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BUILDING INFORMATION MODELING AND OPERATING OF RFID TECHNOLOGY TO IMPROVE OCCUPATIONAL SAFETY IN CONSTRUCTION INDUSTRY

AGNES KELM, MANFRED HELMUS, and ANICA MEINS-BECKER

Teaching & Research Area Construction Management and Construction Industry, Faculty of Civil Engineering, University of Wuppertal, Wuppertal, Germany

Despite a slight decrease of the number of accidents at work on German construction sites in recent years, prevention activities should be strengthened and started explicitly in addition. In particular, a large number of accidents on construction sites are carried out by the collision of different trades and the absence or not wearing appropriate PPE for workers of adjacent trades. An important potential is seen in the optimization of the safety and health by making available pre-defined information about safety and health throughout the life cycle of buildings. Using this information, preventive measures can be taken faster, more effective, safer and preventive. The method of Building Information Modelling (BIM) forms the basis for a comprehensive building information model or building data model. From the perspective of the applicant the method of BIM in conjunction with the Auto-ID-based tracking of actual process data, however, provides additional data to planning data among other OSH-related processes. This data can be used for the further phases of the life cycle of buildings, which are in the building phase, the use phase and rebuilding phase and the decommissioning phase considerable potential, especially for the optimization of occupational safety and health. The primary objective of this research project is to identify, define and standardize health and safety information and provide them for preventive measures with the BIM method.

Keywords: Occupational Safety and Health (OSH), Preventive measures, Building life cycle, Auto-ID.

1 ISSUE

The construction industry, including the supplying sectors, is a major contributor to the German industry. The gross of the construction industry is about 4% of the whole production. This is more than the percentage of the machine building or auto industry. The construction industry has a high significance in conjuncture, growth and employment policy according to a close interrelationship to other industries. The construction industry, which is shaped out of medium sized companies, is a key industry in Germany. 90% of the 75,000 of the construction companies have less than 20 employees. The construction industry is one of the biggest employers with about 2.4 million employees (about 6% of all employees). Digitization and automation enters the

industries of construction and real estate, caused by the project "Industrie 4.0". By the usage of modern Auto-ID technology an automatic registration and controlling of processes, especially during the stages of constructing and utilization, is realized. A consequent usage of the BIM-method during the whole life cycle of real estate offers the possibility of a complete and media disruption free documentation of process data.

2 RESEARCH APPROACH

The goal of the research project is, to connect preventive design of work with the BIM-method within the construction industry. For this connection a prevention strategy BIM with new tools for a bigger support of work- and health safety will be created with prevention partners from the construction industry. The pilot-application shows exemplary application possibilities and describes new forms of the cooperation between prevention partners and constructing partners in an alliance of prevention. As a result basics and examples for a further systematic usage and working on a digitization of a preventive work- and health-safety during the stages of construction, usage, maintenance and reconstruction of real estate are developed.

Construction processes in the construction industry have huge backlog in digitization and innovative production methods in opposite to other industries. The implementation of data-model-based work methods occurs slowly and without a detailed connection to the content of "Industrie 4.0". The advantages of a stronger digitization were recognized within the construction industry. The core of the digitization in the construction industry is the BIM-method. "Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition."[NBIMS]"

The cooperation inside of the construction industry will change according to the usage of BIM. The availability of all current and relevant data, which are recorded interdisciplinary, achieves a high potential for innovations inside the value added chain of the constructing- and other real estate processes, but it also requires a change in the way of thinking of all professions dealing with real estate. BIM holds the potential to create sustainable impulses for a preventive work- and health safety. Compared to other industries, the construction industry has to handle huge challenges in the development of a safe and healthy working environment, i.e., the transient production at changing locations, a split value added chain with a need for a high intensity of communication and coordination of the cooperating partners, a big diversity of the projects, organization of the projects or the technical solutions. Simultaneously, constructing is characterized by a high number of risk factors, i.e., the danger of falling, working with toxic products, time pressure, influences of the weather and a high physical load. Digitization in the construction industry enables, i.e.:

- To design information inside the split value added chain in a continuous and long living way
- To design platforms and methods of cooperation where all partners bring their information and coordinate their project

- To use the stage of development to develop the best way for a realization of the customer's requirements, to define and to execute those plans without any changes during the stage of execution
- To connect the development of the construction and constructing and to use this for an ergonomic and safe design of execution, usage, maintenance and reconstruction
- To assess and minimize risks of the project by planning and simulating
- To use the potentials of the visualization for communication

On the other hand, a reinforced digitization has a huge impact on the working environment and design of labor, especially as a driving force of a further individualization to an individual preventive work design. The project is also used to design work in a digitized world and to connect the development of digital technologies and methods with the development of social factors. The question "How will we work tomorrow?" is currently asked out of a technical view of designing information flow and valuation. There are only a few concepts dealing with a usage of the existing methods, data and information for work safety. At this point the project starts. Together with technical questions and questions of organization, a discourse will be held with partners from work safety and the industry on questions such as "How does digitization change the work environment?" "How will we work tomorrow?" and "What can we do to support it?". The effects of the demographic change describe significant conditions. The results will be summarized in the prevention-strategy BIM.

