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## Identification and Assessment of Human Error in Electrical Installation Work of Electricity Distribution Company in Tehran Province Using SHERPA Technique

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### Abstract

**Introduction:** Industrial incidents are one of the major problems the most societies. Different studies in this field showed that the main and most important cause of error occurrence is human factor. Therefore, the aim of this study was to identify and asses the risk of human error in the activities related to the operation of electrical installations in Tehran Province Electricity Distribution Company.

**Material and Methods:** This study is a qualitative and cross-sectional research was conducted through direct observation of the tasks, surveying documents, and interview. A task analysis was done using Hierarchical task Analysis, (HTA), the results were presented in the form of HTA. Finally, according to the instructions of SHERPA, the relevant worksheet was completed.

**Results:** The analysis of SHERPA worksheets showed that a total of 3399 errors were detected for 759 tasks as 39.57% of them were action errors, 32.4% check, 7.32% retried type, 19.64% communication and 1.80% were selective errors. According to the results of risk assessment, 12.47% of the errors were in unacceptable risks level, 59.57% were undesirable, and 20.2% were acceptable risks but need to be revised and the rest, 7.93% acceptable with no need for revision or remedy action.

**Conclusion:** According to the results, the most common type of error was action error. Adopting corrective measures such as proper selection of people for occupations, training, monitoring, using smart machines, tag outs and periodical checking and updating the instructions would be useful and effective countermeasures.

**Keywords:** Human Error, Risk, H.T.A, SHERPA

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**1. Introduction**

Industrial accidents are one of the major problems of the most societies. Different studies in this field showed that the main and most important cause of error occurrence is human factor [1]. And the fact that humans are responsible for more than 90% of industrial accidents shows the importance of human factors and human errors [2]. The ever-expanding technology and development of industries has made it increasingly clear that the need for clean energy, namely electricity, is greater than ever before, because electricity distribution networks are more likely to over-distribute and transmit electricity due to the low voltage levels. High intensity accidents occur from extensive burns to destruction of vital body tissues and eventually death among citizens and electricians [3-4]. One of the most validated methods of identification and assessment is the SHERPA method, which identifies errors based on the principles of human psychology derived from task analysis [5].

**2. Material and Methods**

This descriptive cross-sectional study was carried out among the employees of Tehran Electricity Distribution Company, a main contractor, operating in one of Tehran’s power departments in 2016. The study population consisted of all electricians

employed in the main operation contracting company in 2016 with 66 employee work. The shift was a three shift system as (12-hour shift system). How to collect observation information, interviews with the electricians in the department and their supervisors and executives, and reviewing the guidelines and regulations of the Tehran Power Distribution Company and the Tavanir Instructions. The SHERPA technique was implemented using the following steps.

Step One: Hierarchical Tasks Analyze

All content is plotted as an HTA flowchart, as following (Figure 1) for one of the duties of an airline repairman.

Step Two: Tasks Classification

Step Three: Identifying Human Errors (HEI: Human Errors Identification):

Task classification leads the analyst to investigate the errors using downstream error classification. At this stage, the table of human error types in the SHERPA method was used (Table 1).

