MOTT MACDONALD

CONSTRUCTION INNOVATION HUB

The Value of Platforms in Construction

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UK Research and Innovation

Report Mission Statement

To provide an economic and qualitative analysis of the mass implementation of Product Platforms, as recommended by government policy

1
Executive Summary
2
Introduction
3
The case for change
4
Economic opportunities
5
Broader opportunities
6
Reflections

Contents

The tracking bar on the left of this document is clickable to allow targeted navigation through the sections. The page number going forward will be shown in the active section

Executive Summary

Construction has a significant role to play in improving national productivity and creating the assets which society needs to function efficiently. All the while, it needs to address skills shortages, safety and wellbeing challenges, errors and waste. This report shows that the Government ambition for the adoption of Product Platforms through its social infrastructure pipeline can help address some key challenges in construction and make an important contribution to national GDP.

The case for change

The UK has a chronic productivity problem, falling behind the likes of France and Germany by as much as 20% and costing the average household some £5,000 per year. The construction sector could help to improve the country's productivity performance and drive national GDP growth. The sector's unique role in driving growth across the economy and supporting public services stems from its scale at 9%+ of GDP, contribution to the creation of half of the nation's physical capital, and its supply chain.

However the industry faces a number of challenges, many associated with the cyclical, volatile and fragmented project-based approach adopted in response to the commercial environment:

- 30% of workplace fatalities taking place in construction
- Significant wellbeing issues, with rates of suicide in construction being twice as high as other occupations
- A high dependence on, and increasing shortfall in, labour. This shortfall in 2022 equated to a loss of around £2.6bn of output, with 30% of the workforce over 50
- Up to 20% of projects costs – as much as £23bn each year – associated with making and rectifying defects

To fulfil the sector's potential, radical policy intervention is required to change the way we buy and deliver buildings and drive up productivity. Publicly procured social infrastructure represents around 14 per cent (£89 billion) of the total investment pipeline of the construction industry over the 2020s.

Government procurement of construction services therefore offers a significant lever for transforming the sector, and the mass adoption of Product Platforms could help achieve this goal. Product Platforms could lead to permanent shifts in productivity, enabling the sector to reduce costs and/or increase production, with potential knock-on impacts on the economy.

What "good" looks like

To respond to these challenges, the construction sector therefore needs to:

- **be a lot more productive**
  the gap between output and productivity has widened in the past decade and this acts as drag on the economy
- **be safer and less dependent on labour**
  Over a third of UK construction workers are over 50
- **make fewer errors**
  Defect remediation can account for 10-20% of project value
- **generate less waste**
  and construction generates 60% of UK waste [by weight]

And, most importantly

- create the **best possible assets** *because these underpin the operation of other sectors of the economy*

Analysis of the Government's Outcome Delivery Plans points towards social infrastructure that prioritises high skilled jobs that can build on knowledge for continuous improvement. Health of users of social infrastructure is particularly important to government, with a hospital modernisation programme underway. Social infrastructure should also be resilient to cope with a changing population with circularity also in mind.

The value of platforms in construction

Product Platforms support an **increase in productivity** which will:

- **Reduce construction costs by up to 31%**, worth up to £1.8bn a year to Government's social infrastructure spending alone
- Provide a multiplier effect to **increase real GDP by up to £7.8bn a year** on a sustained basis

They do this through an integrated approach to commonality and variability across multiple projects, providing the benefits of manufactured approaches while catering for the project-specific needs of clients and users of buildings.

In increasing productivity and adopting more manufacturing approaches, Product Platforms can **increase safety and reduce dependence on labour**:

This will also improve economic and broader wellbeing through reduced cyclicality; reducing demand for labour overall and drawing from a broader pool of workers who can be distributed across the country and support levelling up.

Reduce errors and waste

Economies of repetition are enabled by utilising Product Platforms. This reduces errors and waste due to the learning curves realised by repetition, contributing to process improvement.

Improve the quality of the assets created

By introducing a manufacturing approach to social infrastructure, more control is achieved in the manufacturing and assembly process. This means that the value requirements set out at the start of the project are more likely to be achieved, improving outcomes for stakeholders involved.

The value of Product Platforms – in construction and beyond

	Within the construction sector	Beyond the construction sector
GDP impacts	**Direct productivity gains worth an estimated £1.8bn p.a. (in 2023 prices) in the construction sector** Reductions in the unit cost of social infrastructure programmes arising through: • Economies of scale and scope • Reduced wastage • Enhanced quality control and minimised risk of rework • Solution optimisation and continuous improvement **Improved construction sector resilience:** • Reduced reliance on a diminishing construction workforce • Enhanced workforce attraction/retention through improved working conditions and geographic spread of labour pool • Increased clustering of activity in manufacturing hubs opens up opportunity to develop specialist (but relatively lower cost) labour pools	**Product Platform-enabled productivity gains unlock GDP growth across the wider economy, worth an estimated £4.7bn to £7.8bn p.a. in the long-run (in 2023 prices)** • Productivity-driven increases in investment in the economy and increased trade between construction and other sectors of the economy, and generates **additional, economy-wide GDP growth** • **Cost savings to the Government** from reducing the costs of social infrastructure construction and increased tax receipts from increasing whole-economy GDP growth**:** • These could fund **reduced taxes or investment** – or a combination of the two. Lowering taxes has a positive effect on household income, enabling households to consume and save more (which is the equivalent of future consumption) • The increase in household savings will support an ongoing **long-term increase in investment**, reflecting the impact of Product Platforms on investment returns across the economy • Alternatively, in a 'Business as Usual' fiscal scenario, the higher tax receipts could be used to cover the **costs of the transition** to Product Platforms (such as changes to Government's procurement process and direct business support initiatives in the sector) • **Increased real incomes for households from economy-wide GDP growth**
Wider benefits not captured in GDP	**Construction workforce benefits:** • **Reduced on-site safety risks**, avoiding the negative health and wellbeing impacts of workers who experience accidents • **Safer, more stable, more pleasant and more inclusive employment** at a more consistent location • **Increased opportunity for longer-term, more meaningful wellbeing initiatives**, targeting a reduction in suicide rates	**Wider national social value:** • **Levelling up the economy:** • Through the redistribution of construction related jobs (and knock-on economic activity) beyond large conurbations to regions with strong manufacturing bases, such as places in the Midlands and North • **Environmental benefits and contribution to net zero:** • Reduction in materials waste and the use of more efficient construction processes will reduce embodied and operational carbon • The shift to off-site construction will reduce negative local environmental impacts of on-site activities, e.g. noise, emissions, traffic disruption • Opening up the circular economy through repeatable and manufactured components used across assets • **Improved quality of buildings:** • Enhanced user experience, contributing to the wellbeing of users (e.g. attainment levels in schools, recovery rates in hospitals, life satisfaction in social housing)

6
Executive Summary
Introduction
The case for change
Economic opportunities
Broader opportunities
Reflections

What are Product Platforms?

Product Platforms are an integrated approach to commonality and variability across multiple projects, providing the benefits of manufactured approaches while catering for the project-specific needs of clients and users of buildings. They are well adopted in other industries as a means of delivering mass customization: offering customer choice and high quality at near mass-produced prices.

Product Platforms span design, production, commercial and use, and comprise:

Standardised repeatable components

- A kit of parts which are digitally designed and can be configured and combined with complementary, bespoke elements within a defined technical framework to produce customised buildings (or parts of buildings) that enable improved outcomes, best-value procurement and efficient delivery

Standardised repeatable processes

- A suite of repeatable processes that de-risk design and business case development through optimising best practice

People and relationships

- Longer-term and strategic relationships based on defined technical and commercial interfaces which allow innovation to take place at multiple levels of the supply chain and continuously improve, driving economies of repetition

They can deliver social infrastructure facilities 30% cheaper

Design	Fast-track development and approval using tried and tested solutions Robust, adaptable designs based on data and feedback	Continuous value management through the delivery process
Materials	Increased value in decarbonisation investments due to pipeline of demand	Reduced waste and over-ordering Improved forecasting due to reduced volatility and variability of demand
Manufacture	Reduced variability in components, enabling higher utilisation of capital Enables increased investment due to repetition and continuity	Repeatable solutions enabling procurement at scale
Assembly	Mitigate delivery risks by simplifying processes and increasing certainty	Manufactured solutions with pre-engineered interfaces and improved tolerances

Unlocking the value of Platforms

In order to unlock the value of Product Platforms, we need to achieve **economies of repetition.**

Changing Government Procurement Models

The Government is a major customer of the construction sector. Over half (53%) of the UK's £649 billion investment pipeline between 2021/2 and 2030/1 is public investment in social and economic infrastructure, as estimated by the Infrastructure & Projects Authority and National Infrastructure Commission.

Of this, around a quarter (26%) is social infrastructure (£89 billion). This means publicly procured social infrastructure represents around 14 per cent of the total investment pipeline of the construction industry over the 2020s.

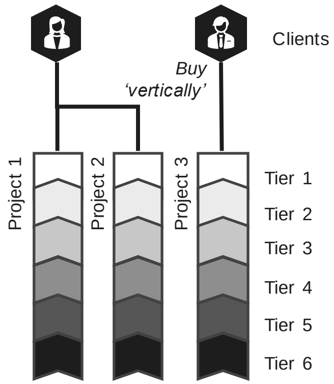
Cross-departmental harmonisation, digitisation and rationalisation, (as per The Construction Playbook), of requirements, spaces and adjacencies will be needed to reduce the variability with which requirements are articulated. Development and use of **consistent data structures** across products, suppliers and systems will help to understand performance and support continuous improvement.

Pipeline aggregation and visibility, which where possible should be evened out using a portfolio approach, to enable more strategic supplier relationships across the sector and consideration of **"horizontal" procurement** as a means to aggregate demand for common parts with consistent technical requirements across multiple projects.

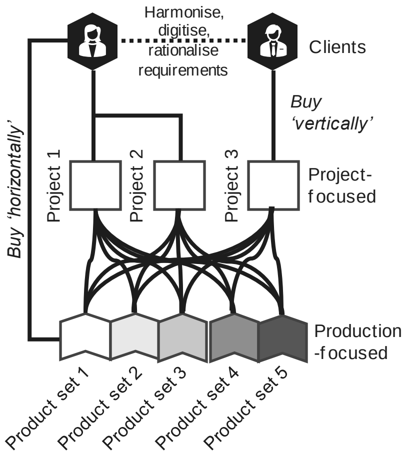
Changing our Supply Chain Models

Construction is highly fragmented, with the largest of firms having a relatively small share of the overall market compared to other industries. A shift to manufacturing approaches may lead to consolidation as a competitive advantage, leading to a smaller number of larger firms.

The aim of a disaggregated supply chain on its own may not support these ambitions. Procurement policy, and the role of smaller firms in creating value, need to be considered during the adoption of platform approaches.



An "aggregated" supply chain
Projects are specified and purchased 'vertically'. Many organisations undertake specialist activities, coordinating on a project-by-project basis.



A "disaggregated" supply chain
Projects can be specified and purchased 'horizontally', and vertically. Suppliers can be decoupled from the project design, allowing scope for repetition.

Locking in Economies of Repetition

Evidence from industries from automotive to aviation, and software to Fast Moving Consumer Goods (FMCG), highlight the potential of "economies of repetition". These refer to the benefits of fixed repeating patterns of work over multiple cycles, creating improvements in performance based on technical and human factors such as waste reduction, process improvement and operator learning. These factors have been seen to reduce cost of a product by as much as 70%. These are closely related to, but not the same as, economies of scale, with the latter failing to be effective in a portfolio of variable projects or products such as construction.

The project-centric approach (from funding and requirements to design and delivery) in construction drives decentralised decision-making and financial control at a project level, with a need for local adjustments at the construction site. The uncertainty factors of incomplete specification, lack of uniformity, and unpredictable environment make the use of standard materials combined with craft labour an appropriate strategy, as opposed to the standardised activities and associated ability to share best practice that has been adopted in other industries.

This strong emphasis on individual projects favours a narrow perspective, both in time and scope, with the widely-held perception that competitive tendering promotes cost effectiveness and efficiency. All this drives the relationships among parties to be transactional, and typified by market-based, short-term interactions between independent firms.

This uncertainty prevents economies of repetition underpinning platform approaches from taking hold effectively, since there is insufficient stability technically, commercially or organisationally.

Changing our Procurement and Supply Chain models will lock in economies of repetition.

Introduction

This document provides an analysis of the implementation of Product Platforms across the UK public sector social infrastructure estate, as recommended by government policy.

The report is split into five sections, as set out below. These provide:

1. An overview of key terms and concepts including construction, manufacturing, supply chains and Product Platforms;
2. An overview of the drivers for change, including comparisons with manufacturing;
3. An analysis of the economic implications of Product Platforms, including construction cost savings, industry structure and impacts on GDP;
4. An analysis of the broader potential impacts of Product Platforms, including employment opportunities and an analysis of Departmental Outcome Delivery Plans; and
5. Reflections on creating the right environment for Product Platforms to deliver benefits.

Structure of this report:

Introduction	The case for change	The economic opportunity	Broader opportunities	Reflections
• Overview of construction and Product Platforms	• The strategic background, current state of the construction industry, and a baseline state and current challenges	• Quantitative macroeconomic modelling of the impacts of Product Platform adoption across the government estate	• Qualitative assessment of broader environmental, human and social impacts of Product Platform adoption across the government estate	• Reflections on the study, focused on creating the right environment for platforms to succeed

Government policy promotes mass implementation of Product Platforms for construction. This report provides an assessment of the impacts.

The Government is aiming for the mass adoption of Product Platforms by 2030[1] as a means of delivering time and cost efficiencies in the construction of bult assets, as well as improvements in the end quality and sustainability[3].

The Transforming Infrastructure Performance (TIP) – Roadmap to 2030, published in 2021, sets out how the Government will, through a platform approach, "generate societal outcomes from its pipeline, by enabling a disaggregated manufacturing industry that creates stable and inclusive employment where jobs are most needed."

The Product Platform Rulebook suggests that the construction sector should become more like the manufacturing sector. It should leverage the "re-use of common components, processes, knowledge and relationships for many years to deliver mass customised products at a reduced cost, faster and with lower risk."

Re-using the same designs repeatedly is expected to allow firms to unlock economies of scale and focus on productivity improvements and high value components. The Rulebook suggests there is potential for a range of benefits at the firm level.

In some cases, these will translate into economic impacts that, in principle, can be monetised and will therefore be reflected in national GDP (and within the scope of this study). These include improved productivity, efficiency and predictability of construction processes and reductions in cost through standardised, repeatable solutions that leverage economies of scale and scope. Specific examples include lower development costs, reductions in on-site labour, minimised risk of rework, and opportunities for solution optimisation and continuous improvement.

Some benefits are likely to be only partly reflected in national GDP, such as a wider, more diverse supply base, which may help reduce costs (which will be reflected in GDP) but also help address regional economic inequalities (which will not be reflected in national GDP).

Other benefits will generate welfare gains for society that are not directly reflected in the money economy and national GDP (and are not therefore within the scope of this study). These include enhanced quality control and reductions in on-site safety risk, reduced carbon footprints and changes in local environmental impacts.

This report presents an assessment of the opportunities of Product Platform delivery and their impact on the UK economy. This includes economic, societal and environmental factors, based on the Value Toolkit categories, which are compared with cross-Departmental Outcome Delivery Plans.

The focus in the literature to date has been how Product Platforms should be rolled out rather than on assessing the nature and scale of the potential benefits, about which there are gaps in the evidence base:

- Product Platforms are at an early stage so the scale of the productivity gain at the firm / sector level is not observed or quantified
- There is also no observed or quantified evidence about how firm / sector level effects transmit benefits into the wider economy and society as a whole

The aim of this study is to address the evidence gap about how firm and sector level benefits generate wider impacts. The following introductory section sets out the key concepts and common definitions of the sectors related to this study and how it links to Platform approaches.

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[1] Defined in the Hub's Product Platform Rulebook as "common, repeatable assets with interoperable components to drive a new market for manufacturing in construction." A good example of a physical platform is the Department for Education's Energy Pod programme. This seeks to deploy annexes housing low carbon heating manufactured offsite.

[2] The Infrastructure and Projects Authority, which reports to HM Treasury and the Cabinet Office, held a consultation on the use of platforms in 2020.

What is construction?

Construction is a large and diverse sector – covering everything from creation, to repair, to improvement, and to demolition of the built environment. It covers hospitals and highways, solar farms to sewage works, and nuclear power stations to high speed rail.

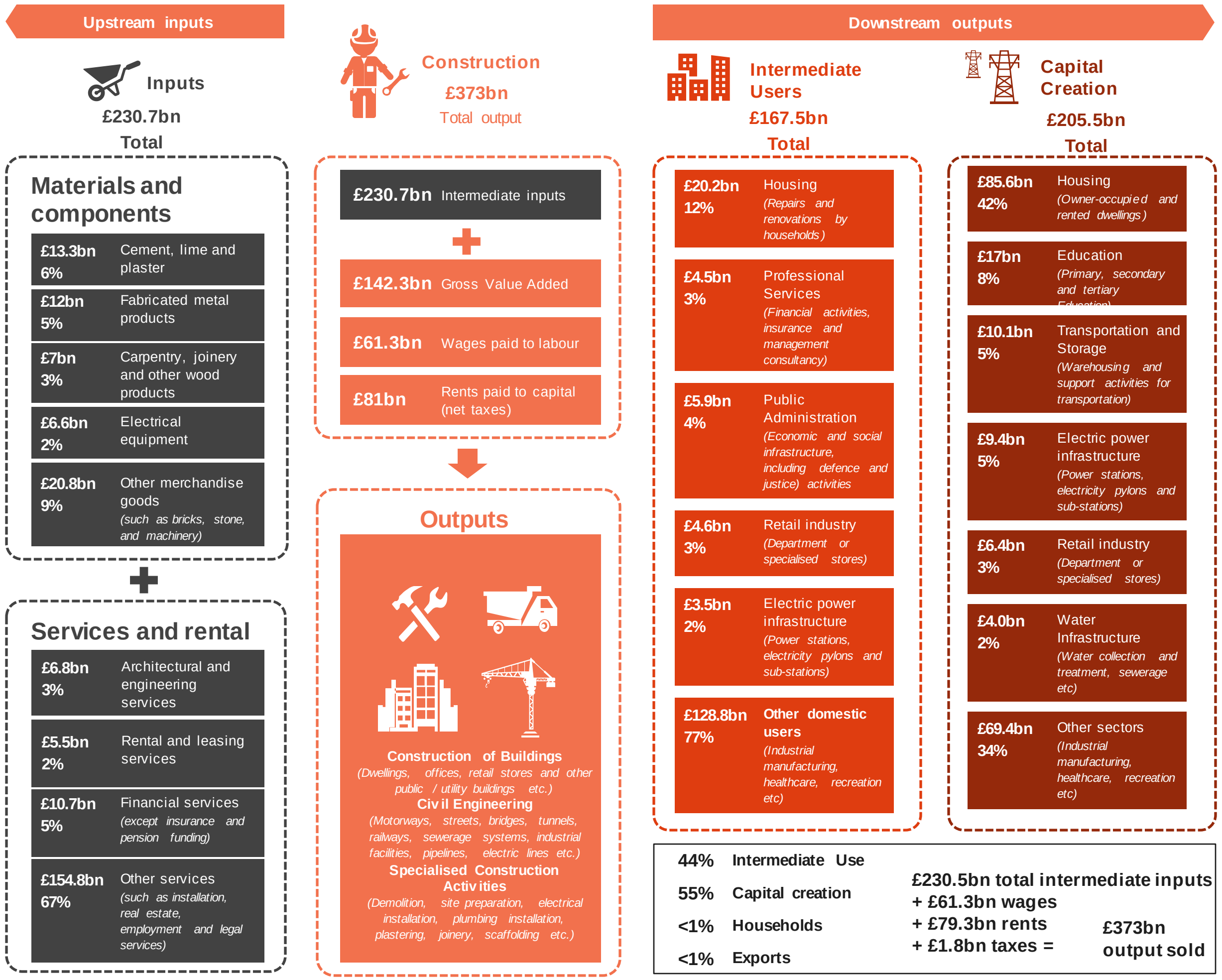
In economic terms, it contributes around 6% of total gross domestic product, or £142bn per annum. It employs 2.1 million people, or 7.8% of the workforce. Almost one in five UK businesses is a construction business (ONS)

These figures are based on standard industry classification (SIC) codes, which places Construction in Section F. This is then divided into three divisions: 41 (buildings), 42 (civil engineering) and 43 (specialist construction firms).

If we factor in the other firms which are generally thought of as "construction", the picture is much larger: it includes a long and complex supply chain, plant hire and designers, along with other services such as legal and employment.

Table 2A: Comparing coverage of this study with industrial classification

	Covered by this analysis	ONS classification of construction
Contractors	Yes	Yes
Consultants (architects, engineers, QS, project managers)	Yes	No
Offsite manufacturers	Yes	Depends on the company
Building materials and components	Yes	In output, not accounts
Merchants and wholesale	Not explicitly	No
Plant hire	Not explicitly	When supplied with operators
Logistics and storage	Not explicitly	No
Client construction teams (maintenance, utilities etc.)	No	No



Upstream inputs

Inputs
£230.7bn
Total

Materials and components

£13.3bn **6%**	Cement, lime and plaster
£12bn **5%**	Fabricated metal products
£7bn **3%**	Carpentry, joinery and other wood products
£6.6bn **2%**	Electrical equipment
£20.8bn **9%**	Other merchandise goods *(such as bricks, stone, and machinery)*

➕

Services and rental

£6.8bn **3%**	Architectural and engineering services
£5.5bn **2%**	Rental and leasing services
£10.7bn **5%**	Financial services *(except insurance and pension funding)*
£154.8bn **67%**	Other services *(such as installation, real estate, employment and legal services)*

Construction
£373bn
Total output

£230.7bn	Intermediate inputs
➕	
£142.3bn	Gross Value Added
£61.3bn	Wages paid to labour
£81bn	Rents paid to capital (net taxes)

Outputs

Construction of Buildings
(Dwellings, offices, retail stores and other public / utility buildings etc.)

Civil Engineering
(Motorways, streets, bridges, tunnels, railways, sewerage systems, industrial facilities, pipelines, electric lines etc.)

Specialised Construction Activities
(Demolition, site preparation, electrical installation, plumbing installation, plastering, joinery, scaffolding etc.)

Downstream outputs

Intermediate Users
£167.5bn
Total

£20.2bn **12%**	Housing *(Repairs and renovations by households)*
£4.5bn **3%**	Professional Services *(Financial activities, insurance and management consultancy)*
£5.9bn **4%**	Public Administration *(Economic and social infrastructure, including defence and justice) activities*
£4.6bn **3%**	Retail industry *(Department or specialised stores)*
£3.5bn **2%**	Electric power infrastructure *(Power stations, electricity pylons and sub-stations)*
£128.8bn **77%**	**Other domestic users** *(Industrial manufacturing, healthcare, recreation etc)*

Capital Creation
£205.5bn
Total

£85.6bn **42%**	Housing *(Owner-occupied and rented dwellings)*
£17bn **8%**	Education *(Primary, secondary and tertiary*
£10.1bn **5%**	Transportation and Storage *(Warehousing and support activities for transportation)*
£9.4bn **5%**	Electric power infrastructure *(Power stations, electricity pylons and sub-stations)*
£6.4bn **3%**	Retail industry *(Department or specialised stores)*
£4.0bn **2%**	Water Infrastructure *(Water collection and treatment, sewerage etc)*
£69.4bn **34%**	Other sectors *(Industrial manufacturing, healthcare, recreation etc)*

44%	**Intermediate Use**
55%	**Capital creation**
<1%	**Households**
<1%	**Exports**

£230.5bn total intermediate inputs
+ £61.3bn wages
+ £79.3bn rents
+ £1.8bn taxes =
£373bn output sold

Source: *Analysis* of ONS Input-Output table (2019) indexed to 2022, basic prices.

Construction draws upstream inputs from 64 other industries (from mining to machinery), and its outputs are consumed by 71 other industries. Over half of the inputs to construction firms are from other construction firms, representing the significant levels of sub-contracting and complexity of supply chains in the sector.

Compared to manufacturing, which has 24 divisions and contributes 9.2% of total economic output, construction is much less granular when measured at an economy level. This matters because it is difficult to measure the impacts of interventions at a sector level when measurement is coarse and incomprehensive.

This document considers the impacts of widescale Product Platform adoption across part of the construction industry in its broadest sense – as illustrated in Table 2A.

What is a manufacturing approach?

Manufacturing is the creation or production of goods in a with the help of equipment, labour, machines, tools. From craftmanship to 3D printing, manufacturing has changed significantly.

Strictly, manufacturing involves three types of activity: casting and moulding; shearing and forming; and machining. Joining or combining components are assembly activities. A **manufacturing approach** to production is broader and is one which focuses on standardisation, repeatability, efficiency, and continuous improvement – all in a controlled environment. It involves using data and metrics to optimise processes and reduce waste, while prioritising customer value and flexibility in design and production.

Before the industrial revolution, manufacturing was primarily done by hand, and goods were produced slowly and expensively. This changed in the 18th century when the steam engine was invented, leading to the development of large factories and machinery that could produce goods faster and cheaper than ever before.

During the 19th and 20th centuries, manufacturing continued to evolve with the introduction of **mass production** techniques, such as the assembly line, which made it possible to produce goods in large quantities at a lower cost (for example the Model T).

In the mid-20th century, computerisation revolutionised manufacturing, leading to the development of computer numerical control (CNC) machines that could automate many manufacturing processes. This resulted in greater precision and efficiency in the production of goods, resulting in **lean manufacturing** (for example the Toyota Production System).

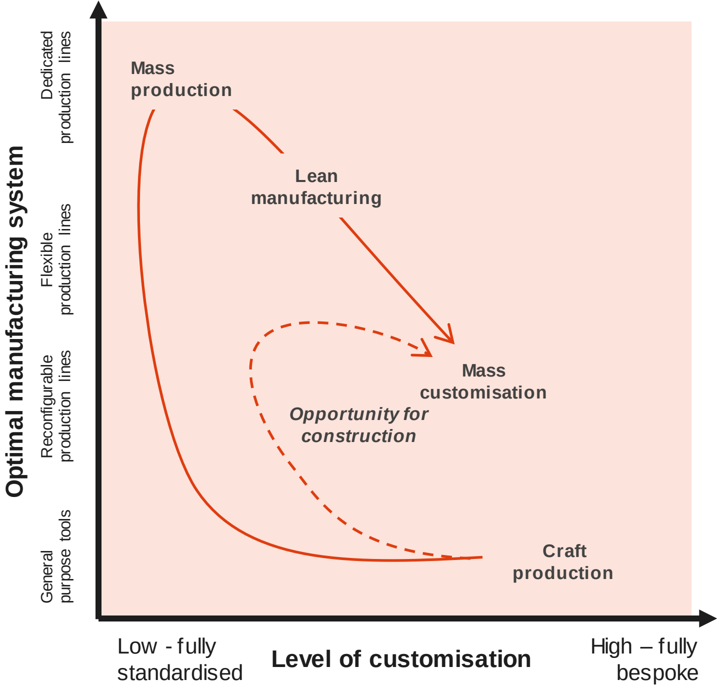
Today, manufacturing is undergoing another major transformation with the rise of digital manufacturing technologies, such as 3D printing and the Internet of Things (IoT). These technologies are making **mass customisation** possible – the production of customised products on demand, while reducing waste and environmental impact.

Product Platforms (or a platform approach) underpin many methods of mass customisation across industries, from electronics to automotive to consumer goods. For example, Apple's iPhone is based on a Product Platform that allows for the creation of multiple models and variations, while still sharing many common components and features. Similarly, many car manufacturers use Product Platforms to produce multiple models from a common set of parts and components.

The growth of Product Platforms has been enabled by advances in digital design and simulation tools, which make it easier for manufacturers to create and test new platform configurations. In addition, the rise of digital manufacturing technologies, such as 3D printing, has made it possible to produce customised components and modules more easily and cost-effectively than ever before.

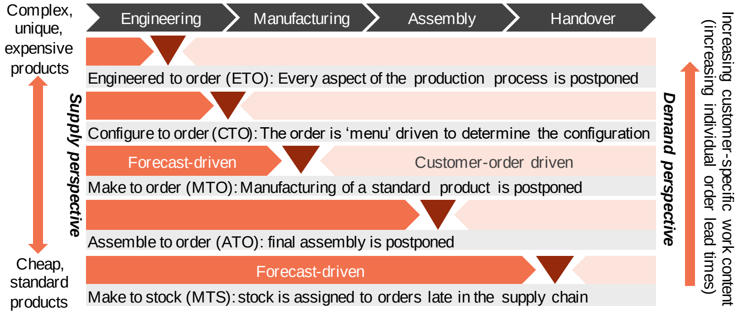
They offer the primary benefit of providing increased choice to customers whilst ensuring that derivative products (individual customised products made using the platform) are economically attractive.

Figure 2A: Evolution of manufacturing from craft production to mass customisation. Construction can shortcut this process.



The Customer Order Decoupling Point (or CODP) is the point in the value chain for a product where activities are linked to a specific customer order. The more decoupled, the more production takes place in isolation of any one order.

Decoupling points ▼ define how much of a design or production process is postponed until a customer order is placed.



Engineered to order (ETO): Every aspect of the production process is postponed

Configure to order (CTO): The order is 'menu' driven to determine the configuration

Make to order (MTO): Manufacturing of a standard product is postponed

Assemble to order (ATO): final assembly is postponed

Make to stock (MTS): stock is assigned to orders late in the supply chain

For example, standard, commodity products such as standard steel plate are produced in isolation of any one customer placing an order. However, a bespoke steel plate for a particular column on a particular hospital would only be designed, engineered and produced after a specific order has been placed.

The position of the decoupling point has a significant impact on production efficiency, storage costs and the quality and scale of logistics. Production typically scales (and unit costs fall) by pre-completing design, production and assembly in advance of a single customer order (mass production).

Construction is currently mostly "Engineer to order" (ETO) – more like the bespoke column, or craft production – whereas much of manufacturing is more like the production of standard steel plate, or mass production. Since it is infeasible to assemble a product which has not yet been designed, this makes adoption of a manufacturing approach difficult in construction supply chains.

Product Platforms change the decoupling point from ETO to CTO. This is done by placing certain constraints on the ordering process – for example in the form of menu-driven configuration and having predetermined interfaces. This maintains customisation within certain bounds while unlocking opportunities to leverage more optimal decoupling strategies within the supply chain.

The result is that a greater quantity of inputs can be produced using repeated methods, whilst avoiding providing identical solutions to a market which requires variability.

What are Product Platforms?

Product Platforms are an integrated approach to commonality and variability across multiple projects, providing the benefits of manufactured approaches while catering for the project-specific needs of clients and users of buildings. They are well adopted in other industries as a means of delivering mass customisation: offering customer choice and high quality at near mass-produced prices.

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A kit of parts which are digitally designed and can be configured and combined with complementary, bespoke elements within a defined technical framework to produce customised buildings (or parts of buildings) that enable improved outcomes, best-value procurement and efficient delivery.

Standardised repeatable processes

A suite of repeatable processes that de-risk design and business case development through optimising best practice.

People and relationships

Longer-term and strategic relationships based on defined technical and commercial interfaces which allow innovation to take place at multiple levels of the supply chain and continuously improve, driving economies of repetition.

A Product Platform in construction balances **repeatability** and **variability** across a set of projects. By being able to use repetitive products, processes, people and knowledge, Product Platforms can deliver productivity improvements that are considered in this report.

Product Platforms still deliver optimum value to the customer by balancing repeatability with variability using **standard interfaces,** so bespoke requirements can be efficiently designed for, built and integrated whilst taking advantage of the productivity gains achieved by using repeatability

The combination of common, repeatable assets with complementary elements, brought together with standard interfaces, enables a Product Platform to be extended to produce product families (a group of related products that share common features) that serve a variety of market segments (asset types, or clients).

Product Platforms, as the name suggests, are defined in terms of the derivative products which can be created using that platform. Products can differ, meaning Product Platforms can be applied at:

A **single element** level – for example, hot rolled structural steel sections use repeated supply chains, materials, equipment, processes and quality control to produce different sections for a range of applications. These need to be customised and arranged with other elements to create a system or part of a building;

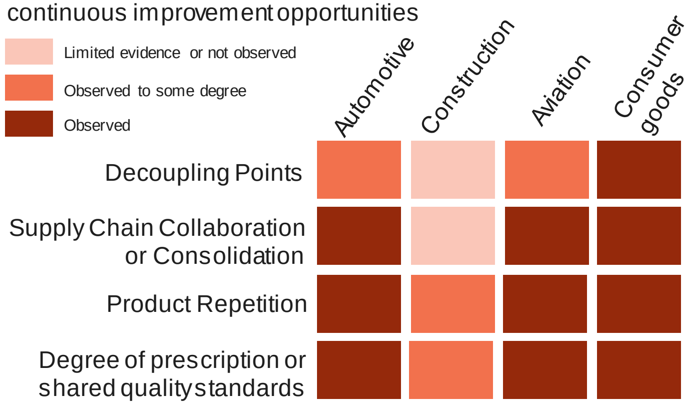
A **single system** level – for example, Modular MEP systems are prefabricated Mechanical Electrical and Plumbing (MEP) modules that can be configured into a sub-assembly off-site for easy installation on site.

