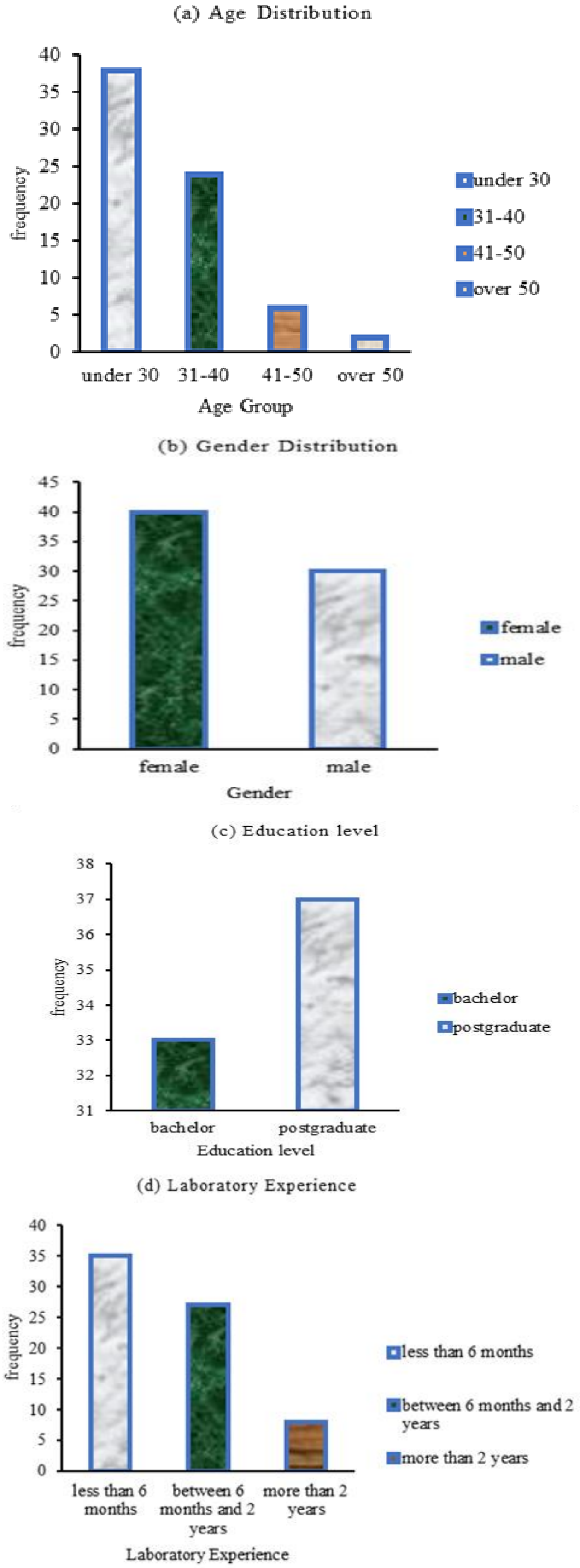

Figure 2. (a) Age Distribution, (b) gender Distribution, (c) Education level Distribution, and (d) Laboratory experience distribution

Table 2. Normality Test for Socio-demographic features of participants

7.5	p-value	A-square	Mean Score	SD
Knowledge	<0.005	2.96	12.043	2.163
Safety Practice	<0.005	1.84	12.314	1.975
Attitude	<0.005	4.83	10.800	2.217

^{ns} not significant, ** significant *** highly significant

Table 3. Nonparametric ANOVA Test for Socio-demographic features of participants

Independent Variable	Knowledge	Safety Practice	Attitude
Age	0.471^{ns}	0.044^{*}	0.003^{*}
Gender	0.058^{ns}	0.053^{ns}	0.58^{ns}
Education	0.02^{*}	0.14^{ns}	0.000^{***}
level Laboratory Experience	0.995^{ns}	0.54^{ns}	0.474^{ns}

Table 5. Correlation between Knowledge, Attitude and safety practice

Correlated Variables	Coefficient (r_s)	P-Value*
Knowledge Score versus Practice Score	0.270*	0.024
Attitude score versus Practice score	0.275*	0.021

