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**HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM (HFACS) MODEL IN ANALYZING CONSTRUCTION ACCIDENTS**

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| **ARTICLE INFO** |  | **ABSTRACT** |
| *Article history :* |  | *Industrialization development which is being implemented in some areas is increasing rapidly. There are over one hundred thousand construction companies in Indonesia. Thus, the risk of accidents in the construction field is also likely to increase. Moreover, Indonesia is one of the countries with the highest construction accidents according to the accident rate on the ASEAN. This will cost a great loss. The Indonesian construction industry should conduct a deeper investigation into the problem so that improvements would significantly decrease the accident rate. This research aims to obtain the result of the first modification of HFACS models to be implemented in the companies. Thus, it is expected that there is a correction to the dominant factor. HFACS model is an accident investigation method based on the human error factor. This research is generally divided into three steps. There are preliminary, data collecting, then conclusion and recommendation. Based on the explanation above, it is obtained that the development of the HFACS model is by adding the level of an external factor, which obtained 1,2% in the construction industry. Through the recommendation based on the result of this research, be expected that construction companies in Indonesia could make continuous improvements to reduce the accident.* |
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**INTRODUCTION**

Building workers in the construction sector have a lot of risks in carrying out their work. This is because the construction services industry has a high working intensity, a considerable length of time, the working period of the target, relatively low education as well as many involving abusive labour. On the other hand, the equipment used is also diverse and has a high risk of danger. According to Findley, et al., (2004) The construction field industry continues to provide a disproportionate amount of work accidents both fatal and non-fatal. The number of construction accidents in Indonesia is also quite high that is 31% (Saputra and Herliafifah, 2015). In ASEAN, Indonesia peaked at number five for the highest construction accident based on accident figures (Endroyo and Tugino, 2007). The high number of occupational accidents in the construction service industry certainly resulted in losses from many things. These losses have an impact not only for yourself but also the company and the environment. To reduce the number of losses incurred, it is necessary to achieve the achievement of ' zero accident ' in the construction site. The results of the evaluation were done by the construction and Human Resources Development Agency (2007) which mentioned that several factors are causing the accident, among others: not involved in the construction experts, the lack of the quality and quantity of availability of personal protective equipment (PPE), weak supervision on the implementation of OHS and construction supervision in the field, the use of improper methods, not fully implement The factors causing the accident is very related to human.

This study used the HFACS model because this model is still used in several industries. The HFACS model is a structured, modifiable model and not only examines accidents caused by operator accidents but also examines the aftermath of human error, though to find a specific result needed more in-depth study (Lenne et al., 2011). HFACS models have not been the perfect model for investigations, so HFACS models require modifications (Paletz, 2009). According to Hughes and Ferret (2008) that the main point of influence external to OHS construction is societal. Therefore, the development of the HFACS model will be done by adding the most tip layer that is external factors (outside 4 layer model HFACS). The examined aspect is the dominant causal factor by implementing the proposed development of HFACS models.

**RESEARCH METHOD**

 2.1 Study of the development of HFACS and Accident report data collection

This research was conducted using a qualitative model, which is a process of research and understanding based on a social phenomenon and human problems. The HFACS model proved to be a good model for identifying accidents (Beaubien and Baker, 2007). The development of the HFACS model in this study was carried out by adding a fifth layer recommended by Yamin (2013), Hughes and Ferret (2008), namely external factors (regulatory and social). External Factors are factors that cause accidents that are outside the scope of a construction company. External Factor is a layer that will be tried to be added in the HFACS Model layer to be applied in the construction of PT X Indonesia. According to Dambier and Hinkelbein (2006) in the world of aviation, aircraft accident analysis that has occurred is an important basis for the safety of further flights. It can be concluded that accident report data is very important, as well as in the field of construction in Indonesia. The data collected for this study is the final report of a construction accident in the company of the year 2011-2015. The number of reports collected is more than 50 final reports of accidents in the field of construction.

2.2. Data processing

The final report that has been collected as a whole is then processed using the HFACS model. The stages include: reading the accident report on construction, identifying the causes of the accident, classifying the causes of the accident that have been identified into the taxonomy of the HFACS model and making a summary of the results of the classification. The respondents for this interview were the target users of the HFACS model, namely practitioners in the safety field (Wang, et al., 2011). The questions raised are about the causes and chronology of an accident related to human factors.

2.3. Analysis and Discussion

Analysis of the classification of the HFACS model was carried out to determine the percentage of the human factor involved in a crash accident. This percentage is then compared with the percentage results found by the company and other research on human factors in construction accidents. The next step is to adjust the model for the company PT X. Adjustment here is more on defining and detailing each factor by following under PT X because the guidelines that exist to date are generally for the transportation industry. After making adjustments, classification is carried out on all data that has been collected. After analyzing the results of the classification of 50 accident reports contained in the company, it can be analyzed as the causes of construction work accidents. The dominant factor can also be seen from the results of the analysis that has been done.