A **'cluster'** level – for example, hospitals comprise a series of different departments, each with their own standard rooms, provisions, staffing levels, equipment and layout. These need to be arranged and combined with other departments to function as a hospital.

A **whole building** Supermarkets use a standard design and pre-engineered components to rapidly deploy bespoke footprint buildings using standard components.

Developing and adopting Product Platforms is not trivial. Automotive companies spend billions. For example, Volkswagen Group spent in the region of £50bn developing their MQB platform, from which over 32 million derivative vehicles in a 10 year period were produced.

In industries where Product Platforms are successful, decoupling points avoid Engineer to Order, have consolidated supply chains, maximise product repetition and work across their supply chain for continuous improvement opportunities



░ Limited evidence or not observed
▒ Observed to some degree
█ Observed

	Automotive	Construction	Aviation	Consumer goods
Decoupling Points	▒	░	▒	█
Supply Chain Collaboration or Consolidation	█	░	█	█
Product Repetition	█	▒	█	█
Degree of prescription or shared quality standards	█	▒	█	█

Key Supply Chain Attributes of Listed Sectors

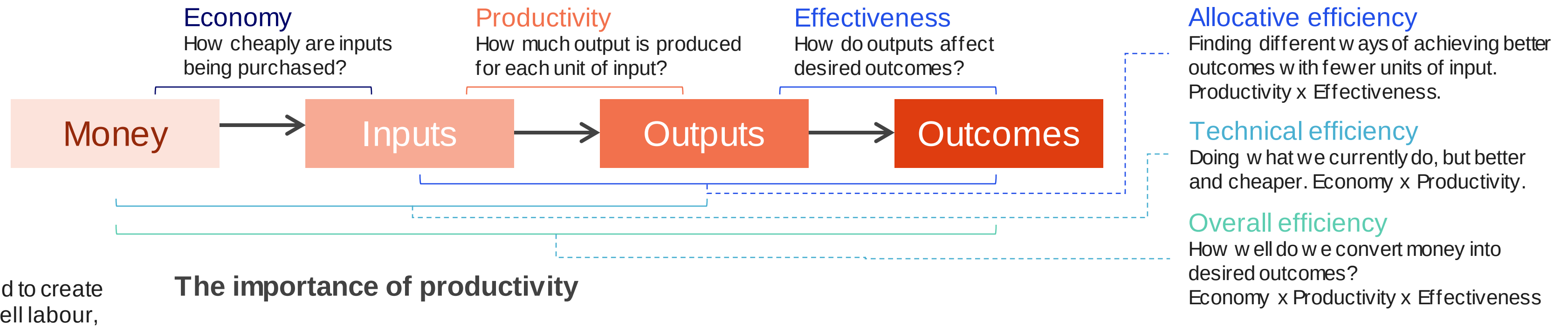
Key areas which predicate success of Product Platforms include:

1. **Organisation**: developing successful Product Platforms involves multiple functions and must not be seen as solely an engineering or procurement challenge. The fragmented nature of construction means that this requires buy-in from clients to construction firms, and suppliers to regulatory bodies.
2. **Stability**: Product Platforms require long-term planning and are best suited to markets with low product instability or architectural change. The construction industry currently experiences a lot of variation from project-to-project, which needs to be managed.
3. **Expectation**: A successful platform balances stability with customisation expectations, allowing for choice in areas most valuable to the customer without compromising standardisation and quality during production.

Product Platforms are referenced in the Construction Playbook, encouraging their uptake in the construction industry. The IPA Transforming Infrastructure Performance: Roadmap to 2030 aims to mandate platform approaches to social infrastructure with repeatable designs.

For further information on definitions and implementation of Product Platforms in construction, please see the Product Platform Rulebook.

What is productivity?



Productivity is a measure of how well resources are used to create outputs. In construction, productivity can relate to how well labour, equipment and materials are used to complete a project. For example, if one crew of workers can install 2 façade panels in one hour, but with improved methods they can install 3 panels in the same hour, their productivity has increased by 50%.

Defining productivity

1. **Labour productivity**: this refers to how much output (such as square meters of wall or linear meters of piping) is produced per unit of labour input (such as hours worked)
2. **Capital productivity**: this refers to how much output is produced per unit of capital investment (such as the cost of equipment)
3. **Material productivity**: this refers to how much output is produced per unit of material input (such as the volume of concrete)
4. **Total factor (or multifactor) productivity**: this refers to how efficiently all inputs (labour, capital, materials, etc.) are used to produce output

Productivity can be considered as different to efficiency and effectiveness, as illustrated above (Cabinet Office). This is important because the main way of being more productive is to produce the correct outputs, since mistakes and rework are avoided.

Productivity can be improved through a blend of technical and human factors – by using better technology or techniques, and by organising resources more effectively. For example, the assembly line dramatically improved productivity in automobile production.

The importance of productivity

Productivity is important for several reasons, and firms and sectors tend to be rewarded for increasing productivity:

Economic growth: When productivity increases, more goods and services can be produced with the same amount of resources. This leads to economic growth, improved wages and conditions, and higher standards of living.

Competitiveness: Firms (and regions and countries) that are more productive are able to compete more effectively with others. Higher productivity can lead to lower costs, higher profits, and better quality products, all of which can make a firm more competitive.

Job creation: Productivity improvements can lead to the creation of new jobs, as firms may need to hire more workers to keep up with increased demand for their products or services.

Innovation: Firms that are more productive often invest more in research and development, spurring new innovations and technologies that drive economic growth.

Sustainability: Productivity improvements allow more production with fewer resources, reducing the environmental impact of activity.

Levers to improve productivity

Technical factors	Human factors
1.Capital investment in improved tooling and machines 2.New technologies 3.Resource allocation 4.Process improvement 5.Better information flows	1.Investment in skills, training and education 2.Organisational structure 3.Employee engagement and motivation 4.Continuous improvement

General Productivity growth in the UK has been a cause for concern

Top UK economists were surveyed by the Centre for Macroeconomics (CFM) to get their take on the causes of and possible policy responses to this productivity slowdown. According to the survey, nearly half of the economists surveyed pointed to low demand due to the financial crisis, austerity policies and Brexit as major causes for this productivity decline.

So, what's the solution? It turns out that a small minority of the panel believes that the answer lies in demand-side policy. Instead, most of the panelists support promoting productivity growth through investments in education and worker training. They're also suggesting other policies, such as infrastructure investments, and tax and regulatory policies, to help combat this slowdown.

It's no secret that output per worker has decreased dramatically since the global financial crisis of 2008-09. In fact, output per hour and real wages are now no higher than they were prior to the financial crisis. What's even more concerning is that output per hour decreased during the last two quarters of 2018 and the first two quarters of 2019.

While other advanced economies have also experienced productivity slowdowns, the UK's slowdown has been more dramatic. In fact, the UK ranked 31st out of 35 OECD countries in growth of output per hour from 2008 to 2017. This is surprising because the UK is near the top of the league table for ICT-intensive employment, where productivity growth has been the strongest.

It's clear that action needs to be taken to address this productivity decline in the UK. By investing in education, worker training and infrastructure, we can help promote productivity growth and bring the UK back to the top of the productivity leaderboard.

How are supply chains organised in construction?

The UK construction industry is an intricate and complex web of firms and individuals, brought together into temporary organisations to bring projects to fruition. From the architects and engineers who design the buildings, to the contractors who build them, the construction industry involves many different parties. The construction supply chain extends far beyond the construction site, with a large array of suppliers, manufacturers, and distributors involved in the production and delivery of materials, equipment, and services.

The construction supply chain is about getting the right materials and equipment to the right place at the right time. This requires coordination and collaboration between different firms, from the producers of raw materials to the logistics companies responsible for their transportation.

The cyclical and volatile nature of construction can mean that long-term relationships are hard to maintain, and there can be a transactional approach, as firms seek to mitigate risk in a project-based environment. Firms compete on design rather than output, meaning that financial decisions and measurement tend to be decentralised to the individual project.

The importance of the supply chain was highlighted during the Covid-19 pandemic, as operations paused and availability dropped. The effects are still being felt today.

The Construction Playbook and the Transforming Infrastructure Performance (TIP) 2030 both recognise the importance of the supply chain, highlighting the need for longer-term relationships, better understanding of capacity and capability, and evolving digital maturity.

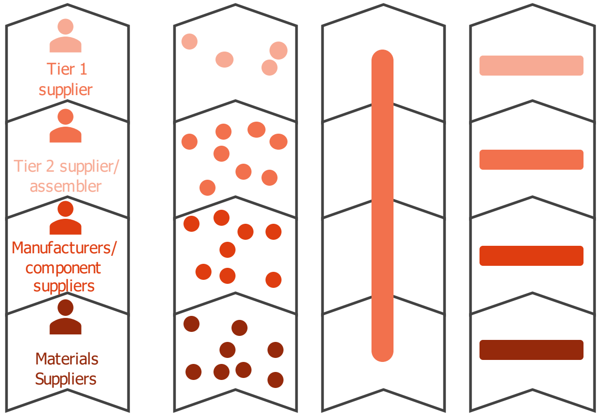
There are key differences between construction and manufacturing supply chains:

Fragmentation - Construction typically involves a more fragmented supply chain, with a large number of small and medium-sized suppliers involved in the production of individual building components. In contrast, the manufacturing industries have a more centralised supply chain, with a smaller number of larger suppliers providing parts and components to a limited number of manufacturers.

Standardisation - Manufacturing industries relies heavily on standardised parts and components, which allows for greater efficiency in production and reduces costs. In contrast, the construction industry tends to rely more on bespoke, customised components, which can make supply chain management more challenging.

Resilience - The construction industry tends to have a higher level of complexity due to the many different types of materials, equipment, and personnel involved in a construction project. In comparison, manufacturing industries have a supply chain that is more streamlined and focused on specific parts and components.

Figure 2B: Types of Supply Chain Organisation



A supply chain for a project

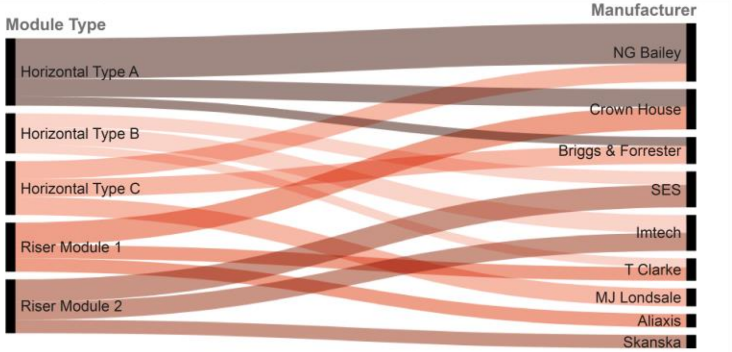
A fragmented supply chain

A vertically integrated supply chain

A horizontally integrated supply chain

When considering a resilient supply chain, Figure 2C shows how a resilient MEP supply chain could be set up for UK construction. Multiple suppliers could deliver interchangeable modules which ensures if there is an issue with a supplier, an alternative can be sourced to deliver the same, specified module

Figure 2C: A resilient supply chain illustration



Laing O' Rourke adopts a vertically integrated supply chain

Laing O'Rourke has simplified its corporate structure to create a single, consolidated UK trading group under Laing O'Rourke Holdings Limited. The aim of this restructuring is to reduce the number of legal entities within the UK group, create a new long-term structure for the business' Europe Hub, and enhance financial reporting to stakeholders while reducing administration costs.

The new UK trading group comprises five operating entities, including Laing O'Rourke Delivery, Explore 2050 Engineering, Explore 2050 Manufacturing, Select Plant Hire, and Laing O'Rourke Services. Notably, Laing O'Rourke is adopting a vertically integrated supply chain by consolidating its manufacturing facilities and adding businesses such as Expanded Piling and Vetter, a specialist stone contractor.

This move is expected to improve Laing O'Rourke's efficiency, reduce costs, and create a more agile and responsive supply chain, ultimately enhancing the company's competitiveness in the UK construction market.

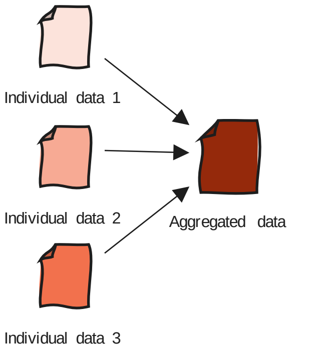
Disaggregated supply chains

TIP 2030 proposes a pipeline product manufacturing approach that involves generating "**greater societal outcomes from its pipeline, by enabling a disaggregated manufacturing industry that creates stable and inclusive employment where jobs are most needed.**"

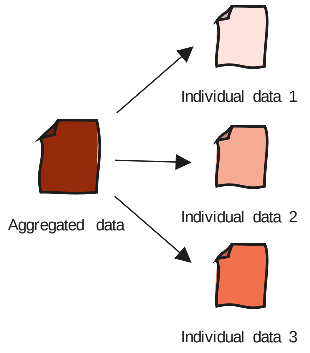
Disaggregate means to separate something into its component parts. Disaggregation takes place in a range of fields, but is typically used to allow focus by taking some larger "thing" (an operation, a building, a dataset, an aircraft, a supply chain) and breaking it into smaller pieces. A disaggregated plan is one which has a series of smaller, semi-independent plans.

When applied to data

Aggregation
the compiling of information from different sources with intent to prepare combined datasets for data processing



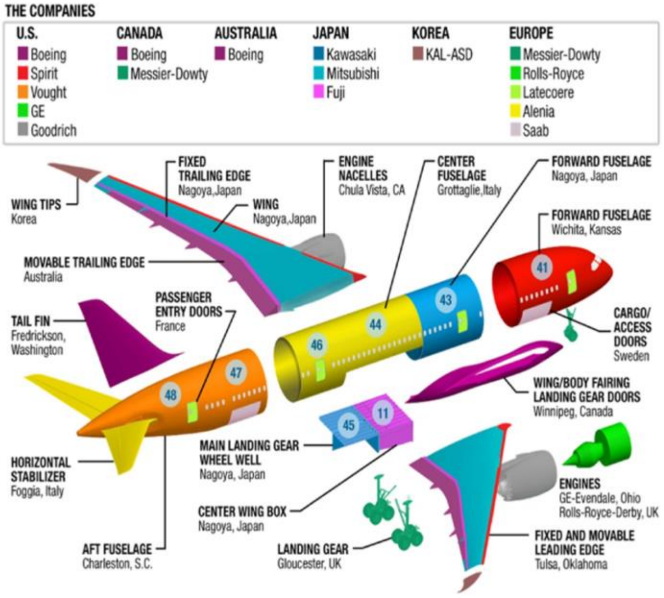
Disaggregation
the separation of compiled information into smaller units to elucidate underlying trends and patterns



When applied to production

Many large, international firms use global value chains, which disaggregate production processes into discrete stages in various locations around the globe to achieve efficient production. Below is an example of Boeing's global supplier partners for the 787 aircraft (Srikanth, 2012), which represents outsourcing by Boeing of the majority of development work to more than 100 suppliers in 12 countries and Boeing serving as 'referee' (Zhao, 2016). This is not dissimilar from subcontracting in construction.

Figure 2D: Boeing's 787 Aircraft Global Supply Chain



Source: Boeing

This programme experienced significant delays due to technical and human factors. Zhao highlights the need to ensure that rewards and the "right" risks are shared (in this case, the risks of unavoidable delays, rather than avoidable delays) as being key to success with a disaggregated model.

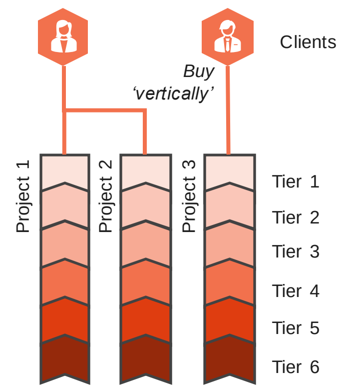
When applied to construction

Research commissioned by BEIS indicates that construction may have a disaggregated supply chain now, with many firms undertaking work on individual projects with relatively low transaction values. One Tier 1 (client facing contractor) may have 50 to 70 Tier 2 suppliers, yet upwards of half of the work may be undertaken by just 5. In turn, each Tier 2 may spend 25% of their contract value on suppliers for values below £10,000. This leads to cost-on-cost, as overhead and profit at each tier of the supply chain accumulates, and makes coordination more difficult.

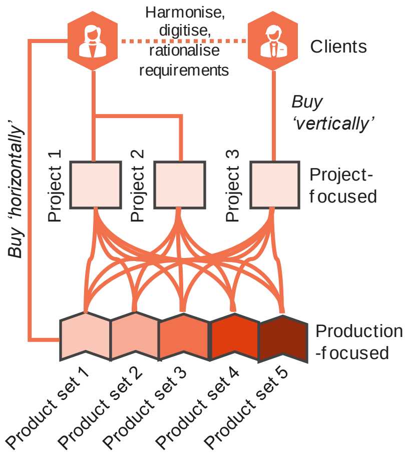
This suggests that a "disaggregated manufacturing industry" relates more to the way in which projects are bought (currently as one offs using an ETO strategy). Taking data and production examples, and the current approach to construction, into account, the following models are proposed to illustrate the difference between an aggregated and disaggregated supply chain. In the latter, production of individual products can be decoupled from individual projects, improving stability and unlocking economies of repetition.

This model suggests that specification and procurement of projects, including identification and handling of the "right risks" will be key. Programmes such as the NHS's P23, New Hospitals Programme and the MOJ's New Prisons Programme Alliance will provide useful case studies for how combining standardised designs with multiple applications can help unlock improvements.

The approach creates the opportunity to: publish an aggregated demand based on defined products but independent of any one project; configure and develop individual projects; projects can then draw from a range of pre-approved suppliers.



An "aggregated" supply chain
Projects are specified and purchased 'vertically'. Many organisation undertake specialist activities, coordinating on a project-by-project basis



A "disaggregated" supply chain
Projects can be specified and purchased 'horizontally', and vertically. Suppliers can be decoupled from the project design, allowing scope for repetition

The case for change

- The UK has a long-standing productivity challenge – important because this is the key determinant of long-term economic growth and, ultimately, living standards.
- The performance of the construction sector is a key driver, accounting for 6 per cent of total output of the economy and taking a broader definition of construction, construction may be equivalent to over 15% of GDP[1].
- Government is the biggest single customer of the construction sector. Through its social infrastructure programme alone, some 39% of national pipeline is delivered by the public sector.
- Social infrastructure faces similar challenges to the wider construction sector and in the current economic and fiscal climate is becoming increasingly unaffordable
- There is therefore a clear rationale for driving the productivity of the social infrastructure sector to:
  - Reduce costs to the Government
  - Promote growth of a more sustainable construction sector
  - Drive wider national growth

Yet the construction industry is facing a number of challenges, well documented in industry reports going back to at least 1944 with the commissioned Simon Committee report. We have not considered the effect of the transactional and often adversarial approach documented by many of these reports and which, more recently, has been the focus of Project 13.

Key areas of improvement for construction:

Be a lot more productive
Poor productivity relative to other sectors is a global challenge. The gap between output and productivity has widened in the past decade.

Be safer and less dependent on labour
A quarter of all work-related fatalities occur in construction, and over a third of UK construction workers are over 50.

Make fewer errors and generate less waste
Defect remediation can account for 10-20% of project value, and construction generates 60% of UK waste [by weight].

★★★★★

Create the best possible assets, because these underpin the successful operation of other sectors of the economy:
- There are direct links between the asset and outcomes from the use of that asset
- Emissions need to reduce by 95% by 2050. 5% of UK carbon emissions arise from embodied materials used in construction, and 20% arise from operation of buildings

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[1] CIOB, The Real Face of Construction, September 2014

Be a lot more productive

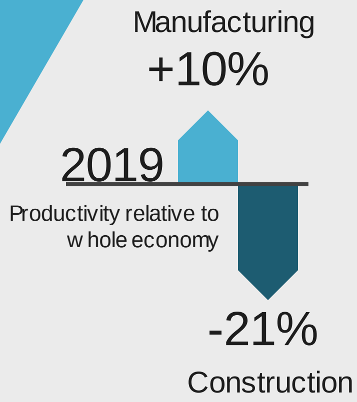
6%
Of GDP is from construction

50%
Capital created in the economy by construction

6.5x
increase in productivity for manufacturing vs construction 2009-2019

40%
More output per hour worked in manufacturing than construction

39%
Of all construction work purchased by the public sector



- Construction contributes 6% of GDP and is responsible for the creation of over half of all capital created in the economy. Construction is therefore uniquely placed to improve productivity performance.
- Sector productivity has not performed as well as others or the economy as a whole and is more susceptible to downturns and inflation, which further impacts productivity. This matters because it means buildings become more expensive over time.
- The Government is construction’s biggest single client, representing 39% of new work. This provides a strong lever to improve construction and the economy as a whole.

Construction output lags, is more susceptible to downturns and inflation

Construction output is defined as the amount chargeable to customers for building and civil engineering work done in a particular period, excluding VAT and payments to subcontractors.

Based on the current gross value added (GVA) weight, construction equates to 6.0% of the economy. Construction includes **three broad industry groups**:

- **Construction of buildings** – general construction of buildings, new work, repair, additions and alterations:
- **Civil engineering** – civil engineering work, including road and railway construction, and utility projects; and
- **Specialised construction activities** – covering trades that specialise, common to different structures.

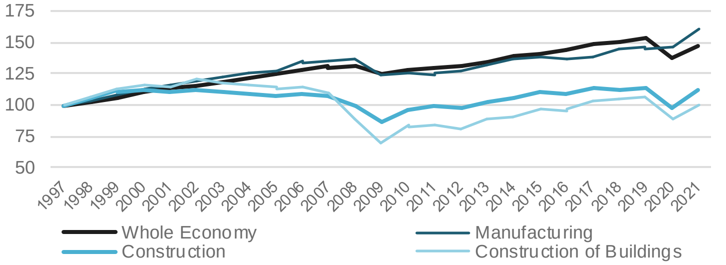
Productivity in an industry is measured through several standardised Office for National Statistics variables. Data series may vary in presentation, but they fall into three categories:

- **Chained Volume Measures** – data from successive years, measured in real term
- **Current Price** – estimates of the period when the activity occurred
- **Constant Price** – chosen base year, the outprice is measured using the price level of the base year.

Construction GVA lags and is susceptible to shocks

GVA for the construction sector has grown since 1997-2019, however at slower rates than the rest of the economy. During the pandemic, it dropped more than the whole economy. This suggests **lagging growth in output** at an aggregate level for the construction industry and also **more susceptibility to economic events**, evidenced by greater decline in 2008/9 compared to the economy.

Figure 3A: GVA, (CVM), UK, 1997 to 2020 (1997=100)

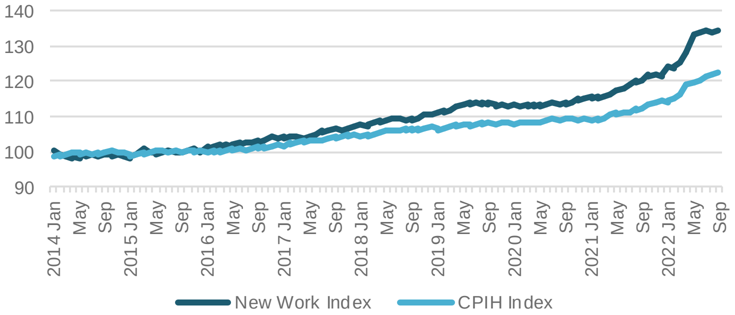


Source: ONS - Monthly GDP and main sectors to 4 decimal places

Prices are increasing above inflation, raising the cost of new construction work

Output Price Indices (OPIs) measure the relative differences in output over time for the level of work done in each period of measurement after controlling for price differences. The quarterly OPIs for construction are used as deflators to convert the output of construction work for those sectors from current to constant prices. The trend in figure 3B shows an increase in construction prices above general inflation, making the cost of new construction work more expensive relative to the rest of the economy.

Figure 3B: Construction New work Output Prices and CPIH Index, January 2014 to June 2022 (Jan 2014 = 100)



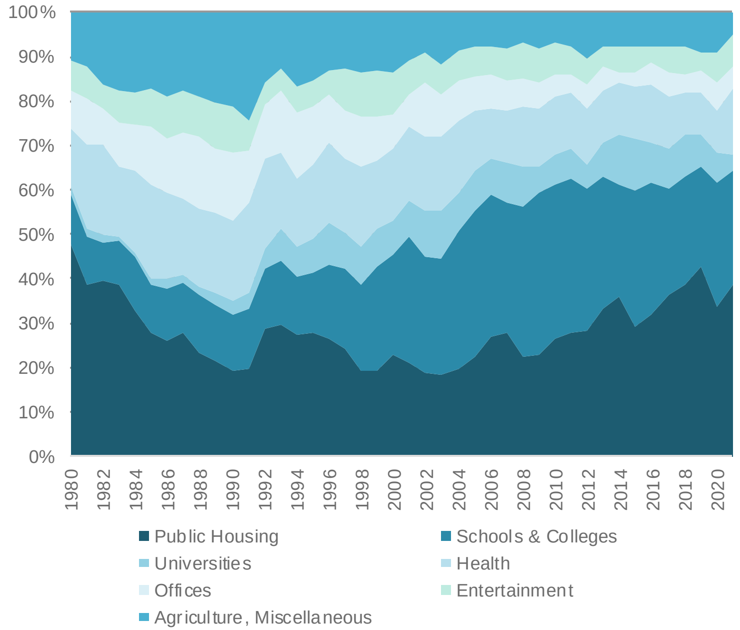
Source: Office for National Statistics – Construction output price indices

From January 2019 to September 2022 **public housing and public non-infrastructure spend totalled £38,268 million in current prices**. Public housing comprised the majority of the output being 36% of the overall total. Following this schools and colleges representing 25% and health with 11%. Other areas are less than 10% of the total spend.

Figure 3C presents public construction output between 1980 and 2021, represented by the proportion of spend against total spend:

- **The trend for housing has been increasing**, from ca.20% in the early 2000s to 36% since 2019
- **Spend on schools and college had been trending upwards since the first point in the data set**, from ca.10% in 1970 and peaking at 35% between 2008-2010. However, since this peak, spending has reduced to 25% of total spend.
- **Spend on health has remained broadly consistent since 2000**, between 10% and 15% of total spend.

Figure 3C: Public Construction by type of Work in the UK, Current Prices, 1980 to 2021



Source: ONS - Output in the construction industry: sub-national and sub-sector

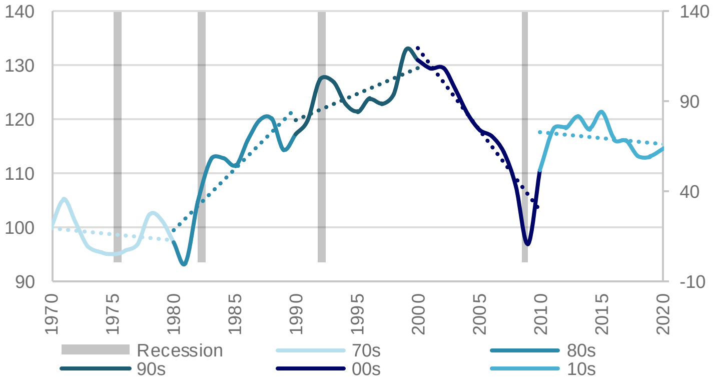
Construction productivity has underperformed and is cyclical

National measurements of output per hour allow for comparison of relative productivity within the construction sector between periods. **Rapid expansion and contraction in the construction industry is common and can be linked to macroeconomic effects,** exogenous impacts can drive or starve investment above steady state levels.

Figure 3D includes decade-long trendlines showing how growth in the construction industry can be viewed at a high level, including where the peaks and troughs can be linked to known events such as:

- 1990-99: Recovery in 1990 from 1989 slump until recension in 1992 triggers a decline, strong recovery thought to 1999.
- 2000-09: Decline from peak in 1999, productivity dropped consistently prior to 2008/09 global financial crisis (GFC) w here further massive declines are evident
- 2010-20: Recovery to pre-GFC levels by 2011 and a small uplift until 2015, how ever steady decline from this point until 2020
- 2020: Data has not been published for Covid period, based on pervious trend a deep U shape for output is expected in 2020-22

Figure 3D: Construction output per hour (UK, 1970-2020) 1970=100

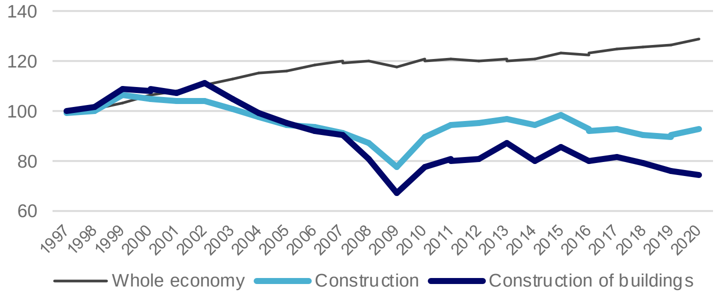


Source: Office for National Statistics – Labour and multi-factor productivity

Construction productivity has not changed significantly since 1997

The growth of productivity (Output per Hour) in the construction industry has not changed significantly since 1997. Figure 3E shows that all the construction sub-industries have had negative growth in output per hour worked between 1997 and 2020.

Figure 3E Output per hour worked, construction industry and sub-industries and whole economy, UK, 1997 to 2020 (1997=100)

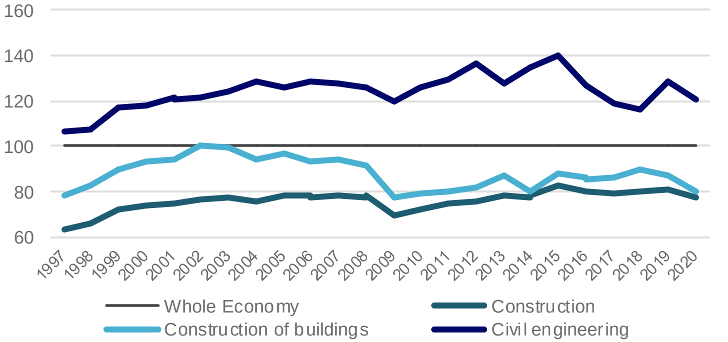


Source: Office for National Statistics – Labour productivity

Productivity of building construction has grown much slower than the economy

Benchmarking productivity growth in the construction industry against that of the whole economy shows that construction has had significantly slower productivity growth since the measurement began by the ONS. The gap between these has shrunk in recent years but overall construction has only reached over 80p on the pound three times in the last 24 years.

Figure 3F: Output per hour worked, construction industry and sub-industries, UK, 1997-2020, level relative to whole economy, index UK = 100



Source: Office for National Statistics – Labour productivity

Construction relies on credit, meaning it reacts strongly to recessions

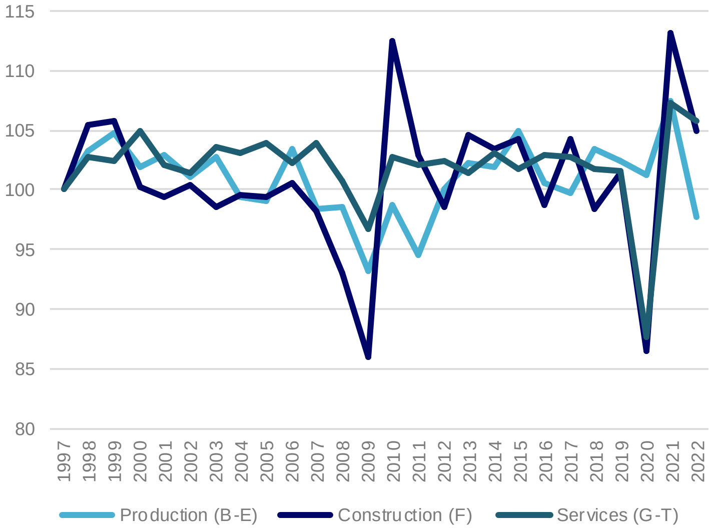
Compared to the production and services sector, **construction reacts strongly to recessions** on both the downside and the upside. This is caused by the **reliance of the construction industry on credit:** recessions are followed by a credit crunch which tightens the availability of capital and increases lending standards, thus reducing the construction outputs .

Yet, as central-bank interest rates were decreased after recent recessions, the construction sector quickly bounced back, as liquidity became more available, highlighting the high dependence of the sector on interest rates .

Medium run (2022-26): rate **of decline in productivity returns to 2015-20 rate 0.2-0.5%** (relative to rest of economy) per year.

Long run (2026+): Continued long run decline in productivity at a diminishing rate suggest this is capped at ~75% relative to whole economy but allow to naturally drift to this floor.

