ice

Knowledge

State of the Nation 2022

Improving infrastructure productivity

ICE Working Paper

ice.org.uk

Summary

The key objective of this year's State of the Nation report is to map a practicable path to transforming infrastructure productivity within sustainable, secure and resilient systems, in doing so delivering the additional benefit of carbon reduction goals.

This Working Paper proposes that the Institution of Civil Engineers (ICE) establishes a programme of extensive research into productivity, both inside and outside of the civil engineering community, the principal focus of which is the activities and responsibilities throughout the infrastructure lifecycle. Productivity in other industries will also be reviewed in this light. State of the Nation 2022 will highlight significant opportunities for boosting productivity throughout the lifecycle, backed by best-practice examples, in so doing offering potential actions for future infrastructure projects. It will also pose questions to drive future ICE efforts towards improving productivity in the sector.

The research will use the basic principles from this paper to test a small number of activities through the entire infrastructure lifecycle: brief; concept and definition; planning; design; procurement; construction and commissioning; operation; and eventual decommissioning.

The results will deliver opportunities for civil engineers and their clients to deliver more productive infrastructure through smarter ways of working.

In presenting an authoritative and influential report on infrastructure productivity in the UK, ICE will highlight best practices for its members to:

- Break down the barriers often encountered in a diverse and competitive sector
- Enable replication of existing industry improvements and further innovation
- Contribute to better outcomes for all
- Use everyone in their network as advocates for optimising the relationship between input and outcome

ABOUT STATE OF THE NATION

State of the Nation has been one of ICE's flagship reports since 2002. Based on extensive research and member engagement, it gives an assessment of the 'state of the industry'. The report aims to stimulate debate and highlight the actions ICE believes are necessary to improve UK infrastructure.

State of the Nation 2022's focus is 'Improving infrastructure productivity' and aligns with the work of ICE's Productivity Community Advisory Board (CAB), a group of 23 industry experts (see page 11) who advise ICE's Knowledge programme on their areas of expertise.

The CAB – co-chaired by Andy Alder, vice president of major projects and programmes at Jacobs, and Darren James, chief executive of Keltbray – will oversee delivery of the 2022 State of the Nation report, to be published in October, and approve final outcomes and outputs.

This Working Paper expands on the initial concept for State of the Nation and is based on desk research, a literature review and input from the CAB. Its purpose is to invite contributions from members to the final report – please get in touch at knowledge@ice.org.uk

We are seeking knowledge on current thinking and global best-practice case studies from ICE members and key stakeholders in the UK and across the world – get in touch at knowledge@ice.org.uk

Introduction

Improving productivity is about delivering the infrastructure that society needs, with the resources that we have, more effectively and efficiently. It is not about working fewer people harder – it must not be to the detriment of health, safety, quality or environmental protection.

Several authoritative studies have already identified poor productivity in UK infrastructure projects, reinforcing the need for a closer look at the entire lifecycle of a project and its assets:

- As far back as 1998, Sir John Egan's Rethinking Construction report concluded that "the industry as a whole [was] underachieving" and called for "dramatic improvements".
- In 2009, Constructing Excellence's Never Waste A Good Crisis report assessed the progress the industry had made since 1998 and set out further improvements that could be made. Few of the Egan targets had been met in full, the report found. "Since 1998 we could have had a revolution and what we've achieved so far is a bit of improvement," it said.
- In 2016, the Farmer Review, Modernise or Die, suggested that the UK's construction industry was facing "inexorable decline". The review highlighted the sector's dysfunctional training model, its lack of innovation and collaboration, and its non-existent research and development culture. It found that high levels of cost inflation, driven by labour shortages, had caused numerous housing schemes to stall as their costs rose prohibitively.
- The Infrastructure and Projects Authority (IPA)'s 2017 Transforming Infrastructure Performance report showed that the construction sector still faced issues such as low profit margins and lagging productivity compared with other sectors, as did 2021 data from the Office for National Statistics.
- In 2018, the Get It Right Initiative's Guide to Improving Value by Reducing Design Error found that up to 25% of UK construction project costs could be associated with avoidable error (process non-compliance).
- The Centre for Macroeconomics' 2020 survey The UK Productivity Puzzle reported a dramatic slowdown in productivity, with the UK ranking 31st out of 35 Organisation for Economic Co-operation and Development countries in growth of output per hour from 2008 to 2017.