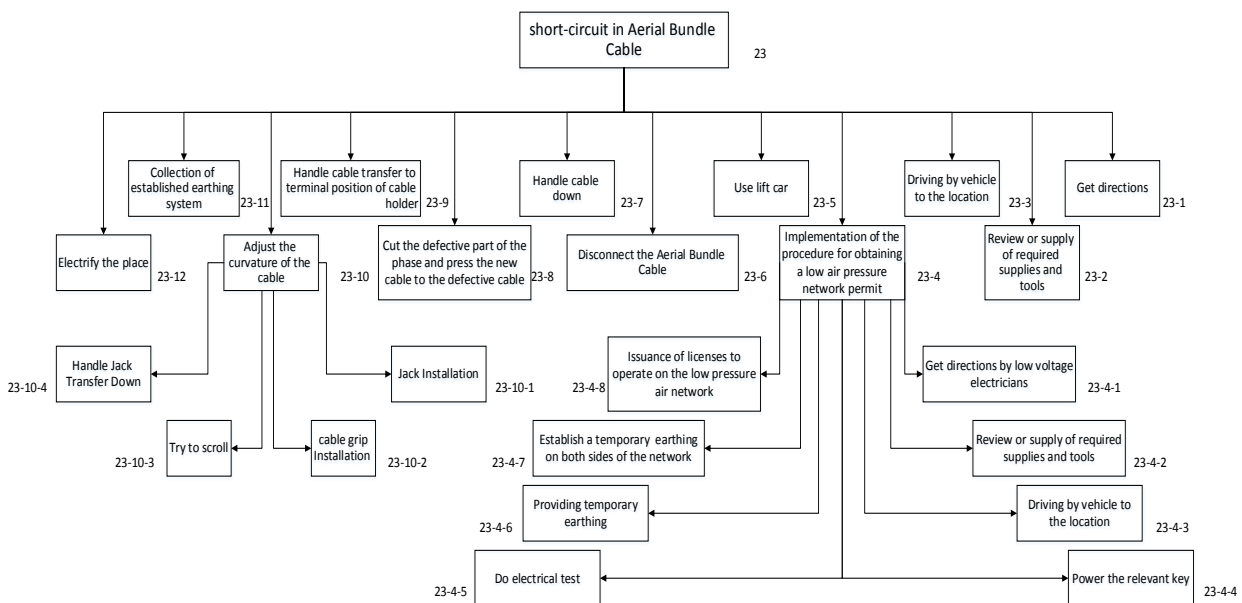
Step 4: Consequence Analysis

Step Five: Recovery Analysis

Step Six: Ordinal Probability Analysis

Step Seven: Criticality Analysis

Step Eight: Remedy Analysis



**Fig. 1.** An sample of a hierarchical task analysis

**Table 1.** Classification of Human Errors in the SHERPA Method [6-8]

Error description	Error code	Error type
The operation is done sooner or later.	A1	(Action Errors)
The operation is done in wrong time.	A2	
The action is done in the wrong direction.	A3	
The operation is performed more or less as necessary.	A4	
The wrong adjustment is done	A5	
The correct action is done on the wrong option.	A6	
The wrong action is done on the correct option.	A7	
The desired action is forgotten.	A8	
The operation is incomplete.	A9	
Wrong action is done on the wrong option.	A10	
Checking is missed.	C1	(Checking Errors)
The survey is incomplete.	C2	
Correct checking is done on the wrong option.	C3	
Error checking is done on the correct option	C4	
Examination is done at the wrong time.	C5	
The wrong check is done on the wrong option.	C6	
The required information is not available.	R1	(Retrieval Errors)
The information is presented incorrectly.	R2	
Incomplete information retrieval.	R3	
There is no exchange of information.	I1	(Communication Errors)
Wrong information is exchanged.	I2	
Information exchange is incomplete	I3	
The selection is missed.	S1	(Selection Errors)
The wrong choice is made.	S2	

### 3.Results and Discussion

Following the basic steps to complete the SHERPA Worksheet, the relevant completion table and an example of it are presented in Table 2. As can be seen in the Table 2, the SHERPA worksheet contains information on job tasks and the five common errors associated with each task - describing each of the errors in the fourth column of the table, as well as the consequences of errors based on accidents, interviews which presented in the fifth and the sixth column the level of risk based on predefined matrices of intensity and probability in this study was identified and In the last column, control strategies on the basis of , interviews, review of instructions, and approval and modification by managers and supervisors more provided.

After completing the SHERPA worksheet and examining it by statistical methods, a total of 488 tasks for the airline repairman electrician, 237 for

the electrician repairing ground and underground substations, and 34 for the low pressure maneuver electrician were identified and 3399 errors were identified. About 2160 errors (63.55%) related to overhead maintenance electrician, 1080 errors (31.78%) to the electrician repairing ground and underground substations, and 159 (4.68%) errors related to low pressure maneuver electrician. 39.57% of the errors were action error, 32.04% check, 7.32% retrieval, 19.4% communication and 1.80% selective errors. (Table 3)

Regarding the frequency of errors, action errors (41.57%) in overhead maintenance electrician job had the highest and selective errors (1.26%) in low pressure maneuvering job had the lowest share.

According to the results of the risk assessment, 12.47% of the errors were unacceptable and, 59.57% were unacceptable, 20.02% were acceptable but requiring revision and 7.93% were

**Table 2.** A sample of the completed SHERPA worksheet for the over head maintenance work

Control solutions	Level of risk	Error consequence	Error description	Error type	comment
implementation and training instructions*- Careful examination of location - full use of personal and group safety equipment - training correct executives on how to work safely	2C	Falling from altitude / Injury / Death/ Burn / Electricity / Network Damage / Increased Distribution Energy / Increased Consumption Costs / Increased Blackout Time	Installing the capacitor incorrectly on the correct beam / Installing the capacitor incorrectly on the wrong beam / Checking location forgotten / Checking location incomplete	A7 /A10/ C1/C2	Installation of capacitors on low pressure air lines
implementation and training instruction (OPD/W/09)-Detailed Site Checking – Teaching Executives How to Work Safely	3C	Network Damage / Increased Unsupported Energy / Increased Power Off Time / Increased Consumer Costs	Installing the capacitor in the wrong direction / Installing the capacitor incorrectly / Installing the capacitor in the wrong way	A3/A5/A6	