Figure 3G: GDP per year in the UK, index

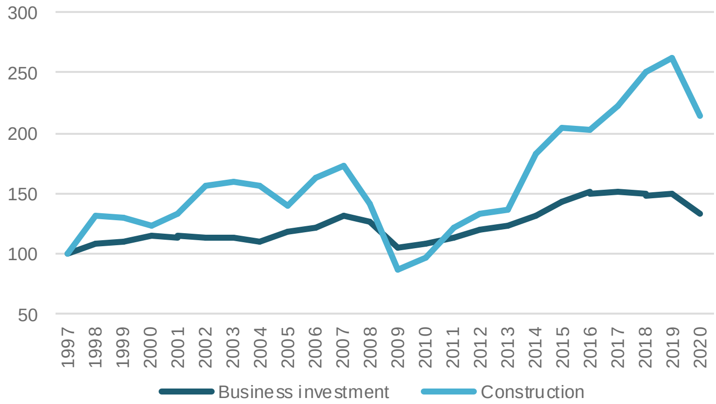


Source: ONS - Monthly GDP and main sectors to 4 decimal places

Capital investment does not improve productivity

Overall, construction investment has grown in real terms since 1997 and in periods of economic contraction has only once fallen below 1997 investment levels during the 2008 financial crisis. **Ongoing significant investment within the construction sector in real terms means that lower levels of productivity cannot be explained through lack of capital investment.** For the construction market on a per-worker basis **there is more capital available to equip or invest with today than 20 years ago, yet as can be seen in previous data consistent decreases in worker productivity within the sector is evident.**

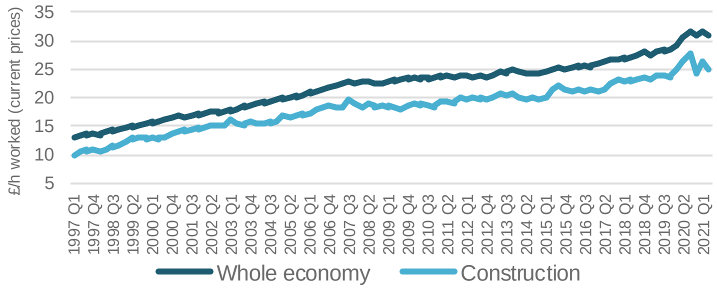
Figure 3H: Real capital investment, construction (excluding buildings, structures and land improvements) and the market sector, UK 1997-2019



Source: Office for National Statistics – Capital services estimates

Labour income per hour worked is persistently lower in the construction industry than the rest of the economy as shown in Figure 3I, however it has grown mostly in line with the rest of the economy suggesting that despite the lower productivity the value paid to labour has not diminished over this period.

Figure 3I: Total labour costs per £/hour worked

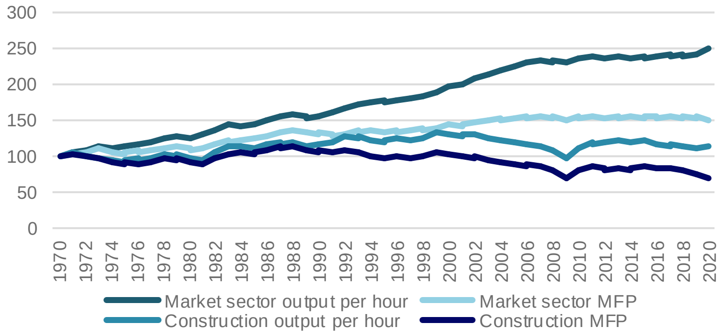


Source: Office for National Statistics – Supply and use tables, and labour productivity

Multi-Factor Productivity is the unexplained growth in output after accounting for growth in capital and labour inputs.

After controlling for the effects of growth in capital and labour inputs, the multifactor productivity (MFP) measure shown in Figure 3J provides a clear picture of how **the construction sector productivity has fallen behind the rest of the economy, declining in real terms since 1997, whilst that of other sectors has grown.** The cause of this is unclear and the implication is that the source of the decline is exogenous to capital and labour inputs and is likely captured within the MFP in a macroeconomic model.

Figure 3J: Output per hour worked and multi-factor productivity (MFP), construction industry and market sector, UK, 1970 to 2020



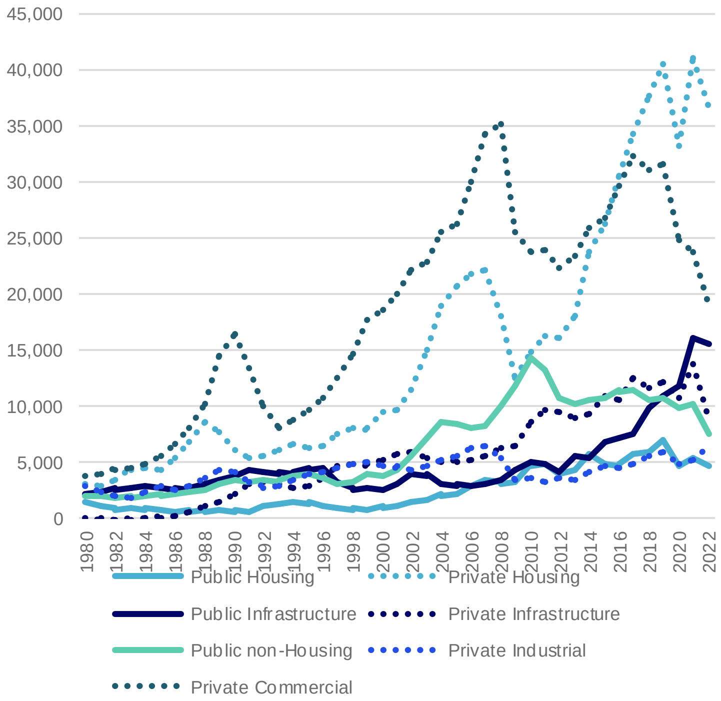
Source: Office for National Statistics – Labour productivity and MFP

New Orders for Construction are largely consistent but tend to be affected by macro shocks

Measurements of volume of construction new work is measured annually by the ONS.

The data below shows that between 1980 and 2022 new work orders are largely consistent but tend to be **affected by macro shocks**, where in recession the output drops, but then rebounds once the economy enters expansion phases. Public investment is less susceptible to these shocks.

Figure 3K: Construction output, current prices by type of work, £ million



Source: Output in the construction industry - Office for National Statistics

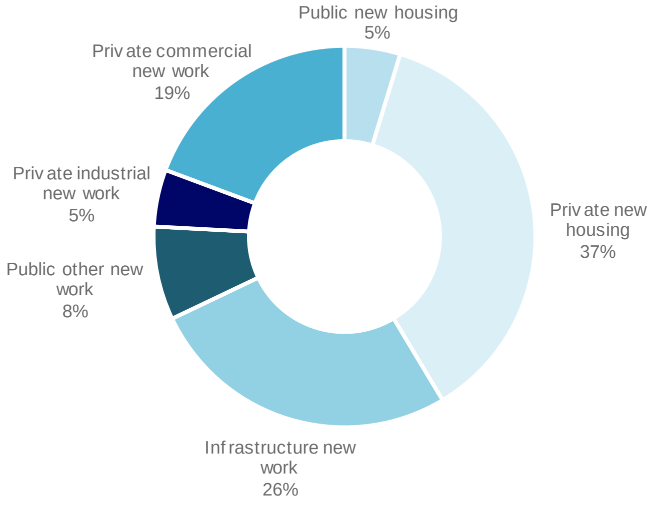
Executive Summary
Introduction
21
The case for change
Economic opportunities
Broader opportunities
Reflections

Government is construction's biggest client

The makeup of the construction market output is split between public and private through a variety of subsectors by share.

The most representative shares of the **public construction industry** are Public New housing (5%), Public other work (8%) & infrastructure (26%) **making up approximately 39% of the construction industry.**

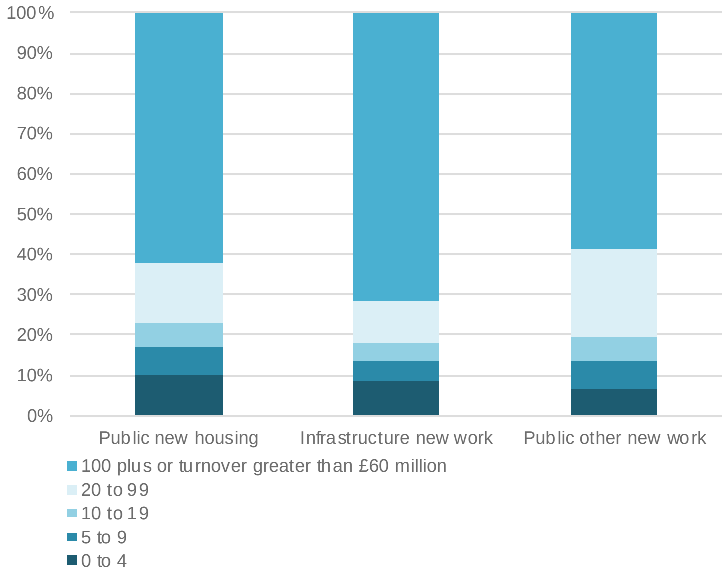
Figure 3L: New work split public/private construction output - Current Prices Jan 21 - Sept 22



Source: Output in the construction industry - Office for National Statistics

In the figure below we have the distribution of firms by size for different types of construction output. For public sector construction, firms of 100+ employees make up over 50% of each of the public construction subsectors, with this reaching over 70% for infrastructure.

Figure 3M. Public Work, by proportion, Employment Size



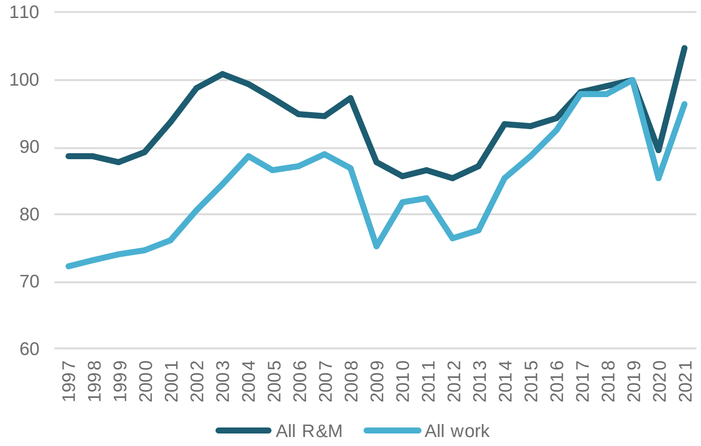
Source: Output in the construction industry - Office for National Statistics

Repair and Maintenance does not have a significant influence on the productivity decline

Given the level of recent investment in urban renewal through programmes such as the Levelling Up Fund, Towns Fund and others, the contribution of repair and maintenance (R&M) of construction should also be considered.

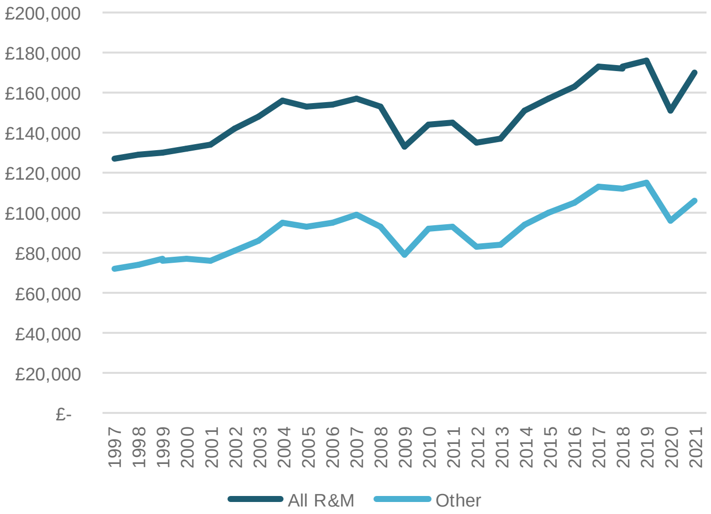
This is shown in Figure 3N in index form and in Figure 3O in £m per year respectively. The data does not show **any apparent shift in the share or value of repair & maintenance, and this has remained relatively stable since 1997 in terms of the proportion of sector output. This can mean that R&M has not had any significant influence in the decline of construction sector productivity shown in previous sections.**

Figure 3N: Construction output in Great Britain, index numbers, by sector, 1997-2021, 2019=100



Source: Output in the construction industry - Office for National Statistics

Figure 3O: Construction output in Great Britain, Repair & Maintenance vs. New work, £millions 1997-2021



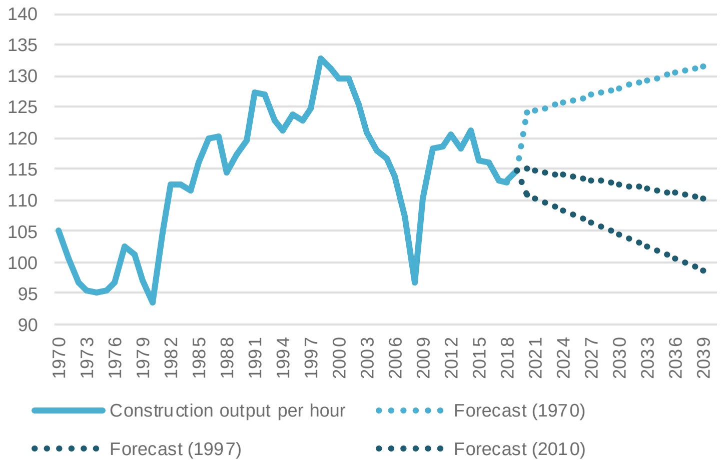
Source: Output in the construction industry - Office for National Statistics

Productivity trends suggest declining output

Based on empirical evidence shared in the previous Construction Output section, the following analyses provides estimates of possible growth scenarios for construction sector productivity in the UK for the next 20 years. These forecasts are based on observed data points and are constrained by the information contained in the data sample, the analyses was carried out using a basic trend forecasting method – OLSM *(NB: Forecast included is only for illustrative discussion on potential growth patterns within the construction sector for the CIH project and should not be used for any other purpose).*

Taking information from *Figure 3D: Construction output per hour (UK, 1970-2020)* and applying OLSM to it, the figure here shows that **data selection is important as the results yield a variety of outcomes, with more recent data suggesting declines in output for future years.**

Figure 3P: Construction output per hour & trend forecast data

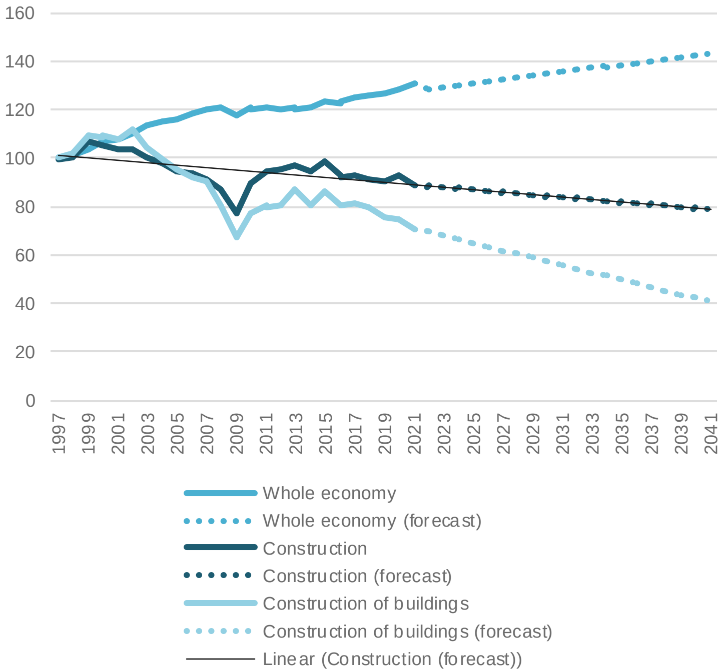


Source: Office for National Statistics – Labour productivity and MFP

Condensing the forecast to include more recent trends, the growth of both construction and the overall economy is flatter

Further condensing of the forecast could be done to include more recent trends and forecasting on data from *Figure 3E: Output per hour worked, construction industry and sub-industries and whole economy, UK, 1997 to 2020 (1997=100)* to shows that the **growth in both construction and the broader economy is flatter.** This is primarily because of the lower levels of volatility from 1997 (*only one major decrease during 2008 GFC*) whilst there has been low levels of long-term positive growth in the whole economy and long-term decreases on productivity in the construction sector.

Figure 3Q: Output per hour worked, construction industry and sub-industries and whole economy, UK, 1997 to 2020, index 1997 = 100; Trend Forecast data = 1997-2020

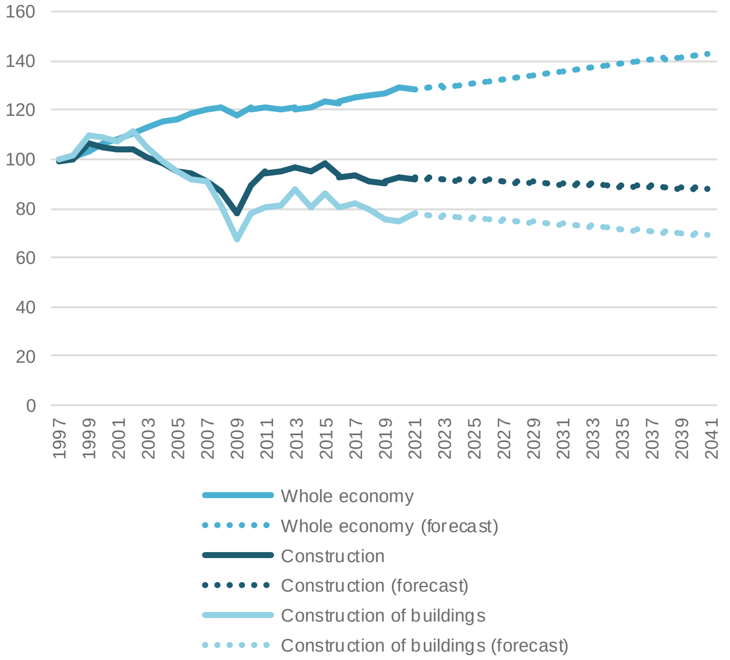


Source: Office for National Statistics – Labour productivity

Sub-setting the forecast to only include recent data values, the forecast is even flatter

Sub-setting then the data further to **only include the most recent data values** – post 2010 – **the trend forecast in Figure 3R below shows even flatter negative projections for Construction and Construction of buildings, resulting in a lower rate of productivity decrease.** However, the impact in the long-term trajectory and long-term growth in the whole economy remains similarly flat, with a positive trajectory growth.

Figure 3R: Output per hour worked, construction industry and sub-industries and whole economy, UK, 1997 to 2020, index 1997 = 100; Trend Forecast data = 2010 - 2020



Source: Office for National Statistics – Labour productivity

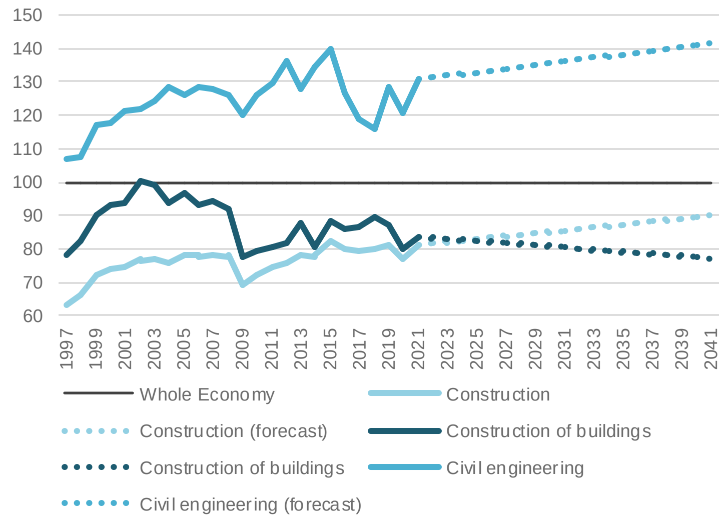
Executive Summary
Introduction
23
The case for change
Economic opportunities
Broader opportunities
Reflections

Condensing the forecast to include more recent trends, the productivity gap is forecast to close, with decline in construction of buildings

We can apply the same technique to include more recent trends, and forecasting on data from _Figure 3F: Output per hour worked, construction industry and sub-industries, UK, 1997 to 2020, level relative to whole economy_, and make relative comparisons with the rest of the economy.

Figure 3S suggests the gap in productivity between construction overall and the economy may close, driven by civil engineering. Construction of buildings meanwhile is facing a downward trend. However, these trends may be caused by volatility of the data and **does not seem to be a useful comparison**.

Figure 3S: Output per hour worked, construction industry and sub-industries, UK, 1997 to 2020, level relative to whole economy



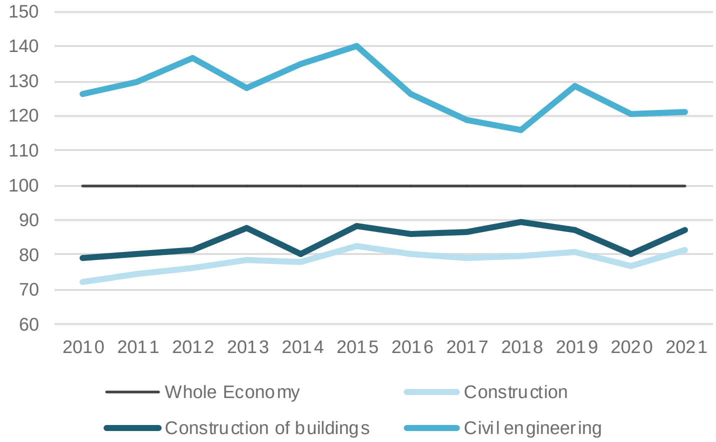
Source: *Office for National Statistics – Labour productivity*

More recent values yield a projection of productivity convergence to the rest of the whole economy

Following the same approach of the previous analysis, sub-setting the data further to only include the most recent data values – post 2010 – **the trend forecasts in Figure 3T indicate a convergence with the rest of the economy in terms of relative productivity**.

This is contradictory to the rest of the data set and one of the limitations of sub setting with small data sets is that is creates a bias towards the recovery from GFC data points in the early 2010s.

Figure 3T: Output per hour worked, construction industry and sub-industries, UK, 2010 to 2020, level relative to whole economy

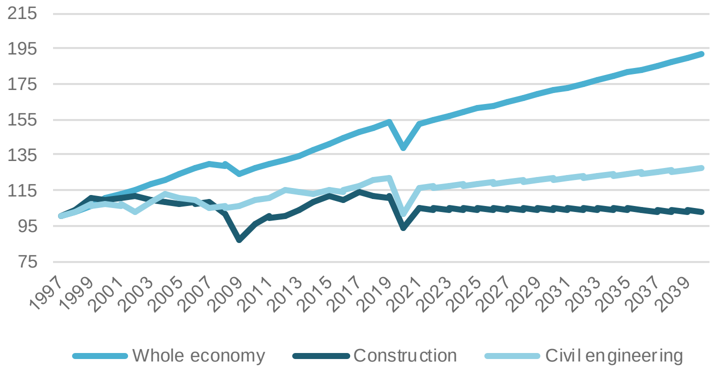


Source: *Office for National Statistics – Labour productivity*

Projections indicate an expanding gap in construction GVA compared to the whole economy

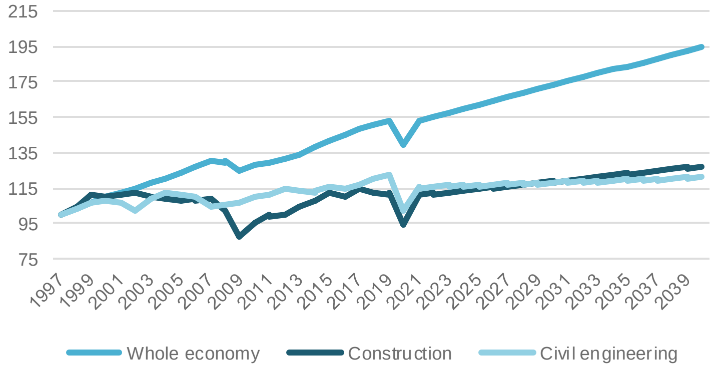
GVA projections based on _Figure 3A: Gross value added, chain volume measures (CVM), construction industry and sub-industries and whole economy, UK_, show that **the trend forecast indicates an expanding gap in Gross-Value Added in the construction sector relative to the rest of the economy**. Sub-setting then the data from 2010 onwards the results are pretty similar for the whole economy, but with even less growth in GVA for the construction sector.

Figure 3U: GVA, chain volume measures (CVM), construction industry and sub-industries and whole economy, UK, 1997 to 2020 Forecast



Source: *Office for National Statistics GDP(O) low level aggregates table*

Figure 3V: GVA, chain volume measures (CVM), construction industry and sub-industries and whole economy, UK, 2010 to 2020 Forecast

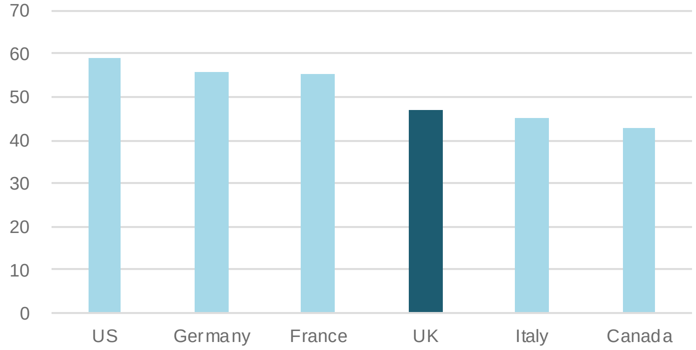


Source: *Office for National Statistics GDP(O) low level aggregates table*

Productivity will continue to decline without change

In 2021, output per hour worked was almost 20% higher in France and Germany than in the UK, and the UK workforce is only 10% more productive today than it was in 2009. If productivity had grown over this period at the previous trend rate of 2% per year, the average household would now be £5,000 per year better off. Construction sector productivity trails that of the economy.

Figure 3W. Annual output per hour worked (component method), whole economy, current price (CP) in GBP



Source: Office for National Statistics – International comparisons of productivity

Analysis by a leading Economic institute (NIESR) indicates that the slowdown in national productivity was caused by a combination of: lower 'multi-factor productivity' growth, e.g. **a slower rate of technology adoption**, starting from the 2007 economic downturn, and less capital deepening since 2012 (**less investment**).

Construction has unique potential to improve UK productivity performance

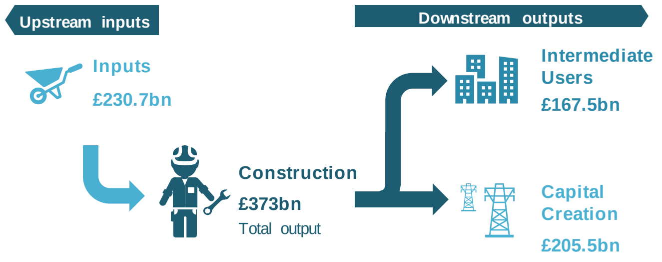
The sector currently contributes some £373 billion to the national economy, which represents ~9% of GDP (estimate based on ONS data), but it is also unique in the size of its role in driving growth across the whole economy and supporting public services.

The construction sector drives growth and supports services in two ways:

1. The 'economic footprint' of the sector extends beyond traditional construction firms into design and architecture, professional services, product manufacturing and raw materials. Including this supply chain the sector's current contribution increases to ~16% of national GDP This means productivity gains enabled by Product Platforms for one type of firm have positive economic consequences for other firms that it typically trades with;
2. Around 55% of the sector's output is investment in capital and over half of all capital created in the economy comes from the construction sector. This means that in producing infrastructure and buildings, the construction sector plays an outsized role in the creation of the 'physical capital' that the UK relies on as a foundation for:
   - Economic activity and growth in the public and private sectors
   - The provision of public services such as healthcare and education

Therefore, improving the productivity performance of the sector will:

1. **Make a sizeable direct contribution to economy-wide productivity growth**, owing to the size of the sector's 'economic footprint'
2. **Grow the UK's capital stock**, acting as a powerful spur to productivity growth elsewhere in the economy and driving long-run GDP growth
3. **Help reduce the cost of providing public services** to the Government and, ultimately, the taxpayer



Upstream inputs

Inputs
£230.7bn

Construction
£373bn
Total output

Downstream outputs

Intermediate Users
£167.5bn

Capital Creation
£205.5bn

To fulfil the construction sector's potential, radical policy action is needed.

In 2019, output per hour in manufacturing was 10% higher than the UK average (across all sectors); in construction it was 21% lower (i.e., output per hour in manufacturing was 40% higher than it was in construction).

Over the decade to 2019, output per hour in manufacturing increased by ~45%, while in construction it increased by less than 7%. This means the construction sector acts as a drag on economy-wide productivity growth rather than the powerful driver that it should be. This shortfall cannot be explained solely through capital or labour inputs.

As will be outlined, workforce demographic trends pose a significant threat to the construction sector's future – in the absence of a dramatic improvement in productivity, the sector will not be capable of producing enough output to fulfil its vital role in the economy and wider society in the coming years.

The above analysis indicates that policy changes that increase labour quantity or capital investment may not improve sector performance and would likely yield diminishing returns above current levels of investment in policy interventions focused on how to shock MFP. Whilst still too early to see the impact of the Construction Playbook and other policies, projections indicate a worsening of sector productivity relative to the whole economy (0.2-0.5% per year) until 2026, followed by a diminishing rate beyond then.

These long-standing challenges make the construction sector fragile to future macroeconomic trends and shocks, and ultimately means it lacks economic resilience. Radical policy intervention is therefore required to modernise the construction sector, drive up its productivity and position the sector for sustainable economic growth.

UK national productivity is increasing at a slower rate than other nations', which directly impacts households. Construction's economic footprint makes it uniquely placed to improve economy-wide productivity, grow capital stock and reduce the cost of public services. Yet long-standing challenges lead to fragility and difficulty in increasing productivity. Without radical and effective policy intervention, sector productivity will continue to decline, exacerbating issues for other sectors, the broader economy and individual households.

Safety and dependence on labour

80%

Reduction in fatalities and injuries 1997-2020

30%

Work-related fatalities each year are related to construction

13x

More suicides among construction workers than fatalities

700,000

Construction workers aged over 50

226,000

New construction jobs needed by 2026

CITB's CSN report

- Construction has made huge progress with health and safety performance, reducing injuries and fatalities by 80% in 25 years. Yet it still has a way to go.
- Improvements in performance have slowed since 2012 and construction still accounts for 30% of work-related fatalities.
- An average of two construction workers take their lives each working day – twice as high as many other occupations.
- Since 1997, the workforce has aged significantly, such that 30% of the more than 2 million workers in construction are over 50. Yet the economy is near full employment.
- Without a change which addresses safety and wellbeing, as well as dependence on an aging workforce, construction will become even more unaffordable.

80% safer than 1997, but could be another 60% safer again

Health and safety in all industries has made strides in recent years, with the construction sector in particular having made significant progress. [Construction statistics in Great Britain (2022)] produced by the Health and Safety Executive gives an annual review of construction statistics in Great Britain. The report found:

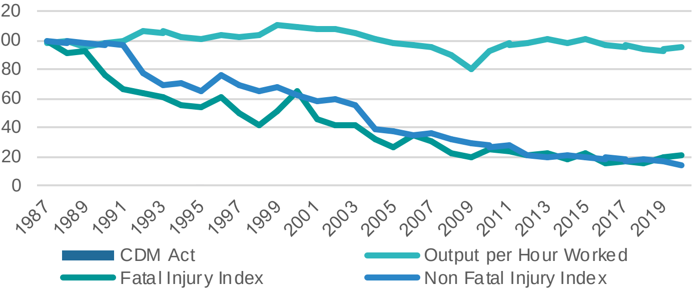
- **Ill-health**: 78,000 workers, average over 2019/20-2021/22. 3.7%, not statistically different from the rate across all industries (4%). This has seen a slight downward trend since 2003/4
- **Fatal injuries:** 30 compared to an annual average of 36 since 2017/18 (mainly because of 'fall from height'). The fatal injury rate (1.63 per 100,000 workers) is 4 times the all-industry rate. This has been on a downward trend since 1981
- **Non-fatal injuries:** 59,000 (downward trend), 2,9% of workers, higher than the all-industry rate (1.6%). The downward trend since 2001/2
- **Economic cost**: £1.4 billion, 7% of the total cost of all work-related ill health and injury (£18.7 billion). Costs are both financial and non-financial (loss of quality of life or loss of life, monetised here)
- **Working days lost:** around 2.2 million (full-day equivalent) were lost each year due to workplace injury (25%) and work-related illness (75%). This is 1.1 working days per worker, which is comparable to the all-industry level of 1

If construction were to become 'like manufacturing', each year we might expect:

16,865	17	18,310
(22%) fewer instances of ill health	(57%) fewer fatalities	(31%) fewer non-fatal injuries

The rate of fatal and non-fatal injuries in the construction sector have seen a decline since 1987/88, approximately 80%, Non- fatal injuries have seen a similar reduction. The Construction Regulations also came into force in 1995, with a second reduction in injures commencing in 2000. Progress has, however, slowed since 2012.

Figure 3X: Fatal and Non-Fatal Injures and Output per Hour Worked, UK Construction sector, 1987/88 to 2021/22, 1987/88=100



Source: Office for National Statistics - Work-related injuries under RIDDOR from 1974

Table 3A shows a comparison of Construction and Manufacturing industries. Of the variety of manufacturing industries included within the classification, those relating to transport and transport products, and metallic groups are typically above average. However, it is not possible to isolate figures for manufacturing activities which sit within the supply chain for construction.

