JAEHR Journal of Advances in Environmental Health Research

An empirical investigation into the relationship between workshop operations and accidents in local automobile garages in Ghana

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Original Article

Abstract

Local automobile garage workers carry out daily workshop operations, which sometimes lead to accidents and injuries. Therefore, this study was carried out to establish a relationship between automobile workshop operations causing accidents and safety practices among local garage workers in Ghana. Three main data collection approaches were used in the study namely focus group discussions (10 FGDs), observation and survey (250 respondents). Data were analyzed with SPSS. From the FGDs, participants identified workshop operations that had the potential of causing accidents, safety factors and safety practices. Factor reduction analysis was carried out where identified workshop operations were clustered into three factors relating to worker's attitude toward workshop operations, working environment and management practices, and work monotony. Safety practices were clustered into two main components regarding worker's approach to safety measures and provision and storage of chemicals appropriately. Five safety measures were mentioned to be practiced in garages that had a positive moderate correlation with the potential workshop operations causing accidents. Finally, it could be said that local garage workers had some level of knowledge concerning safety measures but the practice does not measure up to standard and best safety practices. Therefore, safety seminars and training sessions should be organized for local automobile garage workers.

KEYWORDS: Accidents, Safety, Automobile, Local Garages, Ghana

Date of submission: 28 Apr 2014, Date of acceptance: 17 Jun 2014

Citation: Akple MS, Turkson RF, Ezugwu CI, Biscoff RK, Bosrotsi CK. **An empirical investigation into the relationship between workshop operations and accidents in local automobile garages in Ghana.** J Adv Environ Health Res 2014; 2(3): 142-50.

Introduction

Local automobile repair workshops (or garages) are one of the small scale industries which serve as engine for economic growth by providing employment for people.[1] This industry plays a vital role in the economic development of most developing countries. For instance, in Eritrea, garage work is an important source of job creation, provision of potential for improving skills and devising new technology.[2] There are various new technological trials and innovations in progress undertaken by different groups of garage workers. However, previous studies

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indicated that automobile mechanics have higher rates of occupational health hazards compared to workers in other occupations[3,4] leading to injuries, some of which could be fatal.

Accidents in local automobile garages are largely preventable with the use of appropriate occupational safety measures and health services. This is because there are safety standards and practices, which garage workers must adhere to during the execution of garage operations. Adhering to the stipulated safety measures and practices could significantly reduce accidents in garages.

In developing countries such as Ghana, occupational health and safety (OHS) practices have generally been given little or no attention especially in the informal job sector. However, this sector employs a significant proportion of people and contributes to the gross domestic product of the nation. Local automobile garages in Ghana are formed by a group of automotive mechanics who come together to offer automotive maintenance and repair services under the informal job sector. The garages are operated under one or more masters owning the workshop with a number of apprentices. The master mechanics may have different specializations and could be automotive electricians, automotive mechanics, welders, brake binders, interior vehicle liners or vehicle body sprayers.[5] Most of these garages are not officially recognized by governmental authorities and therefore are not provided with the necessary support such as OHS training. However, automobile repair work involves multiple activities that expose workers to many potential accident-causing factors and require multiple approaches for enhanced safety. This study was, therefore, carried out to analyze the relationship between potential workshop operations that could lead to accidents and safety measures practiced among local automobile garage workers in Ghana.

Materials and Methods

The study involved all local automobile garages in three municipalities and two districts in Ghana. The willingness of participants to be part of the study was sought first because the researchers believed unwillingness on the part of participants would not provide reliable information. In all, 250 participants were involved in the study. The participants were local garage mechanics who were engaged in vehicle maintenance and repair work, including automotive electricians and welding technicians operating in the informal small-scale enterprises.

Three main data collection techniques were employed in this study namely focus group discussion (FGD), survey and direct observation. The researchers believed that using more than one data collection approach would enhance the quality and validity of the study by combining and integrating the strengths associated with each method.

Ten focus group discussions were first conducted, two each in the five municipalities and districts. This was done for group members between 8 and 10 people. The composition of the groups was heterogenous involving different ages of participants, experience and positions in workshop (i.e., Masters, Senior and Junior Apprentices) for adequate and in-depth data gathering. It was believed that when people are involved in projects, appreciation of findings is easy because they feel they were part of the work. The main focus for carrying out the FGDs was to ask the participants to identify various workshop operations that had the potential of causing accidents and safety factors in their occupation. This was done to involve participants in the study from the onset, so that any recommendations could easily be adopted.