"Because of what we do, we are part of the problem. Because of what we do, we must be part of the solution"

Ed McCann, ICE President 2021-22

Other reports and studies, such as the Government Office for Science's From Waste to Resource Productivity: Evidence and Case Studies and Resource Efficient Scotland's Best Practice Guide to Improving Waste Management on Construction Sites, have also identified endemic problems of waste, error, inefficiency and poor-value outcomes as major barriers to improving productivity.

However, to focus merely on the construction stage, as many of these reports do, would be wrong. Decisions made in the early stages of projects have a huge influence on the efficiency of their delivery throughout the lifecycle, and this needs to be understood and addressed.

Improved productivity means less waste and less carbon

Getting to grips with productivity now will also help to meet the UN Sustainable Development Goals and deliver a net-zero society. More effective, efficient infrastructure projects have fewer errors and less waste, and thus a lower total carbon 'cost'. This is critical as infrastructure is responsible for 54% of the UK's total carbon emissions, while 70% of emissions worldwide can be linked to it.

Net zero is about balancing carbon emissions and understanding the impacts of what civil engineers do. If ways can be developed to deliver infrastructure more efficiently using less resources, we will be better able to provide the infrastructure that society needs and support the move to a zero-carbon economy.

Where possible, State of the Nation 2022 will identify carbon reduction outcomes

Two of the five key themes in ICE's latest three-year plan have direct relevance to State of the Nation 2022: productivity and climate action. Both issues were also examined in ICE's recent Infrastructure in 2022: A Horizon Scan of the Year Ahead for Civil Engineering report.

This year, State of the Nation will be a powerful vehicle for ICE to lead a collective effort towards improving infrastructure productivity while driving the net-zero agenda, building on the 2021 State of the Nation report, Six Ways for Civil Engineers to Act on Climate Change.

ICE believes that detailed analysis of how infrastructure is delivered throughout its lifecycle, and the activities and responsibilities of all parties involved, will lay the foundation for greater effectiveness and efficiency and, therefore, improve the sector's productivity.

Drawing on existing best practice throughout the infrastructure lifecycle will be crucial to this exercise, with ICE members themselves being well placed to suggest a wide and appropriate range of examples.

A key aspect of this work will also be to identify existing and new social, political, economic and systemic barriers that could block progress, and propose ways of unblocking them.

"No other issue is more important than climate action when it comes to change for infrastructure and engineering. Fixing issues that have plagued our industry for decades will help to address the climate emergency"

Rachel Skinner CBE, ICE President 2020-21

Defining productivity

Various definitions of productivity exist. State of the Nation 2022 will review existing definitions and propose one that is most suited to infrastructure and that can also be referenced more widely, throughout the whole lifecycle.

Central to the application of productivity in the case of infrastructure are the concepts of 'effectiveness' and 'efficiency', rather than the traditional determinants of cost and time. Improving productivity means increasing the value of both, as something deemed efficient can still be ineffective if it delivers the wrong outcomes.

■ **Effective infrastructure delivery: delivering meaningful benefit**

For example, the effectiveness of the London 2012 Olympics can be measured in several non-financial outcomes, such as societal benefit, legacy and access. All benefits, from climate impact to citizen happiness, have to be valued. We should ask: does a completed project deliver a need? Does it look and feel good? Does it make life better for the communities involved?

■ **Efficient infrastructure delivery: delivering without creating waste or unnecessary harm**

By thinking about how we deliver better, we can make infrastructure more efficient and safer, of better quality and less harmful to the environment. Greater productivity throughout the lifecycle drives more reliable and efficient outcomes.

A traditional way to improve efficiency is to reduce inputs such as materials, cost or time for a given output, such as repairing a road. However, it can be more usefully understood as a process of waste elimination, whereby waste is defined as inputs that do not add value to the process.

This is part of a wider approach to rethinking how infrastructure is delivered and improving the delivery system throughout the whole lifecycle. Good decisions made in the early stages of a project, including planning, scheme design and procurement, set the foundation for productivity throughout. This enables teams to drive for excellence in the detailed design, construction, commissioning and operational stages.

State of the Nation 2022 will provide guidance on how engineers in the infrastructure sector can show leadership in productivity throughout the lifecycle.

Infrastructure waste typically occurs in terms of human capital; materials; machinery; time; energy; social capital, land and ecosystem; and information and data. It can be eliminated with improved efficiency by optimising:

- Quantity of inputs
- Quality of inputs
- Timing of inputs
- Process methodology
- Process compliance or execution
- Impact of external factors

State of the Nation 2022 will provide guidance on how engineers in the infrastructure sector can show leadership in productivity throughout the lifecycle

Current thinking

Foundations of productivity

ICE's Productivity CAB has set out eight foundations that emphasise that productivity is not only found in new tools and techniques but also in leadership and management. From the outset, these foundations will set a project up either for success or for a troubled and wasteful future.

