A Review of HFACS Research

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Abstract

Safety accidents are common in all kinds of human activity whose reasons are various. In order to better analyze the causes of accidents, the Human Factors Analysis and Classification System (HFACS) was proposed under the efforts of many experts and scholars. HFACS is widely used in the fields of navigation, aviation, mining, medical care, electric power, construction and railway, which are closely related to human activities. The system can accurately analyze the human factors that have effect on the happening of accidents and can go back to the shortcomings of senior management of organizations by analyzing direct behavior that cause accidents, which has great significance in finding causes and good preventive measures of accidents.

Keywords

HFACS, analysis of human factors, management organization, Precautions.

1. Introduction

According to statistics, there are more than 300,000 people who died in traffic accidents each year, injured up to about ten million. There are many reasons for these casualties, which caused by ideological paralysis, illegal operation of up to 86%, leaders do not attach importance to safety, illegal orders accounted for 16%, other causes accounted for 14%. These figures indicate that the incidence of accidents is closely related to human factors. In order to better study and analyze the human factors in the accident, in 1936, WH Heinrich proposed the accident-causing theory, in which he thought that the accident occurred by several small events successive results. And with a domino to explain the causal relationship, that is, a card down will lead to the back of the dominoes fall in turn, when the last card fell when the accident that occurred. In 1953, Barr developed the theory of the aforementioned dominoes into the theory of "time chain", which believed that the previous factors of the accident were chain locks of events, a ring a ring, a ring set. Dr. Reason proposed the Reason model in 1977, linking each piece of cheese with an empty piece of cheese. If the hole in each piece of cheese was on a straight line, it would represent an accident.

The error management and system security experts Shappell and Wiegmann in 2001, combing the US military and civil aviation flight data based on the "Swiss Cheese" model of Reason, proposed the "Human Factors Analysis and Classification System", which was applied to the analysis of the cause of the aviation accident, then obtained the rapid development and wide application [1]. HFACS is composed of four levels of unsafe behavior, unsafe behavior, unsafe supervision and organizational influence. Each level is a causal relationship in turn, and we can find out the defects and disadvantages of each level, which can determine the cause of the accident and make corresponding prevention measures by analyzing from the direct unsafe behavior causing accidents to the upper story by turn.

The HFACS system was initially applied to the U.S. navy, which has a high proportion of accidents in areas closely related to human activities. Using HFACS framework, the U.S. navy identify nearly a third of all the accident is consistent with the conventional violations related. The navy can take

corresponding measures to intervene and reduce accidents related to the violations according to the trend. The HFACS system has been adapted to the high risk fields related to human activities closely such as mining, medical treatment, electric power and ocean shipping and it reduces the occurrence of some accidents and combines different management systems in their respective fields to develop the corresponding HFACS framework system.

2. The Human Factors Analysis and Classification System

In 1990, the Reason model was proposed by Professor James who was a professor at the University of Manchester in the United Kingdom and a conceptual model presented in his book Human error which was a psychology monograph [1]. With this model applied in accident analysis, in 1977, Dr. Reason proposed the Swiss cheese model for accident analysis, the meaning and structure as follows:

1> Each piece of cheese in the figure represents an event where the holes on a piece of cheese present error points and as soon as the holes on every piece of cheese are in a straight line where one or more error points are in the cheese pieces joined together, the accident happened immediately.

2 > An accident does not occur when the hole in a piece of cheese is not in a straight line.

3 > These cheese pieces joined together constitute a whole that Emphasizes the overall accident prevention capability when the holes in a piece of cheese doesn't cause an accident.

