Proceedings of the 2017 Winter Simulation Conference
W. K. V. Chan, A. D'Ambrogio, G. Zacharewicz, N. Mustafee, G. Wainer, and E. Page, eds.

APPLYING LEAN PRINCIPALS FOR AN INTEGRATED PROCESS-BASED APPROACH TOWARDS IMPROVED SAFETY IN BUILDING CONSTRUCTION

Dr. Jürgen Melzner

Bauhaus-University Weimar
Marienstrasse 7A
99423 Weimar, GERMANY

ABSTRACT

In the very competitive construction business construction companies looking for methods to improve their processes. The accident rate in the construction industry is the highest rate among all industries. Lean Construction methods offer opportunities to a comprehensive job hazard analysis. The nature of construction projects are separate stages in the planning process. Modern technologies, such as Building Information Modeling, are offering an object-orientated planning approach. This paper solves this problem by applying a lean-process-orientated job hazard analysis based on Building Information Models (BIM). The proposed system generates 4D-visualizations of processes by applying lean construction principals. Thus, safety hazard can interactively detect, accessed and communicated in an early stage in the planning process (Melzner et al. 2013). The aim of this research is to allocate process risks and hazards, and to implement these in a 3D building model of an actual construction project and simulate different scenarios.

1 INTRODUCTION

Construction remains one of the most risky professions in the industrial sector. The main reasons are the constantly changing construction environments, the inconstant personnel situation and decreased budgets on construction projects. To act preventively, an attempt will be made to integrate safety regulations and scheduling rules in an object-oriented building model. A review of the latest aspects of hazard analysis and safety planning indicates that there is no integrated planning tool that would combine safety regulations and a particular project. The literature indicates that 2D drawings are still commonly used for many building projects (Melzner et al. 2014). All data and correlations between components are evaluated manually and text-based checklists are used. Another issue in safety hazard detection is the awareness of time-space relationship between the construction processes. Many decision-makers have not yet fully utilized the full potential of three-dimensional (3D) and time-based visualization of information models. Consequently, temporary states and temporary equipment may not find adequate consideration in the construction process planning.

This research contributes to the improvement of safety planning for construction sites. As explained before, lean and safety need to be considered concurrently rather than separately. This research is based on a 3D object-oriented building model, a rough schedule and a database with the hazard information.

2 MODEL ARCHITECTURE

The major parts of proposed framework are shown in Figure 1. The input data will be delivered on one hand from the 3D-building model and on the other hand from the rough schedule of the project. The building information model represents the geometrical attributes of the building. Accordingly, objects belong to a

class with the respective properties. Building information models contain the geometric data, furthermore, about the material, location, weight and other properties.

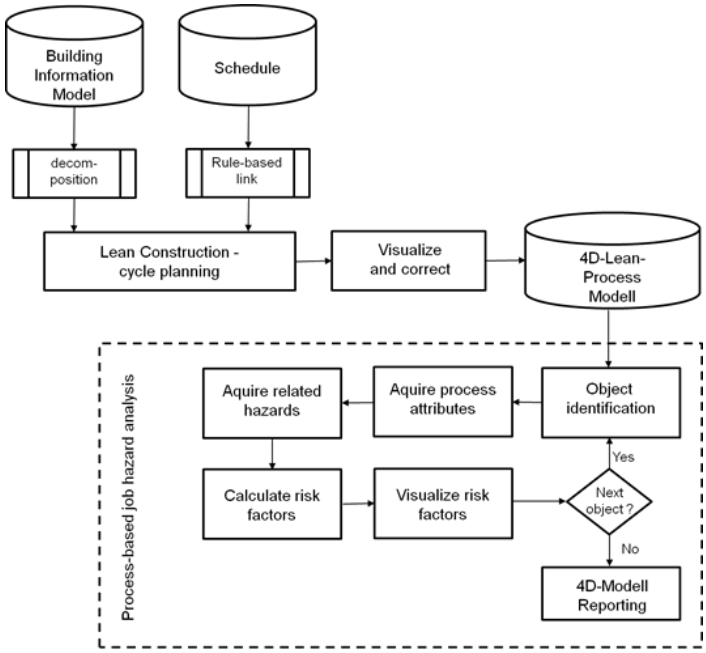

Figure 1. Framework of the 4D-BIM job hazard analysis

All activities are associated with building objects in the building information model. Construction process planners can view the 4D-BIM of the project with the building's components displayed in colors that indicate the different trades and processes which are changing over time. The finished 4D-model will be checked by observing the construction processes with focus on time space conflicts and a continuous workload of the crews. The result is a 4D-Lean process model where chronological-logical sequences of activities are represented and the calculated risk factors can be visualized and reported.

3 IMPLEMENTATION AND RESULTS

The developed approach has been tested in a BIM software on a construction project. A hotel building with seven floors is applied in this study to test and research the benefits and limitations of the developed approach. The initial schedule has 168 activities including milestones. After applying the circle planning method on the project the final schedule has 761 activities. By analyzing the initial schedule time-space conflicts cannot be detected. The final schedule includes a detailed process planning for building construction and finishing works without time-space conflicts. Future research on this topic may include the expansion to different trades and an evaluation of a real construction safety process.

REFERENCES

Melzner, J., Walther, T., and Bargstädt, H.-J. (2014). Object-oriented Hazard Analysis in Building Construction Projects. In: Proceedings of the Second Australasia and South-East Asia Structural Engineering and Construction Conference (ASEA-SEC-2), Bangkok, Thailand.

Melzner, J., Zhang, S., Teizer, J., and Bargstädt, H. J. (2013). A case study on automated safety compliance checking to assist fall protection design and planning in building information models, Construction Management and Economics, 661-674.