Living Lab

Transport Infrastructure Efficiency Strategy

TIES LIVING LAB PROGRAMME

Drivers of project performance (IP6)

October 2022

INTRODUCTION

The UK Government has embarked on a £650 billion infrastructure investment plan that aims to transform the delivery of major infrastructure projects by using modern methods of construction (MMC) and fostering collaboration across clients and suppliers in the transport sector and beyond.

Knowing the inherent risks of waste and inefficiency in any large infrastructure project, the Department for Transport (DfT) established the Transport Infrastructure Efficiency Strategy (TIES) Living Lab Programme, which brought together key implementation, delivery and research organisations (the TIES Partners) to establish the collaborative working environment as well as develop the data collection and analysis protocols needed to maximise efficiency across the sector.

This information paper (IP6) summarises the work of the TIES Living Lab project on Identifying the Drivers of Project Performance, which had the aim of preparing the foundations for collecting data and developing the benchmarks needed for setting targets and monitoring efficiency over the time frame of the financial investment. The project included the creation of seven Communities of Practice (CoPs) to drive the collaborative process. This information paper should be read in conjunction with IP7, which sets out the vision of each CoP in more detail, including timelines for implementing the TIES Living Lab legacy up to 2030.

BACKGROUND

The TIES Living Lab, which ran from May 2020 to July 2022, comprised four demonstrator projects that tested the practicalities of and potential for using MMC in transport infrastructure projects (see IP2, IP3, IP4 and IP14). These real-time on-site projects ran in parallel with a group of artificial intelligence (AI) and data-driven projects managed by an Analytical Consortium made up of experts from industry and academic centres of excellence. from the TIES Partners, industry experts and academic partners. Those projects, on Metrics, Benchmarking & Repository and the Intelligent Infrastructure Control Centre, built and tested data management and benchmarking tools using real data from the demonstrator projects (see IP5a and IP5b, and IP8–IP13).

A crucial aspect of all work under the Analytical Consortium was the need for a robust understanding of what projects should cost and the anticipated construction time, as well as an understanding of their expected environmental impact. Only then will it be possible to predict, plan and benchmark project performance – specifically cost, construction duration, and carbon and environmental performance.

Developing this core knowledge was a project in its own right, managed by the University of Leeds with colleagues at Accelar Ltd and Lean Construct Ltd (via the University of Dundee).

The project had two main objectives:

1. Undertake top-down statistical analysis, deep-learning techniques and process benchmarking of precisely what drives:
    - Cost
    - Duration
    - Carbon and environmental performance.
2. Establish a holistic approach to developing the analytical tools for benchmarking, by drawing together data requirements and assessing value using a roadmap for the routine benchmarking of future collaborations among the TIES Partners (Reported in IP7).

While cost and construction duration are relatively familiar to infrastructure project managers, six additional themes – carbon, circular economy, biodiversity and climate resilience, as well as productivity and quality plus social value – presented new challenges.

Analytical tools to assess the sustainability of construction projects have existed for some time, but are not generally well integrated into core benchmarking tools. Often they are an after-thought, or regarded as a “nice to have” additional expense.

That situation needs to be urgently addressed in order to achieve the Government’s target of net zero greenhouse gas emissions by 2050 – a challenge that must be met through inculcating a culture change across the transport sector and beyond.

As part of the holistic approach that underpins the TIES Living Lab, seven Communities of Practice were established.

The seven CoPs are **working groups of subject matter experts** drawn from all the TIES Partners, who are committed to meeting regularly to share experience and collect data. The CoPs each focus on one of seven performance areas: (1) cost, schedule and productivity; (2) quality; (3) carbon; (4) circular economy; (5) biodiversity; (6) climate resilience; and (7) social value (see IP10 for a specific information paper on social value).

Overall the CoPs are forums which bring together subject matter experts fromthe TIES Arms Length Bodies and analytical experts to enable and analysis and experience sharing of best practice, to facilitate better strategic decision making within organisations.

For each performance area, an implementation plan out to 2030 has been developed and these are presented in IP7.

CHALLENGES

Having established the CoPs and optimal methodology for collaborative working (see IP1), the major challenge for the Analytical Consortium was that, while it is relatively simple to assess and benchmark concepts such as cost, the question of what to measure and how to measure it in large projects is extremely complex. This is especially true when trying to make comparisons across

industry sectors. There are certainly important lessons to be learned from comparing major projects but attempts to extract those lessons can be extremely frustrating. Often, it is as if their secrets are written in different, mutually unintelligible languages. If only we could find a reliable translator, we could unlock a world of value (See IP5b for more details).