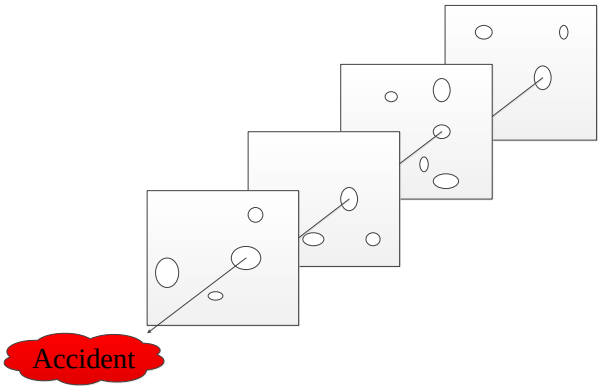

Figure 1 Swiss cheese model

Another approach to human factor analysis was the SHEL model first proposed by Edwards in 1972 and the model Frank Hawkins further improved in 1987 was widely applied to many areas afterwards [2]. SHEL model includes four elements that are the software, the hardware, the environment and the liveware, and the model was named after the first letter of the four elements. The human element is the most important in the system. The basic frame of the system is composed of the relationships between person and person, people and environment, man and hardware as well as the relation between man and software that is the four interface of the model. This square is serrated and only these interfaces are matched each other to coordinate the relationships between each interface can the system function properly. The model is shown in figure 2.