An observational study was carried out by the researchers to ascertain workshop operations, the availability or otherwise of safety equipment and facilities and safety measures practiced at the various workshops to support responses from the participants.

Based on the factors listed in table 1 a questionnaire was developed using a five-point Likert scale (1 = strongly disagree, 2 = disagree,

3 = indifferent, 4 = agree and 5 = strongly agree) for local garage mechanics to rate their degree of agreement against each of the identified workshop operations and safety variables. In addition, a scale rating using (1-not at all, 2 - sometimes, 3- neutral, 4- often, 5- very often) was used to assess respondents' agreement with their safety practices at their workshops. The questionnaire was pre-tested outside the study area to identify mistakes and avoid ambiguous questions. The questionnaire comprised both open and close-ended questions. The questionnaires were randomly administered to 250 local automobile garage workers from three municipalities and two district capital cities in Ghana.

The questionnaires were coded and entered into using SPSS for Windows (version 16.0, SPSS Inc., Chicago, IL, USA). Descriptive and reliability tests [i.e., Cronbach alpha test and Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity] were carried out to analyze the demographic characteristics and determine the internal consistency of the data respectively. Furthermore, factor reduction analysis (or principal component analysis) was performed to cluster the workshop operations and safety measures into factors. Correlation analysis was performed to determine the relationship between the workshop operations and safety measures practiced.

Results and Discussion

Analysis of FGDs

The results from FGDs indicated that local garage workers had some level of knowledge concerning OHS. Table 1 shows potential accident causing workshop operations, proposed safety measures and safety measures practiced by the respondents in the various local garages. It is noteworthy that workers mentioned that the accidents in local garages could result from any workshop operation, including the environment of the workshop and attitude of workshop managers.

Demographic characteristics of respondents

The demographic characteristics of respondents are illustrated in table 2. It showed that all the local garage mechanics interviewed were males (100%). This is because the automobile industry is mostly a masculine occupation in Ghana. It is, therefore, not common to see females involved in the vehicle repair business. In addition, most of the mechanics involved in the study were adults (i.e., > 33 years) and had a lot of working experience between 5 and 10 years as mechanics (62.4%). This implied that the majority of the respondents had enough work experience in the local garages and could provide more in-depth information concerning the study.

Table 1. Potential accident causing workshop operations, proposed safety measures and measures practiced by respondents

No.	Accident causing factors and safety measures
	Potential accident causing workshop operations
A1	Use of tools and equipment that are out of order
A2	Violation of standard safety rules and regulation
A3	Inexperience
A4	Inappropriate handling and storage of chemicals
A5	Poor handling of tools and equipment
A6	fatigue and boredom of workers
A7	Reluctance of management towards safety
A8	Working environment
A9	Natural causes
A10	Inadequate operation space for workers
A11	Physical condition of workers
A12	Workers poor job satisfaction
A13	Constant exposure to a particular job
A14	Physical build of workers
	Safety measures
S1	Appropriate storage of chemicals
S2	Enforcement of safety rules by experienced apprentices
S3	Strict compliance to workshop safety rules
S4	Regular orientation on safety practices
S5	Use of safety information materials
S6	Specific safety instructions for particular jobs
S7	Safety awards for motivation workers
S8	Investigation of accident causes
S9	Use of PPEs
	Safety measures practiced
M1	Use of PPEs
M2	Using appropriate tools for operations
M3	Adherence to some specific safety instructions
M4	Proper storage of chemicals
M5	Having first aid box

PPE: Personal protective equipment; A1-A14: Potential accident causing factors; S1-S9: Safety measures; M1-M5: Safety measures practiced

Descriptive and exploratory analysis

The results show that the means for each of the variables appeared to be reasonable as each of the variables was measured on a five-point Likert scale as shown in table 3. No mean values were above 5 or below 1. The standard deviations were all similar suggesting that there were no outliers for any of the variables.

Table 2. Demographic characteristics of respondents

Characteristics	Frequency	Percentage
Gender		
Male	250	100
Female	0.0	0.0
Age (years)		
18-25	66	26.4
26-33	78	31.2
> 33	106	42.4
Workshop experience (years)		
< 5	43	17.2
5-10	156	62.4
> 10	51	20.4

Reliability test

To determine the degree of consistency for the set of variables or scale of measurement, a reliability test was conducted. The reliability test checked the consistency or whether the variables composing the scale were correlated with each other.[6] In this study, the internal consistency reliability was employed to measure the reliability of the research instrument. Internal consistency reliability is used to assess the consistency of the results from the variables within the test.[7] For the purpose of this study, two of the tools namely cronbach alpha test, KMO and Bartlett's sphericity tests were employed.

