

BEEYONDERS: Breakthrough Technologies for a Human-centric, Digitalized and Automated Construction Sector: Challenges and Impact Analysis

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Abstract:

The construction sector is currently facing unprecedented global challenges, including labour shortages, workforce aging, low productivity, and increasing demands for sustainability and safety. These issues are similar to those encountered in Japan, where the preparation for the Tokyo Olympic Games prompted a national shift toward automation and digitalization under the “Smart Construction” initiative—a technology-driven approach emphasizing automation, robotics, and artificial intelligence.

The European Union’s demographic trends and labour market evolution suggest that the construction sector in Europe is approaching a comparable situation. Consequently, the European construction industry must follow a similar paradigm shift, integrating advanced technologies to stay competitive. Inspired by Japan’s experience, the BEEYONDERS research project has been established to address these major sectoral challenges.

BEEYONDERS has developed and validated a portfolio of breakthrough technologies in five key domains: autonomous vehicles and collaborative robotics, additive manufacturing, real-time safety and monitoring systems, digital twin platforms, and AI-based decision support. These innovations have been tested and demonstrated in six diverse use cases, one of which highlights European-Japanese collaboration—underlining the vital role of international cooperation in fostering a sustainable and competitive construction sector.

This paper presents a comprehensive analysis of the challenges addressed and results achieved by BEEYONDERS, focusing on social impact, economic feasibility, and environmental benefits. By approaching the transformation of the construction sector from multiple complementary perspectives—technical innovation, social inclusion, economic viability, and environmental

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sustainability—we demonstrate how digitalization and smart technologies can profoundly reshape the future of the construction industry, ensuring resilience and long-term success.

Keywords:

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