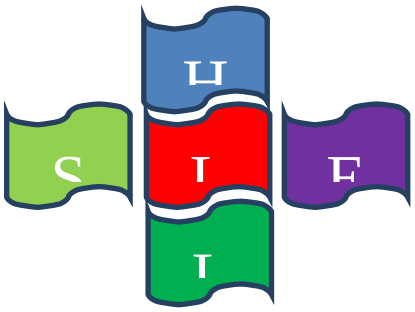

Figure 2 SHEL model

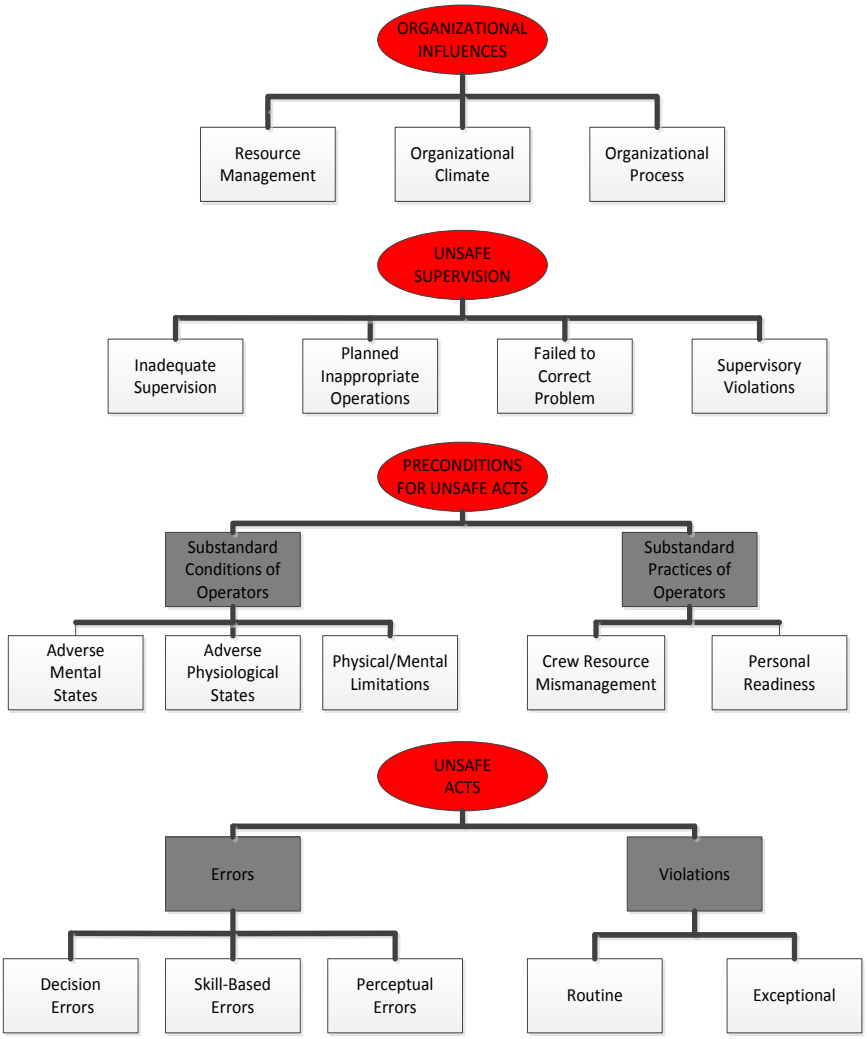

Figure 3 HFACS frame

Reason's "Swiss cheese" model does not elaborate the specific content of the holes in each piece of cheese, that is, the leaks in the system are not described in detail. Shappell and Wiegmann tried to carry out a specific description of the "hole" in the Reason model. In 2001, the "Human Factors Analysis and Classification System (HFACS)" was proposed by integrating the accident data of aero amphibious security center and civil aviation [3] and the model was the human factors accident model and accident analysis tool based on system theory that has been currently accepted by many people. HFACS is consisted of the four levels including organizational influence, unsafe supervision, preconditions for unsafe acts and unsafe acts [4]. And each level has its own specific elements. HFACS framework structure is shown figure 3.

2.1 Unsafe Acts

Unsafe behavior is the most direct cause of accidents, and there are two types: error and violation.

Error refers to a person's mental or physical activity that does not achieve the desired effect, such as the illusion causing an error in route selection and body tired without clenching the steering wheel, usually including skill-based errors, perceptual errors and decision errors, etc. Decision errors are due to the fact that the deciders don’t have the proper knowledge, even though "the mind is in the right place", choosing the wrong behavior ultimately. The skill-based errors is due to the fact that the individual itself make hasty decisions and take action without proper or adequate consideration of appropriate rules. Perceptual errors are behaviors that are made by the perception of the wrong information.

Violation refers to safety rules, safety regulations and the relevant safety rules and regulations of deliberately ignore [5], such as drilling bop is not regular maintenance, the Titanic carry lifeboat is insufficient, not with a telescope to outlook. Violations are not mistakes, violations and mistakes are people's unsafe behaviors.

2.2 Preconditions for Unsafe Acts

The precondition of unsafe behavior leads directly to the occurrence of unsafe behaviors. The precondition of unsafe behavior includes non-standard operating conditions and nonstandard operation of operators.

Non-standard operating conditions are divided into three categories: bad mental state, which can affect the mental state of normal work, such as depression, fatigue, malaise, etc. The term "bad physiological state" means that it is not possible to follow the pathological or physiological state of the safe operation, such as the effect of the pharmacological or medical abnormality on the staff, the hallucinations, the obstruction of the nose, or the cough, etc. Physical and mental limitations refer to the tasks that exceed the limits of the individual's ability to control, such as limited nighttime vision, insufficient understanding and reactivity, etc.

There are two types of non-standard operations for operators: poor communication between staff and managers, poor collaboration and execution of plans. The preparation state of the individual, such as the lack of rest of the staff, and the work before the work, can affect the individual cognitive accuracy.

2.3 Unsafe Supervision

There are four types of unsafe supervision due to management defects: lack of supervision, lack of guidance for operators, and less training for operators; Improper planning implementation means that the task plan is not implemented in the prescribed manner, such as unreasonable scheduling of operators, unreasonable task allocation, etc. Failure to correct known problems means that defects in individuals, equipment, training, or other relevant security issues have not been corrected and that defects continue to exist and develop; Regulatory violations mean that regulators intentionally fail to comply with regulatory regulations.