Cronbach's alpha test (α)

Cronbach's alpha test (α) measures the correlation among the variables of the scale. It is the most common measure of reliability (consistency) of a scale. The higher the correlation among the variables of the scale, the more consistent the research instrument.[8] In general, the accepted Cronbach alpha value is 0.7 and above, whiles a reliability coefficient of 0.6 is acceptable for exploratory research.[6] In this study, the Cronbach alpha reliability test (α) of the scales was 0.778, 0.701 and 0.729 for potential workshop operations causing accidents, safety factors proposed and safety measures practiced respectively (Table 3). This implied that all the variables under the factors were worthy and adequate to be retained on the scale and that there was no need for deletion.

KMO and Bartlett tests of sphericity

KMO is a measure of sampling adequacy and it is used to compare the magnitudes of the observed correlation coefficients in relation to the magnitudes of the partial correlation coefficients. Furthermore, the KMO test is used to assess whether the factor analysis is appropriate for a set of data or not.[8] The value for KMO varies from 0 to 1. Large KMO values are good because correlation between pairs of variables (i.e., potential factors) could be explained by the other variables. According to Field,[7] a value of 0 implies there is diffusion in the pattern or trend exhibited by the correlation and the factor analysis is not appropriate. However, the value of 1 is an indication of correlation and compact pattern or trend and hence factor analysis is suitable for a particular case. Based on this a commonly acceptable KMO value is 0.5 and above whiles a dataset with a KMO below 0.5 is not appropriate for factor analysis. From table 4, it was observed that the KMOs determined for all the factors was above 0.5 indicating or confirming the appropriateness of factor analysis for the variables under each factor.

Furthermore, the Bartlett test of sphericity was used to determine the overall significance of all the correlation within the correlation matrix.[5] According to Field,[6] the Bartlett test of sphericity shows whether a correlation exists between the variables on the scale. The population correlation matrix is an identity matrix; each variable correlates perfectly with itself (r = 1), but has no correlation with the other variables (r = 0). The Bartlett test must be significant for factor analysis to be performed on a dataset. The results indicated that all the factors were highly significant confirming the appropriateness of carrying out a factor analysis (Table 4).

Table 3. Descriptive analysis of potential accident causing workshop operations, safety factors proposed and practiced by respondents

Factors	No.	Workshop operations and safety factors	Mean ± SD	α
Workshop operations	A1	Use of tools and equipment that are out of order	3.25 ± 0.79	0.778
	A2	Violation of standard safety rules and regulation	3.19 ± 0.80	
	A3	Inexperience	3.57 ± 0.87	
	A4	Inappropriate handling and storage of chemicals	3.02 ± 0.75	
	A5	Poor handling of tools and equipment	3.04 ± 0.65	
	A6	Fatigue and boredom of workers	3.09 ± 0.52	
	A7	Reluctance of management towards safety	2.77 ± 0.57	
	A8	Working environment	2.89 ± 0.64	
	A9	Natural causes	2.49 ± 1.00	
	A10	Inadequate operation space for workers	2.67 ± 0.64	
	A11	Physical condition of workers	3.67 ± 0.51	
	A12	Workers poor job satisfaction	2.46 ± 0.67	
	A13	Constant exposure to a particular job	1.88 ± 1.04	
	A14	Physical build of workers	2.03 ± 0.45	
Safety factors proposed	S1	Appropriate storage of chemicals	3.33 ± 0.57	0.701
	S2	Enforcement of safety rules by experienced apprentices	3.19 ± 0.66	
	S3	Strict compliance to workshop safety rules	3.21 ± 0.41	
	S4	Regular orientation on safety practices	3.47 ± 0.61	
	S5	Use of safety information materials	2.83 ± 0.70	
	S6	Specific safety instructions for particular jobs	3.09 ± 0.67	
	S7	Safety awards for motivation workers	3.68 ± 0.88	
	S8	Investigation of accident causes	3.01 ± 0.67	
	S9	Use of PPEs	3.13 ± 0.77	
Safety factors practiced	M1	Use of PPEs	3.03 ± 1.03	0.729
	M2	Using appropriate tools for its operations	1.76 ± 0.43	
	M3	Adherence to some specific safety instructions	2.41 ± 0.99	
	M4	Proper storage of chemicals	2.12 ± 1.02	
	M5	Having first aid box	2.58 ± 1.11	

Figures in bracket are means and standard deviations (SD) respectively, PPEs: Personal protective equipment, SD: Standard deviation; A1-A14: Potential accident causing factors; S1-S9: Safety measures; M1-M5: Safety measures practiced; α: Cronbach's alpha

