Prioritization of Occupational Accident Causes in the Automotive Manufacturing

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Abstract-The automotive industry is a significant contributor to the economy. Additionally, it is prone to occupational accidents. The current study focuses on organizational accidents in high-risk activities, particularly occupational accidents in the automobile and manufacturing industries. This investigation aims to rank and quantify the causes of occupational accidents. These reasons are identified through a literature review and are investigated utilizing the Analytical Hierarchy Process (AHP). An AHP model is built based on a literature review. This model created a questionnaire and its evaluation via a survey of experts' opinions. This study shows that the most significant and dominant elements in accidents are human and organizational factors since they receive roughly equal weighting, whereas environmental factors weigh less.

Keywords-Analytical Hierarchy Process (AHP); automotive; occupational accidents; high-risk operations

I. INTRODUCTION

Management commitment to safety culture varies from organization to organization. Organizational and psychological factors increasingly influence the accident rate [1]. According to a quantitative survey of 225 complaints, dangerous activities constitute the top cause of occupational accidents. Additionally, hazardous circumstances and elements associated with machines and equipment significantly impact occupational accidents. Additionally, it is essential to develop new plans and programs for assessing workers' occupational health to take preventative measures against health risks [2-4]. In Turkey's metal production industry revealed that the majority of workplace fatalities are caused by risky activities and lack of training [5, 6]. Additionally, at an Italian steel manufacturing company, it was shown that working in a hypercritical atmosphere results in occupational accidents and disease. The study noted that working at a high temperature and being exposed to environmental conditions such as noise, vibration, poor air quality, and a demanding workload may result in severe injuries and burns [6]. Similarly, factors that contribute to occupational stress, lack of a reward system, and worker health may also contribute to occupational sickness and job stress results in an increase of dangerous behaviors [7].

Numerous factors have been identified as contributing to occupational mortality. These ambiguous situations occur due to a variety of personal characteristics, behaviors, and organizational circumstances [8, 9]. This partiality and bias in safety management contribute to the development of flawed policies. While doing a safety review, operators' psychological behavior, religious and cultural beliefs must be considered when examining fatality reports [10-12]. This aids in

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understanding their risk perception along with the cause of death [13]. Numerous manufacturing companies employ the Six Sigma methodology to enhance their product quality and operational efficiency, and to increase security. It is an organization's responsibility to safeguard the operator's safety. Workplace accidents occur mostly due to unsafe working conditions and behaviors, low visibility, and a hazardous atmosphere. These variables can result in life-threatening illness, accidents, lifelong disability, or death [14].

The conclusion of [15] indicates that these accidents have certain characteristics. There is a greater probability of limited exposure, and most injuries are caused by power machinery. These judgments would predate programs on accident prevention in the automotive industry. Human factor engineering is concerned with ensuring that the design of the man-machine system does not exceed the human capacity for information processing. Emotional stress affects one's ability to digest information, as defined by reception and feedback time. These indicators focus on employee safety, particularly pre-employment screening and stress management practices. It is the company's responsibility to give stress management training. Additionally, monitoring, interpreting, and interfering in employees' risky activities prevents accidents [16].

The evaluation of circumstances is a systematic tool used in occupational safety to ascertain the reasons of accidents. Conducting this type of study can assist a company in forecasting future occurrences. The analytical report is deficient in detail due to the absence of examining the variables associated with the workplace conditions. Also, a systematic model for evaluating workplace accident causes is required and a database containing accident statistics. Numerous studies have been conducted to improve the quality of accident analysis models and procedures to reduce the number of accidents. However, the increasing number of accidents motivates analysts to conduct additional research in this field. Numerous sectors have implemented continuous improvement systems to increase worker safety, productivity, and quality. However, just a few occupational publications examine using the research's standardized recommended criteria. This chasm will have been closed by addressing the training and skills of the professionals responsible for compiling an accident investigation report. Similarly, to ensure the validity of accident cause reports, the firm must implement monitoring mechanisms to ensure the methodology is being followed [17].