When the goals and focuses of prevention are discussed and defined, digitization can be expanded to a tool of preventive work design: With the pilot-application examples of the usage will be demonstrated exemplary, also supporting and blocking factors will be highlighted. Concrete forms of cooperation between prevention partners and constructing partners will be developed with these examples.

The research project for connecting digitalization and prevention inside the constructing industry aims on developing tools and methods for a preventive work design in the construction industry to anchor it sustainably. To this belongs, i.e.:

- Using digitization, as an impulse, to discuss and to support goals of a preventive work design as a part of an attractive working condition in the construction industry
- Designing BIM as a new base of information flow and evaluation of work safety by work safety partners
- Using digitized processes and BIM to develop a cooperation between the prevention partners and other partners dealing with real estate
- Develop digitization and BIM close to the reality, to enable an individual and preventive work design

The BIM-method is currently highly topical in the construction industry. With a lot of pressure standards for the future are defined. Now is the time where it is decided, if

work safety will be included in BIM. Because of that, basics for a safe and healthy work environment by working with the BIM-method have to be set.

3 RESEARCH METHOD

3.1 Analysis of the Potential of Prevention by Digitizing and "Prevention-Strategy BIM" during the Whole Life Cycle of Real Estate

In stage 1 construction, usage, maintenance and reconstruction of reference projects are analyzed through process analysis with regards to work safety, work content, and predictable changes of the work content. The goal of the analysis is to estimate potentials for prevention through digitization not only during the stage of development but also during the stage of execution. The analyzed projects are provided by partners from the industry. Interviews with experts complete the process analysis and support an environment analysis. The identified work safety relevant processes are systematized, standardized and discussed in workshops with the prevention partners. On this basis, the prevention goals and concepts are structured and orientated on the demographic change. Also solutions for the high physical demands are focused, i.e., working while standing, lifting and carrying of heavy objects or working in a forced stance. The realization of the prevention goals and concepts, i.e., a reduction of a high physical load, is analyzed further in stage 2. Important information of the data models, i.e., data content, date quality, data responsibilities and (data) communication is analyzed and defined for the usage of the BIM-method.

The result is a preliminary draft of the prevention strategy BIM and prevention alliances, which are discussed by the prevention partners and other professionals dealing with real estate. The first consolidation of the prevention strategy BIM and the designed prevention alliance is tested with the pilot-application.

The results will be summarized to a consolidated prevention strategy for a concluding workshop, aiming on the purpose to set the prevention strategy BIM as a common basis of further action. The prevention strategy BIM becomes a stabile basis for a further designing of the digitization through the prevention partners and for a further usage based on the pilot-application.

3.2 Development of Pilot-Applications to Demonstrate Specific Process-Parts of the Prevention Strategy and Prevention Alliance and their Validation

On the basis of previous results processes with a special relevance on work safety are defined for an optimization of work safety, health protection and work design through digitization threw pilot-applications.

Possible topics for pilot-applications are:

- Integration of work safety measures into development, calculation and work preparation
- Constant actualization of the security and health plan
- Providing of real-time information, i.e., receiving information and introductions (text, videos) about construction materials, which are marked with Auto-ID technologies

- Optimizing the data base for stock real estate through a gradually data structure
- Improvement of the stage of development and minimizing risks through feedback-automatics

3.3 Testing and Evaluating the Pilot-Applications for Specific Process-Parts of the Prevention Strategy and Prevention Alliance

In this work-package, the developed pilot-applications are tested on a real project and modified.

3.4 Transfer of Knowledge and Realization of the Project-Results Parallel to the Project

Multipliers are integrated under the aspects of the realizations parallel to the project. Also results will be published parallel to the project. Meetings and presentations for a transfer of the project results will be held and presented.

The digitized prevention activities, its possibilities and the short- and long-term advantages for the value added chain of all professions dealing with real estate, is usually not know to the small and medium-sized companies of the construction industry. This impedes a fast spreading and a use in the whole industry. According to a heterogenic structure of the construction industry with its many small and medium-sized companies, a fast implementation of the digitized prevention activities is hard to realize without wide transfer activities. Integrating social partners and represents of interests of construction companies is supposed to have the effects of, on the one hand spreading the project results in the construction industry, on the other hand getting feedback from the industry already during the project runtime. With this it is guaranteed, that the developed prevention strategies and pilot-applications are designed on the needs of the companies. Following actions should be taken:

- Public relations through the installation of a project website, presence in the media, publications in trade presses, usage of social media (i.e., Xing) and spreading the results at events and fairs
- Organization and execution of workshops and a symposium “digitization and prevention in the construction industry” as a final project event integrating the social partners of the construction industry
- Connection of all partners, integration of the project-results in the work of social partners, federations and networks of the project “Gutes Bauen”

4 RESUME

In the point of the view of the author, the BIM-method, in correlation with Auto-ID based experiences of process-data next to the stage of development, holds great potential in optimizing not only for the stages of construction, utilization, and reconstruction of real estate, but also in optimizing the planning of work safety and health protection.

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