\*(OPD/W/09)-(SAF/W/03)- (OPD/W/13)-(OPD/W/23)-(OPD/W/07)-(SAF/P/01)

**Table 3.** General Status and Frequency of Errors (P= Percent, N=Number)

Total		Optional		communicational		Recovery		Review		operational Review		Error type
P	N	P	N	P	N	P	N	P	N	P	N	Personnel
100	2160	1.9	41	17.36	375	7.50	162	31.7	684	41.57	898	Airline repairman electrician
100	1080	1.67	18	21.76	235	7.41	80	32.69	353	36.48	394	Electrician repairing ground and underground substations
100	159	1.26	2	28.30	45	3.77	6	30.18	48	30.19	48	Low pressure maneuver electrician

acceptable without revision ( was safe). As a result, most errors at the risk level are undesirable and the least at the risk level are acceptable but need to be revised (Figure 2).

Regarding the frequency of error risk, undesirable risk level (66.47%) in the overhead maintenance electrician job had the highest risk level and acceptable risk level without the need for revision with (2.94%) in the electrician repairing ground and underground substations job had the lowest share.

#### 4. Conclusion

This study was one of the few studies in the country that has investigated human errors in electricity distribution Company. Using the results of this study can be effective in prevent human errors.

The results of the present study are in line with the results of many similar studies. The important result of the present study was that the most identified type of error is the type of performance and in order to reduce this type of error by using the necessary corrective measures such as selecting the right people in the right job, training, supervision Second, the use of smart machines, the use of tag out and check-in systems at the right time, and the updating of used instructions including selecting the right people in the right job, training, second-hand monitoring, using smart machines, using the system tag out and check in at the right time and update the instructions used, oven The error event is taken from the individual performance, which can reduce the risk of unacceptable considerable influence there. On the other hand, considering the

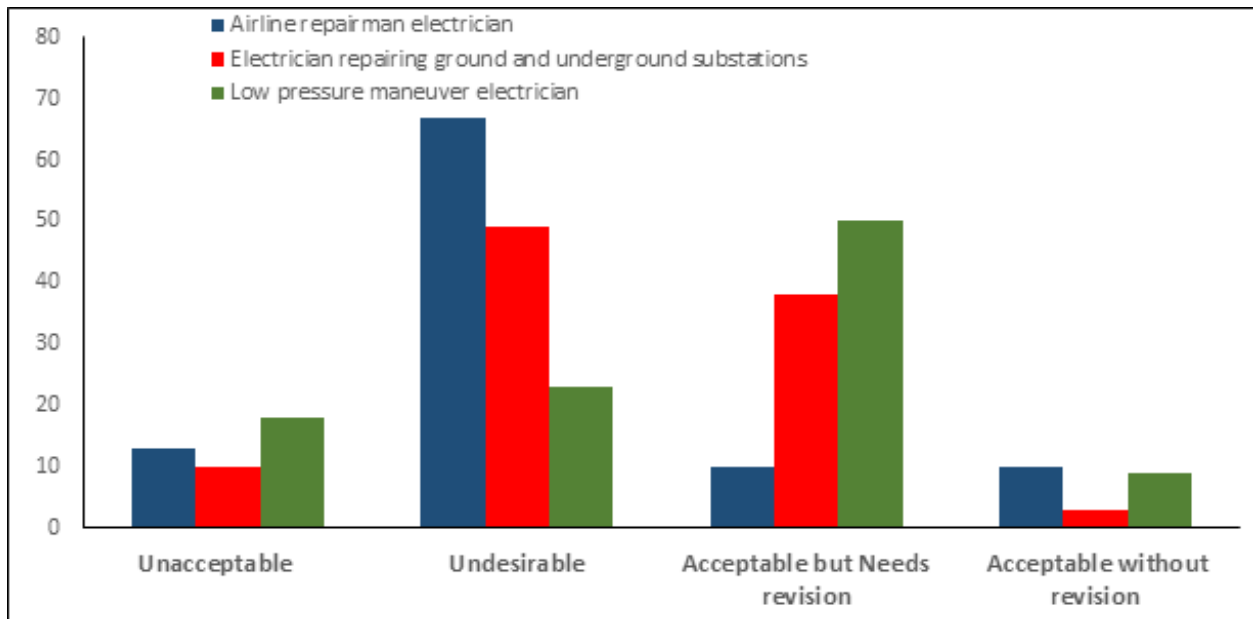


Fig. 2. The risk level of electrician job

results of this study, it shows that this technique is well identifying and evaluating the errors of electricians working in power distribution companies as a useful method.

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