Table 3A: Comparing Construction and Manufacturing statistics (HSE, 2022)

Factor	Construction (SIC41-43)	Manufacturing (SIC10-33)
Proportion of overall workforce	6%	8%
Ill health	78,000 (3.7%) Statistically similar to average	92,000 (2.9%) Statistically lower than average
Of which stress, depression or anxiety	21,000 (1%) Statistically much lower than average	37,000 (1.1%) Statistically lower than average
Fatal injuries	30 (1.63/100,000)	22 (0.68/100,000)
Non-fatal injuries	59,000 (2.9%) Statistically much higher than average	54,000 (2%) Statistically higher than average
Economic cost	£1.4bn	£1.3bn

Source: ONS

Silent suffering: a hidden epidemic in construction

Construction workers around the world are more likely to take their own lives than to be killed by an accident on site. In the UK, the rate is three times the national average across professions, and stands at around 395 per year – or 30 every three working weeks. There were 30 site fatalities last year.

Research by Mates in Mind, a charity seeking to improve the mental health and wellbeing of workplaces, cites causes including intense workloads, financial problems, poor work-life balance and COVID-19 pressures on the supply of materials are combining to significantly raise stress and anxiety levels.

There are a number of charities and routes to help, such as the Construction Industry Helpline, run by the Lighthouse Club charity, seeking to raise awareness across workplaces.

Adopting a less cyclic, less pressured, more certain, and more stable approach to construction could help improve working environments conditions for workers across the industry.

The HSE cites four underlying causes health, safety and well-being issues in construction as a whole, noting that there is significant variation across the scale and nature of projects.

1. **The site environment** – unlike a factory, construction work takes place in many and varied environments. Sites can present a range of health risks which vary within and between sites.
2. **Dynamic work**: sites are constantly changing and a large number of trades increase potential dangers.
3. **Risk appreciation**: a generally low awareness of health risks and controls can dismiss harmful workplace exposure, which may take many years to develop.
4. **Employment**: self-employment, small companies, frequent job changes, and remote work make health and wellbeing management challenging.

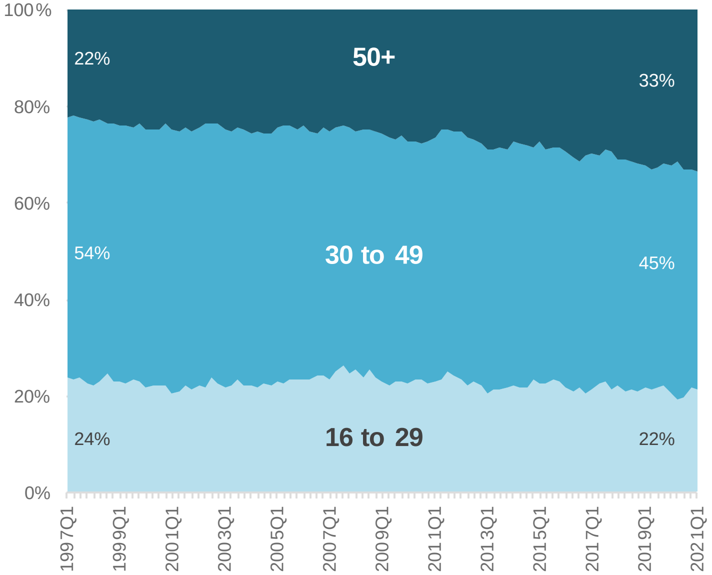
By adopting manufacturing principles, the sector can standardise processes and create a controlled environment, which can reduce risks, increase risk awareness, and improve culture as well as access to occupational health professionals for workers.

700,000 workers are over 50. That's 30%.

The construction workforce comprised in excess of 2,100,000 people in 2021. Of these, some 30%, or 700,000, are over the age of 50 and therefore will have reached retirement age by 2038. Taken together with flat or declining productivity, and a forecasted need for an addition 225,000 construction workers by 2027 or over 950,000 workers by 2030 to meet demands of government. This may cause construction projects to become undeliverable. This may arise due to affordability or a lack of workers altogether.

Labour shortages already affect the industry, with an estimated loss of £2.6bn (£7m per day) in 2022 due to unfilled vacancies.

Figure 3Y: The number of hours worked by workers 50 years and over has increase substantially, while for younger workers there is little growth



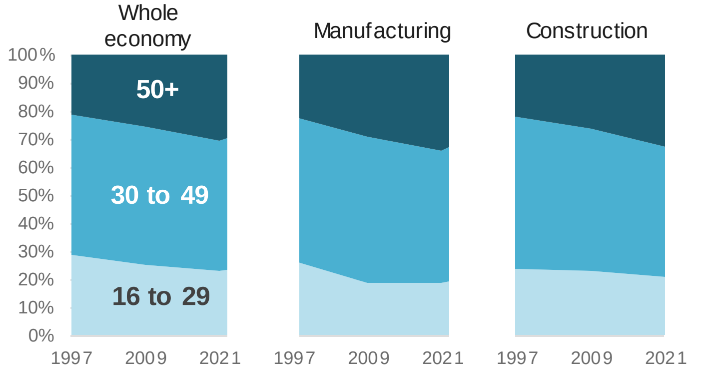
Source: ONS Construction statistics

An increasing share of total hours worked in the construction industry are by older people (50 years and over). This figure has been rising since 1997, with the 50+ age group representing the lowest share of the sector in 1997, but this share has since grown by 50% such that it exceeds that of the 16–29-year age group.

The overtaking of the 16-29 age group may be explained through a higher proportion of the general population completing secondary schooling; however, this trend only became evident around 2008/09 so a more likely explanation is that during the financial crisis it was challenging for school leavers to find positions in the sector.

ONS data indicates that the same pattern has taken place in the manufacturing sector. Indeed, at a whole-economy level, the share of working hours for the 16 to 29 age group has decreased – in part due to increases in higher education.

Figure 3Z: Increasing proportion of hours worked is by workers 50+older



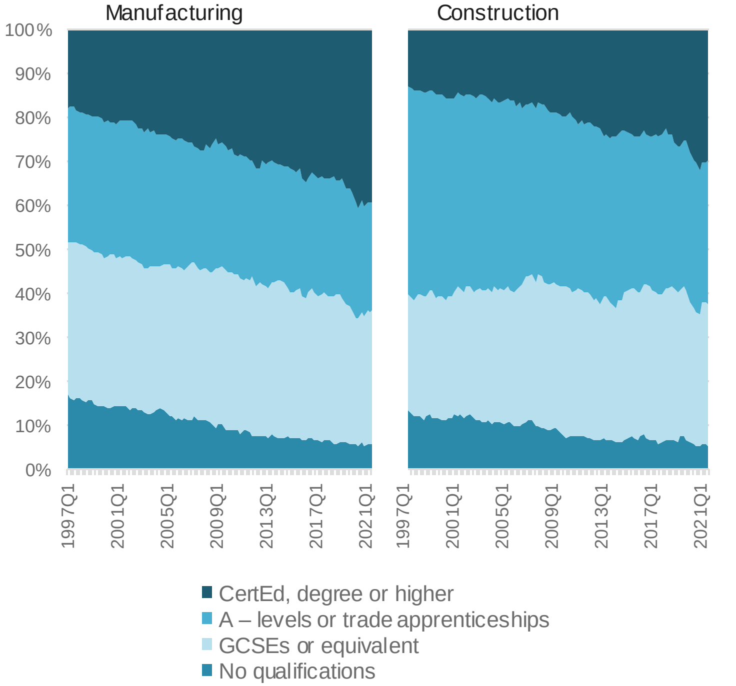
Source: ONS

Overall hours worked by younger workers in construction has remained about the same since 1997, while total hours worked has increased by around 15%. Over the same period, manufacturing has seen overall hours worked reduce by around 45%, with the greatest reduction seen in the 16 to 29 year age group.

This suggests that neither manufacturing nor construction is particularly appealing for school leavers or graduates. However, a shift to the use of more manufacturing approaches would help to reduce the dependence on an aging workforce (by increasing productivity). This was highlighted in "Modernise or Die" in 2016, which called for greater collaboration, investment in skills and training, adoption of new technologies, and a shift towards modern methods of construction. Manufacturing approaches can also help draw from a larger and more diverse pool of roles.

Increasing education levels in the construction workforce may not necessarily lead to improved productivity due to the importance of on-the-job training and experience, which can be approximated by age, according to a report. The largest increase in hours worked in construction came from less-educated workers aged 50 years and over, and highly educated workers aged 30 years and over. This trend may reflect a significant increase in university attendance in the early 2000s, resulting in a more educated workforce in the industry. Manufacturing has seen a steady increase in working hours with higher levels of education and an increase in productivity.

Figure 3AA: Education levels increase in manufacturing and construction, but does not seem to improve construction productivity.



Source: ONS

By adopting more productive approaches and achieving parity with the wider economy in terms of output per hour worked (an increase of 30% based on 2020 levels), construction could help address both an aging workforce and a flat or reducing intake. However, the importance of on-the-job training and experience suggests that finding ways to accelerate learning is key to boosting productivity

Too many errors; too much waste

£23bn

Potential cost each year of error and rework in construction

90%

Of construction projects experience cost and time over-runs

33%

Of the waste produced in Europe originates from construction

- Errors and rework in construction cost up to £23 billion each year, which is equivalent to 3.6% of GDP (ONS + GIRI).
- Over 90% of construction projects experience cost overruns and delays due to inefficiencies in planning and delivery.
- Construction waste accounts for 1/3 of the total waste produced in Europe(EU) and results in losses of over £1.5 billion in the UK alone per year(WRAP).
- By adopting manufacturing approaches, construction can streamline processes, minimise waste and errors, and increase productivity, resulting in significant cost savings and increased efficiency.

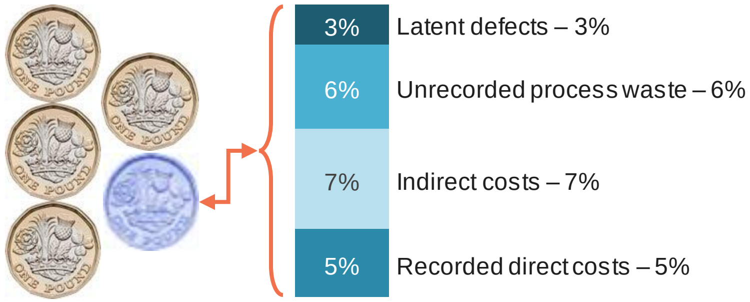
20% of construction spend is due to error

The Get it Right Initiative produced the **Improving Value by Eliminating Error report (2016)** to review the level and key sources of error spending in the UK construction industry. The study found that defects in construction represent a significant proportion of construction spend.

This report also noted significant variation in how (and whether) companies record the cost of error. Few have detailed data on the cost of errors, with financial information that may be available typically only accounting for the direct cost to the organisation and not to other parties.

The main areas of financial impact were in concrete, MEP and facades, and these are carried by Tier 2 contractors (albeit the costs tend to be invisible and so are included in procurement costs).

Cost of error – 21%



Error could account for up to £23 billion each year (3.6% of GDP)

The construction industry is facing an epidemic of avoidable errors that cost billions of pounds every year. To identify the root causes of these errors, researchers conducted a thorough investigation and found that the top ten causes are:

1. Inadequate planning: This refers to poor planning or insufficient preparation for a project, which can lead to errors later in the construction process.
2. Late design changes: When designs are changed late in the construction process, it can lead to confusion and errors. This can happen for a variety of reasons, such as poor communication or changes in project scope.
3. Poorly communicated design information: Communication breakdowns between designers, engineers, and contractors can result in misinterpretation of design information, leading to errors during construction.
4. Poor quality culture: A poor quality culture within an organisation can lead to a lack of focus on quality and a lack of attention to detail.
5. Poorly coordinated design information: When design information is not coordinated effectively, it can lead to inconsistencies, conflicts, and errors during construction.
6. Inadequate attention paid in the design to construction: If the construction process is not considered during the design phase, it can lead to errors and inefficiencies during construction.
7. Excessive commercial (financial and time) pressure: When financial or time pressures are prioritised over quality, it can result in errors and compromise the safety and performance of the final product.
8. Poor interface management and design: Poorly designed interfaces between different components or systems can lead to errors, inefficiencies, and safety risks.
9. Ineffective communication between team members: Communication breakdowns between different team members can lead to misunderstandings, errors, and rework.
10. Inadequate supervisory skills: Poor supervisory skills can lead to inadequate oversight of construction activities, resulting in errors and safety risks.

Royal Liverpool Hospital more than £300 million overbudget due to defects

The Royal Liverpool Hospital project was halted in February 2018 after Carillion's collapse. A review found that three floors at the new hospital needed to be rebuilt because of "complex" structural flaws left by Carillion. the discovery of cracks in the beams that supported the hospital's floors was a serious safety concern, as it could have led to the collapse of the building. The issue was discovered in 2018, and led to a major delay in the hospital's construction while the problem was addressed.

To address the structural issues at the Royal Liverpool Hospital, a significant amount of remedial work was required. This work involved strengthening the existing beams and columns in the building, as well as replacing some of the faulty components. The remedial work was carried out by Laing O'Rourke who took responsibility for completing the hospital, along with a team of structural engineers and safety experts. The work was overseen by the hospital trust and the Government, to ensure that it met all necessary safety standards.

In addition to the remedial work, the hospital also underwent a thorough review of its design and construction processes, to identify any other potential issues. This review resulted in a number of changes to the hospital's design and construction methods, to ensure that it met all necessary safety standards and regulations.

Overall, the process of fixing the structural issues at the Royal Liverpool Hospital was lengthy and expensive, but ultimately necessary to ensure the safety of patients and staff.

29% of government clients rate their satisfaction with defects as lower than 8/10 at asset handover

Increasing the use of manufactured approaches would allow significant reduction in the level – and associated costs – of error in construction. This is because processes and procedures would be standardised. This improves certainty and reduces scope for error by allowing identification of potential errors and risks in advance, reducing unplanned activities and improving quality control.

60% of the UK's waste is generated by construction

The negative impact of waste generated by the construction industry on the environment cannot be ignored. The excavation waste produced during site preparation, earth-moving activities, and land clearance can have a significant impact on soil quality, biodiversity, and ecosystems. The displacement of soil and vegetation can alter the natural water flow and cause soil erosion, leading to further environmental degradation.

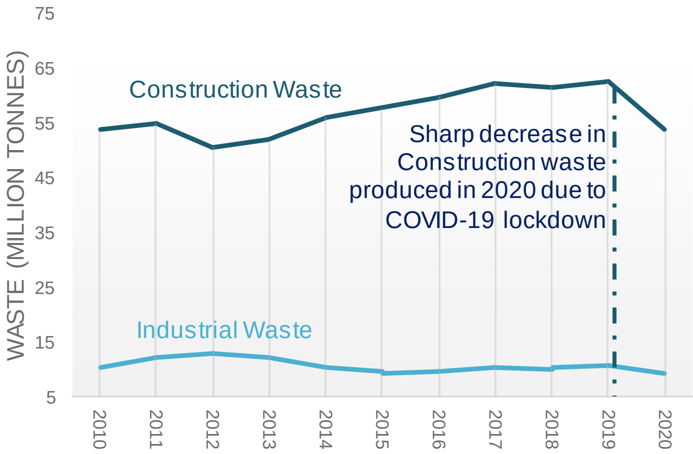
In addition, demolition waste, such as concrete, bricks, and timber, can emit dust and particulate matter, leading to air pollution. The transportation of materials to and from construction sites can also contribute to air pollution and greenhouse gas emissions, increasing the carbon footprint of the construction industry.

The disposal of waste generated by the construction industry is also a significant challenge. Landfills are becoming scarce and costly, and the over-reliance on them can lead to soil contamination and groundwater pollution. Incineration is an alternative method of disposal, but it has significant environmental impacts and can emit harmful chemicals and gases into the air.

Furthermore, the management of hazardous waste generated by the construction industry poses a significant risk to human health and the environment. Asbestos, lead, and other chemicals commonly used in construction processes can cause cancer, respiratory diseases, and other health issues if not handled correctly. The mishandling of hazardous waste can also cause soil, water, and air pollution, leading to long-term environmental degradation.

It is estimated 13% of construction material ends up as waste without ever being used, at a total value of £1.5 billion per year across all construction (WRAP)

Figure 3AB: Construction and Industrial Waste Produced in England



Source: UK Government

Construction has increased its output of waste consistently while industrial waste has remained constant

To address the challenges posed by waste generated by the construction industry, it is essential to adopt sustainable practices and reduce waste production. One way to achieve this is by designing buildings that use fewer materials and have a longer lifespan. Using prefabricated materials and modular construction can reduce waste production and the carbon footprint of the construction industry. Furthermore, adopting sustainable waste management practices such as recycling, reusing, and repurposing materials can reduce the amount of waste sent to landfills and promote sustainability.

The UK Green Building Council estimates that the construction industry is responsible for approximately 60% of the country's total waste.

Types of Construction Waste

Excavation waste includes materials such as soil, rocks, and stones generated during site preparation, excavation, and earth-moving activities. This waste can be voluminous, heavy, and challenging to dispose of, and often ends up in landfills

Demolition waste includes various types of materials such as concrete, bricks, wood, and metals. This waste can be bulky and heavy, and if not managed correctly, it can cause environmental pollution and contribute to landfill overflows.

Packaging waste is produced when construction materials are transported in packaging materials such as cardboard, plastic, and timber, contributing to waste production. While some of these materials are recyclable, others may end up in landfills

Offcuts and spoil are produced when materials such as timber, pipes, and steel are cut or fabricated to fit specific dimensions during construction. These offcuts and spoils can be challenging to dispose of and may contribute to landfill overflows.

Hazardous waste includes materials such as asbestos, lead, and chemicals used in construction processes, which are harmful to human health and the environment. If not managed correctly, these materials can cause pollution and contamination

Non-hazardous waste includes materials such as plastic, paper, and glass generated in the construction process, which may be recyclable. Effective management of non-hazardous waste reduces landfill and promotes sustainability

The adoption of manufactured solutions will enable a higher degree of control of processes that create elements of social infrastructure. When assessing construction by the types of waste it produces, manufacturing approaches can particularly minimise **offcuts and spoil** by ensuring input material is procured in the correct form. Using methodology such as lean manufacturing can further reduce waste produced in a process.

In a manufacturing context, waste is often described in terms of Lean principles. Lean is a methodology that originated in the automotive industry and has since been applied to various manufacturing sectors, including construction. By identifying and eliminating waste using lean principles, organisation will improve their efficiency and effectiveness of their manufacturing process.

Create the best possible assets

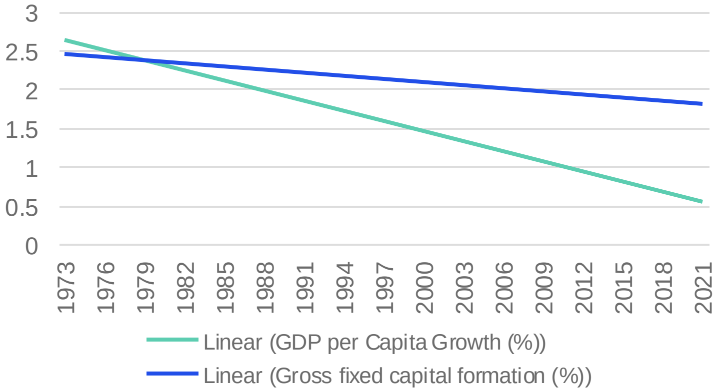
- Construction creates the assets that other sectors of the economy rely on. The more productive construction is, the more assets can be produced.
- Productivity influences pupil attainment, health outcomes, housing conditions and climate outcomes.
- Improving productivity can therefore have much broader implications beyond just in the capital phase.
- Education, healthcare and housing are central to society. Current challenges in all these areas mean that there is both the imperative and the opportunity to improve productivity in construction.

Capital formation – construction creates the foundations for society to flourish

Gross fixed capital formation is an estimate of the Capital Expenditure by both the public and private sectors. Examples of capital expenditure include spending on plant and machinery, transport equipment, software, new dwellings and other buildings, and major improvements to existing buildings and structures, such as roads.

In macroeconomics, the principal sources of economic growth are capital, labour, and technical progress. When the quantity of labour is restricted as is the case in the UK the rate of growth of capital (physical and human) and technical progress have been found to account for a significant proportion of economic growth.

Figure 3AC: Gross fixed capital formation (annual % growth) and GDP per Capita (annual % growth) – UK, 1973 to 2021

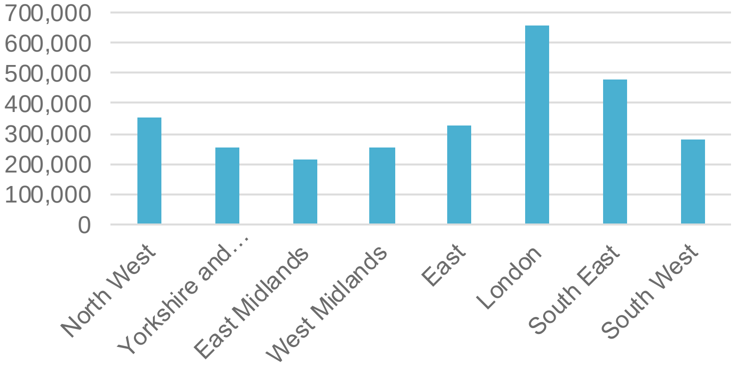


Source: – World Bank, national accounts data

As shown in figure 3AC, in the UK GDP per capita growth is slowing at a faster rate than the growth in fixed capital formation. This suggests either a slowing rate of technical progress or inefficiencies in capital formation

Within the UK capital formation has been central to regional growth, concentrated in London and the South East from 1997 to 2020, with the output per job in London 40% above the UK average.

Figure 3AD: UK, Annual GFCF investment in buildings and structures in the UK, by ITL1 and industry, 1997 to 2020, current prices



Source: ONS, Experimental regional gross fixed capital formation

Construction is a key sector for capital formation since it involves investment in physical infrastructure. Low construction productivity reduces the availability and quality of the buildings other sectors need to operate efficiently. Examples of these effects include:

Health – *Decline in labour productivity and economic activity rate, should be widening the already built-in gap in health-care sector*

Education – *Decline in knowledge industry productivity, linked to lower proportions of higher educational attainment*

Housing – *Decline in productivity, linked to labour and capital misallocation and poor health conditions*

Rest of economy – *the effects of worse health-care outcomes* (e.g missed work days or premature worker death**)** *flow through all sectors of the economy*. Further productivity decline linked to school performance translates into a decline in productivity across the knowledge lead industry.

The UK Government has a significant holding of this capital and is committed to its use, creating productive conditions for growth.

Improving the quality of this portfolio is central to increasing the amount of capital formation, and the ability for people to use it productively.

Table 3B: Baseline Size and Cost by Portfolio

Portfolio	Floor Area m2	Annual Running Cost
School	78.8 million	£3.3 bn
Defence	31.3 million	£3.7 bn
Health	29.1 million	£10.8 bn
Prison	5.6 million	£0.98 bn
Office	4.6 million	£1.6 bn

Source: – Government Property Strategy 2022-2030

As shown in Table 3B the capital portfolio held by the public sector has significant inefficiencies, with running costs for education, health and defence approximately £18 billion. The estate needs to be fit for purpose and in a good condition, while the estate is currently only 61% in good or satisfactory condition, with a significant maintenance challenge across the government estate where backlog maintenance liabilities have been identified. The transformation of this portfolio is based upon the pillars of smaller, better and greener which requires a modern construction industry to provide;

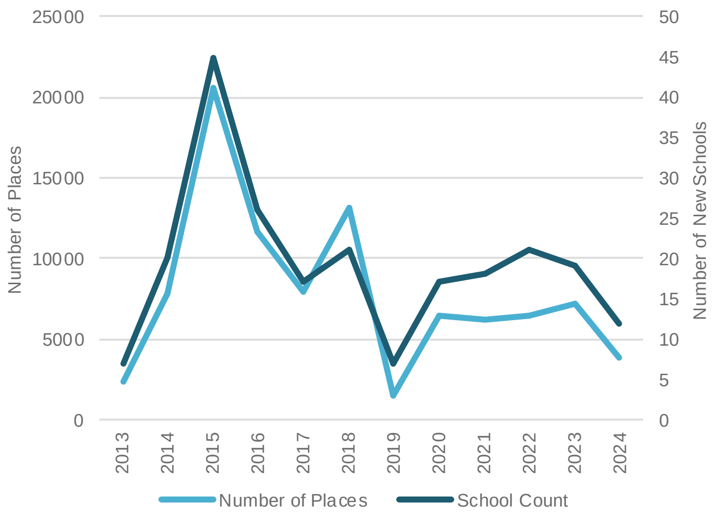
- **Increase of Interoperability** – to be effective, the public sector increasingly needs to work across organisational boundaries. In the future space needs to be interoperable, with consistent standards for access and technology
- **Reduce emissions** through sustainable methods and efficient construction/buildings, whilst aiding the reduction of annual running costs
- **Minimising waste and promoting resource efficiency**, including reducing water use
- Procuring sustainable products and services, with the aim of achieving the best long-term, overall **value for money for society**

Productivity contributes to pupil attainment

The current estimate of pupil population released by the Department for Education (DfE) shows that there are 8,344,703 pupils across all schools in 2022 and this is expected to be the peak, with **the pupil population expected to be declining until 2032**. The UK population is projected to keep growing until mid-2030s, driven by international migration.

Since 2013 the UK has averaged 19.8 new builds of free schools with 8700 new places per year. As shown in figure 3AE in recent years there has been a reduction on annual average of new schools and new places, however even with a declining pupil population a significant level of new schools will still be required.

Figure 3AE: No. of New Schools and New Places for free schools



Source: – Approved and Under Consideration Schools

Class size over this period shows the average primary school class size slightly declining while the secondary classes slightly increasing. The evidence suggests therefore that **the continued building of new schools and colleges** will be needed to replace existing facilities, rather than to account from a growing supply of students.

Rebuilding and repairs is need to refurbish 50 schools a year across England

The School Rebuilding Programme was launched in 2020 with a commitment to rebuild or significantly refurbish buildings in poor condition at 500 schools over the next decade. To support this rebuilding programme a condition of school building survey was enacted, reviewing the condition of 22,031 school across England:

- **£11.4 billion total condition need**, defined as the modelled cost of the remedial work to repair or replace all defective elements in the school estate;
- Of which **£5.8 billion to repair the structural** condition by element type.

Table 3C: Condition of School Building Survey – Breakdown of Modelled Need by Element

Element Type	No. of schools with this element	Total modelled condition need
Electrical services	22,030	£2,496,318,288
Mechanical services	22,026	£2,077,169,222
External walls, windows & doors	22,023	£1,769,698,665
Roofs	22,016	£1,570,866,426
Site area & external areas	22,024	£1,551,480,963
Fixed furniture & fittings	22,026	£608,028,009
Floors & stairs	22,026	£501,934,796
Internal walls & doors	22,026	£225,237,920
Playing fields	18,587	£190,826,646
Ceilings	22,025	£181,900,328
Redecorations	22,031	£177,212,602
Sanitary ware	22,019	£18,059,081
Total		**£11,368,732,846**

Source: Department for Education - Condition of School Buildings Survey

The correlation between capital investment into school facility, quality of school facilities and pupil attainment has been the subject of multiple of research papers. The key findings across literature on the correlation between capital investment into school facility, their quality and pupil attainment, is a **correlation between pupil attainment and the condition of school facilities**, with raising the condition of the lowest quality school and the building of new schools providing the greatest benefit.

Study	Findings
School funding and pupil outcomes: a literature review and regression analysis, 2017, Department for Education	At key stage 2 and increase per-pupil funding has a small positive and statistically significant correlation with attainment. Similar impacts were found for KS4.
Building better performance: An empirical assessment of the learning and other impacts of schools capital investment, 2003, PWC	Small but statistically significant positive relationship between capital investment and pupil attainment The strongest positive findings are in relation to measures of investment which can be related directly to the teaching of the curriculum (e.g. ICT-related capital spending, science blocks etc, referred to by the DfES as 'suitability' investment)
Building Schools for the Future: Technical Report, 2007, PWC	Newer and better school buildings contribute to higher levels of pupil attainment. The largest benefits are seen when the condition of the worst schools are improved
An evaluation of performance of schools before and after moving into new buildings or significantly refurbished premises, 2007, Estyen	From a sample of 23 primary schools the average improvement was 11.6 percentage points. From a sample of 16 secondary schools the average improvement was 3.9 percentage points.
Do School Facilities Matter? Measuring the Effects of Capital Expenditures on Student and Neighbourhood Outcomes, 2018	Spending 4 years in a new school increases test scores by 10% of a standard deviation in math, and 5% in English-language arts.

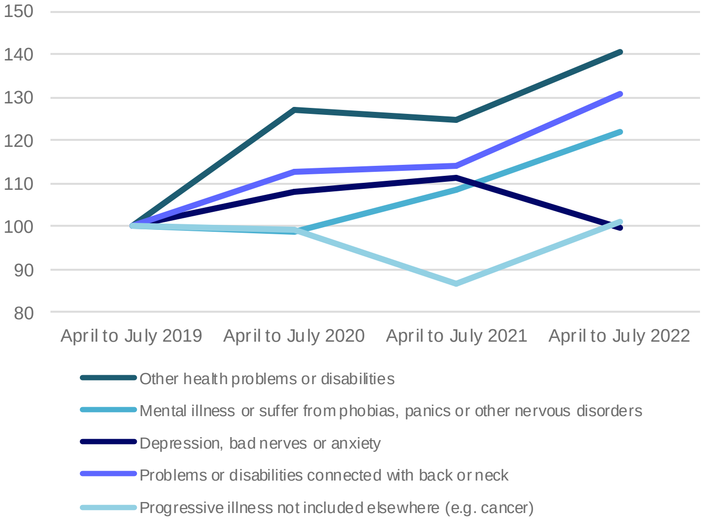
In addition to new schools, there is an £11bn pipeline of repair or rebuilding work across nearly 22,000 schools in England. The condition of schools has a direct correlation with pupil attainment, and the repair bill is directly correlated to construction productivity. The adoption of more manufacturing approaches could help to do this, both with rebuilding and potentially with repair and retrofit.

Productivity contributes to better health outcomes

The current waiting list backlog in secondary care – care that the NHS would normally have delivered but was disrupted as COVID-19 impacted service delivery – stands at a record high of almost 7.1 million people waiting for treatment.

The waiting list length, alongside long COVID and the ageing workforce, are seen as the main contributing aspects to the growing risk in long-term sickness. There has been an 18% increase in economic inactivity owing to long-term sickness from 2019 to 2022.

Figure 3AF: % change in economic inactivity owing to long-term sickness, by most common primary condition, people aged 16-64y, UK, 2019 to 20



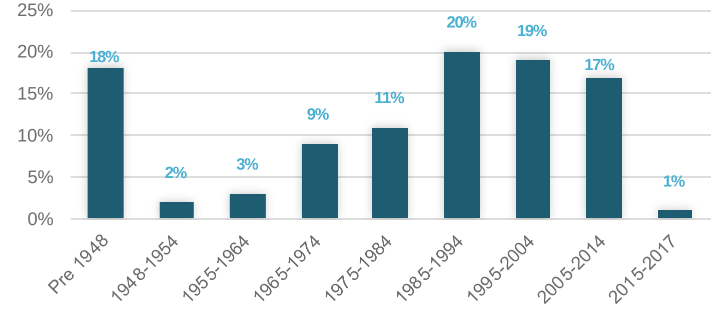
Source: ONS – Labour Force Survey

In addition, the reduced workforce has led to an increase in vacancies. Firms are struggling to recruit while employment remains below pre-Covid levels, and the supply of people available to work remains lower than at the start of 2020.

NHS Properties and Estates need ongoing maintenance

As the age of the NHS stock grows – 43% of the estates are more than 30 years old – so does the need for ongoing maintenance of buildings to maintain current levels of care.

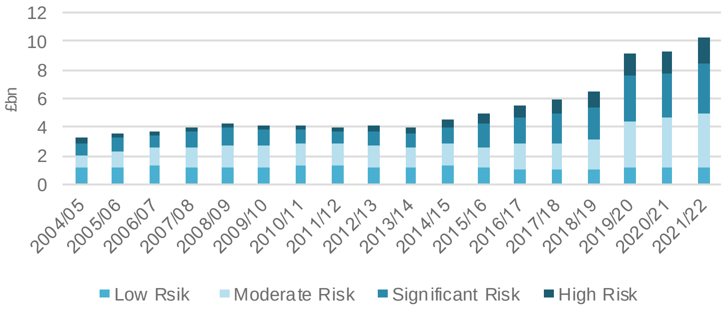
Figure 3AG: Age of NHS Estates



Source: The Naylor Report – NHS Property and Estates

Levels of capital investment have changed dramatically over the past 15 years: from 2014/15 to 2019/20, **funds from capital budgets were transferred to support day-to-day spending,** increasing the maintenance backlogs for NHS buildings and rising numbers of patients experiencing safety incidents caused by estate or infrastructure failures.