Productivity relies on a clear vision, embedded values and a culture of respect and inclusion. It depends on systems thinking, collaboration, doing the basics right, embedding best practice and embracing innovation in its processes and tools.

Currently, there is insufficient collaboration across the industry. Collaboration has to involve more than simply the people in one office or department – it needs to be expanded to foster greater cooperation across companies, sectors and countries.

Civil engineers have rarely felt able to learn from the manufacturing sector when it comes to end-to-end processes, control of the working environment or ruthless elimination of waste because they often consider the two industries to be very different.

The automotive sector, for example, which comprises only a few large, vertically integrated organisations, stable supply chains and controllable working environments, may seem many miles from diverse, discrete and disconnected infrastructure projects. Still, without such discipline, it is difficult to align the processes that are essential to eliminating waste.

Key issues affecting infrastructure productivity

From drawing on relevant literature and interviews with experienced UK construction and infrastructure professionals, the following 10 factors appear to have affected construction productivity:

- Nature of work activity and output
- Physical environment
- Sociopolitical factors
- Extent of use of industry best practices in relation to 'front-end activities'
- Extent of use of industry best practices in relation to 'execution stage activities'
- Enterprise models and company size distribution in the sector
- Effectiveness and efficiency of 'adjacent' processes
- Availability of skilled labour
- Use of technology onsite
- Modularisation and offsite fabrication

Best practice: maximising productivity

There is no one-size-fits-all approach when it comes to maximising productivity. Best practice has two distinct tasks:

- Sharing and achieving current best practice – making best use of existing and proven processes and technology
- Improving best practice – developing new processes and technology to improve productivity and, in effect, redefine what constitutes best practice

Both tasks are necessary and interrelated, although 'sharing and achieving best practice' will be the focus of State of the Nation 2022 as it is likely that this will have the biggest impact across the industry. Consistently applying this across the sector will have huge benefits and provide the foundation for further developments in best practice.

"Working together achieves amazing results. In times of uncertainty, we need eternal truths and efficiency is always a good idea"

ICE President Ed McCann

Initiatives for change

The following is an initial list of initiatives that will form part of our research into improving productivity:

- The Construction Playbook, published in 2020, outlines how the UK Government will strengthen the financial assessment of its suppliers to make sure that projects are delivered on time and on budget. It has been produced through collaboration with the construction sector, with case studies including the recently opened 'super-prison' HMP Five Wells and Anglian Water's @One Alliance collaboration with seven partners. Initiatives in the Playbook promote the use of carbon assessments to understand and minimise emissions. It includes expectations of how contracting authorities and suppliers, including the supply chain, should engage with each other. These are set out in 14 key policies for the Government to assess, procure and deliver public works projects and programmes.

- Project 13 champions a 'people-focused infrastructure industry' that considers value in terms of outcomes and whole-life cost. It is an industry-led approach that is seeking a new business model, jettisoning traditional transactional arrangements. Its 'enterprise' approach brings together owners, partners, advisers and suppliers to work in more integrated and collaborative arrangements, underpinned by long-term relationships. Examples include residential blocks in London's Stratford East Village and the five-year transformation of the A14 in Cambridgeshire.

- Transforming Infrastructure Performance (TIP) is the Government's plan to boost the effectiveness of investment in infrastructure by improving productivity in terms of how we design, build and operate assets. Published in 2021, Transforming Infrastructure Performance: Roadmap to 2030 supports the effective delivery of infrastructure investment that puts societal outcomes, digital technology and innovation and environmental impact at the heart of the approach. As an example, in December 2020 the IPA published an overview of progress made by government departments that are committed to offsite construction.

- Measuring the performance of infrastructure (TIP, IPA, Infrastructure Client Group). To be effective, infrastructure projects need smart data, metrics and supporting technology. In TIP, the Government has committed to developing a benchmarking process to compare the cost, schedule and performance of a project against other similar projects. In 2019, the IPA published its Best Practice in Benchmarking guidance, which recommended a methodology for benchmarking and included a step-by-step guide to undertaking or commissioning a benchmarking exercise. In June 2020, it published its Benchmarking Capability Tool, which supports organisations to measure and improve their benchmarking capability against industry best practice. The Infrastructure Client Group (ICG)'s Productivity Working Group is also working on fundamental priorities relating to productivity, what enables it and how we measure it effectively so that improved data can be used to help reduce waste, carbon and costs. This year, ICE will work closely with the ICG to review and identify the most appropriate system of measurement.