Data standardisation therefore presents a significant challenge in the infrastructure sector and the wider construction industry. But existing benchmarking tools are already demonstrating the latent value that could be unleashed through a determined, long-term commitment to standardisation and collaboration (See IP5a, IP8 and IP9 for further discussion).

The rest of this information paper explains the tools and techniques used to explore the existing data to identify what data already exists and how it might be interrogated to make meaningful comparisons of "value" across projects and sectors, where value is viewed not just in terms of cost and schedule, but in terms of the more challenging carbon and environmental goals.

ANALYSIS OF COST AND PROJECT DURATION

Using data from ballasted track renewal projects for Network Rail and Transport for London (TfL), National Highways Major Schemes and footbridge projects for Network Rail, quantitative analysis techniques (i.e. regression) were applied to understand how both construction cost and construction duration vary depending on various project attributes.

In general, the data collected through the TIES Partners is suitable for such analysis, but a significant constraint is the lack of availability of relevant project attribute with contextual data (i.e. data on why there would be a difference in performance).

Key findings

- The analysis of project cost tended to indicate that projects delivered at a large scale (e.g. renewing more track under one project) yield cost savings per unit up to a certain point. After this point the unit costs start to increase. This might be because, for example, it was not possible to finish the work within one track possession window. The analysis quantified a range for this "sweet spot" of project size for the applications investigated.
- It was also possible to detect and quantify the cost impact of different environmental and access constraints, as well as the impact of existing structures. These can be substantial and need to be planned for when setting a benchmark for a given project.
- The analysis of project construction duration has tended to indicate that bigger projects yield lower time per unit delivered, and this contrasts with the findings on cost. However, this result is based on fewer project types (only National Highways Major Schemes) so further exploration is needed before conclusions can be drawn.

The study was less successful in codifying – and therefore including in the analysis – measures of "innovation" which were adopted within projects. There is some evidence that combining delivery of, say, a footbridge with other asset improvements does reduce the footbridge cost (e.g. by implicitly spreading fixed site setup costs over more assets). However, data was not available on such attributes (e.g. whether a project involved MMC) to allow the impact to be quantified.

Opportunity

Robust evaluation of what works can be achieved by considering not just cost, product duration and physical attributes, but also by providing qualitative data that can be categorised regarding innovation and contracting models relevant to the project.

ANALYSIS OF ENVIRONMENTAL PERFORMANCE

Accelar undertook data analysis, particularly in the performance areas of carbon and circular economy, where TIES parties were able to provide most data. For carbon, Accelar explored the opportunities and challenges in looking at the data from a top down perspective (at the level of programmes and projects). This was contrasted with a bottom-up approach to carbon data that looked to identify the benefits and challenges associated with analysing data at a much more granular level (at the asset, product and material level). This bottom-up approach unlocked more potential for insightful benchmarking as well as identifying specific carbon reduction opportunities.

For the circular economy, Accelar looked at examples of both capital and operational and maintenance waste data to see how it could be analysed to give new insights on waste prevention and re-use potential with links to carbon reduction opportunities. Both areas of work looked to improve the quality and flexibility of data visualisation through the use of business analytics software.

Key findings

The Living Lab project has established that there is a real opportunity for TIES Parties to work smarter with the data they already have and identify data gaps that would enable insights to achieving better environmental performance.

The environmental themes focussed on during the TIES Living Lab project are at different stages of maturity and require bespoke solutions to improve performance, for example, a change in organisational culture, or improved data aggregation.

Across all four themes (carbon, circular economy, biodiversity and climate resilience), Accelar has developed more effective ways to collect, collate and organise data to help provide cross-sector comparisons. This includes taxonomies for each theme to help provide a list of static data to help categorise and organise the data which will facilitate future benchmarking.

Through the Communities of Practice, the TIES Parties in house environmental experts can share their substantial knowledge base and experience, rolling out innovations that are proven to work and not reinvent the wheel.