Discussion

The sample size of 80 (eighty), students, were used for this research out of the sample size only 70 (seventy) of the students participated, and out of the 70 students, 37 were postgraduate students and 33 undergraduate students. The participants' age, gender, education level, and laboratory experience distribution among the 70 (seventy) students working in the four units of the material laboratory is shown in Figure 2(a),(b),(c), and (d). The result indicates that ages under 30 (thirty) were made up of 38 (thirty-eight) students making 54.3% of the total sample. This age group comprises the majority of the total sample population. This is probably because the majority of students enrolled in school at an early age, 31-40. Meanwhile, 24 (twenty-four) students were within the age range of 31-40 making 34.3% of the study population, while, 41-50 has 6 (six) with students making 8.6% of sample size and over 50 of age distribution have 2 (two) students forming 2.9% of the study as illustrated in figure 2(a). Besides, the number of females and male students using the material laboratory was comprised of 40 (forty) female students making 57.1% of the sample size and 30 (thirty) males students were made of 42.9% as shown in the figure. 2(b). Similarly, the Education level distribution for both postgraduate and undergraduate student using the units of the material laboratory from the sample size, shows that 37 (thirty-seven) postgraduate students making 52.9% student, and 33 (thirty-three) undergraduate student making 47.1% of the total sample size. The high number of postgraduate students may be because a large number of research students fall within the postgraduate students as shown in figure 2 (c). Figure 2(d) indicates the result of the laboratory experience of students using the material laboratory. The result shows that students with less than 6 months experience are 35 (thirty-five) making 50.0% of the sample size, students between 6 months and 2 years' experience are 27 (twenty-seven) making 38.6% of sample and students with more than 2 years' experience are 8 (eight) making 11.4% of the sample, as shown in the figure. 2(d).

The normality test was carried out using the Anderson Darling test to know if the data collected for Knowledge, Safety Practice, and Attitude scores follow a normal distribution. Established from table 2, the knowledge, Safety Practice, and Attitude scores did not follow normal distribution because the result indicates a low p-value of less than 0.05. The p-value obtained was (p-value <0.005) with A-square of 2.96), (p-value <0.005) with A-square of 1.84), and (p-value <0.005) with A-square of 4.83) for knowledge, Safety Practice and Attitude scores respectively. Since no data followed a normal distribution, there is a need to conduct a non-parametric Analysis of variance (ANOVA test).

A nonparametric test (ANOVA) was conducted among Knowledge, Safety Practice, and Attitude scores to observe the relationship between age, gender, and education level and laboratory experience distribution groups. The result indicated that there was no significant relationship that exists among knowledge scores with age, gender, and laboratory experience distribution (p-value >0.05). Age, gender, and laboratory experience with p-values of 0.471, 0.058, and 0.995 and median score for age, gender, educational level, and laboratory experience of 11.0, 10.5, 12.0, and 12.0 for Under 30, 31-40, 41-50, and Over 50. Gender median of 12.0, and 11.0 for females and males. The educational level median of 12.0 and 11.0 for Undergraduate and postgraduate. Laboratory experience median of 12.0, 12.0, and 12.0 for less than 6 Months, Between 6 Months and 2 Years, and More Than 2 Years respectively shown in table 4. The result of knowledge and education, on the contrary, showed, that there is an existing relationship between knowledge and Level of education with a p values 0f of 0.02 as illustrated in table 3. The result of age distribution is contrary to [14] who carried a study and found that the result had a statistically significant positive relationship between the workers' age and total knowledge score. The result showing non-significance of the relation between knowledge of laboratory users and age is contrary to [14], in his work carried a study and found that statistically significant positive relationships exist between the worker's age and total knowledge score. The result of gender in a similar study by [15] had a conflicting result that gender was significantly related to knowledge (p=0.20). Similarly, laboratory experience also gave a divergent view to [16] in his study that there is a significant relationship between the Experience of workers and total knowledge scores. The educational level of laboratory user gave a contracting view with a study by [17], his comparison between knowledge and education level, he found out that there was no significant relationship between knowledge and education level.

The result for Safety Practice indicated that there was a significant relationship existing among knowledge score with age group, with a p-value of 0.044. Safety practices among age distribution are contrary to [17] who carried a study and found out that there was no significant relationship between safety practice and age distribution, similarly, [16] indicated a significant relationship exists between workers' age and safety practice. Gender, educational level, and laboratory experience distribution (p-value >0.05) did not indicate any significance with p-values of 0.053, 0.14, and 0.54 with a median score for age, gender, educational level and laboratory experience of 13.0, 10.0, 13.5, and 12.0 for Under 30, 31-40, 41-50, and Over 50. Gender median of 12.5, and 12.0 for females and males. The educational level median of 13.0 and 12.0 for Undergraduate and postgraduate. Laboratory experience median of 13.0, 12.0, and 10.0 for less than 6 Months, Between 6 Months and 2 Years, and More Than 2 Years respectively, as illustrated in table 4. The results for the Gender support study by [16] while, educational level is contrary to the study [16], in which educational level plays a significant in work safety practice. Work experience to safety practice study by [16] agrees with this study.

Laboratory user's attitudes toward safety practice result from Age, and education level and laboratory experience distribution groups showed a significant impact with p-values of 0.003, 0.00001, and 0.040 respectively. Age distribution relation disagrees with [18], but educational level results agree with [19], which showed a statistically significant difference between attitude score and education level. This study was a contrary statistically significant difference between attitude score and education level. The result of the Attitude score of laboratory users and their experience was contrary to (Nee and Sani, 2011) because their conclusion was that, no significant difference between attitude score and laboratory experience. Gender on the other hand indication that gender has no significant difference with a p-value 0.58. The median score is illustrated in table 4 for age, gender, educational level, and laboratory experience of 9.0, 9.0, 9.0, and 11.0 for Under 30, 31-40, 41-50, and Over 50. Gender median of 10.5, and 10.0 for females and males. The educational level median of 12.0 and 9.0 for Undergraduate and postgraduate. Laboratory experience median of 9.0, 9.0, and 11.0 for less than 6 Months, Between 6 Months and 2 Years, and More Than 2 Years respectively.

