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A system dynamics approach for modeling construction accidents

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Abstract

A construction project is prone to occupational accidents due to its dangerous characteristics and unpredictable changes. Occupational accidents can be caused by members of the supply chain, namely the parties involved in construction projects, from the management to workers, working environment, and work stress related to targets, costs, quality, and time. An accidents will cause an impact to costs, especially OSH costs. Therefore, it is important to know variable correlation that causing the accident.

Various studies have been conducted to determine the variables causing accidents and the influences of occupational accident on the performance of a construction project, especially the cost. However, the studies are uncompleted, they do not comprehensively describes the relationship between the causes, accidents, and its influence on the supply chain. A system dynamics approach is a simulation method in solving real-world problems to describe relationships among variables in complex real systems. The simulation method for the analysis of occupational accidents in the construction project is considered appropriate because of the probabilistic characteristic of variables that influence it. The resulting model describes the process of occupational accidents and the direct and indirect cost incurred. In the end, the model generates OSH cost components that need to be controlled as well as improvements in the supply chain of subcontractors and supervisors to enhance the quality of workers.

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1. Introduction

Occupational Safety and Health (OSH) is very important and can't be separated from a production process that involves people, including the field of construction. Occupational (work) accidents that occur not only bring financial loss to a company, but also can cause workers death, as well as long-term loss for the company, workers, and workers' families. These problems happen not only in Indonesia but also in other countries in the world.

In general, high rates of work accidents in construction industry are due to several things, as declared by [1]. Starting from unique properties or working characteristics, moving work locations, open space working conditions heavily influenced by the weather, limited execution time and tight schedule, types of works which are dynamic and require high physical endurance, as well as unskilled workers and weak implementation of OSH. Reference [2] confirms that the safety management and safety protection system are also the causes of high work accidents in construction industry.

Construction and manufacturing works have different characteristics. As expressed by [3] that the differences in characteristics can be seen from the human resources qualification involved, quality standards references, method of purchasing goods or materials, and methods of storage of goods or materials. In the construction works, OSH must be highlighted. Failure of OSH management in construction works can lead to failure and loss of construction works for contractors in implementing the construction projects.

The implementation of construction projects are generally divided in several stages. According to [4], the stages are feasibility stage, design stage, construction stage, and operation stage. Construction stage is the most prone to work accidents because in this stage the entire construction project resources are used and they interact each other, thereby increasing the risk of work accidents.

Reference [4] in their study mentions that the risks of construction projects include cost, time, quality, safety, and environment. Controlling construction project risks is the responsibility of construction project management by involving the existing resources. Planning, operation, management, and control are performed thoroughly and in integrated manner toward the five risks on all existing supply chain to achieve the goals of the project, especially zero accident for OSH management.

Referring to [5], construction work accident can cause human tragedy, demotivate workers, disrupt activities, delay the progress of the project, and affect cost in general, as well as affect the productivity and reputation of the construction industry. Rate of construction work accidents in the types and the number affect the overall project costs and OSH cost in particular. Therefore, the rate of occupational accidents need to be controlled so as not to negatively bring impact beyond the ability of contractors which can inhibit the implementation of construction projects.

Occupational accidents can occur because of two factors: unsafe conditions and unsafe action as disclosed in [6]. A triggering factor for unsafe action is the low awareness of worker safety in the workplace. This can occur in the level of workers, who ignore safety regulations, as well as the management, who does not pay attention to OSH management.

Reference [6] states that construction workers are closely related to unsafe behavior. A study on construction workers in Hong Kong, involving Chinese and non-Chinese workers, investigated the reason why a high number of occupational accidents occurred in construction projects by collecting information on age, work experiences, and work environment, as well as through interviews with construction workers.

Every construction work accident will bring impacts. As described in [7], the impacts of which are (1) in terms of workers, pain, disability, and death; (2) in terms of project activity, disturbing the smooth running of the project, delay in project completion, or termination of the project, and cost overruns for project completion; and (3) in terms of time, as well as additional expenses, and delay in the implementation of the project. The cost mentioned is the one not included in accident insurance, namely cost due to work accidents and due to delays in project activity.

In more detail, [8] describes that risk financing is allocating funds to handle or cope with particular risks. The costs incurred to evaluate the cost of accidents, injuries and deaths are:

1. Direct costs of injury and death
2. Indirect costs of injury and death
3. Occupational Safety and Health Program costs, consisting of three elements: (a) inspection to supervise the implementation of OSH; (b) prevention to prevent the risk of OSH; and (c) accidents due to the OSH risks.

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