



# From Norm to Swarm: development of a Balanced Scorecard for evaluating Automation in Construction

Benefits to UK Government and policy-makers (UKG), construction industry: i.e. contractors and clients (UKCI), IT/tech companies (ICT), education and research institutions

Assessing and optimising the performance of digital construction projects is essential to achieve a sustainable and efficient construction industry

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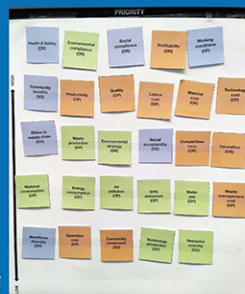
## Summary

The adoption of digital technologies in construction (e.g. BIM or robotics) shows great potential to transform the way we currently plan and construct the built environment. Construction organisations expect an increase of productivity, efficiency, quality and safety, as well as a reduction of costs, emissions and waste. Yet a lack of management tools and standards to evaluate automation and set business strategic improvement drivers is hindering wider adoption in the construction industry. The aim of the project is to deliver a Balanced Scorecard (BSC) to support the adoption of automation in the UK building industry by delivering a framework to evaluate automated construction processes from a holistic perspective (financial, social, and environmental). The BSC is co-created with industry and is based on a set of hierarchic

Key Performance Indicators (KPIs) that will help construction organisations to set improvement targets to achieve their long-term strategy. Finally, the BSC is tested through the evaluation of a case study of 3D printing with aerial robotics provided by the EPSRC-funded project Aerial Additive Building Manufacturing.



TOWARDS CONSTRUCTION 4.0: A collaborative workshop on the future of automation.



Results from the "Prioritisation" workshop exercise

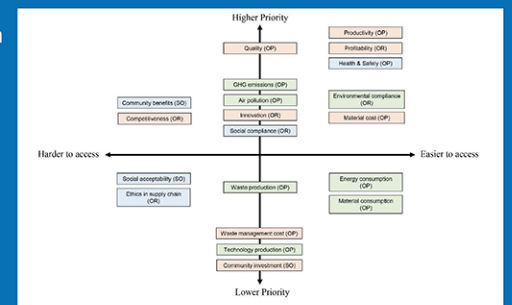
## Impact and Value

- The BSC will raise awareness and interest in automation in construction and provides a realistic vision of the impact of digital technologies and processes.
- The BSC will support the sustainable implementation of automated technologies in major UK construction projects, which will improve commercial competitiveness and productivity, while ensuring the well-being of the natural environment and citizens
- The BSC will establish minimum performance requirements for automated construction processes and technologies, which will serve as a base for the production of standards in automation in construction.
- The BSC will guide decision-making during the transition to digital economy, e.g. improving ways in which data is collected and assessed.
- The BSC will create new partnerships between industry and academia.
- The BSC will establish new knowledge of automated construction processes and technologies, which can be transferred to research and education programmes in UK institutions.

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## Key Findings

- The proposed Balanced Scorecard (BSC) model uses KPIs from the three dimensions of sustainability at three assessment levels, which provide a holistic understanding of the impact of automated construction processes and facilitates a new pathway for achieving sustainability in buildings.



Initial classification of KPIs for assessing automation in construction.

- The hierarchic organisation of indicators according to priority supports management teams in decision-making regarding the adoption of automation and in defining relevant issues to be targeted and optimised in the organisation.
- Overall, the BSC shows that traditional out-turn measures (e.g. Productivity, Quality and Profitability) tend to dominate thinking in construction organisations.
- The model also shows that the priority of indicators related to compliance of regulations is intermediate and the majority of environmental and social indicators tend to be deemed lower priority than economic indicators.
- The development of the BSC based on industry stakeholders' views ensures the applicability of the framework for assessing the performance of automation in the industrial context.
- The evaluation of a case study confirms the effectiveness of the BSC model by highlighting the relevant data to be measured and transferred throughout the value chain (design-construct-operate-maintain) of the organisation.

## Long-term Vision

- The BSC will help clients, business and policy makers to assess impacts and shape decisions based on whole life value.
- The final goal of the project is to facilitate the implementation of digital and automation technologies in construction to improve productivity, while ensuring the well-being of the environment and society.
- This project is the starting point of an extended performance evaluation framework applicable to a broader range of innovative construction projects. This standardised framework will be developed in line with similar industrial and governmental initiatives, such as the work of the Construction Leadership Council. Dr Isolda Agustí will continue this work in the Whole-Life Performance workstream of the Construction Innovation Hub.

## Next Steps

Submission of a scientific publication describing the development of the Balanced Scorecard to the journal Automation in Construction