Spearman Correlation Coefficient (rs) test. Using the nonparametric test to observed if there exists any significant association between knowledge, attitude, and safety practice and socio-demographic data. Cohen's standard was applied to evaluate the strength of the relationship, where coefficient bet 0.10 and 0.29 represent a small effect size while coefficient bet 0.30 and 0.49 rep moderate effect size, and 0.5 and above represent large effect size [20]. Correlation analysis was conducted between knowledge and safety practices by considering both knowledge and safety practices as continuous variables. The results show that there was a significant correlation between Knowledge and safety practice (rs =0.270 and p-value 0.024) as shown in table 5, indicating a positive correlation. Meaning that when there is an increase in knowledge contribute to increase in practice. This was similar to a study of [16], [21]. 0.270 indicates a low positive effect size. Result of Correlation between attitude and safety practice, by considering both attitude and safety practice as continuous variable showed that a significant linear relationship exists between attitude and safety practice (rs = 0.275 and p-value = 0.021). Pointing that when there is an increase in better attitude corresponds to an increase in safety practice. This agrees with [22]. 0.275 showing that there exists a low positive relation. Therefore, the result shows as there is an increase in attitude also there is an increase I safety practice see table 5.

IV. CONCLUSION AND FUTURE SCOPE

The study shows that physical hazard was such as Ergonomic hazards, Falling hazards, cuts, burns, electrical hazards, manual handling of heavy objects, excessive noise were identified as hazards within the laboratories. However, the study revealed that demographic features of material laboratory users like, age, educational level, and laboratory experience has a significant effect on the attitude, knowledge, and safety practice observed in the laboratory. It further implies that there is a clear positive correlation between both knowledge and Attitude with safety practice. Concluding that, laboratory safety practice improves as knowledge toward hazards increases, and good attitudes towards precautions improve. However, further study should focus more on other engineering workshops and laboratories due to variations like hazards and risks associated with such research and profession.

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Table 1: Hazard identification in the material Engineering laboratory

SN	Hazard identification
1	Ergonomic hazards associated with laboratory activities awkward and sustained postures, high forces, repetition, and compression forces
2	Exposure to ionizing radiation
3	Falling hazards associated with slips, trips, and falls
4	Cuts from broken glassware
5	Cuts from sharp instruments
6	Burns related to contact with hot surfaces (ovens, heating plates, burners, etc.) Or products
7	Electrical hazards arising from the use of electrical cords and appliances
8	Mechanical equipment
9	Electrical equipment
10	Manual handling of heavy objects
11	hazardous substances
12	Working at height (fall from a stepladder)
13	Excessive noise
14	Work surfaces kept dry
15	Combustible scrap,
16	Protective goggles
17	Safety glasses
18	Protective gloves
19	Appropriate foot protection
20	Clear Aisles and Gangway
21	Appropriately marking of Aisles and Gangway
22	Spill materials
23	Standard guardrails
24	Exits marked and sign with an illuminated light source
25	The directions to exits,
26	Appropriately marking of Doors, Gangways or stairways or "NOT AN EXIT",
27	Are all exits, kept free of obstructions?
28	All tools and equipment
29	Hand tools such as chisels, punches,
30	Broken or fractured handles on hammers,
31	Worn or bent wrenches
32	Handles used on files and similar tools appropriately
33	Appropriately safeguards provided for Grinders, saws, and similar equipment
34	Power tools with the correct shield, guard
35	Guarded Rotating or moving parts of equipment
36	Well stored powder-actuated tool
37	Machine Operation
38	There adequate supervision to ensure that employees are following safe machine operating procedures
39	Welding, cutting or brazing equipment
40	Compressed gas cylinders
41	Storage of cylinders, safety valves, relief valves,
42	compressors equipped with pressure relief valves, and pressure gauges
43	Compressor air intakes installed and equipped to make sure they are clean uncontaminated air enters the compressor.

Table 4. The median score for Socio-demographic features of participants

Variable	Measured Level	Knowledge	Safety Practice	Attitude
Age	Under 30	11.00	13.0	9.0
	31-40	10.50	10.0	9.0
	41-50	12.00	13.5	9.0
	Over 50	12.00	12.0	11.0
Gender	Female	12.00	12.5	10.5
	Male	11.00	12.0	10.0
Education Level	Bachelor	12.00	13.0	12.0
	Postgraduate	11.00	12.0	9.0
Laboratory Experience	Less Than 6 Months	12.00	13.0	10.0
	Between 6 Months And 2 Years	12.00	12.0	10.0
	More Than 2 Years	12.00	10.5	9.0

