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Identification of factors affecting the accident rate in the construction industry

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Abstract

The construction industry is one of the most accident-prone sectors of the Polish economy. There are many causes of accidents and they result from the factors that occur in the working environment. These factors, in favourable circumstances, can significantly increase the probability of a hazard becoming operational and leading to an occupational accident. The article presents the most important factors affecting the development of accidents in the construction industry, which were identified on the basis of surveys. These factors are divided into three groups due to their location in the construction work environment and its surroundings. Mutual relations between the identified factors are graphically presented in the form of the cause and effect diagram of Ishikawa. The relation between the value of construction and assembly production and the accident rate in the construction industry was calculated using the correlation coefficient.

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1. Introduction

Data published by the Central Statistical Office show that the construction industry is one of the most accident-prone sectors of the Polish economy [1]. Based on analysis of post-accident protocols, it can be stated that there could be several causes of an accident and that they may be very different. Causes of accidents result from many factors that occur in the work environment, which in favourable circumstances can significantly increase the probability of the hazard becoming operational, and in consequence leading to an occupational accident.

The purpose of the article is to identify and systematize the most important factors and direct causes that affect the occurrence of accidents in the construction industry. Such analysis will enable the cause and effect relations leading to an accident to be determined, and indicate the directions for further research that would aim to develop tools to reduce the occurrence of hazards in workplaces in the construction industry.

2. Analysis of occupational safety in the systemic approach

Each building site is part of a larger system i.e. a building enterprise. The system is a concept attributed to a certain community that creates a logical integrity that is separated from the environment. The environment affects the system via input quantities, while the system interacts with the environment through output quantities. By separating the system from the environment, we neglect those impacts which, due to the purpose of research, are not relevant. Figure 1 shows the general scheme of the system i.e. the building enterprise. In analysis concerning occupational safety in the construction industry, factors that have an impact on the accident rate and are generated by the enterprise's environment are significant. The accident rate is then expressed as the number of occupational accidents. The environment of the system is divided into, among others, closer and further or internal and external [2].

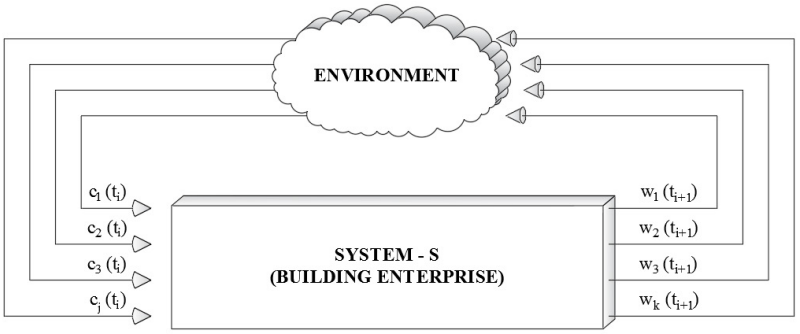

Fig. 1. General scheme of the relations between the environment and the system

A vector of input variables is created from the factors that generate hazards – $c_j(t_i)$. As a result of the operation of the system, these factors are transformed into output values $w_k(t_{i+1})$, which in occupational safety analysis are occupational accidents, potentially accidental events, occupational diseases and material losses. The cause and effect relation described above can also be presented in the form of the relation (according to [3]) presented below:

$$s\colon c\,(t_i) \rightarrow w\,(t_{i+1}), \qquad t_i < t_{i+1} \tag{1}$$

$$c = \begin{bmatrix} c_1 \\ c_2 \\ \dots \\ c_j \end{bmatrix}; \qquad s = \begin{bmatrix} s_1 \\ s_2 \\ \dots \\ s_n \end{bmatrix}; \qquad w = \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_k \end{bmatrix}; \tag{2}$$

where:

c – the vector of input variables (factors that generate hazards)

w – the vector of output variables (w_1 – occupational accidents, w_2 – potentially accidental events, w_3 – occupational diseases, w_4 – material losses)

s – the process state vector