II. METHODOLOGY

This research conducts a thorough analysis of the occupational accident causes in the automobile industry. It has been discovered that occupational deaths are caused by three distinct cause categories: environmental, human, and organizational factors. These factors have sub factors as shown in Figure 1. These factors and sub factors have been identified through an extensive literature review [8-12]. This process results in the development of a model based on these criteria and sub-criteria under the supervision of safety specialists and academic experts. The AHP approach determined the relative importance of many causes in an occupational accident or sickness.

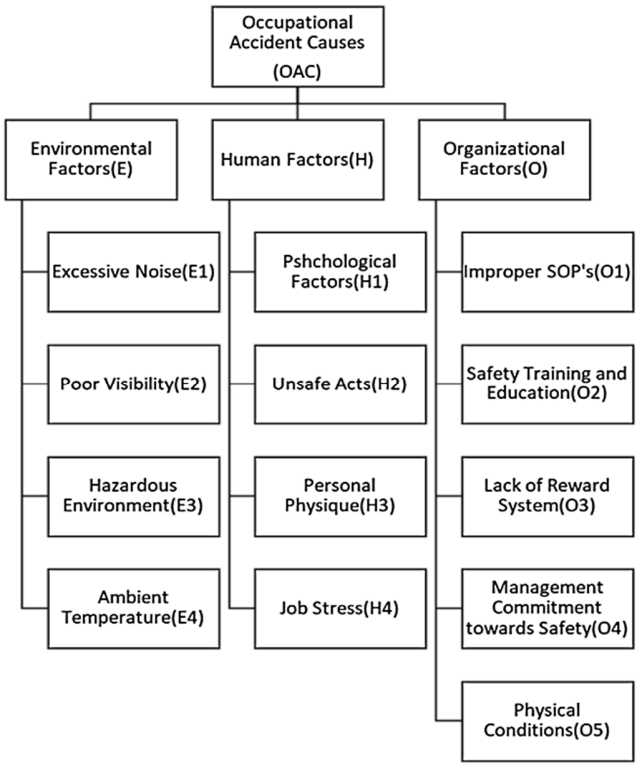

Fig. 1. Criteria and sub-criteria of occupational accidents cause in the automotive industry.

Decisions are usually quick and even have to be made at the instant. However, these decisions require time, tools, and techniques to resolve many situations. Sometimes it is challenging to quantify many alternatives to make a judgment. In such circumstances, executing these judgments requires logical, systematic, and mathematical tools through which decisions would be obtained. Numerous decision-making approaches and procedures have been proposed and AHP [18] is one of these methods. There are many reasons to use AHP in decision-making, and one of them is to prioritize factors. This method necessitates the establishment of an objective or goal, classifying various criteria, selecting a scale, evaluating preferences, conducting a consistency test, and aggregating the resultant weights of sub-criteria about the primary criterion. Figure 2 summarizes the entire study hierarchy. The pairwise comparison questionnaire requires an assortment of a scale. The pairwise comparison of different alternatives was assessed by employing the Saaty scale [18, 19] to conduct the examination. Before evaluation, the design of the questionnaire was validated by academic professionals. The standardized procedure of AHP requires a pairwise comparison of one criterion to another through a questionnaire and results in a ranking of the factors. The geometric mean was applied to the whole sample size and was further evaluated for consistency in order to prioritize the causes leading to the objective.

III. RESULTS

This analysis included 5 automobile manufacturers in Pakistan and 220 participants. To ensure the reliability of the results, the primary focus during sample collection was on

safety management specialists. As a result, safety management specialists and automobile industry experts discussed and responded to the questionnaire. The comprehensive literature assessment on occupational accident causes follows a logical structure and focuses on diverse developed and developing countries. The complete analysis, conducted using Microsoft Excel, is summarized in Table I, including pairwise comparisons of the major risk factors for occupational accidents.

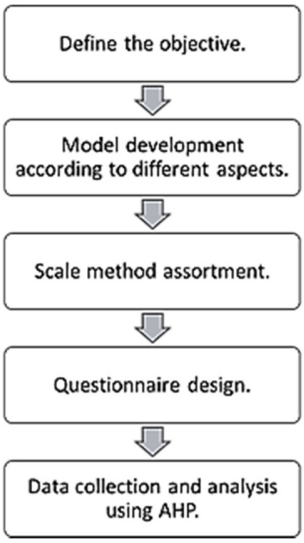

Fig. 2. Research flow diagram.

