Identifying the Causes of Accidents and Evaluating them Using the Tribod - Beta Method in the Electricity Industry

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Abstract

Examining the records of accident analysis shows that so far more direct and indirect causes of accidents have been dealt with and more rooting has not been done in the field of revealing the hidden causes of accidents. Unfortunately, most of the shallow analyzes of accidents focus on the obvious causes of accidents. If in the next steps it is necessary to identify the hidden causes of accidents that are usually hidden from the eyes of non-experts. In this article, while considering the obvious and hidden causes of accidents, the evaluation of two accidents that happened in the electricity distribution company of Chaharmahal and Bakhtiari province is discussed. By drawing the tree of each incident, the percentage of frequency of the causes of each incident is calculated. The results are as follows: Non-observance of safety principles with the highest percentage of frequency (66%) had the greatest impact on the occurrence of these accidents. The lack of supervisor supervision and non-observance of training have played a role in the occurrence of these incidents with the same percentage of frequency (33.3%).

Keywords: incident, Tripod-Beta, obvious causes, hidden causes, electricity industry

1. Introduction

According to the report of the International Labor Organization (ILO), there are 2.3 million occupational accidents leading to death, 160 million non-fatal work-related diseas and 317 million non-fatal occupational injuries worldwide [1]. With the expansion of electricity technology and non-compliance with safety requirements in the use of its energy, we always witness the occurrence of many accidents for the experts and employees of this field, as well as for the consumers of household and industrial electricity [2]. Since many groups such as exploitation, repair and renovation groups and ordinary people are exposed to electricity distribution network installations; The occurrence of repeated and sometimes shocking accidents in the electricity distribution network sector, despite the existence of comprehensive safety regulations and instructions and providing solutions after the accident and then forgetting it with the passage of time, strengthens the possibility that there is still no coherent system to investigate. There is no root cause of accidents in electric power distribution companies, and in the investigation of accidents, it is enough to identify superficial and obvious causes [3].

Therefore, it seems that the introduction of these superficial causes under the title of the causes of the accident has not solved

the problem and it shows the bitter truth that every incident has been repeated many times and we see that similar incidents with similar reasons are happening repeatedly. The causes of accidents are divided into two categories: obvious causes and hidden causes [4]. Unfortunately, most of the shallow analyzes focus on the obvious causes of these incidents. If in the next steps it is necessary to identify the hidden causes of accidents that are usually hidden from the eyes of non-experts. In this method, it is tried to consider the obvious and hidden causes in parallel in the evaluation and analysis of the incident [5]. Examining the records of accident analysis shows that so far more direct and indirect causes have been discussed and more rooting has not been done in the field of revealing the hidden causes of accidents. Therefore, the need to achieve a systematic method to investigate the root causes of accidents, motivated the authors of this article to find a way to achieve this goal.

2. Materials and Methods

This article introduces tripod beta method and its application in the analysis and evaluation of accidents that occurred in electric power distribution companies. By drawing the beta tripod tree, the author introduces the symbols and components of this method. In order to demonstrate the application of this method in the analysis of incidents, two incidents were selected as samples from the incident table of the electricity distribution company of Chaharmahal and Bakhtiari province and analyzed these two incidents. At the end, suggestions are made to improve the causes of accidents.

3. Tribot - Beta evaluation Method

Today, the use of hazard identification and risk assessment methods is expanding in various industries, so that currently there are more than 70 different qualitative and quantitative risk assessment methods and techniques in the world. These methods and techniques are usually used to identify, control and Reducing the consequences of risks is used. Most of the existing methods of risk assessment are suitable methods for assessing risks and their results can be used for management and decision-making regarding the control and reduction of its consequences without worry, each industry can use this method depending on its needs. have different advantages and disadvantages compared to each other. Therefore, one of the duties of the existing health and safety management system in every industry (HSE) is to check all the methods of assessing risks and dangers and choosing the appropriate method for implementation in the respective industry and organization. In general, it can be said that from the type of method used in risk assessment and the depth of its assessment, the ability of the existing safety system can be understood to some extent, and as a result, the safety management method in the mentioned industry [6,7]

