

Use of artificial intelligence in construction

Options for the building of tomorrow

The digitalization of construction and the associated automation of various planning and building processes is continuing to pick up speed. Nevertheless, the building sector remains largely analogue when compared to other branches of industry. A wealth of recurring tasks – fields of activity that have long since been solved by robots and controlled digitally in the automotive sector, for example – still need to be carried out on our construction sites by hand and with physical strength. However, artificial intelligence (AI) and machine learning form an important foundation here for making planning and building more automated, efficient and high-quality in future. And AI reduces the strain on the many people who go about their challenging work every day on construction sites and in architecture and planning offices.

The benefit of using AI across all industries and established technologies is currently being described again and again and predicted by numerous studies. But it is not possible to predict exactly what economic added value artificial intelligence and machine learning will achieve over the next decade. However, the conceivable optimizations from automating standard processes in the construction industry are so striking that we can assume a potential of several billion euros in the next decade in Germany alone.

Building is manual labor

The reason for this is obvious: To this day, building is still a manual process with all the advantages and disadvantages that go with it. Intelligence in building has always primarily come from the know-how that architects and planning offices, construction companies and specialist trades companies enter in the planning and building process, and therefore have significant control of the quality of our architecture. Human intelligence, not artificial intelligence, is therefore the compass on which the further development of intelligent systems must be based. This is what sets the direction of digital developments. In addition, there is also the diversity of the tasks that arise during the design, planning and construction process and the subsequent operating phase of a building, as well as the various planning partners and protagonists involved in a complex structure of technical requirements, standards and regulations, implementation options and solution approaches for the built environment. If you look at the network of dependencies, it quickly becomes clear where the greatest development potential for artificial intelligence in the construction industry currently lies: *1) in the automation of planning, 2) in the standardization of construction processes and 3) in the reduction of personnel on construction sites.*

Driving automation in planning

Digital planning methods such as Building Information Modeling (BIM) create a comprehensive pool of data and information early in the planning phase which can enable the use of machine learning. AI already offers a significant boost to efficiency in the form of “deep learning” during the tendering and awarding process, as this is usually similar regardless of the construction project itself and enables a high degree of digitization thanks to database-supported processes. Algorithms are already being used by forward-looking construction and planning companies around the world to determine the optimal (which is not always the cheapest) offer for project and construction services from various bidders. An objective evaluation is carried out for the respective project requirements based on previously defined parameters (e.g. proven know-how for the special task, advanced use of technology, efficiency advantage in the market). The understanding of the bid requirements, which results from a broad application of deep learning in various construction applications, areas of application and tasks, then flows back into the software and allows the intelligent algorithms to learn again from new decisions in the next project.

Generative design in the building sector

This example illustrates that machine learning and AI enable new qualities in the planning process, especially in the case of recurring planning tasks with redundant tasks. Nevertheless, human knowledge in architecture and planning offices is still an important foundation for all digitally initiated learning processes of software and technology. Generative design – simply put, designing under consideration of previously stored parameters and continuous optimization of the design result – is another area of AI application in construction. Still relatively young, parametric-based planning is nevertheless a promising field of work in the architectural sector. Since many parameters are specified when planning buildings and the individual user requirements, construction, location and function of the rooms as well as the connected technical systems are directly related to each other, they can be intelligently combined in generative design. In the specific planning application, this means that technical regulations and standards, planning specifications and spatial dependencies flow into the generative process. The result is, for example, optimized floor plan variants that take into account all the properties required by building law and desired by the client. However, by no means does this make experienced project architects or highly specialized structural engineers redundant. Rather, their work is made easier thanks to the support from AI. At the same time, the risk of simply forgetting important points in the draft is reduced.

Standardization and automation in the building process

The use of building models created as part of BIM planning can also be extended to the construction site. This creates added value in terms of both planning and construction: On the one hand, self-propelled construction machines or robots access adapted BIM model data for their autonomous movement over the construction site or the execution of construction work (masonry robots, automated excavation pits with GPS-controlled excavators, digitally supported construction progress and quality management with animaloid robots). On the other hand, the new data generated when using them can be used in reverse, to compare the planning and actual situation on the construction site, to discover and evaluate relevant deviations and thus to avoid expensive execution errors.

In the near future, artificial intelligence in construction should make it possible to design the multitude of recurring work processes on a construction site efficiently and automatically. The basis for this must always be an extensive pool of available data and information. For example, the more detailed and specific the information from the building model and the specialist planner models is, and the more empirical values are already available from previous projects, the more intelligently processes can be automated. The aim should be to enable work such as excavating the construction site, tying steel reinforcements and manual formwork or simple masonry and concrete work to be carried out automatically and under the quality control of qualified skilled workers in the future – but no longer with any physical effort for these strenuous construction tasks. The acceptance and relevance of modular construction and prefabrication in the construction sector will continue to grow, as will the efficiency of the construction process. Likewise, construction site activities will become significantly more attractive in the future, since the proportion of physically demanding work is noticeably decreasing.

“Man is the measure of all things”

In the context of our architecture, humans play the most important role in the use of AI and machine learning, deep learning, generative design or the use of robots in construction. The structural quality of the architecture created by AI technology, high cost security and minimizing of sources of error for planning, construction and operation are certainly important aspects for their increased use in construction. However, it is no less important to relieve the protagonists of planning and implementation in the medium and long term. At 5 to 6 percent, the annual migration of specialist staff, especially from the shell construction trades, is well above the average compared to other branches of industry (approx. 4 percent). Artificial intelligence can help to significantly increase the appeal of working in planning and on construction sites in particular. The first examples, which are leaving the research stage and are now

being used on a broad scale, are an encouraging indication of smart “teamwork” between humans and artificial intelligence in future.