Figure 3AH: Historical trends in Maintenance Backlog

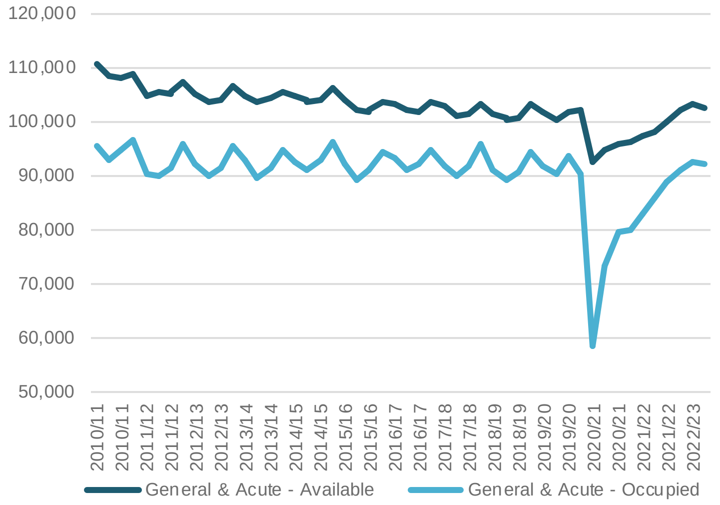


Source: The Kings Fund – Analysis of NHS Digital Data

The number of available beds is declining while the number of required beds is growing

The number of available hospital beds has been in decline since 2010, resulting in increasing occupancy, rising from 85% to 90% - evidence shows that hospitals work most safely and effectively at bed occupancy levels no higher than 85%. Projections produced by the health foundations demonstrated that an additional 23-39,000 general and acute hospital beds would be required by 2030.

Figure 3AI: General and Acute Bed Availability vs Use, NHS 2010/11-2021/22



Source: NHS – Bed Availability and Occupancy Data

To address the shortage of beds in 2020 the UK government confirmed funding for 40 hospitals, with a further 8 schemes invited to bid for future funding to deliver 48 hospitals by 2030 as part of the New Hospital Programme.

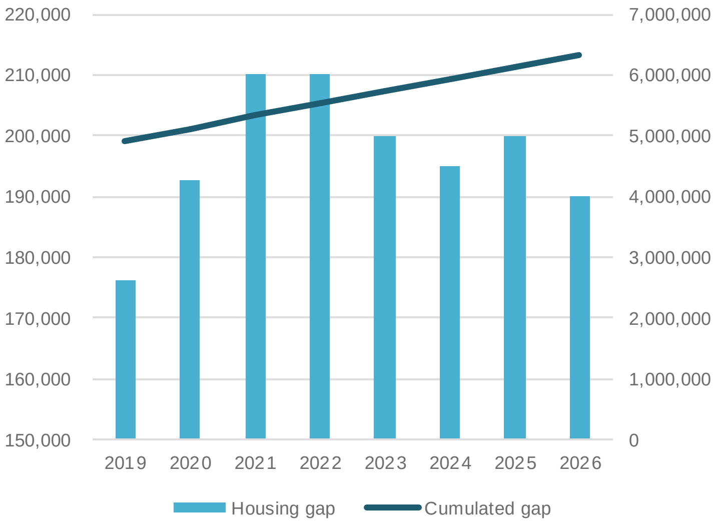
> The NHS is struggling with long waiting lists, high occupancy rates, growing demand, and decreased capital funding for maintenance and construction. This has led to safety incidents and maintenance backlogs. Implementing manufacturing approaches can help make construction and maintenance more affordable, reducing the backlog and risk.

Poor productivity is contributing to the housing shortage

The supply of housing has significantly lowered since the 1970s. Dwellings completed by the private sector have been quite stable, while the delivery of public housing has shrunken since the 1970s, causing a long-term issue. In England, the Government set a target in 2019 to deliver 300,000 homes per year. Yet, this level has never been achieved and forecasts shows that it will not be in the coming years. The same backlog exists for affordable housing as England's affordable housing scheme fell 32,000 dwellings short of target.

Considering the overall housing sector, forecast shows that the supply will stay lower than the yearly needs, increasing the backlog and worsening the housing shortage.

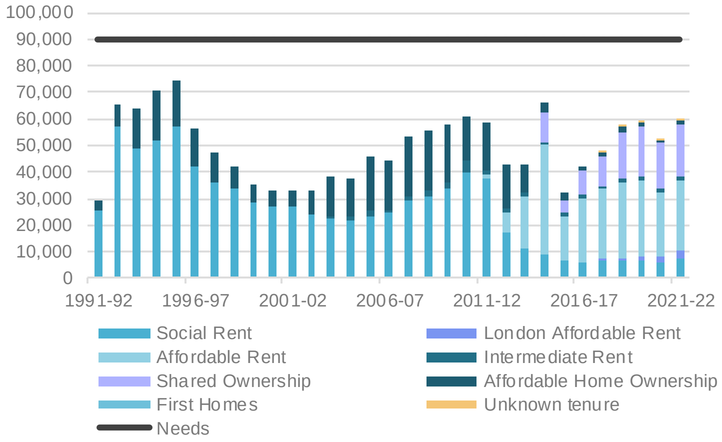
Figure 3AJ: The housing gap, forecasts



Source: JLL (2021) and Crisis (20128)

Figure 3AK below shows that Local Authorities and Housing Associations have failed to deliver enough dwellings to accommodate the needs. The needs are shown as constant over time but are expected to increase as the housing shortage deepens and the prices increase.

Figure 3AK: Affordable housing completion by tenure, England



Source: ONS – Affordable housing supply in England

As the demand is high, **the housing supply shortage is causing important increase in prices**, **increasing hence the needs for public sector housing.**

Poor Housing conditions have a demonstratable impact on health

A report from the Health Foundation demonstrated the impact of poor housing conditions on health. The housing factors influencing health are:

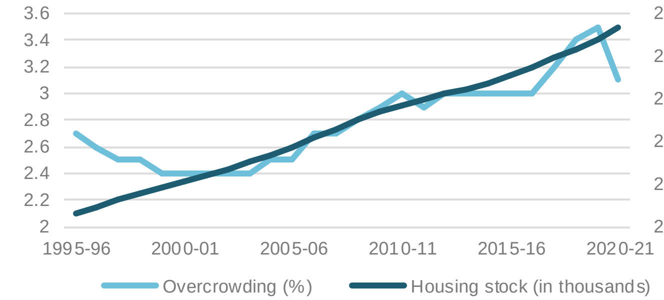
- The **quality and condition of accommodation**, as damp is linked to many health problems, such as respiratory issues, physical pain or headaches – *the situation is improving but 2019 17% of homes were non-decent*
- **Affordability,** as housing payments can represent a strong financial pressure, causing direct effects, such as stress and indirect effects
- **Stability and security**, there is a demonstrated relationship between moving more frequently and poor self-rated health

Ultimately, poor health condition represents a risk for economic growth as it results in an increase in health-related productivity loss.

The increase in housing stock has insufficiently increased to change the upward trend in overcrowding, higher than 3% in 2020-21.
The lack of supply has two effects on overcrowding:

- **A lack of adequate housing**
- **Accommodation less affordable (prices increase)**

Table 3AL: Historical trends in Maintenance Backlog



Source: The Kings Fund – Analysis of NHS Digital Data

• The Housing shortage has also an influence in labour mismatch

The housing shortage, since it results in higher prices, prevents labour movement in areas with high productivity and high wages. The 'key-worker problem' rising in the UK political agenda in the 2000s describes how the middle-class workers essential to a city daily operations are unable to afford housing, thus preventing local governments to run efficiently.

Booming housing prices are also linked to inefficient capital allocation: overall, high housing prices favour capital misallocation by reducing commercial lending to companies that would benefit it the most.

The UK's housing shortage has caused high prices and negative effects on health and the economy. To address this, implementing manufacturing approaches to increase productivity could increase housing supply, reduce overcrowding, improve affordability, and facilitate labour movement, resulting in economic growth and improved public health.

Productivity influences net zero

Industry and government are working towards the legally binding target of **net zero emissions by 2050**. To reach this deadline, significant change needs to be made to reduce both embodied and operational carbon throughout the built environment.

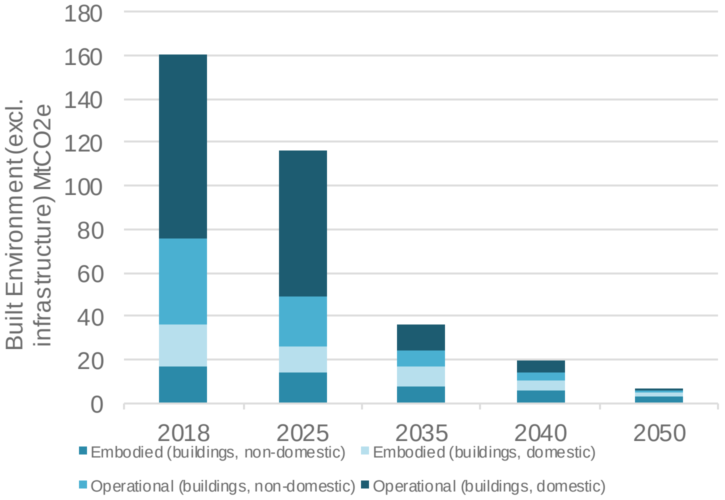
The current scope of the challenge is large, and the construction industry is disproportionally worse when it comes to carbon emissions in comparison to other sectors. According to Climate Watch, most of the Green House Gas (GHGs) or CO2e emissions are emitted through energy use in industry, buildings and transport.

25%

Proportion of UK emissions from the Built Environment

20% Embodied	**80%** Operational

Figure 3AM: Future emissions targets



Source: UKGBC

Policies and legislations are driving the need to reduce carbon across the built environment. However, in response to the 'Building to net zero: costing carbon in construction' report, the government has clearly acknowledged that changes in the policy environment alone 'will not be enough'. In this report the government has stated that 'our choice of materials, and the way we design and construct buildings will also need to change to reduce embodied carbon'.

The relationship between productivity and net zero is not simply cause and effect. Complex, expensive and time consuming techniques can be implemented to reduce carbon which come hand in hand with negative impacts on productivity. In comparison, initiatives that reduce carbon emissions via simplifying processes, reusing materials and upskilling employees can unlock productivity gains.

A Product Platform approach can **shift the dial in the industry to enable approaches to net zero which boost, rather than hamper, productivity**. This is because:

- Standardisation improves the ease at which circular approaches to construction can be realised due to the increased ability to reuse and interchange materials.
- Improved accuracy of demand forecasting is likely to reduce the embodied carbon released through waste processing and disposal.
- Greater levels of repetition will improve the efficiency in which tasks can be completed and streamline processes. Overtime, it is likely this will lead to decreased energy use, resulting in a reduction in carbon.

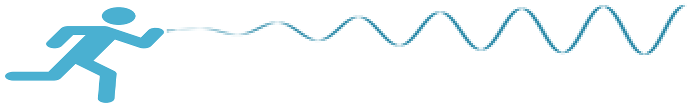
> "High costs in the building industry, which has **not raised its productivity in the past 20 years**, mean that the deep energy retrofits that are right for the climate could be a drain on productivity. If the UK can **rethink how to retrofit** buildings, it could align emissions savings with productivity gains. But, to do so, this must be a deliberate policy goal."
>
> Green Alliance report
> Climate for growth: productivity net zero and the cost of living

> "There is clear value in considering net zero and productivity together. Positive outcomes are not arrived at passively, the government will need to ensure they are realised."
>
> Green Alliance report
> Climate for growth: productivity net zero and the cost of living.

The bullwhip effect

The bullwhip effect refers to the situation where a small alteration to demand at the material and parts end of the supply chain becomes amplified further along the supply chain. This shows the value of accurate forecasting and predictable demand to those at the beginning of the supply chain. Product Platforms can help reduce these fluctuations in demand as they create greater certainty at the start of the supply chain.

From an environmental perspective, the bullwhip effect can be used positively. Recent research has been published about the 'green bullwhip effect' – a situation which shows environmental requirements can be transferred along the supply chain following a similar pattern, ultimately triggering the development of positive change and new capabilities. This is another way that Product Platforms can be harnessed to trigger positive change. If environmental requirements are standardised at the beginning of the supply chain, the positive impact can be expected to be even larger once transferred along the supply chair in comparison with the initial intervention.



Source: The green bullwhip effect -Transferring environmental requirements along a supply chain

The UK has committed to reaching net zero emissions by 2050. However, the built environment is currently responsible for **25% of UK emissions** and still has a long way to go to achieve this goal. Product Platforms partnered with a drive by government to reduce carbon emissions would **unlock productivity improvements that simultaneously drive net zero.**

The case for change

If we do nothing, then the construction sector is likely to continue to underperform relative to the whole economy. Low construction productivity reduces availability and quality of the buildings other sectors need to operate efficiently. Construction therefore influences national GDP, pupil attainment, patient risk in hospitals, quality of life and reaching net zero.

Challenges exist with the current project-based approach, including error and waste levels, high dependence on labour in an aging workforce, and high sensitivity to recessions. Labour shortages will increasingly exacerbate these challenges.

There is therefore a clear rationale for driving the productivity of the social infrastructure sector, and the Government, as construction's biggest client, has a significant opportunity to drive this improvement.

Unlocking the use of more manufacturing approaches to construct the UK building stock would not only improve productivity, but also save and improve lives in the process.

Product Platforms help to unlock these manufacturing approaches; while recognising the inherent variation and specifics of individual buildings, their environs and their stakeholders.

Economic opportunities of Platforms

£1.8bn
potential annual CAPEX saving

£7.8bn
potential real GDP improvement

Wide-spread adoption of Product Platforms across social infrastructure will reduce project costs by up to **30%***, or **£1.8bn per year** through **economies of repetition**. These refer to productivity and efficiency gains that result from producing and delivering similar goods or services in large quantities and making improvements through learning. This has a knock-on effect of up to an **£7.8bn increase in annual GDP** in the long-term, a multiplier of 4.

This section presents an approach to quantifying the economic value of Product Platforms in construction by assessing potential firm level productivity improvements and applying these across the Government's social infrastructure pipeline of work. A spatial Computable General Equilibrium (CGE) model was used to inform the study. This is a large numerical model which combines real economic data with economic theory so that the impacts in the economy of policy changes (or other "shocks") can be computationally derived.

Productivity gains will support the sector and deliver cost savings of up to 30%

- Reduced **dependence on labour** through increased productivity
- Reduced on-site **safety risks and overall accident rate** due to an increased use of manufacturing approaches
- Increased opportunity for **wellbeing**-related improvements for the workforce
- **Reductions in waste** through better precision, and **reduction in errors** through economies of repetition

Productivity gains will unlock financial benefits beyond construction

- Productivity-driven increases in investment and cross-sector trade, generating additional economy-wide **GDP growth**
- Increased **tax receipts** from increasing whole-economy GDP growth
- Increased **real incomes** for households from economy-wide GDP growth

There are broader benefits to the sector and other government initiatives

- Redistribution of construction-related jobs away from large conurbations to regions with stronger manufacturing bases, supporting **levelling up** of regional economies
- Increased quality of buildings, enhancing user experience, which could contribute to **economic wellbeing of users** (e.g. attainment in schools and recovery rates in hospitals)

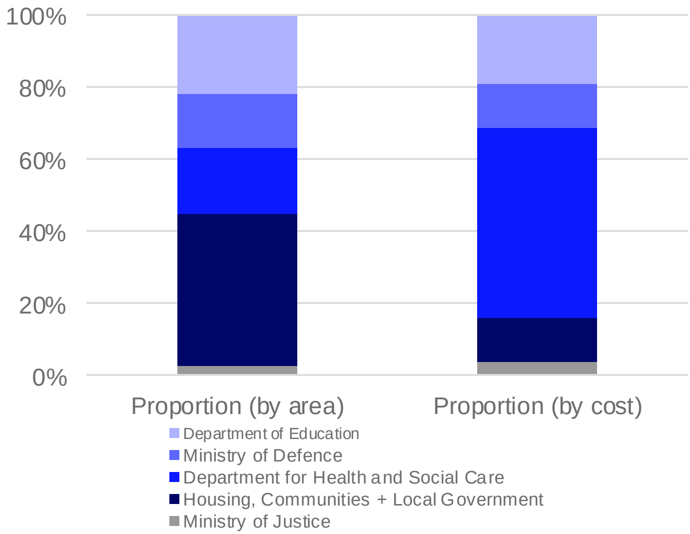
*Individual case studies suggest this may be a conservative figure.

Product Platforms could improve £60bn of projects over 10 years

The 10 year pipeline of social infrastructure has been calculated using Defining the Need, a Construction Innovation Hub report considering the scale and potential for commonality of the UK government social infrastructure pipeline, updated with data from the National Infrastructure Commission and the CPA's Construction Industry forecasts.

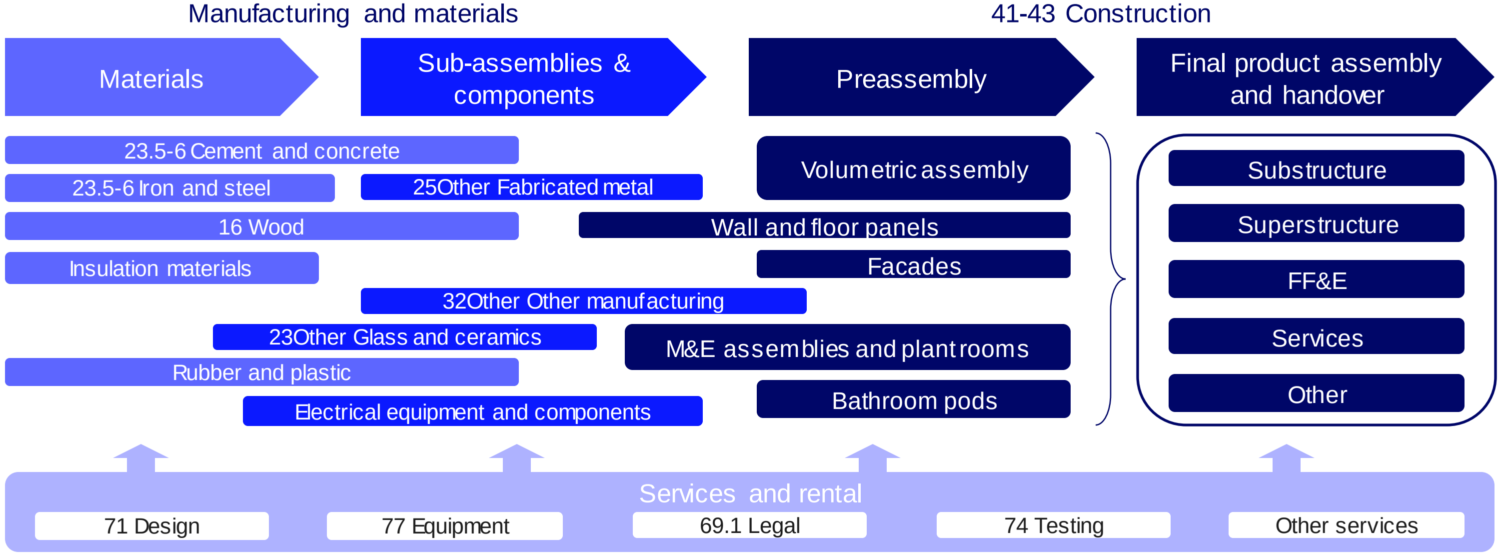
The total pipeline considered represents more than 20 million square metres of space, and nearly £60bn of capital expenditure, across approximately 3500 projects. This represents 9% of construction infrastructure investment over a 10 year period.

Figure 4A: Proportion of Pipeline for 5 Government Departments



Source: UK Government

Figure 4B: Categories and firm SIC codes considered in this study



Manufacturing and materials

41-43 Construction

Materials

Sub-assemblies & components

Preassembly

Final product assembly and handover

23.5-6 Cement and concrete

23.5-6 Iron and steel

25Other Fabricated metal

16 Wood

Insulation materials

32Other Other manufacturing

23Other Glass and ceramics

Rubber and plastic

Electrical equipment and components

Volumetric assembly

Wall and floor panels

Facades

M&E assemblies and plant rooms

Bathroom pods

Substructure

Superstructure

FF&E

Services

Other

Services and rental

71 Design

77 Equipment

69.1 Legal

74 Testing

Other services

The delivery of these social infrastructure projects has been broken down into five main categories for the purposes of this study, as shown in Table 4A. This diagram also shows the SIC codes associated with the firms undertaking activities in each of these categories. The basis for improvement from Product Platforms is illustrated in each case below.

Certain inputs to construction have not been considered in this study because they are either a small input to construction, or there is a limited data on which to derive an improvement, even with consideration of other comparable industries.

Table 4A: Five activities for the delivery of social infrastructure projects

Activity	**Description**	**Basis for improvement**
Design	The plans and instructions for the project, typically provided by separate design organisations.	Design once use many times
Project	Site-based activities; final assembly and handover. Typically ETO, on site and by a Tier 1 or subcontractor. This includes all major packages of work undertaken on site.	Economies of repetition
Preassembly	A preassembled set of elements designed to be incorporated with other assemblies on site. These may have an ETO or "Make to Order" (MTO) decoupling point and take place away from site by a Tier 1 or 2 contractor. e.g. volumetric units, wall panels with integrated services and windows.	
Sub-assemblies & components	Components or small assemblies of components designed to be incorporated with other units into a larger manufactured assembly. These typically have an "Assemble to order" (ATO) decoupling point, with works undertaken by manufacturing firms.	
Material	The commoditised inputs to the project, such as concrete, steel, timber, copper piping, wires, cable trays and so on. These typically have a "make to stock" (MTS) decoupling point.	Reduced waste

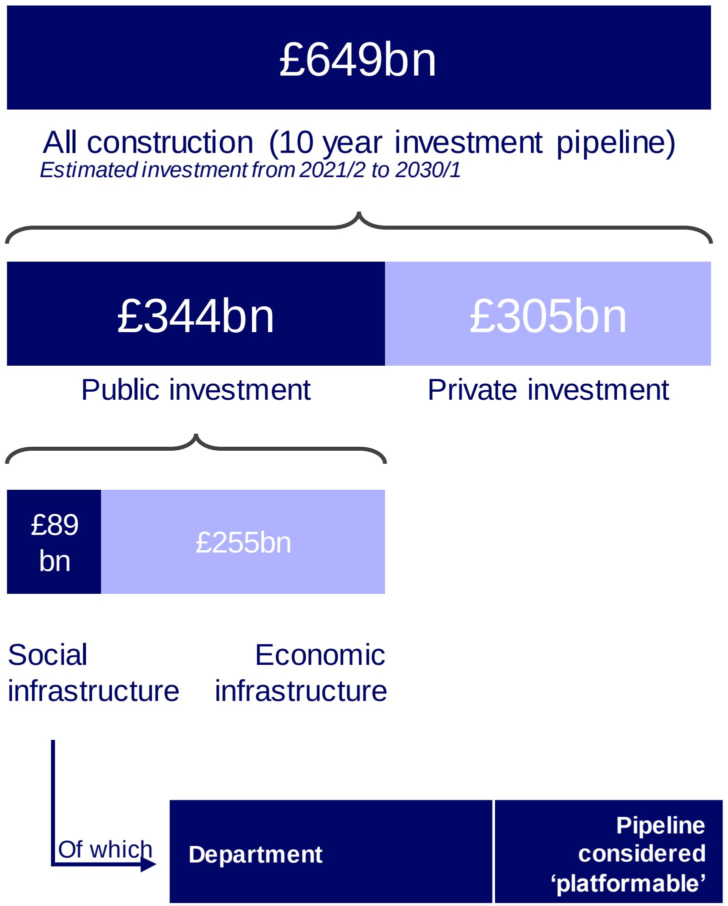
Government procurement is a lever for transformation

The Government is a major customer of the construction sector. Over half (53%) of the UK's £649 billion investment pipeline between 2021/2 and 2030/1 is public investment in social and economic infrastructure, as estimated by the Infrastructure Projects Authority and National Infrastructure Commission.

Of this, around a quarter (26%) is social infrastructure (£89 billion). This means publicly procured social infrastructure represents around 14 per cent of the total investment pipeline of the construction industry over the 2020s.

Social infrastructure includes investment by:

- **Department for Education** e.g. schools, university campus buildings;
- **Department of Health and Social Care**, e.g. hospitals, GP trusts.;
- **Ministry of Justice**, e.g. prisons;
- **Ministry of Defence**, e.g. armed forces accommodation.
- **Department for Levelling Up, Housing and Communities** (DLUHC), e.g. social housing;



£649bn

All construction (10 year investment pipeline)

Estimated investment from 2021/2 to 2030/1

£344bn

Public investment

£305bn

Private investment

£89 bn

Social infrastructure

£255bn

Economic infrastructure

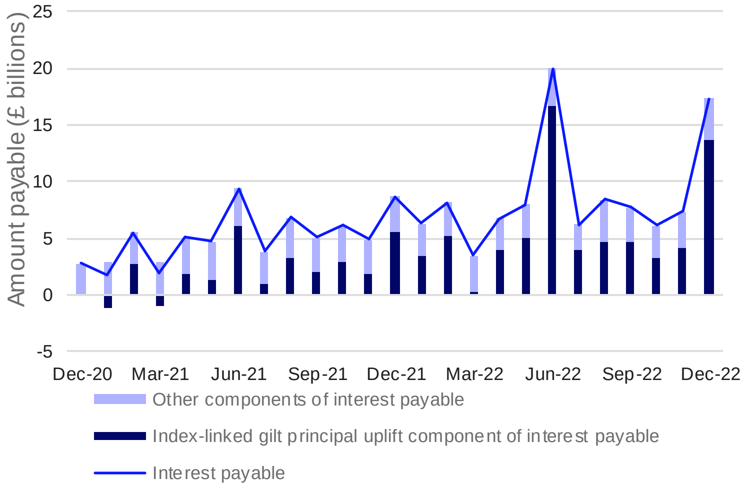
Of which

Department	Pipeline considered 'platformable'
Department of Education	£11bn
Department for Health and Social Care	£31bn
Ministry of Justice	£2bn
Ministry of Defence	£7bn
DLUHC	£7bn
Total	£59bn

As a major buyer of social infrastructure, improving the productivity performance of construction offers the potential for transformative cost reductions to Government and ultimately the UK taxpayer. This opportunity is set against the challenges in the construction sector outlined elsewhere in this report.

In addition, the affordability of the Government's investment programme is increasingly under threat in the current inflationary economic and fiscal climate, as inflation and debt costs impact on pipelines.

Figure 4C: Increases in central government debt interest costs, tied to prices, erode capital allowances.



Source: Office for National Statistics – Public sector finances

Widespread adoption of Product Platforms in the delivery of the Government's social infrastructure programme will:

- **Generate savings** for taxpayers by reducing the costs of delivering the Government's social infrastructure programme
- **Increase national tax receipts** from the economy-wide productivity growth that would be unlocked from driving up the construction sector's productivity

Government can choose how prescriptive to be

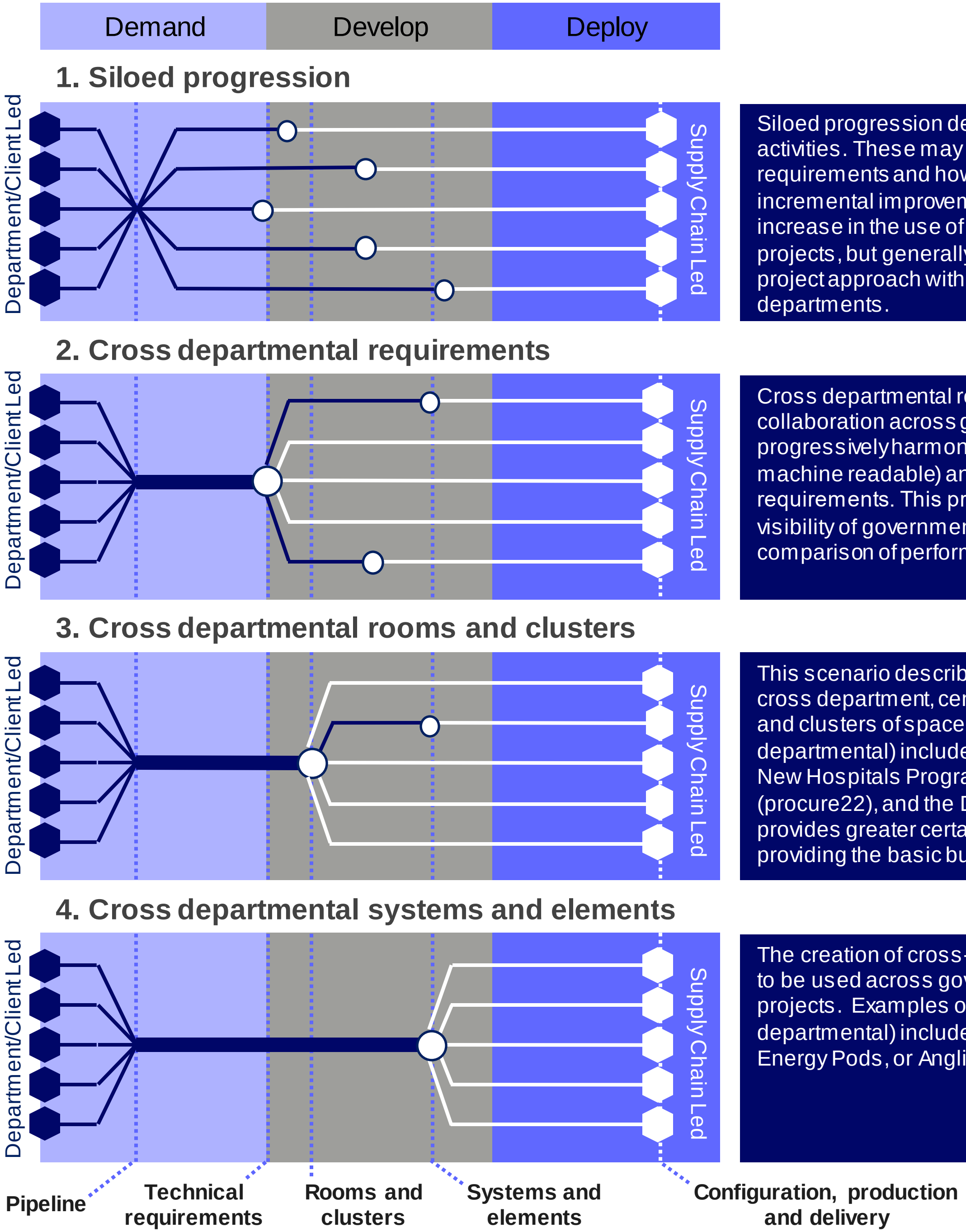
The Product Platform Rulebook proposes a methodology for Product Platforms that is structured around three domains: Demand, Develop, and Deploy. Within this framework, there is an opportunity for government to collaborate with the supply chain to determine its role within these domains and the level of prescription it should impose on project requirements. TIP: Roadmap to 2030 provides only a potential vision of the future, without clearly assigning roles or providing definitive descriptions.

4 scenarios can describe the level of prescription that government and departments as shown in the figures opposite. To move from siloed progression to the other scenarios, departments must harmonise, digitise and rationalise their requirements as described in the Construction Playbook. When cross-departmental requirements are harmonised, digitised and rationalised, the supply chain has the ability to respond across departments, enabling a stable order book and the ability to create cross departmental platforms.

Departments have the ability to be more prescriptive by designing clusters of spaces, enabling further certainty in the pipeline. Going one step further, departments could specify the elements that create the cluster of spaces which will enable the supply chain to focus on manufacturing and delivery of the system and element specified in this way.

Higher levels of prescription from the Government mean that the supply chain gains greater certainty, and the decoupling point for design and production can be postponed more reliably across more of the pipeline of demand. This is the case which has been modelling in this study, although further work is needed to defined the basis for competition, risk and value creation.

As shown in the illustrative diagrams on this page, each scenario builds upon the previous scenario. This means a progressively more developed, aggregated department/client led approach the higher the scenario.



1. Siloed progression

Siloed progression describes changes in line with current activities. These may include better articulation of technical requirements and how they might vary over time, incremental improvements to visibility of pipeline, gradual increase in the use of programmes to deliver multiple projects, but generally government retains a project-by-project approach with little collaboration across government departments.

2. Cross departmental requirements

Cross departmental requirements describes the collaboration across government departments to progressively harmonise (make comparable), digitise (make machine readable) and rationalise (reduce variability) requirements. This provides greater consistency and visibility of government construction pipelines, and allows comparison of performance across projects.

3. Cross departmental rooms and clusters

This scenario describes the development of one or more cross department, centralised sets of designs for spaces and clusters of spaces. Examples of this (although not cross departmental) include the use of standard clusters by the New Hospitals Programme, or of standard rooms by "P22" (procure22), and the DfE approach to design guides. This provides greater certainty, reducing coordination risk and providing the basic building blocks of government assets.

4. Cross departmental systems and elements

The creation of cross-departmental systems and elements to be used across government social infrastructure projects. Examples of this (although not cross departmental) include the Department for Education's Energy Pods, or Anglian Water's Standard Products.

Modelling how platforms improve productivity

If Product Platforms can drive productivity gains for firms within the construction sector and its wider supply chain, this will, in aggregate, lead to a permanent shift in productivity, enabling the sector to reduce its costs and/or increase production.

The direct productivity gains realised in the sector could have a knock-on impact on economy-wide UK GDP because in the real economy, sectors and markets interact with one another – one sector's output is another's input.

A change in one sector's productivity, such as construction and as long as it is a permanent shift, can flow through to other sectors of the economy through changes in the price and quantity of goods and services in producer, consumer, and factor markets.

Summary of benefits from Product Platforms on construction inputs

Design	Accelerated design of new social infrastructure assets, since they are being configured using systemised solutions.
Final product assembly & handover Preassembly	Reduced costs for assembly and pre-assembly as teams learn from experience (repeating similar processes) and the designs of the systems improve.
Sub-assemblies & components	Greatly reduced costs for components as volumes increase in scale (economies of scale and scope).
Materials	Reduced waste from over-ordering in construction due to systemised and manufactured approaches.

