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Risk-based construction site layout planning

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ABSTRACT

Over the last decades, the problem of construction site layout planning has received more and more attention, proportionate to its importance for the construction process. Construction site layout planning is a complex problem, which involves the selection of the locations within the site boundaries of all the necessary facilities for the implementation of the project. Incorrect choices during the placement increase the chances of congestion or excessive farness of facilities on the construction site, which in turn lead to increased costs for transporting materials and machines, delays in completing tasks, lowering the overall level of safety, and last but not least, accidents.So far, in the existing literature, multiple criteria have been examined for the layout problem, such as total travel distance, transportation costs and some environmental and safety factors. However, a complete importation of site risk analysis has not been made to the process of the construction site layout problem. The aim of this work is to develop a model that imports the results of the risk analysis into the process of tackling the problem of construction site layout.In the part of risk analysis, all the risks were identified for each facility and their level was examined. The risk level (RS) is a function of the two classical parameters, the probability and severity of the risk, and a new parameter, the detectability of risk. In order to address the uncertainty in the valuation of these parameters and the calculation of the risk level for them, trapezoidal fuzzy numbers were used. The objective of the model is to minimize the overall weighted Euclidean distance between the facilities. The weights take values from the combination of the risk levels of each facility and the user's judgment of the relative position of the facilities. The user chooses whether the facilities should be close, far or indifferent, while the risk levels adjust how important this position is. The optimization process is carried out using genetic algorithms, due to their ability to find optimal solutions, in MATLAB 2018a, a numerical computing environment.The proposed model was examined in an example involving a construction site of 3.300 m2 with a building under construction and nine necessary facilities. The same problem was also presented to two civil engineers, one inexperienced and one experienced in construction site management, in order to compare the model with field practice. The results showed that the model provides optimal solutions in a short period of time, which only take into account the results of the site risk analysis. The methodology enables the site engineer to include in the selection of the positions of the facilities the risk factor as a whole, which until now has had limited influence over the process.

KEYWORDS

Risk analysis, Site layout planning, Genetic algorithm, Optimization