TABLE I. PAIR-WISE COMPARISON OF OAC

OAC	E	H	O
E	0.250569035	0.315352748	0.199831687
H	0.300700026	0.378444924	0.442300229
O	0.448730939	0.306202328	0.357868084

Similarly, as shown in Table I, the study obtained results for the sub-criteria of environmental, human, and organizational aspects. Finally, the results, as shown in Table II of occupational accidents indicated that ecological variables (E) had a 26% weighting, human factors (H) had a 37% weighting, and organizational factors also had a 37% weighting on the accident rate, as illustrated in Figure 3. The complete results in Table II also contain the weights of sub-criteria at the local and global levels. According to Table II, the leading environmental factor that causes an occupational accident or illness is excessive occupational noise (E1) with 8% weightage. The human factors that cause occupational accidents are unsafe acts (H2) with 13% weightage, job stress (H4) with 9% weightage, and personal physique (H3) with 8% weightage. Finally, the most significant organizational elements that contribute to the accident occurrence are the lack of safety training and education (O2), which account for 10% of the weight, and the physical conditions of the workplace which account for 8%.

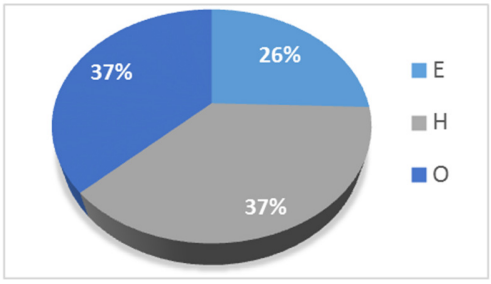

Fig. 3. Weightage of OAC.

TABLE II. LOCAL AND OVERALL WEIGHTS OF OAC

Main criteria	Local weights	Sub-criteria	Local weights	Global weighs	Overall weights
E	0.255	E1	0.303	0.08	26%
		E4	0.211	0.07	
		E3	0.228	0.06	
		E2	0.258	0.05	
H	0.374	H2	0.194	0.13	37%
		H4	0.349	0.09	
		H3	0.212	0.08	
		H1	0.245	0.07	
O	0.371	O2	0.157	0.10	37%
		O5	0.274	0.08	
		O4	0.159	0.07	
		O1	0.193	0.06	
		O3	0.216	0.06	
Total			1.00	1.00	1.00

IV. CONCLUSION

This study discusses important occupational accident causes in car production, including environmental, human, and organizational factors. The AHP approach categorizes and prioritizes the primary causes of occupational accidents. Identifying these factors encourages the prevention of the leading causes. Based on past research, a logical assessment of the literature on various ergonomic and managerial variables was conducted, and a new model was built. Human and organizational variables are the most significant and dominant components in accidents, since they receive approximately equal weighting, while environmental factors receive less weighting.

APPENDIX

RESEARCH SURVEY

Name:
Organization/Industry:
Email:
Do you have experience with the Health & Safety department in the Automotive Sector?

Instructions

- If you think criterion 1 is more important than criterion 2, you must pick a number from the left side. Let's suppose you think criterion 1 is five times more important than criterion 2, so you can circle 5 from your left.
- Similarly, if you think criterion 2 is more important, you can mark 5 from the right.
- Circle only one number in each comparison.

Criterion 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Criterion 2

Questionnaire - Pair-wise Comparison of Occupational Accident Causes

Q1) PAIR-WISE COMPARISON OF OCCUPATIONAL ACCIDENT CAUSES

E	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H
E	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O
H	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O

Q2) PAIR-WISE COMPARISON OF ENVIRONMENTAL FACTORS

E1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	E2
E1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	E3
E1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	E4
E2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	E3
E2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	E3
E3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	E4

Q3) PAIR-WISE COMPARISON OF HUMAN FACTORS

H1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H2
H1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H3
H1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H4
H2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H3
H2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H3
H3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	H4

Q4) PAIR-WISE COMPARISON OF ORGANIZATIONAL FACTORS

O1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O2
O1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O3
O1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O4
O1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O5
O2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O3
O2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O4
O2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O5
O3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O4
O3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O5
O4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	O5

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