Direct impacts on the construction sector

The results of implementing Product Platforms in the delivery of social infrastructure for the construction sector.

Productivity scenario

Define adoption model to be tested in model design, including how prescriptive government chooses to be

Scope of construction sector adopting platforms

Scale of firm-level productivity improvement

Wider impacts on the whole economy

The results of adopting Product Platforms in the construction off social infrastructure for wider beneficiaries, beyond the construction sector.

GDP impacts

Economic modelling
The estimated firm-level productivity changes are applied as productivity 'shocks' to the relevant sectors in the model, taking account of:
- Type of productivity improvement (i.e. labour vs capital vs materials vs total factor productivity)
- The scale of implementation at the sector level

→ Growth in wider economy via sector's upstream and downstream linkages

→ **Increased UK GDP over time**

Non-GDP impacts (not monetised in this study)

Safer, more pleasant working environments with less risk

Less dependence on labour

Reduced error

More stable, inclusive employment

Levelling up through redistribution of construction activity

Higher quality, more sustainable buildings, with reduced operational carbon

Reduced embodied carbon from improved processes

Reduced local environmental impacts

Value to people and nature

Construction sector

Whole economy

Overview of approach for estimating changes in firm-level productivity enabled by Product Platform adoption

Productivity scenario	Scope of construction sector adoption Product Platforms	Scale of productivity improvement from Product Platforms at firm level	
Government's target of widespread adoption of Product Platforms by 2030, maximising potential Product Platform-enabled change in productivity in the construction sector.	The parts of the production process affected by Product Platforms (projects, preassembly, subassembly and components, materials, design, rental and logistics)	Calculated savings generated by the adoption of Product Platforms through economies of repetition, reduced waste and reductions in inputs to production.	Scale of savings as a proportion of total project cost (lower and upper bound)
Defining the Need, with ONS and NIC data estimate the Government's social infrastructure pipeline covering investment in buildings by: • Department for Education • Department for Health and Social Care • Department for Levelling Up, Housing and Communities. • Ministry of Defence • Ministry of Justice Scenario represents 11% of total construction investment.	**Design**	Since platforms are configured, rather than engineered, to order, the design inputs for each project have reduced meaning more projects can be designed for the same resource.	6-12%
	Projects On site activities for individual projects	Through increased predictability and repetition of standardised and centralised kits of parts, processes and supply chains, organisations can learn from experience and become more productive as the use the same process over and over again and the designs of the systems improve through DfMA.	22-42%
	Pre-assembly Offsite assembly		13-14%
	Sub-assemblies and components	Greatly reduced costs for components as volumes increase in scale (economies of scale and scope).	43-73%
	Materials	The use of more manufactured approaches reduces waste from construction activities through better predictability and certainty. Further improvement possible from better design, although this has not been considered.	4-8%

Economic modelling

Note: owing to limited observed data at industry scale about the productivity impacts of platforms, there is a degree of uncertainty about the level of cost savings, hence lower and upper bound ranges (for speed of learning) have been adopted.

Quantifying firm level improvements

Economies of repetition

Learning curves are described as percentages, with a lower percentage representing a steeper learning curve and a greater level of improvement with increasing production. There are numerous indicators that a learning curve will be steeper, including:

- Many repetitive elements in the activity
- A high proportion of manual labour
- A high level of continuity in the workforce

Learning curves can be applied to an entire industry, or to individual activities. We have adopted a hybrid of this, by decomposing project delivery into a series of distinct activities, each with an applicable learning curve. This learning curve is then applied to the "gross value added" for that activity, as opposed to the whole sale price.

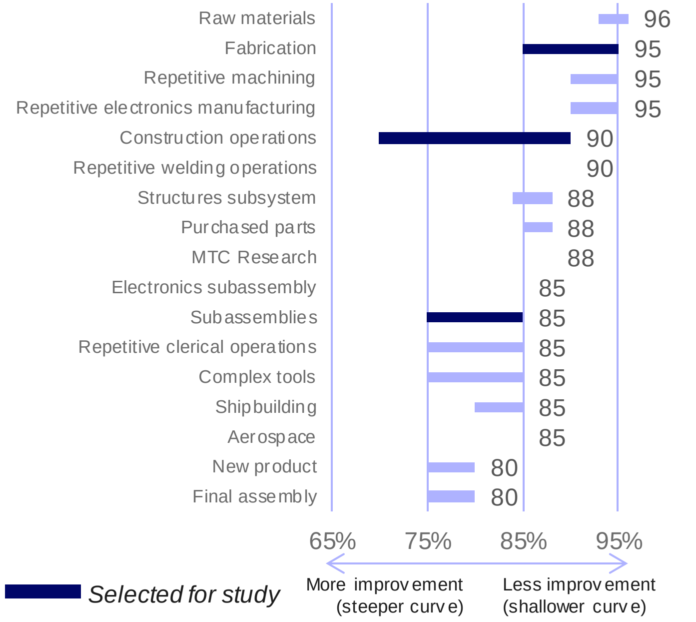
For example, improvement in site activities will not lead to a same level of reduction in overall costs for the project, rather the costs associated with the site activities will reduce with repetition. This means that inputs – such as logistics, materials and prefabrication costs – are not affected by improvements in site activities. This is a conservative assumption, given the derivation of learning curves as applying to the total unit cost to the customer.

The values for learning curves selected are highlighted in Figure 4D.

The pipeline and research (see box, right) have been used to determine the number of iterations in each case:

- Project iterations are based on the estimated number of projects in the pipeline and a throughput of 50 per firm over 10 years
- Preassembly is based on units derived from the floor area (assuming one unit is equivalent to 3.6m x 7.8m of area, or half a school classroom), with an annual throughput of 1,500 per firm
- Subassemblies are based on ten units per preassembly unit and a throughput of 3000 per firm

Figure 4D: Improvement curves for different industries, highlighting those selected for this study.



Source: NASA, MTC

The MTC has undertaken research into potential productivity improvements in the construction supply chain, focused on volumetric (MMC Category 1) solutions and related to "CMC level" (capabilities for modern construction). This research presents three main types of production process with progressive lean operational improvement between each. These improvements are tied linked to a level of throughput and result in increased productivity. The corresponding learning curve is 88%, in line with comparable figures in literature.

Relative productivity	100%	140%	190%	240%
Throughput	<300	>300	>1500	>3000

Reduction in waste

Each year, poor design, site management and site activities lead to approximately 13% of raw materials ordered are discarded unused. The adoption of Product Platforms can reduce waste from overordering in construction by 5-10% points due to systemised and manufactured approaches, and an improved opportunity for recovery of unused materials due to repetition.

At an industry level, we can make the simplifying assumption this is spread approximately equally across materials supplied. This improvement is applied as a reduction in intermediate consumption by construction of those inputs.

Reduction in design effort

The adoption of Product Platforms dramatically improves the design process for new social infrastructure assets, since they are being configured from systemised solutions rather than designed from fresh.

In house evidence suggests that standardised kits of parts can be configured for a fraction of the cost of bespoke designs - for example, developing standard modular substations enabled a reduction in design cost of approximately 80% due to a combination of improvements in economy (through the use of lower cost resource) and in productivity (through the use of automation). This is likely to be unachievable for social infrastructure, given the stakeholder engagement process, but reductions from 16% to 10% have been seen in education.

Figures from MIT research into platforms in the automotive sector indicate BMW have reduced engineering costs by 28% for each new model through the use of Product Platforms.

A mid-range figure of 12% has been adopted as an upper bound (6% as a lower bound), given the variation in the assets within the pipeline. Further savings are likely to be achievable were business case and planning processes to be streamlined for platform-based approaches. This is modelled as a reduction in the price of inputs to construction from this industry, meaning that more projects can be designed using the same resource.

These are summarised overleaf.

Product Platforms can systematically boost productivity

Construction creates assets which are large, geographically-specific, complex and designed to last a long time. They are also capital intensive and are commissioned for clients through individual projects where stakeholders may have limited prior experience of construction. These factors contribute to demand which is both cyclical in scale and volatile in nature.

The size and location of construction means that logistics and coordination vary from project to project. Variable and temporary teams of 'loosely coupled' firms and stakeholders lead to variable requirements. Trades, suppliers and service providers specialise, creating horizontal fragmentation within project phases, as well as vertical fragmentation between phases.

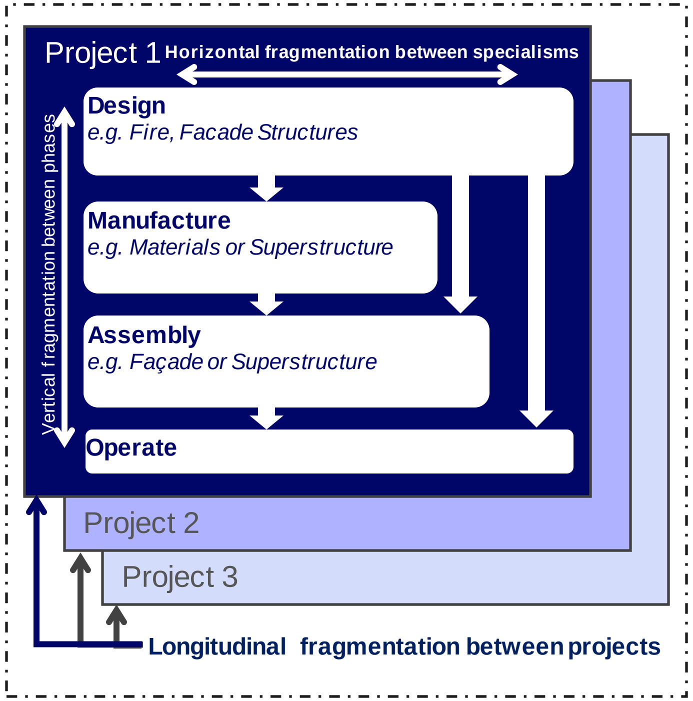
The resulting lack of standardisation from a project-based, fragmented approach leads to increases in unplanned work and change, resulting in more labour-intensive, site-based activities. It also reduces the viability of manufacturing approaches – which thrive off stability and certainty – and prevents more decoupled, forecast-driven production.

Cyclical demand and the commercial environments within projects makes long-term relationships difficult, exacerbating longitudinal fragmentation between consecutive projects and reducing scope for learning.

Increasing productivity is not a priority when the supply chain is focused on lowest price, risk mitigation and even survival (construction has the second highest rate of insolvency across all industries).

Jones et al. (2021) highlight the opportunity for Product Platforms to address this fragmentation and enable iteration across and within projects.

Traditional Construction Projects



Project 1

Horizontal fragmentation between specialisms

Vertical fragmentation between phases

Design
e.g. Fire, Facade Structures

Manufacture
e.g. Materials or Superstructure

Assembly
e.g. Façade or Superstructure

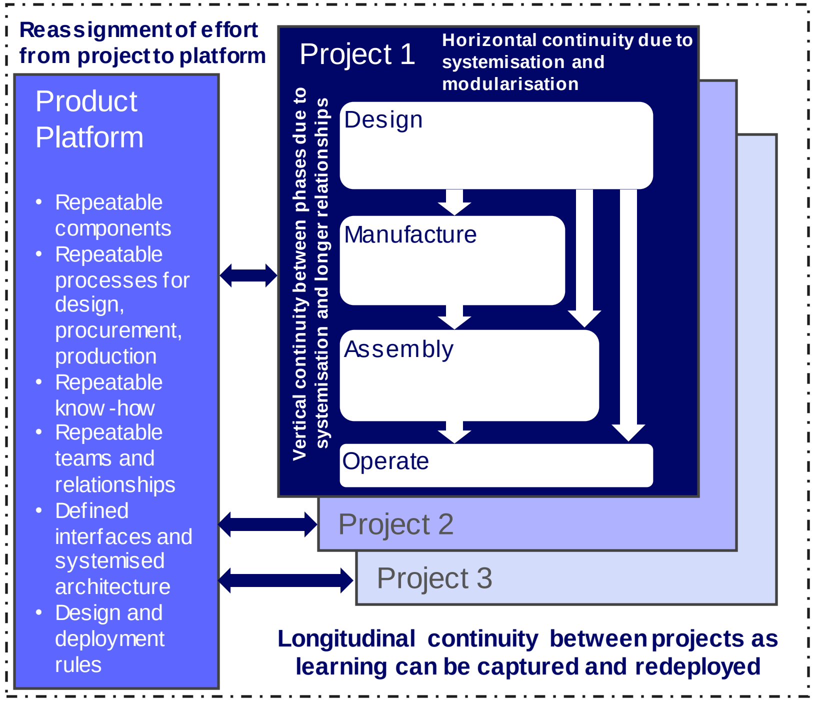
Operate

Project 2

Project 3

Longitudinal fragmentation between projects

Platform Approach to Construction Projects



Reassignment of effort from project to platform

Product Platform

- Repeatable components
- Repeatable processes for design, procurement, production
- Repeatable know-how
- Repeatable teams and relationships
- Defined interfaces and systemised architecture
- Design and deployment rules

Project 1

Horizontal continuity due to systemisation and modularisation

Vertical continuity between phases due to systemisation and longer relationships

Design

Manufacture

Assembly

Operate

Project 2

Project 3

Longitudinal continuity between projects as learning can be captured and redeployed

Product Platforms can help address fragmentation in construction, which currently create inefficiencies in delivery

Successful Product Platforms help reduce and mitigate these three dimensions of fragmentation by leveraging commonality of components, processes, people, relationships or knowledge. By establishing this core commonality and associated feedback loops, learning can be safeguarded and used to enable continuous improvement. This, in turn, drives greater consistency, predictability and reduced portfolio risk

Impact of fragmentation in construction projects and supporting features of Product Platforms.

Fragmentation	Impact	Product Platform features which help
Longitudinal, between projects	Learning is not carried from one project to another, hindering continuous improvement and productivity gains from economies of repetition.	Common repeatable assets (including relationships) and structured information allow knowledge and learning to be retained and iterated across projects.
⟷ Horizontal, between specialisms	Inefficient coordination and understanding between specialists leads to errors and rework and variable implementation.	Systemisation and modularisation to develop repeatable assets (components, processes) with defined interfaces embeds coordination between disciplines.
↕ Vertical, between phases	Communication problems cause errors, delays and contractual risk based on incomplete information.	Systemisation of repeatable assets (including relationships) improves communication and provides greater certainty and completeness earlier, reducing risk.

Product platforms use economies of repetition

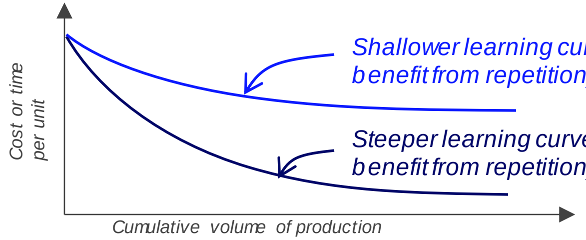
Economies of repetition refer to the improvements in performance, cost savings and efficiency gains from producing and delivering identical or similar goods or services in large quantities. This can be achieved through standardised production processes, specialised equipment, and other economies of scale.

Evidence from industries from automotive to aviation, and software to Fast Moving Consumer Goods, highlight the potential of "economies of repetition". These refer to the benefits of fixed repeating patterns of work over multiple cycles, creating improvements in performance based on people rather than machines. These are closely related to, but not the same as, economies of scale, with the latter failing to be effective in a portfolio of variable projects or products such as construction.

The improvement in unit cost is based on the number of those units delivered by an organisation and can be calculated using the Crawford (or unit cost) system. This approaches uses a mathematical relationship between a first unit cost, a learning curve, and a future unit cost.

These curves are described as most appropriate where there are: high proportions of manual labour; uninterrupted production; production of complex items; no major technological change; and continuous pressure to improve. These situations are present in construction.

Figure 4E: Economies of Repetition – Learning Curves



Improvements occur due both to technical and human factors in relation to the production costs and times. In addition, material costs also show improvement.

Technical factors	Human factors
1. Improved methods, processes, tooling, and machines 2. Process improvement 3. Design for manufacture 4. Design for assembly 5. Improved data 6. Use of machines for hand operations 7. Waste Reduction	1. Operator learning 2. Management learning 3. Personal factors such as fatigue, personal matters, or employee morale. 4. Improved relationships

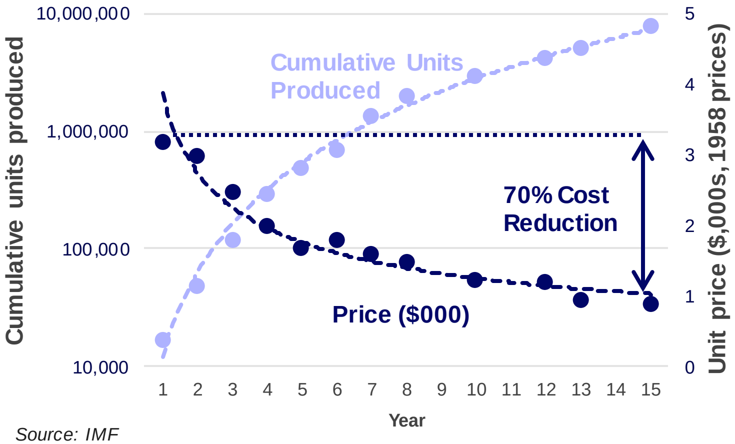
Economies of repetition lead to reductions in unit price (and unit production time) as volumes increase. Mathematically, this is described as the unit cost reducing by a percentage each time cumulative units produced doubles:

$$Cost(Unit_n) = TFU\ x\ n^b$$

With: n = unit number; TFU = Theoretical First Unit cost; $b = \ln(Learning\ curve\ (\%)/2)$

The learning curve applies to the whole firm, rather than just to front-line workers and hence apply to unit prices for consumers. The curve is expressed as a percentage, representing the residual proportion of effort needed after each doubling of production.

Figure 4F: The Ford Model T exhibited continued economies of repetition



Source: IMF

Ford Motor Companies' Model T

The Ford Model T was produced by Ford Motor Company from 1908 to 1927. It is generally regarded as the first affordable automobile, using economies of repetition to drive down the costs of automobiles so they became accessible to the mass market. Famously, the "any colour as long as it's black" offered next to no choice to consumers, which allowed the large-scale use of interchangeable parts and progressive improvements in total factor productivity – and hence reductions in unit costs.

Figure F illustrates economies of repetition in action for the Model T, which saw $3,000 price tag for the 50,000th vehicle reduce to $1,000 by the 8Mth unit – a cost reduction of 70% in real terms in 15 years. The learning curve slope is 85% for this example, meaning a 15% reduction in cost for each doubling of production.

Lean Six Sigma – formalising economies of repetition

Lean Six Sigma is a methodology that minimises waste and variation in a standard process to increase productivity.

Lean Thinking focuses on what the customer defines as value, assessing every process step to analyse whether it adds value. Waste is classified as anything that does not add to this customer-defined value. Typically, waste can be categorised as Transport, Inventory, Motion, Waiting, Overproduction, Overprocessing, Defects and Skills. Lean Thinking originated in America with the Ford Motor Company and was further developed by Toyota into the Toyota Production System.

Six Sigma was developed by Motorola in the early 1980s to minimise defects and improve overall quality. Six Sigma strategies seek to improve manufacturing quality by minimizing variability in manufacturing and business processes. The roots of Six Sigma as a measurement standard can be traced back to Carl Friedrich Gauss (1777-1855) who introduced the concept of the normal distribution curve. Six Sigma methodology proposes 5 key process steps for improving a process by reducing variability by Defining the variation, measuring it, analysing it, improving it and controlling it. This improves productivity by minimising variation of Key Performance Indicators such as cost, defects and time.

The Liberty Ship Program benefitted from economies of repetition

The Liberty Ship program involved large-scale shipbuilding during World War II to build cargo ships for the Allies, so named for the cargo ship that was designed for quick and easy construction. It was one of the most successful industrial efforts in history and it demonstrated the importance of repetition in increasing productivity.

The program was launched in 1940 by the US government a year before they entered World War II. The purpose of the program was to address the Allied need for cargo ships, which were crucial for the transportation of troops, supplies, and equipment during the war. The ships were designed to be simple and cheap to build, so that they could be produced quickly and in large numbers.

The key to the success of the program was the use of assembly-line techniques in shipbuilding. The shipyards were modelled on automotive factories, with each worker responsible for a specific task in the process. The use of mass production techniques allowed the shipyards to produce Liberty ships quickly and efficiently.

The program demonstrated the power of repetition in continuously increasing productivity – with time to produce a ship reducing from 180 days to 30 days within 18 months. By breaking down the shipbuilding process into smaller, repetitive tasks, workers were able to specialise in their roles and become more efficient at their jobs. The use of standardised parts and procedures also helped to increase productivity, as workers became familiar with the tools and techniques required to complete their tasks.

In total, over 2,700 Liberty ships were built during the war, making it one of the largest and most successful shipbuilding programs in history. The success of the program demonstrated the opportunity for repetition to increase productivity.

Why did the Liberty Ship Programme Increase in Duration after May 1943?

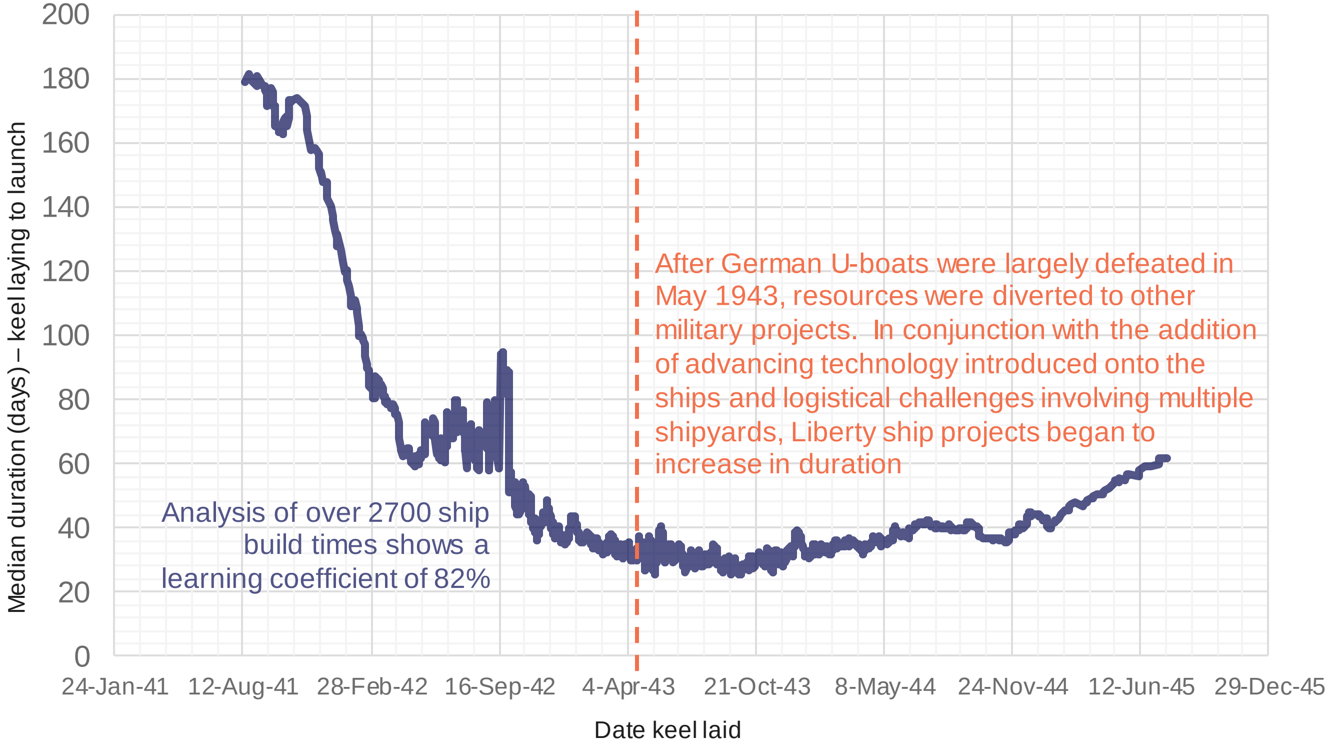
Despite the initial success of the Liberty ship program, there were several challenges that arose during the course of the war. One of the main challenges was the threat posed by German U-boats, which were sinking Allied shipping at an alarming rate. This led to a significant increase in demand for Liberty ships, as the loss of ships meant that more needed to be built to replace them.

However, the German U-boat threat was **largely defeated** at the end of May 1943, which led to a decrease in demand for Liberty ships. This decrease in demand, combined with the introduction of more complex ship designs, led to a steady increase in the duration of the Liberty ship project.

Another challenge that arose during the Liberty ship program was the competition for resources with other military projects. As the war progressed, the demand for resources increased, which led to competition between different military projects for materials, labour, and other resources. This competition made it more difficult to complete the Liberty ship program on time and within budget.

Finally, the logistical challenges of using different shipyards also posed a challenge for the Liberty ship program. Because the ships were built using prefabricated parts, they could be assembled at different locations across the country. However, this also meant that there were logistical challenges in coordinating the production of the ships and ensuring that they were delivered to the right location at the right time.

Figure 4G: Liberty Ship Programme - Project Commission to Launch (days



After German U-boats were largely defeated in May 1943, resources were diverted to other military projects. In conjunction with the addition of advancing technology introduced onto the ships and logistical challenges involving multiple shipyards, Liberty ship projects began to increase in duration

Analysis of over 2700 ship build times shows a learning coefficient of 82%

Source: WW2 Ships

Executive Summary

Introduction

The case for change

48

Economic opportunities

Broader opportunities

Reflections

Estimated CAPEX impacts of Product Platforms

In addition to modelling macroeconomic effects, we can apply improvements at a project level and consider potential savings under different scenarios of government intervention.

Evidence of the benefits of manufactured approaches

As highlighted earlier in this report, there is limited evidence in construction for the potential benefits of widespread adoption of platforms in construction. Given that a key aim of adopting Product Platforms is to unlock the benefits of manufacturing at scale through commonality across different assets, whilst accommodating the variability needed within those assets, it is instructive to look towards evidence of manufactured solutions bringing benefits to construction.

Numerous reports and inquiries have gathered and presented examples and estimates of the benefits which might be realisable, although most refer to one-off or localised improvements.

Examples of quantified benefits include:

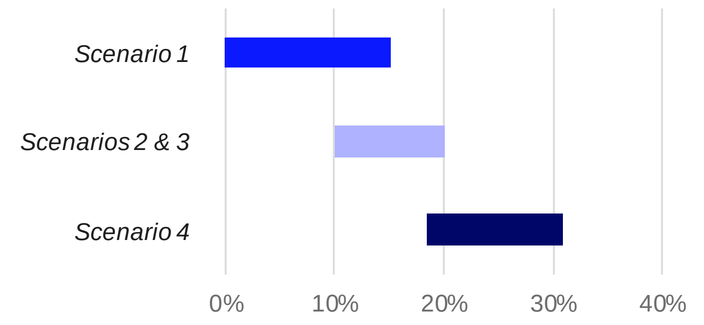
- Productivity improvements of 50% and construction cost reductions of up to 40% (evidence reported by the House of Lord's Science and Technology Select Committee inquiry)
- Efficiency improvements of up to 40% (IPA's Transforming Infrastructure Performance)
- Cost savings of up to 30% (reported in McKinsey's Modular construction: From projects to products)
- Deliver housing 40% more productively and with 50% fewer workers (reported in Make UK's Who will be the builders?)

Whilst these are not all directly comparable, they give a broadly consistent indication of the scale of opportunity available, were construction of social infrastructure to radically change.

Estimating project-level savings for different scenarios

We can consider the scale of potential opportunities under each of the different scenarios described previously, by taking into account the variable scale and nature of each department's pipeline. It should be noted that this modelling is developed for an aggregated pipeline and hence there are limitations to its application at a project level. A range of indicative potential savings at a project level are shown in 4H below.

Figure 4H: By working together, Departments would gain greater savings than working alone



Source: Own analysis

- 🟦 *Scenario 1 "Siloed progression", assuming systems and elements are specified by each department*
- ▨ *Scenarios 2 and 3: Cross-departmental requirements, spaces and clusters*
- ■ *Scenario 4: Cross-departmental systems and elements*

This analysis indicates a potential saving at project level of:

1. Up to **15%** savings for adoption of platform approaches at an individual department level (Scenario 1).
2. Up to **10-20%** for the harmonisation, digitisation and rationalisation of technical requirements (via output specifications) and of rooms and clusters across departments (Scenarios 2 and 3).
3. Up to **18-31%** if platforms were to be applied across the social infrastructure pipeline of construction.

Additional savings may be achievable through buying gains for materials, and streamlined design and business case processes, which have not been considered beyond reduced design inputs.

A potential saving of £1.8bn a year on a £5.8bn annual pipeline

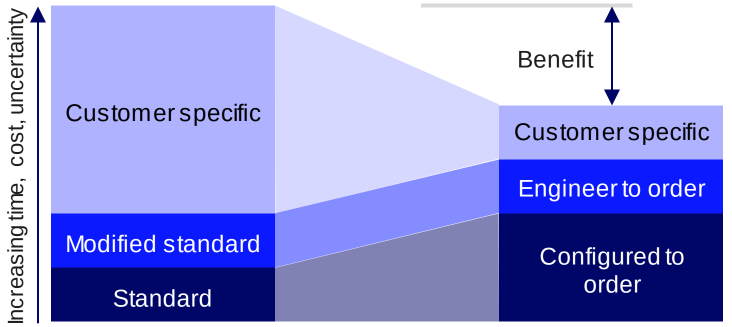
Using the Defining the Need pipeline (approximately £5.8bn a year), these estimates translate to a potential saving to Government of £1.8bn a year across social infrastructure.

At a project level, this equates to reducing the price of a:

- £22m secondary school by up to £7m
- £475m hospital by up to £147m
- £400m prison by up to £124m
- £25m defence accommodation project by up to £8m
- £10m housing development by up to £3m

These savings arise due to a reduction in design cost (design once, use many times); a reduction in material costs due to reduced waste; a reduction in component costs due to reduced waste and buying gains; and a reduction in "processing" costs through economies of repetition. This is summarised in the diagram below, showing a shift from predominantly bespoke by default, to bespoke by choice. Note that this analysis does not consider the investment in technical, commercial and organisational capabilities needed to develop and deploy Product Platforms on this scale.

Figure 4I: Benefits from a shift to Product Platforms



Realising these gains needs stability

Construction is very well evolved for the uncertain environment in which it finds itself: cyclical, variable and volatile. It responds with the structure and performance that it exhibits.

The project-centric approach (from funding and requirements to design and delivery) drives decentralised decision-making and financial control at a project level, with a need for local adjustments at the construction site. The uncertainty factors of incomplete specification, lack of uniformity, and unpredictable environment make the use of standard materials combined with craft labour an appropriate strategy, as opposed to the standardised activities and associated ability to share best practice that has been adopted in other industries.

This strong emphasis on individual projects favours a narrow perspective, both in time and scope, with the widely-held perception that competitive tendering promotes cost effectiveness and efficiency. All this drives the relationships among parties to be transactional, and typified by market-based, short-term interactions between independent firms.

This uncertainty prevents economies of repetition underpinning platform approaches from taking hold effectively, since there is insufficient stability technically, commercially or organisationally.

The Pipeline Rollercoaster describes the volatility in pipeline of notable Tier 1s. This leads to a pattern of inconsistent performance and profit, creating inefficiencies in the supply chain.

> "Today's standardisation…is the necessary foundation on which tomorrow's improvements will be based. If you think "standardisation" as the best you know today, but which is to be improved tomorrow – you get somewhere. But if you think of standards as confining, then progress stops."
> **Henry Ford**

A supplier perspective: Uncertainty in the construction industry

The uncertainty and volatility of demand in the construction sector is constraining investment throughout the supply chain. To build an understanding of how Product Platforms might influence parts of the supply chain, we asked the Builders Merchants Federation to share some of their views on incentives and barriers to investment, as well as the possible implications of a more standardised approach.

Barriers to investment:

*"**Uncertainty** and the all too often cyclical nature of the building industry"*

*"Scalability as a result of slowness to adopt, **lack of common standards, design parameters and connections**."*

"Traditional methods" "Expensive to build offsite wooden homes"

"Uncertainty of future demand linked to visibility of demand from modular house manufacturers"

Incentives for investment:

"Consistency and demand forecasting"
"demand certainty"

"Common data requirements and digitalisations"
"Sustainability, skills shortage and the need for quality supported by digitalisation"

"Government adopting more innovation, seeing the industry as a whole rather than contract led"
''Legislation"

Overall, the greater levels of standardisation unlocked by adoption of Product Platforms would improve the certainty of demand as the pipeline of government projects and programs could be translated into parts and materials. This would increase investment in the sector. Whilst the greater certainty is likely to be beneficial for majority of material providers, our survey highlighted that further analysis is needed to consider how Product Platforms would impact merchants, as some feel greater standardisation may be risky for their role in the industry.

Technical and commercial stability enabled Bowmer + Kirkland to improve productivity and performance

Successive DfE MMC-oriented frameworks and output specifications have provided certainty and stability to enable firms to improve both productivity and performance. Stability and certainty is both technical (since requirements are consistent across projects, and updated on a published cycle) and commercial (since there is a clearer and more certain view of potential work and the associated procurement mechanisms).