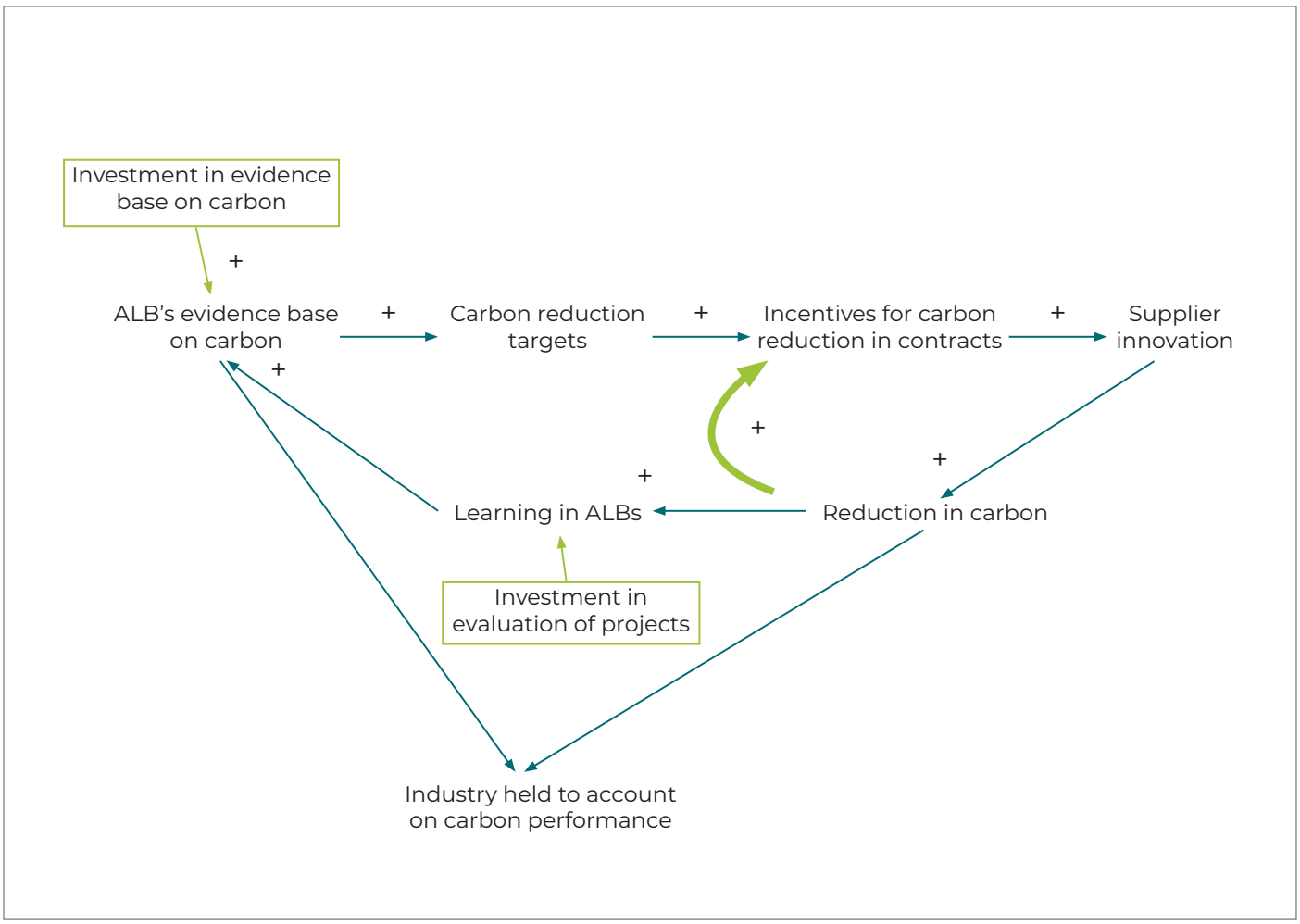
Opportunities

- Continue to improve the use of metrics, data and benchmarking to derive valuable insights that can be readily applied to live and future projects.
- Communicate the value of improving environmental performance within organisational business plans and cases.
- Recognise and utilise the value of granular bottom-up data and insights that can help to improve environmental performance alongside top-down high-level corporate reporting.

ANALYSIS OF COST AND CARBON

This part of the work used a system dynamics approach. Two workshops were held with one of the TIES infrastructure Partners to understand how decisions around carbon are currently made on its projects. The output of the work was a schematic diagram of the key mechanisms around carbon decision-making that highlights where the infrastructure partner should focus their resources in order to reduce carbon from their projects.