Therefore, due to the high sensitivity of safety in the electricity industry and considering the unfortunate consequences, the need for continuous monitoring of reinforcement, evaluation and elimination of hazards in the field is felt. Therefore, after studying and reviewing the existing methods and techniques, the Tripod-Beta method in terms of cost, execution time, simplicity, ease of showing the relationship between human errors, training, imple-

mentation and implementation without the need for software, graphical description of the event and analysis Incidents have been selected from two aspects of control and defense in the electricity industry. The theory of this method is based on the Swiss cheese model, and due to its methodology and standard tables, it is widely used and cited in various organizations and industries. It provides relatively comprehensively. By using this method, it is possible to identify the superficial causes, preconditions, and hidden causes that caused the occurrence of unsafe behavior and conditions, determine the path of the accident, and identify the defects in the control and defense systems that are caused by failure to act. He stated that they caused the accident in time [8,9,10]. The basis of this analysis is based on three pillars, Hazard, Target, and Event. Tribod - Beta tree is as follows:

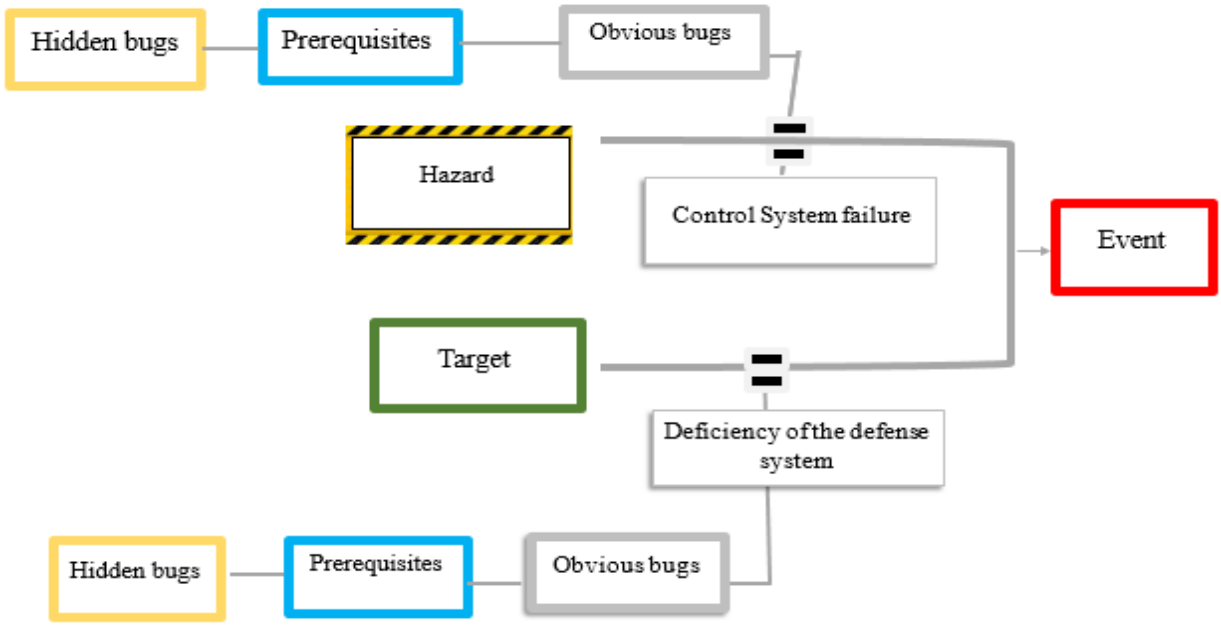

Fig.1. Tripod-Beta tree diagram

The method of analyzing incidents based on the Tripod Beta model

1. Draw the tree and determine the risk, goal and event
2. Specifying protection systems (control and defense)
3. Determining surface defects (unsafe practices or unsafe conditions)
4. Using checklists to determine preconditions and hidden problems
5. Determining the list of preconditions and hidden problems effective in the occurrence of an accident based on the checklist and entering them in the relevant table to manage hidden problems.

4. Tribod-Beta Chart Symbols

4.1. EVENT

An event is a change of state that results from the interaction of a hazard on a target. Important events in electricity distribution companies can be mentioned as: transformer explosion, medium pressure

electrocution, falling from the power base. [11].

