DEVELOPMENT OF HUMAN FACTOR ANALYSIS AND CLASSIFICATION SYSTEM FOR OCCUPATIONAL ACCIDENT ANALYSIS IN PROCESS INDUSTRY

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Occupational accidents still occur frequently and continue to increase even though many regulations/standards/directives have been issued. The number of accidents and deaths in the industry continues to increase. In this study, 30 occupational accidents in process industries between 2011 and 2021 were examined. This study proposes a customized Human Factor Analysis and Classification System for Process Industry to accommodate occupational accident investigation in the process industry. Development was made to the initial HFACS by adding a new level of external factors. The Preconditions for unsafe acts level was modified with 3 different divisions from the initial HFACS of environmental factors, team management, and individual factors. With this customized HFACS, 155 factors were identified through the analysis of 30 workplace accidents in Process. Supervision was the most common factor, at 22%, highlighting inadequate supervision.

Key words: HFACS, Human Factors, Accident Analysis, Process Industry

INTRODUCTION

The National Labor Force Survey (BPS Ketenagakerjaan) in Indonesia has reported a significant increase in workplace accident casualties in 2021, with 234,370 reported cases, compared to 221,740 in 2020. Notably, fatal accidents in the country surged by 92.14% in 2021, reaching 6,552 cases, up from 3,410 in 2020. The worst accidents in the history of the process industry happened in 1984. The accident occurred in Bhopal resulting in 2500-6000 deaths and more than 200.000 injuries (1). Another process industry accident occurred in Flixborough, North Lincolnshire in 1974 resulting in 28 deaths, this accident injured 36 people on-site and 53 people off-site with severe injuries. The disaster also destroyed 1821 houses (2).

Workplace accidents in the process industry sector are often attributed to human factors, in addition to other factors such as malfunctioning equipment, inadequate safety measures, a lack of lockout procedures to prevent unintended operations, or insufficient experience (3). Accidents may stem from complex interactions among individual failures, equipment shortcomings, inventory issues, or environmental factors deviating from expected behavior.

Consequently, the need for accident investigation becomes paramount. Such investigations aim to determine how and why failures occur in the workplace, with the ultimate goal of preventing similar or more severe accidents in the future. It is important to emphasize that the purpose of accident investigations is prevention, not blame (4).

Accident investigations can be conducted using various methods, one of which is the Human Factor Analysis and Classification System (HFACS). HFACS is built upon the Swiss Cheese Model, which was originally proposed by James Reason to address systemic failures. Reason (1990) extended the Swiss Cheese Model by illustrating layers of human failures within an organization contributing to accidents. These layers, depicted as hole-riddled slices of Swiss cheese, represent deficiencies at each level. This model focuses more on the system than individual and arbitrary actions that lead to workplace accidents (5).

The Human Factor Analysis and Classification System (HFACS) is a common method for examining human errors. It was developed with a specific perspective on the purpose of accident investigations. HFACS has been developed and applied in various industrial contexts. Shappell, et. al. structured HFACS into four main levels based on the active and latent failure concepts within Reason's Swiss Cheese Model, namely, unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences (6).

Modifications to HFACS have been widely applied in diverse accident contexts. One adaptation includes integrating Fuzzy Set Theory and Bayesian Networks to quantitatively investigate gas leakage accidents (7). Furthermore, HFACS has been extended to analyze passenger ship accidents, resulting in "Human Factor Analysis and Classification System for Passenger Vessels" (HFACS-PV). This modification involves examining accident databases from various accident investigation committees and organizations related to passenger ship accidents (8). However, modifications for the process industry in Indonesia are not available yet. HFACS was originally designed for military aviation accident investigation and then began to be applied to various sectors. For accident investigation and analysis in other sectors, HFACS cannot be directly applied and needs to be modified.

The aim of this research is to comprehend the factors associated with workplace accidents in the Process industry sector, which is of paramount importance as it forms the foundation for the development of a novel HFACS model tailored to the Process industry. The newly developed HFACS can serve as a valuable tool for investigating workplace accidents.

MAIN RESULTS

This study extended the Human Factor Analysis and Classification System (HFACS) to assess workplace accidents in the Process sector, introducing five hierarchical levels, including an added layer for external factors. Some developments were made in original levels such as *organizational influences*, *preconditions for unsafe acts*, and *unsafe acts*. The development of HFACS for occupational accidents in the process industry can be seen as figure 1.

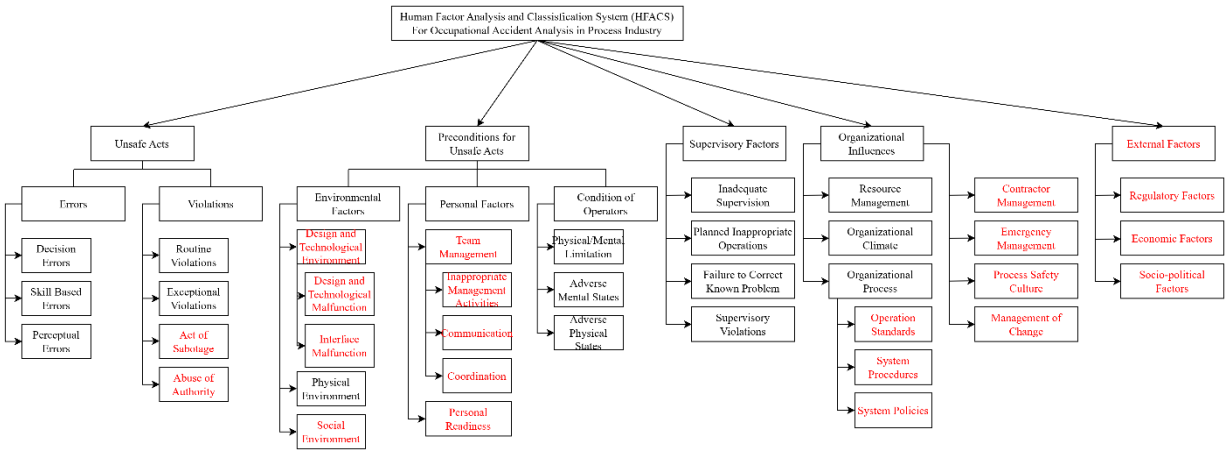

Figure 1. Modifications of HFACS for Process Industry

The modified HFACS model encompassed five levels: external factors, organizational influences, supervision factors, preconditions for unsafe acts, and unsafe acts. In the realm of organizational influences, organizational culture, operational processes, and resource management played crucial roles. Particularly, some factors/subfactors/sub-sub factors become the most common from 30 occupational accidents data. There are skill-based errors, socio-political factors, economic factors, organizational climate, design & technological malfunction, and inadequate supervision.

CONCLUSION

Our study introduces a HFACS modification for investigating workplace accidents in the process industry sector, encompassing an additional tier and adjustments to preconditions for unsafe acts. This adaptation effectively classifies both active and latent failures, providing a robust framework for analyzing accidents in the process industry. By considering actual accident investigation data from process industries, we conducted a frequency analysis to unveil the causal factors and their relative priorities, offering a valuable resource for accident prevention in the process industry. This modified HFACS framework enhances our comprehension of the process industry's workplace accidents, and its compatibility with future research in this domain can be explored.

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