The workshops revealed that, currently, most carbon decisions in the design process are focused on refinements to the design rather than the initial design itself. This means that a significant amount of carbon is embedded in the scheme design from the start, and any adjustments to reduce carbon can have only a relatively limited impact. As shown in the figure below, carbon reductions from design refinements are restricted by a lack of carbon literacy and carbon/cost tools to assess the impact of refinements on costs, which are obstacles to further reducing carbon.



Opportunities

- Strengthen the evidence base on carbon within organisations: Without evidence, carbon reduction targets are not as bold as they could be, which leads to lower incentives for reducing carbon in contracts.
- Standardise carbon tools/data and share data across project stages: Different organisations working on the project use different tools and data formats to measure carbon. For a better outcome, contracts should stipulate the tools and data formats to be used across organisations.
- Prioritise carbon earlier in the design process, including seeking early input from suppliers: Focus on the initial design itself, when it is more efficient to reduce carbon, rather than making changes later, which have only a relatively limited impact.
- Develop carbon literacy and tools to consider carbon versus cost trade-offs: A lack of tools and knowledge make it difficult to assess the impact of carbon-related refinements on costs. It is also important to be able to revise carbon targets as a project develops through its design process.

LEAN PROCESS BENCHMARKING

Lean process benchmarking is simply benchmarking viewed through the lens of "lean thinking". For example, a "lean benchmark" can be derived by calculating a ratio of value-added activity to waste in a given process or task.

The work on this aspect of benchmarking was conducted by Lean Construct Ltd and the University of Dundee. They carried out three activities, each delivering different outcomes.

1. A comparison of the project delivery model of a not-for-profit lean exemplar construction client with National Highways. Outcome: The work revealed an extraordinary performance gap, statistically impossible to have occurred by chance, in the delivery of high-value, complex and bespoke projects. The gap was sustained in the long term. More work is needed to fully explore the key differences in the delivery models.

2. An exploration of productivity measurement on a live project. Outcome: Over £2 million of saving achieved as a result of improvements implemented after direct observations by Lean Construct Ltd. Links between the use of data, understanding variation and capability were established along with short- and medium-term recommendations for improvement.

3. A study into delays arising due to utility diversion works. Outcome: It was calculated that in the UK a minimum of £2 billion pa is lost in preliminary costs alone due to a failure to manage these works effectively during construction projects. Areas of best practice were identified.

LEAVING A LEGACY

In just two years, the TIES Living Lab project has made huge steps forward. Through collaboration with the client-side partners, a unique dataset has been created that allows for the sort of holistic, cross-organisational project analysis that has never been possible before.

Mechanisms are now in place to begin the process of making this huge repository legible, not least through the formation and work of the CoPs. It will be challenging, but the benchmarking tools created through the TIES Living Lab are already demonstrating the latent value that could be unleashed by a determined, long-term commitment to standardisation and ongoing collaboration through the CoPs.

With the commitment of the industry, the CoPs could have a transformative effect on how transport infrastructure is delivered by harnessing data.

Yet fundamental cultural change is needed if the infrastructure we deliver is going to fit the values of the people who are going to use it. What is required now is the commitment of the industry and its clients to embrace what Living Lab has started and what the CoPs are taking on.

This work was led by Professor Phill Wheat of the University of Leeds in collaboration with colleagues at Accelar Ltd, and Lean Construct Ltd (via the University of Dundee) under the project on Identifying the Drivers of Project Performance overseen by the TIES Living Lab Analytical Consortium.

Living Lab

Transport Infrastructure Efficiency Strategy

The TIES Living Lab is a transformative collaboration of 25 partners together with Government, i3P and the Construction Innovation Hub that use data, technology and Modern Methods of Construction within live transport infrastructure projects to deliver significant value-adding benefits across the transport infrastructure sector. The programme is funded via a grant from Innovate UK through the Transforming Construction programme, plus contributions from the Department for Transport, HS2, Transport for London, Network Rail and National Highways.

The four strategic outcomes of the collaboration are to:

1. Improve the way Transport Infrastructure projects are set up to maximise value
2. Achieve better assurance of project and programme value and what assets should cost (benchmarking)
3. Accelerate the wider adoption of MMC
4. Establish the TIES Living Lab as a catalyst for long term cultural change across sectors by making a compelling case for long term HM Treasury funding to scale this facility.

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