This has allowed Bowmer + Kirkland, a construction and development group, to meet a price-rachet of 2.5% as part of the framework, improving productivity performance by 14.6% over 46 projects whilst delivering greater complexity products for the DfE, since 2018, through:

- Repeated and systemised designs that provide stability and clear constraints
- Continuous improvement of production through greater use of manufacturing approaches
- Improved strategic relationships with key suppliers, based on optimising parts for a systemised approach, enabling investment in improved solutions
- Increased design standards beyond Part L, driven by the DfE, directly increased product quality for air tightness and thermal bridging, whilst reducing cost and driving down carbon.

The government is working to make the construction industry more stable and reliable by implementing policies such as the Construction Playbook and TIP: Roadmap to 2030.

These policies encourage the use of procurement frameworks as a dependable way for government to access the market. The recently published "Constructing the Gold Standard" review of public sector construction frameworks also supports this approach, emphasising the potential for frameworks to create a consistent and efficient pipeline that reduces waste and allows for innovation.

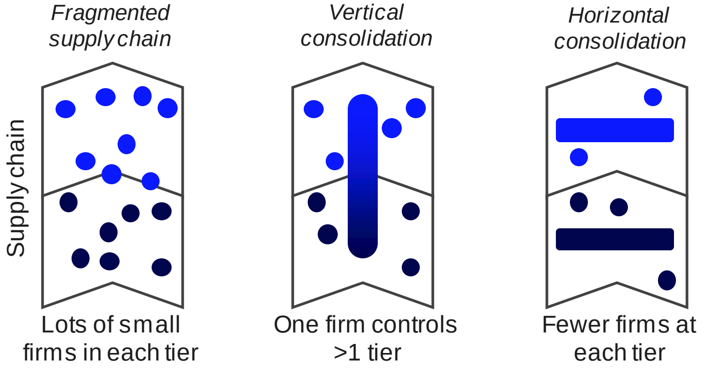
This approach aligns with the goals of the Construction Playbook to improve efficiency, drive innovation, and deliver better value for money in public sector construction projects, and would play a key role in providing commercial stability needed for the adoption of platforms. Further work is needed to increase technical stability in the form of harmonising, digitising and rationalising requirements across departments.

Executive Summary
Introduction
The case for change
Economic opportunities
Broader opportunities
Reflections

Construction is economically fragmented

The fragmentation of an industry describes the degree to which the production and delivery of goods or services are dispersed across different stages of the supply chain (vertical), or different firms within the same stage (horizontal).

Fragmentation reduces when an industry consolidates. This happens when mergers and acquisitions lead to fewer but bigger companies controlling more stages of a supply chain or dominating a market. A highly fragmented industry has a many small firms with inputs from a wide variety of other firms.



Vertical Fragmentation

Measurement of vertical fragmentation tends to rely on the use of industry-level measures of consumption – that is, asking the question of how much of an industry's outputs come from other industries repeatedly along a supply chain. This measures the number of stages involved in the production of a good or service. A higher index means that value-add activities are dispersed across the length of the chain. Individual studies have highlighted that [loads of firms with small transactions].

Horizontal Fragmentation

To measure horizontal fragmentation, metrics such as concentration ratio. A higher ratio or index means a less fragmented (more consolidated) industry. The construction industry is among the most fragmented industries, with only 20% of organisations having more than one employee, and many sole traders and larger Tier 1 contractors competing against each other. The largest 300 firms only have 27% of the market share. In contrast, UK steel-making is an example of high consolidation, with three firms hold over 60% of the market share.

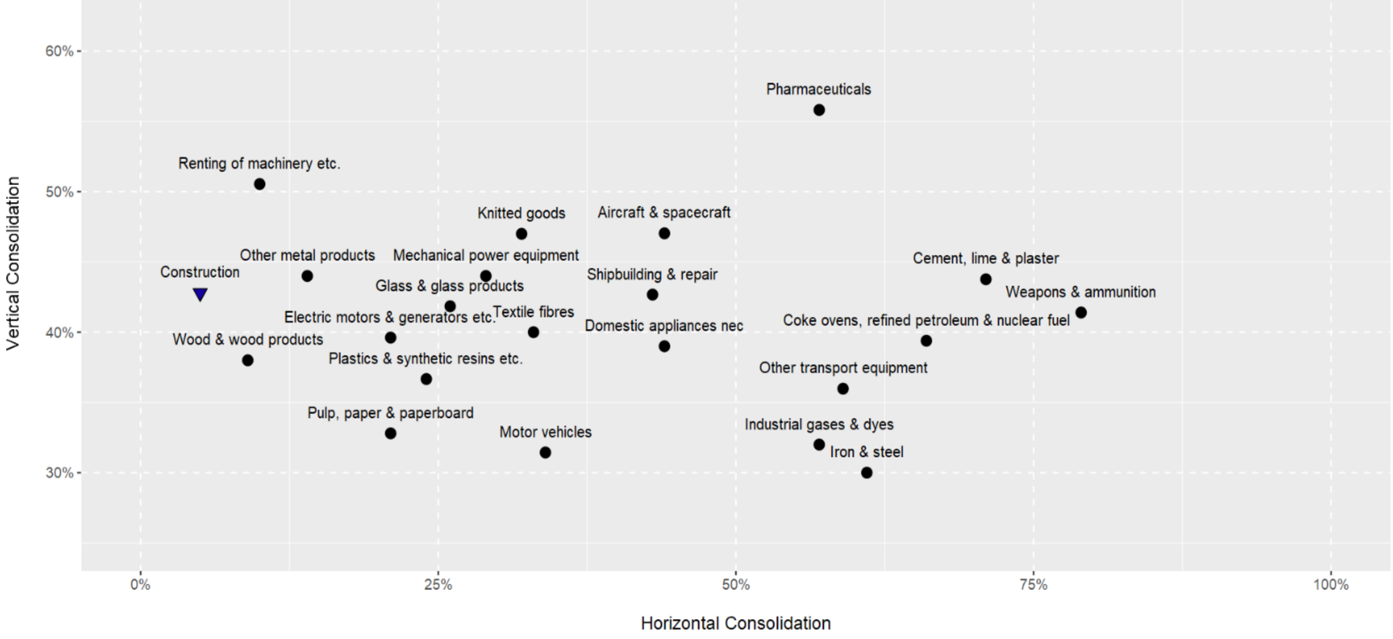
Manufacturing is much more consolidated than construction

Visualising construction against manufacturing sectors indicates that the adoption of more manufacturing approaches through the use of Product Platforms is likely to have a significant impact on the structure of the industry, most likely leading to some relatively minor integration across tiers in the supply chain (most likely through strategic and longer-term relationships) and consolidation within individual tiers as firms benefit from economies of repetition (and hence scale).

Consolidation is neither inherently good nor bad, rather there are pros and cons of each.

	Higher consolidation	Lower consolidation
Pros	Improved purchasing power in production Reduced costs of production Improved ability to scale innovation	Lower barriers to entry for SMEs More resilient industry overall (not at firm level) Increased scope for specialisation
Cons	Reduced choice Higher barriers to entry for SMEs Potential to stifle innovation Potential to reduce industry resilience	Reduced purchasing power Increased costs of production Can lead to exploitation of workforce

Figure 4J: Vertical and Horizontal Consolidation



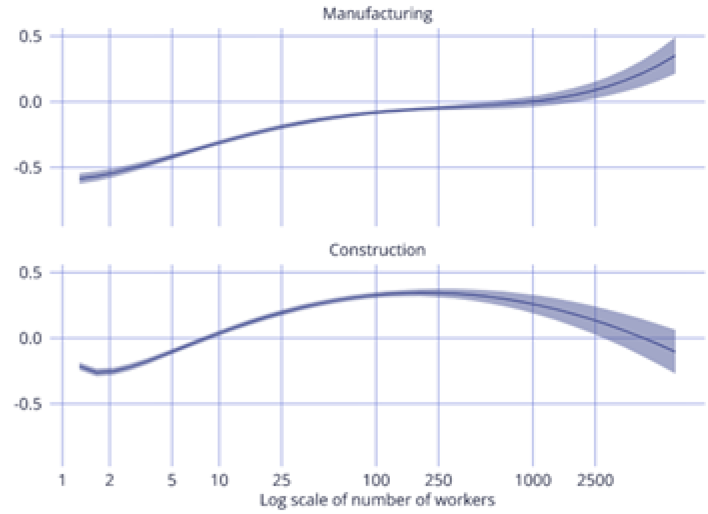
Source: Own Analysis, ONS

Executive Summary
Introduction
The case for change
51
Economic opportunities
Broader opportunities
Reflections

Product Platforms will change the industry structure

The opportunity for repetition and iteration to drive continuous improvement in construction is substantial. In order to iterate, continuity from one project, assembly or component to the next is needed, and the more repetition a firm can undertake, the more its productivity can improve.

Figure 4K: Effect of number of workers on productivity are non-linear. Manufacturing has more visible economies of scale.



Source: ONS

Manufacturing has more visible economies of scale, meaning that there are benefits to productivity when firm size increases. This relationship holds for very large firms. Construction firms do not show this improvement for larger and larger firms. Manufacturing businesses will therefore benefit more from consolidation and increases in scale than construction. This is illustrated in both measures of vertical and horizontal integration.

Industry measurement of automotive (SIC29) excludes repairs, modification and improvement (RMI – SIC45), whereas construction (SIC41-43) does not. Even when this is taken into account, there are still huge differences in organisation size and productivity, as illustrated below. Even a partial shift towards this model would result in significantly higher productivity and far more consolidation.

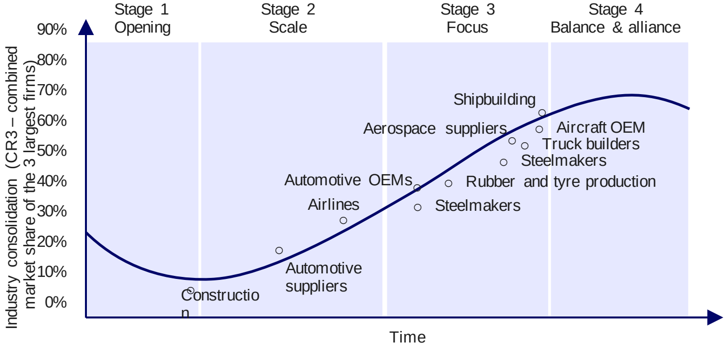
Table 4B: Attributes of listed Sectors

Factor	Automotive	Auto+RMI	Construction
Firms	5,270	105,515	914,475
Staff	145,000	746,000	2,105,000
Turnover/ head	£467,952	£360,265	£157,976
Staff/firm	27.5	7.1	2.3

source: Analysis of 2022 UK Business Population Estimates

Research indicates that there is a cyclic nature to consolidation, following a 15-25 year cycle (see Figure 4L below). With the adoption of platform approaches, construction is likely to accelerate through this cycle. It is not feasible to predict exactly how consolidation might affect the industry. It is possible that existing large firms may get larger, or that new entrants will seize the initiative and take significant market share.

Figure 4L: Industry Consolidation Stages



Source: Adapted from HBR

Increasing the productivity of construction through greater use of manufacturing approaches is therefore likely to lead to a smaller number of larger firms with more capital-intensive activities. The cyclical nature of construction could prevent any one firm from becoming too committed to capital-intensive activities. A cross-departmental approach could mitigate these risks, as one component or system could be used in multiple buildings

This suggests a potential trade-off between productivity and accessibility for SMEs (Small and Medium Sized Enterprises – firms employing fewer than 250 people) as capitally-intensive activities raise barriers to entry . The government acknowledges the importance of SMEs and has launched initiatives to improve opportunities, with targets for 33% of spend to reach SMEs in 2022. This creates a potential trade-off between higher productivity and accessibility.

Either way, the industry will look different to how it does today and individual project examples are unlikely to be representative of the macro effects.

Turning again to the automotive sector: OEMs (original equipment manufacturers) are increasingly seeking to capture more of the connection with the end customer (e.g. dealerships and services). This is reducing their involvement in production and reducing their asset intensity and opening up four types of role in the supply chain. This may provide a model for platform-based construction delivery, with the option of government taking the role of OEM (with an increased connection to end users) or with firms or consortia looking to step into that role.

Systems integrator

Designing and integrating components, subassemblies and systems for assembly into the final product, e.g. interiors, doors, chassis.

Systems standardiser

Design, development and manufacturing of complex systems (ABS, tires), setting global standards and supplying OEMs directly or indirectly.

Component specialist

Specialists in components or subsystems for a particular model or platform (engine components, panels). Increasingly suppliers to integrators and standardisers.

Materials provider

Suppliers of raw materials to OEMs or others. Structure varies depending on the material (steel and polymers are regional). Some are expanding into componentry.

Adapted from The Automotive Supply Chain: global trends and Asian perspectives

Construction is highly fragmented, with the largest of firms having a relatively small share of the overall market compared to other industries. A shift to manufacturing approaches may lead to consolidation as a competitive advantage, leading to a smaller number of larger firms. The aim of a disaggregated supply chain on its own may not support these ambitions. Procurement policy, and the role of smaller firms in creating value, need to be considered during the adoption of platform approaches.

Construction productivity gains improve GDP

By implementing Product Platforms, the construction sector and its supply chain could experience significant productivity gains. This, in turn, could lead to a permanent shift in productivity, resulting in cost reductions and increased production.

This phenomenon is not unique to the construction sector, as real-world examples from other industries have shown. For instance, the use of modular construction in the hotel industry led to a 25% reduction in construction time and a 15% reduction in costs, while increasing the number of rooms available for sale by 130%.

Such direct productivity gains can have a significant impact on the wider economy, as sectors and markets are interconnected. Therefore, a permanent shift in productivity in the construction sector could potentially flow through to other sectors of the economy, leading to changes in the price and quantity of goods and services in producer, consumer, and factor markets.

The wider GDP impacts of productivity gains in the construction sector arise both 'downstream' and 'upstream' of the construction sector itself.

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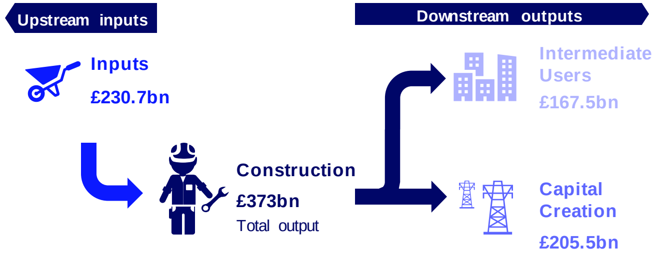


Downstream effects

As a major purchaser of the construction sector's output for its social infrastructure programme, the Government will benefit from, in effect, being able to deliver a given level of public services at a lower cost. These cost savings could be used by the Government in different ways to meet its national economic objectives.

The **scale and pattern of GDP impacts nationally will depend on the policy approach** taken by Government. These choices include:

- **Funding the costs of the transition to Product Platforms,** including supporting the industry accelerate adoption and supporting its workers through the transition through skills programmes etc
- **Returning the money saved to taxpayers through lower taxes**, in turn benefitting households and in so doing generating further spurs to GDP growth through higher spending on other goods and services in the economy, which boosts the output of businesses in these wider sectors;
- **Reducing Government debt** through reducing the fiscal deficit / contributing to a fiscal surplus, which in the longer term is equivalent to reducing taxes, with similar effects to those outlined above;
- **Spending more money on maintaining and improving existing social infrastructure or on improved public services more generally**, e.g. improving existing school buildings / hospitals or on improving the quality of education or healthcare by diverting the cost savings into recruitment, training, etc, which should in the long term also help increase GDP by creating a more productive workforce / reducing ill-health etc;
- **Investing in more economic infrastructure**, such as sustainable transport or flood defence, or other capital goods, which will contribute to productivity and national GDP, as well as social value from outcomes such as reduced journey times and CO_2.

The hypothesis tested in this study is that through improving construction firms' productivity and enabling the sector to deliver the Government's social infrastructure programme more efficiently, widespread adoption of a Product Platform approach will stimulate wider growth in GDP across the whole economy.

GDP can be analysed in terms of the output produced by different industries, or in terms of spending by households, business and government. GDP grew by 0.3% in January 2023. It is 0.2% below the level it was in February 2020, ahead of the pandemic hitting the UK economy. Latest figures (to March 2023) show:

- Services are the largest part of the economy – making up 82% of output in 2021
- Service sector output increased by 0.5% in January 2023
- Manufacturing output was down 0.4% in January 2023
- Construction sector output was down 1.7% in January 2023

> *"Productivity isn't everything, but, in the long run, it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker"*
> *— Paul Krugman*

Upstream effects

As the construction sector becomes more efficient (through simplified design processes, more efficient working, economies of scale in sub-assemblies and reduced waste etc), it will require fewer 'upstream' inputs to achieve the same output, e.g. fewer architectural services and materials.

It will also require *different* inputs as a result of adopting Product Platforms, e.g. fewer bricks and more composite materials. The resources that are saved will be redeployed elsewhere in the economy.

For example:

producing additional social infrastructure that would not otherwise have been built (stimulated by the lower cost of construction)

+

other activities, either within construction (again through demand stimulated in response to the lower cost of construction) or in other sectors of the economy.

In each of these scenarios, the redeployed resources will contribute to growth in output and higher GDP in the form of additional consumption, investment, exports (and Government tax receipts).

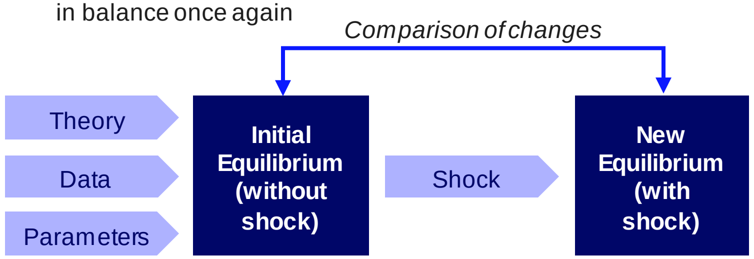
Economic modelling for GDP impacts

To produce estimates of the economy-wide GDP impacts associated with Product Platform-enabled productivity improvements in the construction sector, a Spatial Computable General Equilibrium (S-CGE) model of the UK economy was deployed.

This is large-scale numerical model that simulates the core economic interactions in the economy. It captures complex interactions between different types of economic agents over time – including households, businesses and Government, and the rest of the world – operating in competitive markets with explicit resource and budget constraints. The linkages in the model between different economic agents and markets are shown in the diagram (see right).

The model was used to test the potential impact of sector-level productivity improvements enabled by Product Platforms on the whole economy (valued in terms of GDP) by:

- Translating estimated firm-level changes in productivity into a set of sector-level 'shocks' (economic events) that represent widespread adoption of PP across all social infrastructure in a particular year
- Comparing the 'with' and 'without' policy intervention to look at the long-run, net additional annual impact on whole-economy GDP. This is done after a thirty-year period in which the shock has worked its way through the economy, and a new 'steady state' has been reached with prices and quantities in all markets in balance once again



Adapted from Scottish Government

The economic agents and markets illustrated above are broken down into individual sectors, each with their own sets of inter-relationships. Shocks were applied at sector level, typically by shocking capital factor markets. Since investment occurs over time, the full effect of productivity improvements across sectors is not realised immediately, hence shocks have been applied progressively over time.

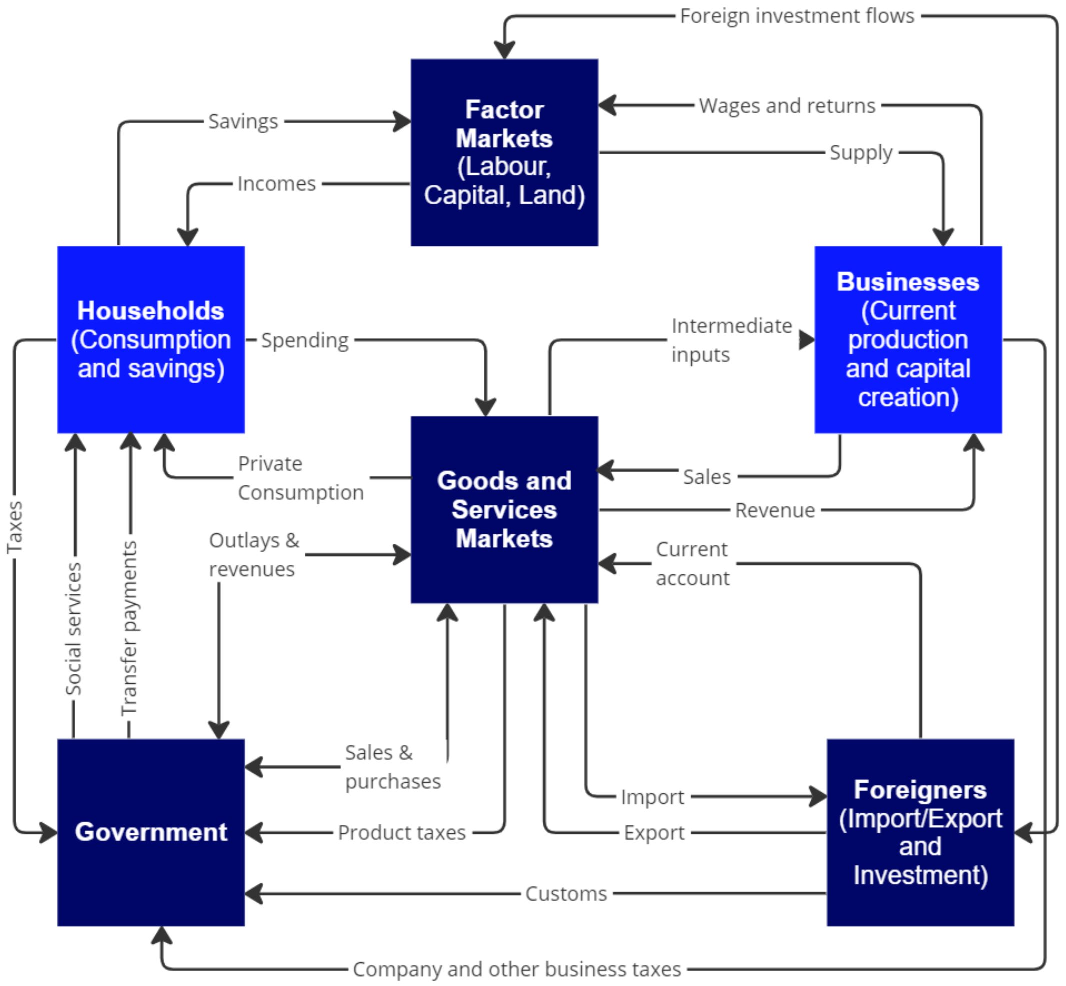
The model does not differentiate between individual organisations within an individual sector, and so cannot quantify the levels of consolidation.

It is important to note that this is economic modelling of a hypothetical scenario and does not represent a forecast of what will happen in the future – either in terms of the scale and rate of adoption or a definitive review on the economy's response to it.

The model does not take account of business cycles and, while it is based on past relationships in the real economy, there is a high degree of uncertainty about how the economy will develop in the future, e.g. technological changes, political developments and so on.

CGE models are widely used by governments, international organisations, academics and private sector consultancies. The World Bank, OECD, IMF and HMRC have all used CGE models.

Figure X: S-CGE Model Schematic



Estimated GDP impacts of Product Platforms

Interpretation of the economic modelling results

The results of the modelling are reported for a single year, 2058, which is 35 years from the 2023 base year. This provides sufficient time for the 'shock' to have worked through the economic model via changes in prices and quantities and a new 'steady state' equilibrium to have been reached in which the effects of mass adoption of Product Platforms have been fully absorbed. This means that the results can be treated as indicative of a typical 'steady state' year, i.e. broadly similar uplifts in GDP will occur *every year* compared to the baseline in which there is no adoption of PP.

Drivers of the estimated GDP impact and implications for the Government's economic policy agenda

This economy-wide GDP impact is broadly proportionate to the value of the total productivity uplift in the construction sector from the mass adoption of Product Platforms, which is passed on as a cost saving to Government in its purchase and use of social infrastructure assets. This enables Government to deliver public services more efficiently, and the savings are returned to households through a combination of lower taxation and lower Government debt (which is the equivalent of future taxation), which leads to the estimated increase in household income.

Through the mass adoption of Product Platforms there is also a significant change in the *composition* of GDP that is estimated through the modelling, with the share of consumption increasing and the share of investment decreasing (alongside a smaller shift towards exports and away from imports). The switch in the *use* of household income from savings to consumption is driven by a lower requirement for capital investment in the economy, owing to the improvement in the efficiency of the production of social infrastructure that results from the mass adoption of Product Platforms.

+£7.8bn

annual real increase in GDP

+£11.4bn

annual real increase in consumption

GDP is estimated to increase by an annual £4.7bn to £7.8bn, and consumption is estimated to increase by an annual £6.9bn to £11.4bn.

This effect is important in economic policy terms for two reasons:

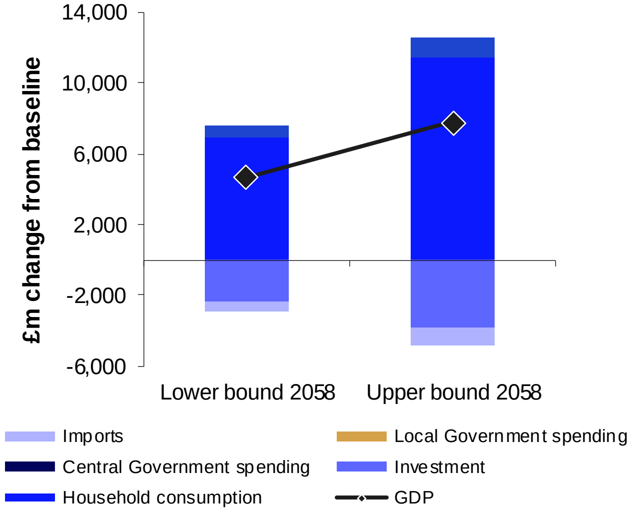
1) **Fundamentally, it is consumption that *drives living standards* in any given year, and this result indicates that mass adoption of Product Platforms could have a significant positive impact on living standards** that is larger in proportionate terms than the total GDP impact per se.

2) **The increase in the share of GDP accounted for by consumption is *sustainable***. It is important to distinguish this from a more general shortage of investment in the economy that is often cited as a reason for the UK's poor productivity growth, which is driven by a range of broader factors, but *not the adoption of improved techniques.* In short, the improvement in efficiency of investment that the adoption of platforms enables means that there are additional resources available for household consumption, meaning households do not need to save as much because the economy requires fewer resources to produce a given level of public services.

It should also be noted that a proportion of the increase in household incomes arises through additional real wages and employment, which reflects changes in economic activity across different sectors triggered by the adoption of Product Platforms.

In practice, there will be shifts in the location of work arising through adoption of platforms that are not fully reflected in the economic model, but which are likely to favour more peripheral locations where manufacturing activity is concentrated, providing a significant contribution to the Government's Levelling Up agenda. This is discussed further on Page 62.

Figure 4M: GDP Increase from Baseline due to adoption of Product Platforms



+£200m

annual increase in net exports

Table 4C : Economic Improvements due to adoption of Product Platforms

	£m, 2023 prices (lower bound)	£m, 2023 prices (upper bound)
Additional real GDP	4,700	7,800
Additional real household consumption	6,900	11,400
Additional household income	4,600	7,600
Additional net exports	100	200
Additional labour incomes (real wages and employment)	800	1,400

Economic Opportunities of Product Platforms

The economic opportunities of Product Platforms have been shown to forecast an estimated £7.8bn increase in GDP for the economy and £1.8bn in capital savings.

It does this by utilising economies of repetition. Economies of repetition promote Improvements in technical and human factors in relation to the production costs and times. In addition, material costs also show improvement. In order to realise these benefits, government procurement models will need to change to promote a stable harmonised, digitised and rationalised pipeline.

Product Platforms will change the structure of the construction industry; capitally intensive processes that improve productivity may increase the barrier to entry for new construction firms and encourage consolidation of the supply chain.

The opportunities presented in this section were estimated using an S-GCE model. This is a large numerical model which combines real economic data with economic theory so that the impacts in the economy of policy changes (or other “shocks”) can be computationally derived.

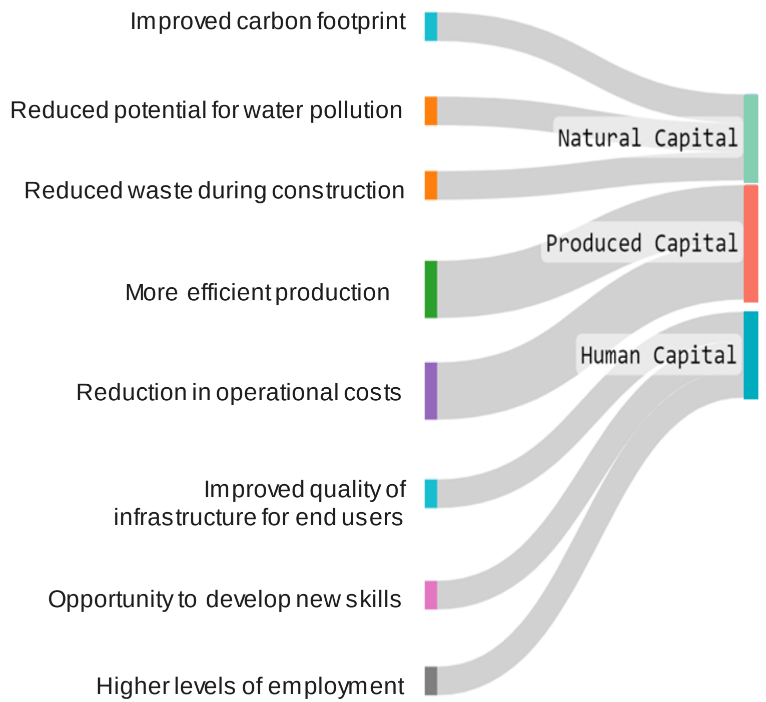
These could fund reduced taxes or investment – or a combination of the two. Lowering taxes has a positive effect on household income, enabling households to consume and save more (which is the equivalent of future consumption). The increase in household savings will support an ongoing long-term increase in investment, reflecting the impact of Product Platforms on investment returns across the economy. Alternatively, in a ‘Business as Usual’ fiscal scenario, the higher tax receipts could be used to cover the costs of the transition to Product Platforms (such as changes to Government’s procurement process and direct business support initiatives in the sector).

Broader opportunities of Product Platforms

This section of the report considers the holistic implications that Product Platforms would have on society and environment as whole, and gain a better understanding of the key industry challenges that the approach could tackle.

- Government and industry have set the direction for our built environment. This includes policy which sets out **what** we are aiming to achieve (For example, Our Vision for the Built Environment and Flourishing Systems) and **how** we could get there (For example, The Construction Playbook and Transforming Infrastructure Performance: Roadmap to 2030).
- The purpose of the Built Environment is to enable **people and nature to flourish together for generations**. For construction to play a valuable role in driving this vision it needs to operate in a way which minimises negative externalities on the environment and society, and creates value for the end users using the assets.
- In line with the direction of the industry, our analysis explores the wider opportunities of Product Platform's beyond GDP growth. It includes an overview of the desirable future state of the Built Environment and considers how Product Platforms can help drive the construction industry in this direction.
- Following this, there is a qualitative analysis of the possible impacts Product Platforms could have on the four capitals areas – natural, produced, human and social capital. Our analysis demonstrates that Produced Capital are affected highly positively by a Product Platform approach; the Human and Natural Capitals are positively affected by a Product Platform approach with a low impact.

Product Platforms offer potential to positively impact all **four capitals** of the Value Toolkit



Supporting The Vision for the built environment

In 2021, the Government and industry came together to clearly define 'Our Vision for the Built Environment' which has the explicit purpose of enabling **people and nature to flourish together for generations**. The direction for the industry is set by this vision, and it advocates a need to move away from resource hungry and wasteful systems and create a built environment which is **sustainable, secure, and resilient.** The approach is based on an understanding that the built environment is made up of interconnected systems of systems including built systems, natural systems and cyber-physical systems which need to be considered holistically as they are innately linked.

From a construction perspective, considering the interaction between the built and natural systems is particularly importantly. To reach this vision, the industry needs to be mindful of the risks that come from the built environment overly constraining the natural system and **consciously take actions that make a positive environmental and social impacts during construction**. This means considering carefully when is appropriate to build a new asset in comparison with retrofit or repair, and effectively integrating new assets into the existing system.

In line with this vision construction needs to focus on supporting the **use** of the built environment whilst simultaneously enabling individual construction firms to achieve their strategic priorities. Over time, the purpose of the built environment will change; individuals will have different needs and values, technology will progress and nature will develop. It's essential that the construction industry is structured in an adaptable way so it can reorient itself to the different use cases of the built environment. A Product Platform approach helps facilitate this adaptable approach.