Relevant ICE publications and webinars include:

- Thames Tideway
- HS2
- Rolls-Royce's proposed new smaller nuclear reactors

Best practice

Toyota

The car manufacturer's lean management approach is a classic example that addresses 'seven forms of waste': overproduction; excess inventory; unnecessary motion/movement; defects; over-processing; waiting; and unnecessary transportation.

These have clear relevance to civil engineering and there is value in considering how this example from the manufacturing sector could be applied, in a modified form, to infrastructure.

Greater diversity of background, experience and skillset within the infrastructure community is also vital.

HS2

The High Speed 2 M42 bridge (see page 14 of our recent Infrastructure in 2022 report) is an example of what can be achieved with good planning, collaboration, innovative thinking and impeccable onsite execution. A raft of modern approaches came together to allow a 65m-long bridge to be installed over the M42 in the West Midlands in only two days as part of the HS2 rail project.

It is hoped that mega-schemes such as HS2 can be a catalyst for productive methods of construction. We can also learn lessons from small contractors working on lower-profile jobs.

Insight

Having explored current thinking and best-practice case studies, State of the Nation 2022 will propose practical steps to improve productivity for civil engineers.

ICE's Productivity CAB will drill down into the activities, roles and responsibilities of stakeholders throughout the stages of a project or asset. Details will be crystallised further during 2022 and incorporated as a key part of the State of the Nation work.

Key stages and stakeholders to be looked at include:

ASSET LIFECYCLE STAGE	STAKEHOLDERS INVOLVED
Brief/concept and definition **Planning/scheme design**	Client/operator/asset owner Programme manager Integrator
	Designer
	Constructor (main contractor and specialist contractors)
Procurement	Client/operator/asset owner Programme manager Integrator
	Designer
	Constructor (main contractor and specialist contractors)
Detailed design	Client/operator/asset owner Programme manager Integrator
	Designer
	Constructor (main contractor and specialist contractors)
Construction and commissioning	Client/operator/asset owner Programme manager Integrator
	Designer
	Constructor (main contractor and specialist contractors)
Handover and close-out/operation	Client/operator/asset owner Programme manager Integrator
	Designer
	Constructor (main contractor and specialist contractors)

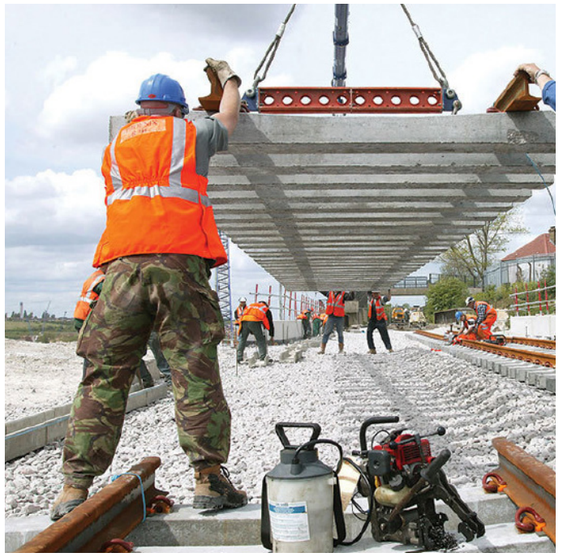
Further research and next steps

The Productivity CAB has identified the following questions that should be explored further and may form part of evidence-gathering via regional State of the Nation workshops and during interviews with key stakeholders, in the UK and globally:

- What is the working definition of productivity that is most suited to infrastructure and that could be widely adopted throughout a project's lifecycle?
- What are the social, political, economic and systemic barriers that could block progress?
- What examples are there for performance baselines to deliver agreed consistent data and metrics to improve productivity and reduce carbon?
- Are you aware of examples of digital technology for data collection and sharing, including tools, systems and processes to improve infrastructure programmes as well as data management?
- When and how should civil engineers engage at each stage of the infrastructure lifecycle?
- Are you aware of any good examples that show improved productivity at each stage of the lifecycle?
- How can civil engineers deliver improved, sustainable outcomes with fewer resources while bearing down on waste?
- Are you aware of any contractual mechanisms that could be used to drive motivation and incentivisation and reward high-productivity performance?

We are seeking knowledge on current thinking and global best-practice case studies from ICE members and key stakeholders in the UK and across the world – get in touch at knowledge@ice.org.uk

We will hold regional workshops to gather knowledge in April and May and publish an interim report in June. The final State of the Nation 2022 report will be published in October.



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