2.4 Organizational Influences

The wrong decision of senior management directly affects the management practice, the environment condition of the operator and the operation behavior. Organizational influence is divided into three categories: resource management, the allocation of hierarchical decision-making areas and the maintenance of organizational assets, such as human resources, monetary assets, equipment facilities, etc. Organizational climate refers to the working atmosphere that affects the performance of the staff, such as organizational structure, command, responsibility, etc. Organizational workflow refers to the rules governing daily activities of a company's decision-making and management organizations, such as an organization having a formal program to deal with emergencies of crisis staff.

3. HFACS Application Research

The application of HFACS in aviation is very broad and mature. On the basis of HFACS model, Wei et al. used the expert supervisor scoring method and the gray system theory to analyze the causes of human error in flight control and quantify the influencing factors to form a comprehensive analysis of qualitative and quantitative method [11].

Coal mine, Song Zeyang [6], such as in combination with the practical situation of coal mine HFACS model is established, and used chi-square and concessions than statistical analysis, it is concluded that lack of coal mine safety management system is due to the lack of culture and management of coal mine safety management regulation, to improve the safety management system to reduce coal mine accidents is of great significance. Zhao-bo Chen, etc. [7] to gas safety accident report and coal mine safety accidents as sample, using HFACS model for investigation and analysis, summed up the

loopholes in management and absence of management culture is the main cause of coal mine safety accidents. In terms of medical treatment, Milligan [8] analyzed the HFACS framework of medical accidents, and the results showed that education health has a positive effect on patient safety. Elbardissi et al. [9] conducted an HFACS framework analysis of human errors in cardiovascular surgery in the manner of interviews, revealing the interaction between factors in the HFACS framework. On the railway side, Baysari and other [10] have carried out HFACS framework analysis of 40 railway accidents in Australia. The results show that most of the accidents in the Australian railway are related to equipment failure. And [11], such as electricity, Li Yanbin HFACS model and grey correlation method is used to power grid in the accident hidden hazards are identified, and to estimate the degree of danger and has a guiding significance for hazard management work. With 130 electric power production accidents as samples, the HFACS model of electric power was constructed, and the chi-square test and concession ratio were analyzed by SPSS22.0, and the main reason for the accident was the organizational influence.

With the increasing maturity of HFACS model, HFACS model has been widely used in navigation. Marchelle ia et al. [12] proposed a maritime traffic accident by error analysis and classification system, for a maritime traffic accident error factors are classified, and using grey relation analysis to quantitative analysis of accident reasons that lead to the root cause of the accident. Christine term et al. [13] do to HFACS system changes and successfully applied to the navigation, pointed out the communication between the ship and the ship bridge resource management pilot for ship collision avoidance and the right of the impact of the dangerous situation get out of decision-making and don't follow the rules of safety management for the influence of the accident. The framework of the HOFs (Human and Organizational Factors), which is presented in [14] for maritime accident investigation and analysis, can reveal the Factors of each identified accident and the causal relationship between them. On the basis of FAHP (fuzzy level analysis), Celika et al. proposed the analysis of HFACS mechanism (analytical HFACS), improved the structure of HFACS model and extended to Marine accident molecules. Y. T. XI and other [15] have proposed an artificial factor data mining mechanism based on HFACS, which is used to analyze and quantify the maritime human factors that influence human error.

4. Conclusion And Future Research

HFACS has been widely used in aviation, navigation, power, medical, coal and railway. HFACS model hierarchy is clear, from the most direct cause accident to individual unsafe behaviors of organization and management conducted a comprehensive analysis, in view of the traditional is given priority to with individual investigation of the accident analysis is not comprehensive, incompleteness, the individual and to the deeper tissue multiple factors simultaneously, back from the surface to the deep reasons, find the most fundamental reason, for preventing safety accident and formulate the corresponding safety regulations have important guiding significance.

HFACAS to a certain extent, explain the cause of the accident, the accident prevention and remedial measures at the time of the accident is still need further perfect, and the preventive and remedial measures were put forward by the actual experiments. Although the HFACS system has been widely used in many fields, there should be a lack of data support for cross-domain usage, and the actual data analysis of the field is needed.

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