2.4. Discussion of Settlement Recommendations and Drawing conclusions

The last discussion is to get a recommendation for a solution to minimize recurrence in cases of work accidents. By knowing the influential factors, improvements can be determined that can be applied by the company. The method of providing recommendations for completion uses references from Hughes and Ferret (2008). The conclusions made must be able to answer the research objectives. The purpose of this study is to get an initial modification of the HFACS model that can be useful to be applied in the construction industry. Making recommendations is intended so that HFACS can be developed even more in Indonesia.

**RESULTS AND DISCUSSION**

3.1 Analysis of the Results of the Alleged Development of the HFACS Model

The HFACS Model has not been a perfect model to be used in investigations, Therefore the HFACS Model requires modification (Paletz, 2009). The HFACS model was first developed in the United States, so the observed condition is in the United States and it is different from the conditions in Indonesia. This research proposes to modify the HFACS Model by adding external factors. It has been confirmed by Hughes and Ferret (2008) that one of the causes of construction accidents is the company's external influence. Based on the classification causes of the accidents using the HFACS model, it is found 36% caused by unsafe acts. The second-highest layer causing construction accidents is a precondition for unsafe acts, which is 31.3%. Unsafe supervision also affects 20.1% and organizational influences 11.4%. As for the fifth layer, external factors are 1.2%.

3.1.1. Unsafe Acts

Figure 1. Percentage of Factors that Cause Unsafe Coating Acts

Based on Figure 1, the most dominant factor causing the accident is skill-based which is included in the category of errors in the unsafe acts layer. As many as 29% of skill-based causes unsafe acts in accidents followed by routines included in the contraventions category with a percentage of 53.1%. Means the root problem of workers who perform unsafe acts are skill-based errors and routine contraventions. Examples of actions included in the routine contravention category found are workers not using PPE (Personal Protective Equipment) when doing work. Another example of actions that fall into the category of skill-based errors is that the worker does not tidy up or put the equipment in its proper place.

3.1.2. The Precondition for Unsafe Acts



Figure 2. Percentage of Factors that Cause Precondition for Unsafe Acts

Based on Figure 2, the most dominant factor causing the accident was a technological environment of 37.3% which is included in the category of environmental factors in the precondition for unsafe acts. Also, the physical environment is included in the category of environmental factors with a percentage of 27.8%. Occupational accidents caused by technological environments such as broken machines, old equipment or materials that are not suitable for use. The root problem of this factor is companies and supervisors who do not care about small things such as the condition of tools/machines. However, if compared to the occurrence of accidents due to the device, the cost of loss can even exceed the cost of periodic maintenance, even up to many times.

3.1.3. Unsafe Supervision

Figure 3. Percentage of Factors that Cause Unsafe Supervision Layer

Based on Figure 3, the cause of the unsafe supervision layer occurred in the category of supervision violations by 34.6%. The role of supervisors is very important in minimizing work accidents. The supervisors in this company have done their job well enough. This is because, in this company, SHE (Safety, Health and Environment) managers often visit projects to control and monitor the development and progress of the project from all aspects including work safety. It is just that the briefing about OHS is done once a week.

3.1.4. Organizational Influences

Figure 4. Percentage of Factors that Cause Organizational Layer Influences

Based on Figure 4, the organizational process and resource management have the same number in causing accidents. In this company, the influence of the organization is good enough in dealing with work accidents. It is proven by the company always coordinating well about accidents between the project head and the SHE manager.

3.1.5. External Factors

Figure 5. Percentage of Factors Causing External Factors

In this layer, the factors causing construction accidents to get a percentage of 1.2%. This figure is obtained from 50 accident reports classified according to the existing HFACS model layer. Based on this, it is necessary to anticipate the causes caused from outside the company. Causes that occur such as being hit by a car where the driver is sleepy. This should be anticipated with clearer and stronger project boundaries.

3.3. Development of External Factor Layers in the HFACS Model

The external layers of the factor are regulation and societal. After the criteria are found from the analysis results, then validation is done using case study validation techniques. It is done by paying attention to 4 things which are, construct validity, internal validity, external validity, and reliability. Additional validation of the development results was carried out through interviews with construction experts and observers in Indonesia. Interviews were conducted with professors in construction management and engineering. Both of these experts were asked to provide views on the results of research and efforts that could be made to reduce the number of construction accidents in Indonesia. From the results of the interview, one of the professors agreed that indeed indiscipline of most workers was the main cause of accidents. Also, based on the viewpoint of the top manager's area, resource persons A and B, said that in fact all causes are related. Occupational health and safety (OHS) will not run smoothly if there is only one person who does not support this program

**CONCLUSIONS**

 a. There is an external factor in the context of the construction industry, with a figure of 1.2% of all reported accidents that have been studied and are the early modification of the HFACS model.

b. Recommendations are made to employees, supervisors and companies to improve the OHS system on each project:

● Creating such work-related systems: selection based on education and the ability to work with APD and training for workers at the start of project work.

● Briefing the OHS every day before doing the job.

● Implement a new program such as sticking to a major injury.

● A supervisor who needs more discipline and who wants to enforce rules.

● Regulatory enforcement and feedback systems.

Improvement efforts are made to address the root of the problem so that no accidents are caused by similar causes and can wish to implement the model HFACS in each accident report to perform more structured and more complete evaluations.

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