Table 4. Kaiser-Meyer-Olkin (KMO) and Bartlett tests of sphericity

Factors	KMO	Bartlett tests
Workshop operations	0.79	P < 0.001
Safety factors	0.63	P < 0.001
Safety measures practiced	0.60	P < 0.001

KMO: Kaiser-Meyer-Olkin

Factor analysis and principal component analysis

Factor analysis and principal components analysis were both used to reduce the large set of items or variables under each factor to a smaller number of dimensions and components. These techniques summarized a number of original variables into a smaller set of composite dimensions, or factors. This was done by removing redundant data or variables and reduced them into components that best suits or measures the construction.[9] Factor analysis is performed to assess whether items or variables on a questionnaire can be clustered clearly and meaningfully into small groups of factors or components.[10] Hence factor analysis results in the grouping of individuals, objects or variables into clusters so that objects in the same cluster are homogeneous in a manner that ensures that there is heterogeneity across clusters. This technique is often used to segment the data into similar and natural groupings.[10] The result of factor analysis basically represents measures and factor loading of each variable. According to Field,[7] in performing factor analysis, factor loading values

of less than 0.3 must be suppressed and the variable associated with that factor loading excluded from the rest of the variables. The rotated matrix analysis (Table 5) shows that no variable could be excluded from the rest of the group since no factor loading was less than 0.3.

Workshop operations causing accidents

The results showed that the workshop operations that cause accidents in local garages were rotated into three main components (Table 5). Nine workshop operations were classified or clustered as factor one, the main causes of accidents in local garages. Generally, it was observed that the first six workshop operations were closely related to workers' attitudes towards the operations. This showed that most accidents were caused by the attitude of workers in the garages. Among them, the three key ones were the use of tools and equipment that were out of order, inappropriate handling and storage of chemicals and poor handling of tools and equipment. Tools and equipment play an important role in the execution of maintenance and repair works in automobile repair workshops. This implies that out of order tools and equipment have the potential of causing accidents. This was affirmed by one respondent who said "out of order tools cause minor accidents which is often not serious for the victim to attend hospital." One key cause of occupational accidents and injuries in developing countries is the use of obsolete machinery.[11] According to Rantanen[12] various factors are involved in the cause of accidents leading to injuries. The most common cause of accidents in their study was hand tools and equipment which is in line with findings of this study. Reports of other studies also indicated that 55% of workshop accidents leading to injuries per year were from machinery, hand tools, splinters, struck by/against an object.[13-15] Chemicals are very important in garages and their storage should be done according to standard procedure. However, most vehicle repair workers operating in the local garages do not pay attention to this.

Workshop operations clustered as factor two were more focused on the working environment and workshop management practices. This clearly showed that the working environment could be the cause of accidents. However, according to this study, the working environment of local garages has not contributed to any form of accidents, and if any, it was in a non-significant manner. Empirical research carried by Lundstrom[16] on industrial accidents indicated that accident causality is attributed to two major factors: Internal (characteristics of the worker in terms of mood and behavior) and external causal factors (characteristics of the work environment).

Table 5. Rotated component matrix for workshop operations

Workshop operations	Factor ratings	Component		
		1	2	3
Use of tools and equipment that are out of order		0.887		
Inappropriate handling and storage of chemicals		0.873		
Poor handling of tools and equipment		0.848		
Inexperience		0.761		
Violation of standard safety rules and regulation	Factor 1	0.711		
Fatigue and boredom of workers		0.699		
Inadequate operation space for workers		0.644		
Physical condition of workers		0.518		
Physical build of workers		0.509		
Reluctance of management towards safety			0.815	
Workers poor job satisfaction	Factor 2		0.649	
Working environment			0.624	
Natural causes	Factor 3			0.831

From the FGDs, it was realized that poor job satisfaction on the part of workers could also be another cause of accidents in the local garages. This is because workers who do not derive optimum satisfaction in the work could carry out workshop operations anyhow which could lead to an accident. When people are dissatisfied with their jobs, company or supervisors, they are more likely to experience accidents. The underlying reason for this is that the dissatisfaction distracts one's attention away from the task at hand and leads directly to accidents.[17] A satisfied worker, on the other hand, would always be careful and attentive while performing tasks, leading to reduced chances for accidents.[18] Job dissatisfaction seemed to be linked to the external causal factors responsible for the occurrence of accidents. It was noted that workers (particularly, accident victims) who expressed higher levels of job dissatisfaction significantly attributed accident causality more to work environment factors than to their personal characteristics.[18]

The operations clustered as factor three rarely caused accidents in local garages. Constant exposure to a particular job would increase the experience of workers. However, in some cases, experienced workers prefer to carry out workshop operations haphazardly, thinking they have done that work several times, and this could easily result in an accident.