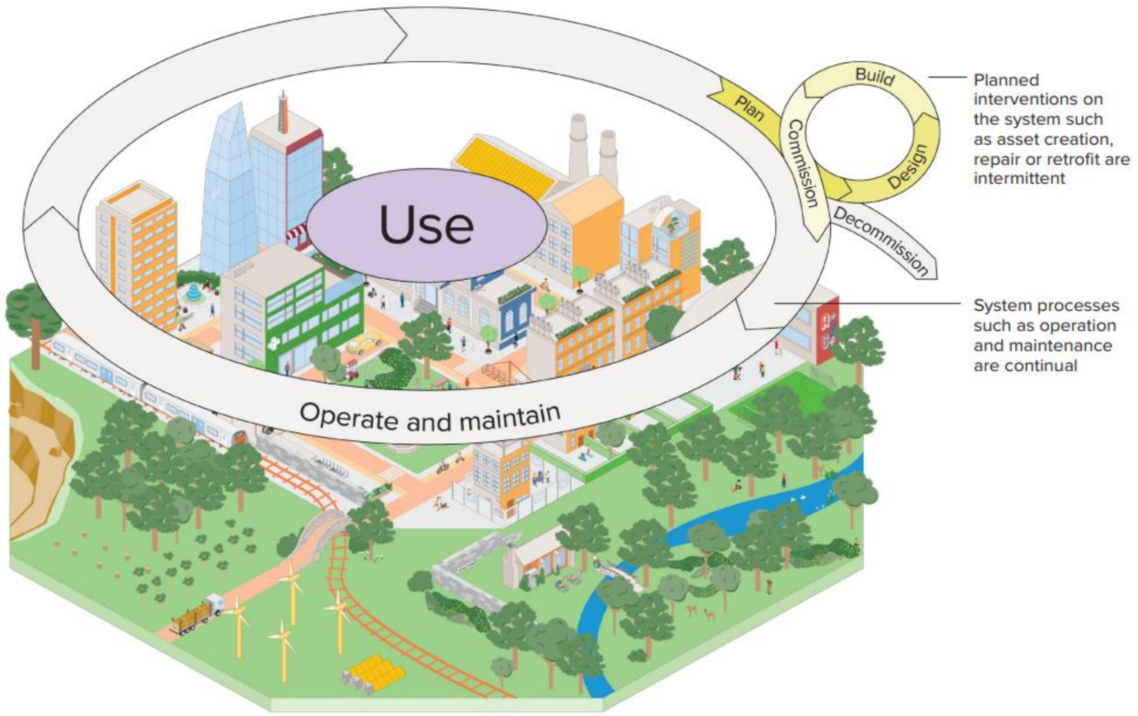


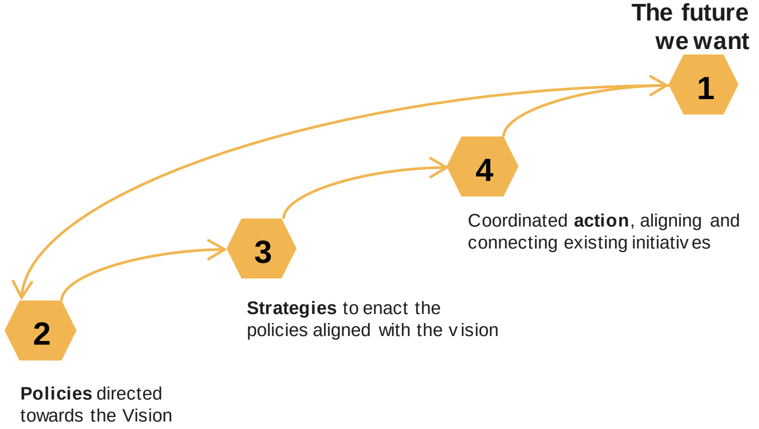
Figure 5A: Purpose of built environment

This image is taken from the Vision for the Built Environment. It highlights that the purpose of the Built Environment must focus on the existing built environment and its future development. It recognises that **use** of the existing built environment is of primary importance and construction must be focused on supporting this. To learn more please visit Vision for the Built Environment.

Source: Vision for the Built Environment

The previous section of this report has shown the potential economic benefits from adopting a Product Platform approach. However, this section of the report analyses how the government's current social infrastructure pipeline impacts natural, human, and produced capital. It also demonstrates that, if adopted effectively, a Product Platform approach could improve the ease at which construction can positively influence all four capitals, driving the industry closer to the Vision for the Built Environment. However, these benefits are not assured, as there are potential downsides to Product Platform approaches which may arise without the correct decisions.

With the vision describing a desirable destination, Product Platforms having a role to play in reaching it, and a need to backcast to work out how to get there, this section explores the potential decisions that may be needed to create a better future.



The future we want

1

4

Coordinated **action**, aligning and connecting existing initiatives

3

Strategies to enact the policies aligned with the vision

2

Policies directed towards the Vision

Understanding the wider impacts of Product Platforms

Ultimately, Product Platforms are a mechanism to implement repeatable elements that can be delivered using manufactured solutions, enabling better productivity. This means Value that has been designed for as part of the Product Platform approach can be influenced differently to traditional construction.

A Product Platform approach can **enable** the construction industry to positively impact the four capital areas, especially if it is combined with a conscious drive by industry and government to focus on improving these areas. The overall impact on the capital areas will be dependent on how intentionally industry players are measuring and targeting the social, human, natural and produced outcomes of their projects and programmes.

The policy paper Transforming Infrastructure Performance: Roadmap to 2030 sets out some of the benefits that focusing on using a platform approach for social infrastructure would enable.

These include:

- **Reducing waste** due to being able to predict demand more effectively and having a leaner process with commodities being handled fewer times
- **Improved health and safety** as a result of changes in factory conditions during the construction phase
- **Greater potential to recycle** as the same components can be used again in different assets when rebuilding or retrofitting
- **Improved resilience** as a result of more effective planning due to improvements in predicting demand

Case Study: Using a Product Platform approach to combat net zero challenges

When the industry is motivated to tackle environmental challenges as a result of behavioural, business or policy drivers then it adopting a Product Platform approach will improve the ease at which this can be achieved. This is demonstrated when exploring how a Product Platform can support the construction sector's net zero ambitions.

The construction sector must become net zero by 2050 in line with government policy. However, the sector faces the pressure of being the UK's largest user of non-renewable materials. To overcome the regulatory and environment pressures, the industry must adopt a more circular economy approach to the reuse and recycling of material.

As set out in ISO 20887, standardisation is a key enabler of circular economy. It improves the interchangeability of materials and ability to recycle disused parts to use on other projects. Partnered with this, the greater accuracy in forecasting demand will lead to a reduction in waste materials which have been previously occurred from miscalculating orders.

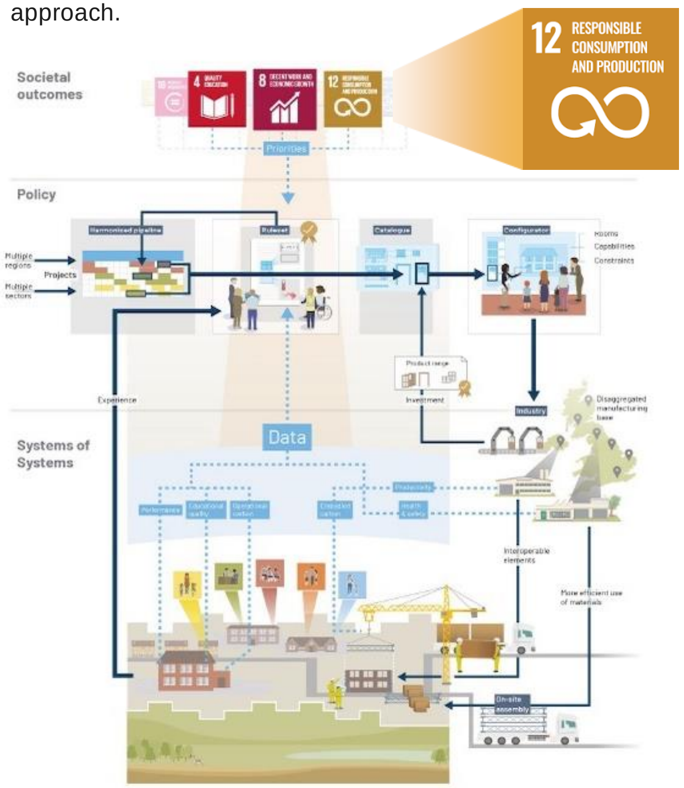
This highlights how if adopted effectively Product Platforms can help the construction sector tackle some of its key environmental challenges.

Sources:

- Circular construction: building for a greener UK economy- Green Alliance
- UK's construction sector won't reach net zero without circular economy focus – Edie
- Sustainability in buildings and civil engineering works - ISO 20887:2020

Figure 5B: Use of a platform approach for social infrastructure

The following image is taken from Transforming Infrastructure Performance: Roadmap to 2030 and shows addressing the need for social infrastructure using a platform approach. In support of the case study, the diagram shows the Sustainable Development Goal 12, 'responsible consumption and production', can be targeted by implementing a Product Platform approach.



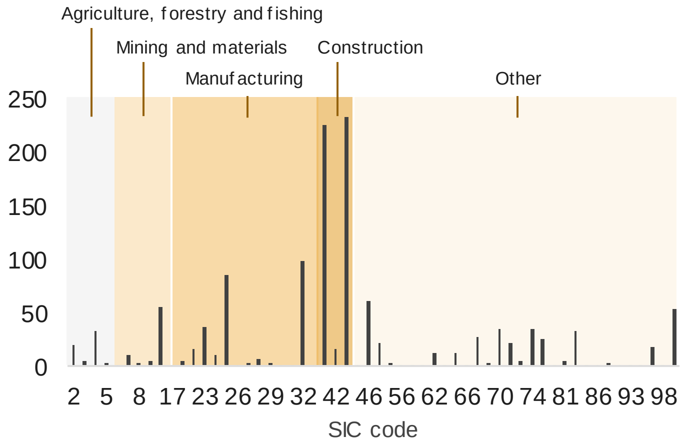
Manufactured solutions by their nature of being repeatable and controlled will have an effect on the 4 capitals described earlier in this report. The following section of the report analyses in greater depth how a Product Platform approach would impact the different categories in the value toolkit, considering natural, produced, human and social capitals.

Source: Transforming Infrastructure Performance: Roadmap to 2030

Geographic employment opportunities

Analysis of 1,000 firms playing a role in the offsite construction sector indicates variability in SIC codes, and hence in how their performance is reflected in the economy. The largest share of firms sit within construction (37%) and manufacturing (25%) sectors.

Figure 5C: Offsite Companies by Sector



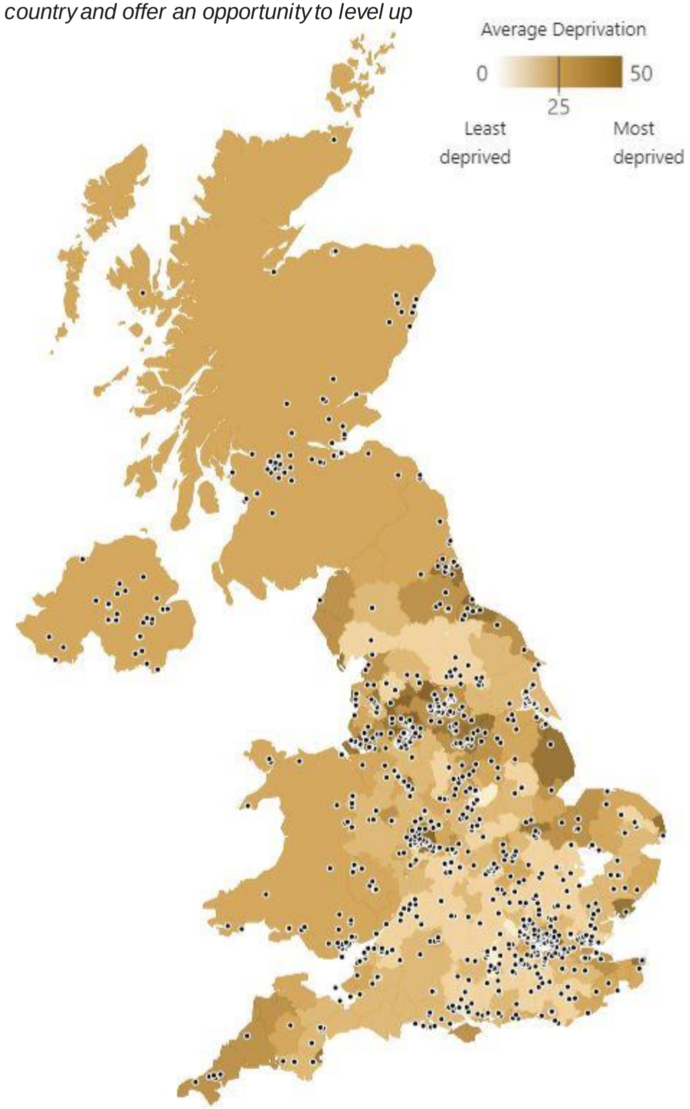
Source: Own analysis, Akerlof

The geographic locations of these organisations are shown adjacent, illustrating good coverage across the country and some level of correlation between location and level of deprivation, although further analysis of this is needed.

The relatively even spread across both the regions and near to the main population centres of the UK demonstrates how moving to offsite construction has the potential to derive benefit of construction activity away from major economic hubs, decoupling production activities from the project location, thereby supporting levelling up.

Those sponsoring development could use greater insight into the supply chain to target investment to gain appropriate benefit for the wider economy through increased use of manufactured solutions unlocked through a platform approach (see e.g. work by Heathrow).

Figure 5D: offsite construction firms are well distributed across the country and offer an opportunity to level up



Source: Own analysis; ONS Deprivation index

The resulting increase in throughput of these facilities will assist in development of more efficient processes, productivity and higher wages. This factory setting is also more likely to support full-time, longer-term and permanent contracts, with more secure incomes and development programmes.

More environmental control of workspaces and a reduction or even elimination of unplanned activities will enable further reduction in accident rates and work-related injuries. Coupled with the use of technology and automation, this could reduce physically demanding and dangerous work. In the long term this should result in reduced demand for treatment of preventable work related injury.

OECD research indicates a clear link between job quality, health and productivity and, conversely, that "bad jobs are bad for people". This research also highlights the need to avoid monotonous, repetitive work (termed a "Fordist" approach) as this leads to "bore-out" or work boredom. Data from ONS assessing different dimensions of job quality indicate that construction can perform better than manufacturing, for example:

- Manufacturing employees report higher level of both unpaid and paid overtime than construction;
- Manufacturing has more employees on zero hours contracts (1.1% compared with 0.7% in construction);
- More construction employees report better career progression opportunities (59% to 51%) and feel more involved in their workplace decision making (58% to 51%).

A manufacturing approach to construction can bring about positive social value changes, including promoting employment and skills, supporting the growth of responsible and regional businesses, creating healthier, safer, and more resilient communities, decarbonizing and safeguarding the planet, and promoting social innovation. Benefits include providing stable employment with good working conditions, upskilling opportunities, ensuring transparency in the supply chain, tackling regional inequalities, supporting initiatives to tackle homelessness, increasing resource efficiency, reducing carbon emissions and waste, and developing innovative measures to promote skills and safeguard the environment.

The widespread adoption of Product Platforms improves the stability and viability of associated manufacturing approaches. These provide local and stable employment as activities can be decoupled from individual project locations.

The approach provides additional economic levers to support levelling up and the case for investment in conditions.

What outcomes is the government targeting with construction?

The Government's Outcome Delivery Plans (ODPs) were used to understand what value means for each of the government departments. Specifically, ODPs analysed to determine how each department's objectives and Key Performance Indicators (KPIs) align with the government's overall priorities and goals. This assessment was crucial in determining the effectiveness of the government's policies and strategies.

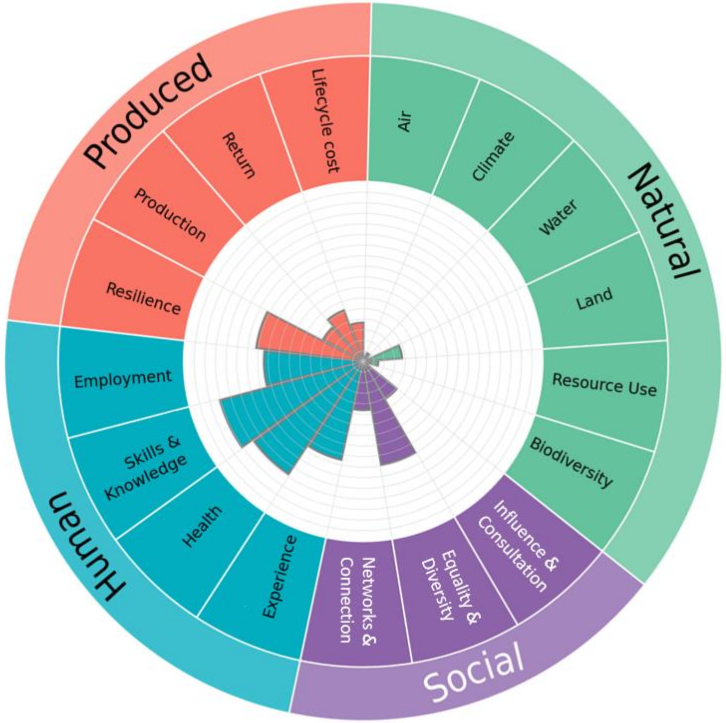
To conduct the assessment of value, the Construction Innovation Hub's Value Toolkit was used. The Value Toolkit utilises a 4 Capitals model that enables the numerical evaluation of value across 17 sub-capital categories. This allowed for a comprehensive and detailed evaluation of each department's ODPs, which provided valuable insights into the government's efforts to deliver on its commitments.

During the assessment process, it was determined that certain policy KPIs were not relevant to the construction and infrastructure sectors. As a result, these KPIs were excluded from the analysis, ensuring that the evaluation focused only on relevant measures of value. This analysis thus focused on construction- and infrastructure-related KPIs set out for the following government departments: Department for Education (DfE), Ministry of Justice (MoJ), Department for Health and Social Care (DHSC), Ministry of Housing, Communities, and Levelling Up (MHCLG), and Ministry of Defense (MoD).

To ensure uniformity in the evaluation of each department's ODPs, data from each department was weighted using cost per department, which involved adjusting data to account for differences in scale. This enabled an fair comparison of departments' performance. Scores for each department from the evaluation described above were also weighted according to the spread of government spend by department. This allowed for a more precise assessment of each department's progress towards achieving its objectives and KPIs, based on an accurate view of public infrastructure priorities and budget.

Overall, the assessment of the government's ODPs using the Value Toolkit provided valuable insights into the government's efforts to deliver on its commitments. By identifying areas of strength and weakness in the ODPs of each department, the assessment provided a roadmap for the government to adjust its policies and strategies as needed to achieve the desired outcomes.

Each of the capitals is aided by improved productivity. Product platforms can improve productivity, which means achieving *more* with *less*.



What are the Government's Outcome Delivery Plans?

The UK government's Outcome Delivery Plans (ODPs) are a set of documents that outline the government's priorities and goals for specific policy areas over a four-year period. The ODPs are updated annually and cover a range of topics, including health, education, economic growth, and public safety. Each ODP sets out a set of objectives and key performance indicators (KPIs) that the government aims to achieve in a given policy area. The objectives are usually focused on improving outcomes for citizens, while the KPIs are used to measure progress towards these objectives.

The ODPs are designed to provide greater transparency and accountability in government by setting out clear targets and goals for each policy area. They are also used to help the government monitor progress and adjust policies and strategies as needed to achieve the desired outcomes.

Summary of Capital Assessments

Current ODPs provide little reference to the link between construction programmes and Natural Capital. 'Land' has a small influence due to the described holistic benefits to children (DfE) and the investment in infrastructure for local communities (DLUHC).

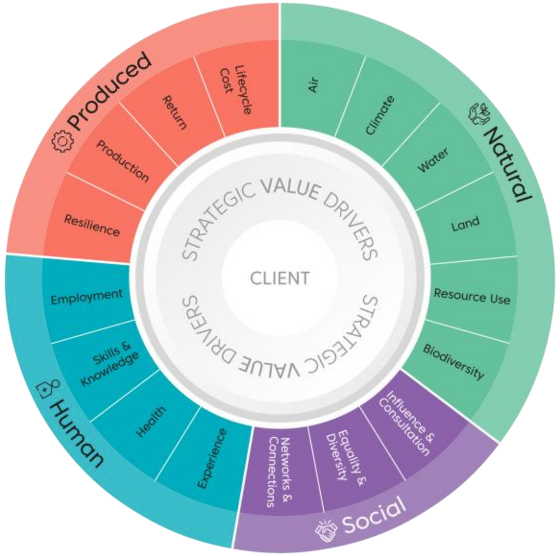
Whilst Government does not tend to explicitly target improved outcomes through 'Influence & Consultation' or 'Networks & Connection', 'Equality & Diversity' commitments such as ensuring equality of access to public services and provisions for marginalised groups through infrastructure investment are more frequent within the ODPs.

Human Capital categories are the most heavily represented in this analysis of ODPs. 'Skills & Knowledge' is a priority across many programmes, highlighting the need for skills development through the many changes occurring in the sector. 'Health' is prominent due to a larger budget having been allocated to the DHSC.

'Resilience' scored highly in the evaluation of the government's ODPs, highlighting the government's commitment to ensuring its policies are sustainable and able to withstand future challenges. In particular this reflects the emphases placed by the MoD and MoJ on modernization that lasts over time.

A Platform approach influences all value categories

This page considers the influence of a Platform approach on all the **Value Toolkit categories**. Each of these categories can be aided by the improved productivity delivered by Product Platforms. Additional benefits may be observed if implemented correctly, but there may be drawbacks where implementation is not considered holistically. For example, as per Jevon's paradox, increasing the efficiency of resource use through increased productivity and reduced waste will generate an increase in resource consumption overall. Without additional policy interventions, this may favour new build over retention and refurbishment and reduce the costs of materials with high embodied carbon. This warrants further assessment, with any policy interventions focused on areas where the potential downsides are more significant.



Resilience: Platform approaches can enhance the resilience of assets through the use of components designed for specific threats and consistent quality. Modular construction has proven effective in rapid reconstruction after disasters.

Production: Manufacturing approaches can result in higher quality components, reduced maintenance costs, and faster construction times.

Return: Modular construction reduces waste and labour costs, increasing profitability. For example, A New York hotel was built in 90 days, accelerating revenue generation.

Lifecycle Cost: Manufacturing approaches can lead to consistent and cost-saving construction. Modular construction of a hospital in Sweden saved 30% on operational costs.

Experience: Manufacturing may enhance construction efficiency and quality, while reducing disruption to communities.

Health: Offsite manufacturing can lead to safer working conditions and less pollution on construction sites, benefiting nearby communities. Adopting a less cyclic, less pressured stable approach can benefit mental health of workers.

Skills and Knowledge: Offsite manufacturing can upskill workers in manufacturing and factory-based production processes. Manufacturers can invest in training and development programs to improve their workers' skills and lead to more efficient and higher-quality production..

Employment: Manufacturing approaches can create new job opportunities in the manufacturing industry, benefiting the local economy. Offsite manufacturing can also reduce on-site labour and improve productivity.

Network & Connections: Adopting manufacturing approaches in construction can improve collaboration and coordination between different actors, enhancing efficiency and productivity.

Influence & Consultation: Increased use of manufacturing approaches can lead to standardised designs and construction processes, making it easier to consult stakeholders and incorporate feedback. This can result in a more collaborative decision-making process and greater satisfaction.

Equality & Diversity: Manufacturing approaches create cost savings that can be reinvested in social programs and promote diversity in the workforce.

Air: Manufacturing approaches in construction can reduce unplanned activity, dust, and improve air quality, leading to cleaner surroundings. Sustainable building materials can lower emissions of pollutants and greenhouse gases during construction.

Climate: Circular economy principles and manufacturing approaches in construction can reduce waste and emissions of greenhouse gases.

Water: Circular economy principles can reduce unplanned water usage, waste generation, and demand for virgin materials in manufacturing, thus lowering the risk of water pollution from material extraction and construction.

Land: Offsite construction can reduce land use for on-site activities and optimise the use of existing land for manufacturing.

Resource Use: Manufacturing approaches can improve interchangeability, adaptability, circularity, and reduce waste in construction.

Biodiversity: Platform approaches can increase productivity and reduce disruption during construction, potentially freeing up land for conservation.

Other Opportunities of Product Platforms

The value of Product Platform's extend beyond improvements in GDP. If adopted effectively, Product Platforms have the potential to positively impact Human, Social, Natural and Produced Capitals. However, these benefits are not guaranteed and to materialise government and industry must be actively focusing on delivering outcomes which release value across these areas. Our analysis of the UK Government's Outcome Delivery Plans shows where the current pipeline of Social Infrastructure projects release value. Currently value is skewed predominately towards human capital, driven by the priority placed on skills and knowledge across many programmes.

Product Platforms can be used as a lever to drive greater value across the four capitals. Individuals that work in construction will feel the direct benefit of **reduced on-site safety risks**, more **stable and inclusive employment** at a consistent location and increased opportunity for **longer-term, more meaningful wellbeing initiatives**. Beyond the construction sector Product Platforms can unlock wider social value across the nation. Product Platforms can **support levelling up the economy** through the redistribution of construction related jobs (and knock-on economic activity) beyond large conurbations to regions with strong manufacturing bases, such as places in the Midlands and North of England. In addition to this, the improved efficiency of construction processes and the reduction in waste will lead to **environmental benefits**. The increased use of repeatable and interchangeable components across assets will **open up circular economy** approaches and support industry in reaching **net zero targets**. These benefits and the associated productivity gains will **improve quality of buildings** within the Built Environment and, importantly, enhance the experience for the end user.

This shows that if implemented correctly and combined with an outcome focused approach, Product Platforms can drive construction towards the purpose of the Built Environment – to **enable people and nature to flourish together for generations.**

Reflections

Changes in productivity in the construction industry will have broader impacts on the economy and society. The Government can make a difference by using Product Platforms, which can unlock savings of **£1.8bn per year** with a multiplier of **4x for GDP growth**.

The construction industry structure will change with the adoption of Product Platforms, and certain areas need more focus than others, such as commercial and behavioural aspects, as opposed to technical.

Construction perfectly answers the question it has been asked.
If we want a better answer, we need to ask a better question.

Executive Summary

Introduction

The case for change

Economic opportunities

Broader opportunities

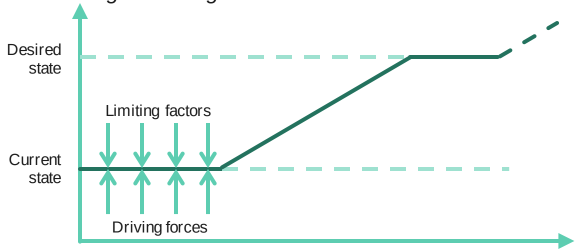
64

Reflections

Construction perfectly answers the question it has been asked.

Construction has **perfectly adapted and evolved to survive** in a cyclical, variable and volatile environment. This is done in spite of the challenges with productivity, safety, workforce availability and more. This means that driving forces and limiting factors must be in equilibrium.

Figure 6A: Striving for Change



Adapted from Lewis (1951)

The organisations which make up the sector and operate in this environment are more-or-less permanent, yet the environment in which construction activity takes place is anything but. It is temporary, fragmented and unique to a place and set of stakeholders. It is therefore often treated as being totally unique.

The industry has evolved to use a skilled workforce to tailor commoditised materials into bespoke assets, limiting the opportunity to systematically learn from experience. This limits productivity which, as we've seen, has impacts on lives and livelihoods.

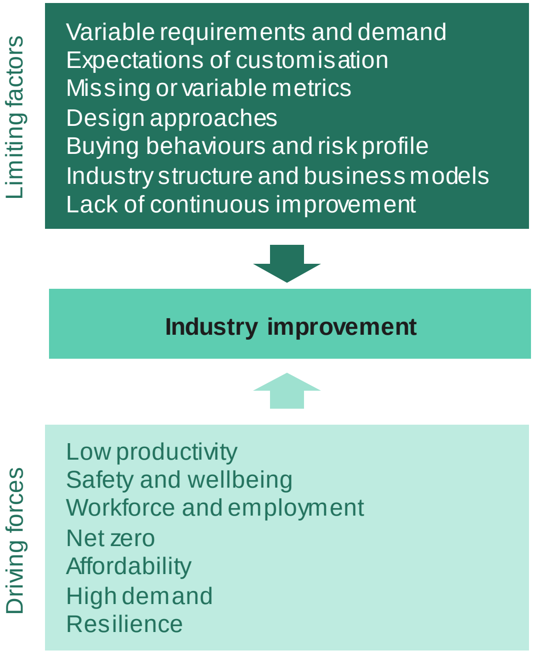
The Government, by using its position as a major client for construction, could drive significant cost savings and broader societal improvements through greater uses of manufacturing approaches.

But parachuting manufacturing into a construction setting on its own doesn't work: this is not just a technical challenge. Our expectations, design approaches, and buying behaviours have all collectively shaped the industry we have today. It is therefore a socio-technical challenge. And one for which there is a moral, social, environmental and economic incentive to solve.

If we want a better answer, we need to ask a better question.

Are we sufficiently committed to change the question we're asking of construction – that is, change the environment in which construction projects take place? The steady stream of reports on problems with construction stretching back to 1944 suggest we understand the driving forces, but have not to date managed to shift the equilibrium. The evolving policy framework seems to have the right elements in place, but practice proves hard and slow to change.

The challenge is not in changing individual construction activities or solutions, but in changing the environment so these can be improved. This means recognising the driving forces and easing limiting factors.



Limiting factors

- Variable requirements and demand
- Expectations of customisation
- Missing or variable metrics
- Design approaches
- Buying behaviours and risk profile
- Industry structure and business models
- Lack of continuous improvement

Industry improvement

Driving forces

- Low productivity
- Safety and wellbeing
- Workforce and employment
- Net zero
- Affordability
- High demand
- Resilience

The symptoms construction shows in response to this equilibrium – including low productivity, levels of insolvency, and accidents – constitute a market failure. Platforms, whilst not a magic bullet, can provide a key part of a better answer and reaching a more desirable equilibrium.

But to do so, the environment needs to **be more stable** (technically and commercially), be more explicit about what **should and should not be customised** at a project level (and the implications of doing differently), and be one in which there is a recognition of **cross-functional change**.

Stabilise the technical environment

Cross-departmental harmonisation, digitisation and rationalisation of requirements, spaces and adjacencies will reduce the variability with which requirements are articulated. Develop and use of **consistent data structures** across products, suppliers and systems will help to understand performance and support continuous improvement. Technical stability needs to be **maintained through design and delivery** to ensure it reaches the supply chain to unlock economies of repetition and improved quality.

Stabilise the commercial environment

Pipeline aggregation and visibility, which where possible should be evened out using a portfolio approach, to enable more strategic supplier relationships across the sector and consideration of **"horizontal" procurement** as a means to aggregate demand for common parts with consistent technical requirements across multiple projects.

Improve coordination of a fragmented industry

Through changing buying behaviours and associated **risk profiles** and **delivery models** to enable the stabilisation of technical and commercial environments. This in turn should help unlock changes to business models and the broader industry structure. **Feedback and learning within and between projects** is essential, which will involve better use of digital technology and information management across multiple functions and diverse organisations, as well as consistently collected and comparable metrics.

These will unlock improved and more certain methods of production, ultimately helping reach the desired state for a better performing, safer, more productive and more resilient construction sector.

Reflections

What do the Numbers mean in this report?

This study and the literature review on which it has been based recognises both the achievements of, and the challenges faced, by the construction sector. It is brutally honest about the task faced in resolving the productivity conundrum, confirming that at a Macro level, despite all the talk and effort of the last 10 years around efficiencies, the sector has stood still. As far as the hard numbers go, that is irrefutable. For all the hard running, we have gained little ground, and the case for change continues to be strong.

That is why bringing in evidenced thinking from other sectors, working through how it can apply to construction, and considering what that means for the way we do things is critical to our future success. It is clear the industry cannot answer these questions in isolation. This research reminds us of something we all knew: Construction in the UK is predominately driven by our largest collective client, the public sector. Given the pressure faced by the public purse in addition to all the other demographic and wider pressures directly faced by construction, this gives us both a business and a moral imperative to improve. Platforms and their deployment supported by fast developing digital technologies that can deal with the complexity of construction mean we are at an inflection point, which as an industry we can choose to seize – or ignore. The size of the productivity prize is huge. By construction's nature, scale and reach, the repercussions extend far beyond our sector.

The Need to Act

To get this right we must, with Government, focus on using platforms to unlock our potential through:

Focus: use the Value Toolkit to define what is most important

Prioritising: what matters most and put it first

Information: get better at sharing what matters through the whole delivery and operational cycle

Delivery: get the model right: define and allocate the right risks and define the right process

Supply chain understanding: through mapping locations, capacity, capability and compatibility; and appreciating implications of increasing demand and supply shocks in supporting a commercially stable environment

Measurement: we need shared standardised performance metrics to support collective improvement

Continuous learning: improving in a structured evidenced way on a reduced pallet of products

The Call to Action

This study is very clear: Product Platforms can help to unlock manufacturing approaches while recognising the inherent variation and specifics of individual buildings, their environs and their stakeholders.

The use of manufacturing approaches to construct the UK building stock would not only improve productivity, but also save and improve lives in the process. Adopting a less cyclic, less pressured, more certain, and more stable approach to construction will help improve working environment conditions for workers across the industry.

We need to stop avoiding the core of the productivity conundrum. We have no choice but to act on the evidence herein and progress the adoption of a platform approach.

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