4.2.HAZARD

It's either a source of energy, matter, or the potential to be harmed, or damag. Like heat, electricity, flammable chemicals, height[12]

4.3. TARGET

It is the subject or case that the risk has affected and probably caused damage to it, and it includes four groups as follows:

A- People (injury or damage to the health of personnel or third parties)

B- Equipment/capital (damage to unit or equipment, loss of materials, interruption or stoppage of operations, damage to third party capital)

C- Environment (damage and pollution in the environment)

D- Validity(mass media controversy, public attention, protest, prosecution, commercial restrictions, regulations) [13]

4.4. Superficial causes

There are problems that were identified in the initial investigation and are divided into two categories as follows:

• Insecure conditions (physical problems of control or defense)

• Unsafe actions (technical errors) [11]

4.5. Hidden causes

Hidden problems are inefficiencies or abnormal conditions that create preconditions. (These pre-conditions lead to superficial problems and are specified through a checklist) [14]

5. Routing and Incident Control by Tribod - Beta Method

The basis of incident control is the creation of appropriate control and defense systems in such a way as to prevent the intersection, collision and interaction of the risk factor and the target factor. It is obvious that when these control and defense systems are available or do not have proper function, the possibility of interaction between the two mentioned factors is provided and an event occurs. In this method of analyzing these systems, the causes of their malfunctions are determined.

To complete the model, it is necessary to specify the following:

✓ What control or defense measures were in place that did not work properly.

✓ What other control or defense measures were necessary in the place [15].

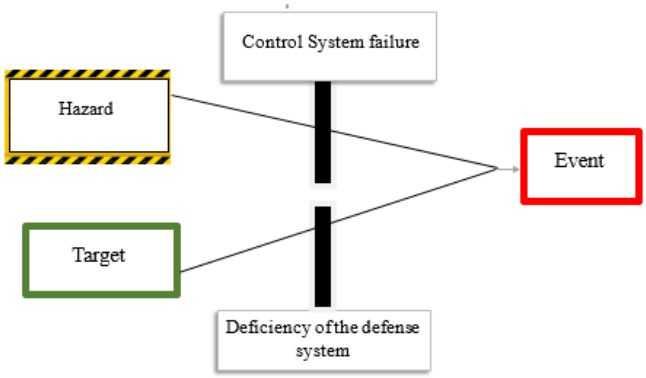

Fig.2. Events management diagram

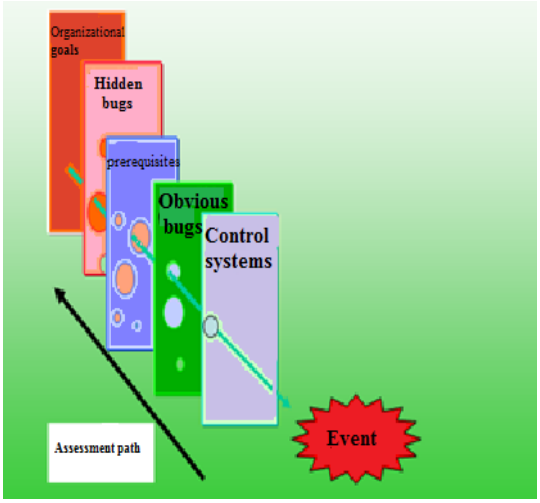

Fig.3. Path of finding the cause by the Tripod - Beta method

6. Case Study and Incident Description

A: Description of the incident 2019/09/14

In this article, the information of the personnel accidents of the contracting companies of Chaharmahal and Bakhtiari province electricity distribution company in 2019 was used.

On a sunny day in the middle of November of 2019 at around 12 noon, there was a public report that a branch of a tree collided with a low voltage network and caused

A connection is received during the wind in one of the villages of the region. At around 15:10, after visiting and checking the network, the colleagues of the operational group will start to repair the weak pressure network as described above. The lift is installed in the place and one of the simbaans (accident person) is installed in the lift basket and disconnects the branch connected to the electricity network. Then he proceeded to install the spacer, and during the installation of the spacer and after tightening three of the five network wires from top to bottom, he was electrocuted in his hand. The person accompanying him immediately separates the elevator carrying his injured colleague from the vicinity of the weak wire pressure network and transfers him down.

At the same time, one of the residents of the village called the 115 emergency service (after taking him downstairs and performing CPR, the deceased began to breathe. Meanwhile, due to the distance of about 15 kilometers from the accident site to the city center and the time it took for the ambulance to reach the place After the accident, the villagers moved to the hospital with a car, accompanied by their colleagues, during which the deceased again suffered a cardiac arrest and CPR was performed again until the ambulance arrived on the way. The deceased was transferred to the ambulance car, but unfortunately, transfer to the hospital and resuscitation did not work and she died. The tree of this incident by Tribod - Beta method is as follows:

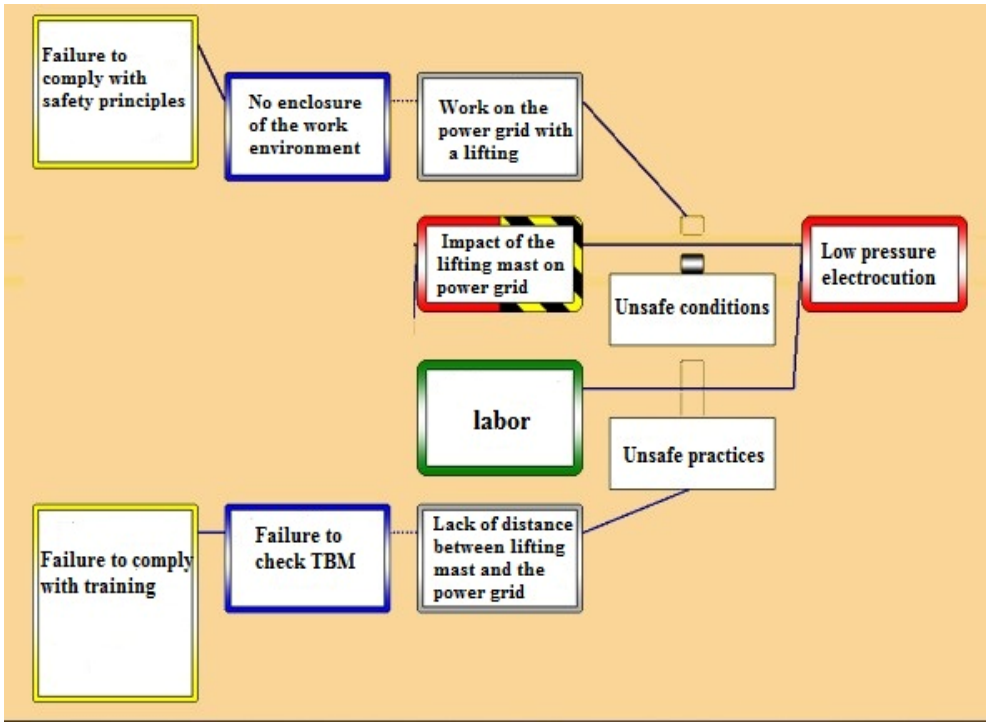

Fig.4. Tree of the incident dated 09/14/2019

B: Description of the incident 2017/03/31

The mentioned person is sent to the place to install the pole in the electricity distribution network. Without considering the safety instructions and not enclosing the working environment, the person fell into the hole dug for the installation of the beam and broke the person's right hand and left ankle. After the incident, the injured person was sent to the hospital. The Tribod- Beta diagram of the incident is as follows.

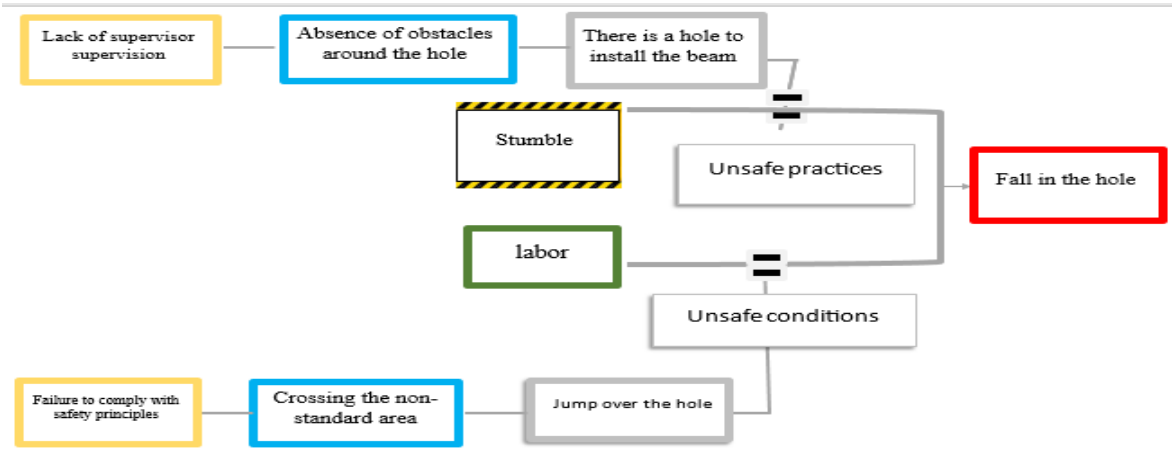

Fig .5. Tree of the incident dated 2017/03/31

According to the Tribot-Beta graph of the above incidents, the frequency table of each cause of the incidents is as follows:

Table 1. Frequency percentage

The cause of the accident	Percent
Failure to comply with safety principles	66.6%
Lack of supervisor supervision	33.3%
Failure to comply with training	33.3%

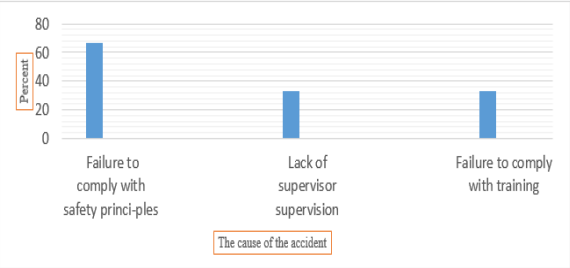

Fig .6. Frequency percentage chart

According to the frequency table of each of the causes leading to the accident, it can be concluded that Failure to comply with safety principles has had the greatest impact on accidents with a frequency of 66.6%.

7. Results

The obvious and hidden causes and preconditions of this incident are as follows:

7.1. Obvious causes

- Failure to use personal protective equipment
- Improper positioning and unsafe body position during work
- Not securing the conditions before doing the work (not covering the network)
- Doing the work in the wrong way
- Failure to carry out TBM before the execution of the work in order to identify the risks ahead and choose the safest and most technical way of doing the work (in such cases, the best reference for choosing the safe steps of the work is to refer to the safety regulations in the distribution department and the execution method depending on the type of work It is possible to say that acting on it will prevent the occurrence of an accident.)
- Unsuitable environmental conditions (surrounding the network by walnut trees and creating unsuitable conditions for the proper installation of the lift and safe work) the desired location in the annual pruning has not been fully pruned due to the fruitfulness of the tree and has created unsafe working conditions.

7.2. Prerequisites of the incident

- Absence of a codified implementation method for installing a network lock (spacer) in the weak pressure network, doing the work in the wrong way
- Improper supervision including the following
- Before doing the work: the supervisor has not visited and checked the personal equipment and properly secured the work environment.
- While doing the work: choosing the right path to do the work and removing the existing obstacles has not been done, and also the proper supervision for the work has not been done in the correct way in terms of technical and safety.
- False self-confidence and, as a result, doing work without using personal protective equipment (insulated gloves) and not paying attention to the supervisor's instructions
- Improper supervision of the employer (operating contractor):

The operation contractor, based on the contract and article 91 of the labor law, is obliged to inspect and supervise his

forces in terms of compliance with safety principles. In this incident, the failure to comply with this issue is evident.
- Inappropriate mental and psychological conditions.

7.3. Hidden causes

- Inadequate and ineffective risk identification, risk assessment and corrective measures
- insufficient and ineffective technical and safety training

Inadequate and ineffectiveness of safety culture

8. Suggestion

- Cultivation among Simban colleagues and working groups to perform TbM. Discussing the safest and most technical work method, choosing and agreeing to do it, the best reference for safe selection of work steps is to refer to the safety regulations in the distribution department and the implementation method depending on the type of work.
- Directly responsible pay a lot of attention to the important issue of the mental and psychological stability of Simbans when they are sent to do work, considering the high risks of working in power distribution networks, which may be the first mistake of a Simban person, the last mistake. It is obvious that Simban He must have enough concentration while doing work, which is not possible in inappropriate mental and emotional conditions.
- The use of personal and group protection equipment by simbaans and compliance with safety and technical regulations
- Explaining the advantages and importance of using personal protective equipment in preventing accidents for Simbanans (creating a culture of safety)
- Supervision of the employer (contractor) on the use of individual and group equipment of Simban forces under supervision
- High supervision of the company's experts and managers on the correct performance of workers and their employers (contractors) in terms of compliance with safety and technical regulations.
- Supervising the correct implementation of preventive technical measures in electricity distribution facilities to increase the reliability of the network and eliminate or reduce the risk for people and Simbans, including the correct execution of pruning in this incident.

9. Conclusion

In this article, we first introduced the Tripod-Beta method, and then, using this method, a real accident that occurred in the electricity distribution company of Chaharmahal and Bakhtiari province was analyzed. The tree of this accident was drawn and the obvious and hidden causes of the accident were discussed and suggestions were made to prevent such accidents.

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