Safety measures practiced to prevent accidents

The five safety measures practiced by the mechanics were rotated into two main components (Table 6). The first three measures that were clustered as factor one were closely related to worker attitudes. This implied that the attitude of mechanics was very important for workshop safety and accident prevention. According to this study, the use of personal protective equipment (PPE) is a key measure that could help prevent accidents in the local garage. However, it was observed that most of the mechanics did not use appropriate and standard PPEs while working. Anything to protect them is considered as PPE. A similar study conducted in Ethiopia indicated that most of the respondents (97.0%) did not use PPEs at work places.[12] The main reason for not using PPE was absence of it. Another study by Ghebreyohannes also indicated that local mechanics lacked knowledge concerning the selection of appropriate PPEs.[2]

One main requirement for workshops is the provision of first aid boxes. This is because in the event of an accident, the victim could receive some treatment in the workshop before appropriate medical care is sought at a health facility. In this study, result from the survey showed that local garages had first aid boxes, which contained drugs that were used when the need arose. However, a contrary situation was observed at all the local garages sampled with none having a first aid box. Proper storage of chemicals was also identified as a safety measure. An explosion of chemicals could result if not stored appropriately and properly.

A correlation analysis between the accident causing operations (As) and safety practices (Ms) was carried out. This resulted in 65 correlation coefficients, most of which were statistically significant (Table 7).

Table 6. Rotated component matrix for safety measures

Safety measures	Factor ratings	Component	
		1	2
Use of PPEs	Factor 1	0.818	
Adherence to some specific safety instructions		0.774	
Using appropriate tools for its operations		0.685	
Having first aid box	Factor 2		0.761
Proper storage of chemicals			0.725

PPEs: Personal protective equipment

Table 7. Correlation between accident causing operations (As) and safety measures practiced (MS)

	M1	M2	M3	M4	M5
A1	0.520**	0.371**	-0.224**	-0.060	-0.252**
A2	0.252**	0.390**	-0.495**	-0.087	-0.196**
A3	0.313**	0.379**	-0.357**	-0.199**	-0.279**
A4	0.300**	0.401**	-0.285**	-0.193**	-0.381**
A5	0.324**	0.329**	-0.109	-0.040	-0.217**
A6	0.292**	0.503**	0.132*	-0.041	0.006
A7	0.152**	-0.087	0.288**	0.243**	0.394**
A8	0.140*	0.000	0.394**	0.127*	0.231**
A9	0.072	-0.035	0.314**	0.097	0.192**
A10	0.124*	0.180**	0.019	0.187**	-0.133*
A11	0.090	0.109	-0.578**	-0.297**	-0.296**
A12	0.125*	0.296**	0.433**	0.148*	0.284**
A13	-0.009	-0.139*	0.370**	0.105	0.214**

* Pearson correlation is significant at the 0.05 level (two-tailed); ** Pearson correlation is significant at the 0.01 level (two-tailed); A1-A14: Potential accident causing factors; M1-M5: Safety measures practiced

Generally, there were moderate correlations between workshop operations and safety measures practiced. This implied that some of the workshop operations carried out by the local garage mechanics really resulted in accidents and their safety practices did not really prevent accidents. However, the negative correlations indicate that some safety measures reduced the risk of workshop operations causing accidents. This was not surprising because it was observed that most of the safety measures practiced did not conform to the standard safety measures.

Conclusion

The results from this study showed that there were workshop operations carried out by local garage workers that caused accidents. These operations were clustered into three main factors according factor analysis. A critical look at the clusters revealed that factor 1 was mainly concerned with the workers' attitude and conditions regarding workshop tools and equipment. However, factor 2 concerned workshop management and environment while factor 3 was concerned with work monotony and natural causes of accidents. In conclusion, the study also revealed that local garage mechanics had some level of knowledge concerning safety measures but the practice did not measure up to standard and best safety practices. This, therefore, resulted in accidents as shown in the correlation analysis. Safety seminars and training sessions could be organized for the local garage workers in order to improve on their safety behavior and to reduce occupational accidents and injuries.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgements

We wish to express our gratitude to the various members of the Mechanical Engineering Department of Ho Polytechnic, Ghana, and the Departments of Materials Science and Automotive Engineering, Wuhan University of Technology, China, for supporting the research in diverse ways.

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