

Developing a new procurement model, using behavioural economics, to enable continuous improvement of productivity and better value in large UK infrastructure projects.

Desarrollo de un nuevo modelo de adquisiciones, utilizando la economía del comportamiento, para permitir la mejora continua de la productividad y un mayor valor en grandes proyectos de infraestructura del Reino Unido.

Perks, Martin *¹

* National Highways Limited, United Kingdom

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Abstract

Global construction has been blighted by productivity inertia caused by behavioural bias for decades. While other industry sector productivity has grown more than fifteen-fold since 1960, construction has stagnated with no more than a seven to ten percent overall growth. McKinsey Global Institute's report Reinventing Construction: A Route to Higher Productivity, reported infrastructure construction amongst a small group of outperforming market sub-sectors at 15 to 20 percent. This paper, which charts the development of a unique procurement model designed for high productivity, builds on that performance using behavioural insights to counter damaging and habitual biases. The new model changes trading relationships using a nudged 'opt-out' contract structure creating a different responsibility dynamic between client and supplier. A recognisable but different infrastructure construction procurement model to improve productivity using recognised behavioural economics and construction economics. Highways England was set up to run England's strategic road network in 2015. The procurement model that resulted, Regional Delivery Partnerships can be refined for any infrastructure sector construction environment and sets up a key step forward in contracting based on integrated project delivery. Using a combination of counter bias strategies built from loss aversion and nudge theory this new construction procurement model uses 'opt-out' from lean construction to drive higher productivity. By setting up an integrator, to create an integrated project team, Regional Delivery Partnerships uses loss aversion as the motivational key to better innovation. It empowers the integrator to counter uniqueness bias and find and eradicate waste (process time and money) to enhance productivity. Reward is aligned to both optimised efficient design and high productivity working. As 100% of budget underspend can be kept rewarding the integrator, the potential of not achieving this triggers loss aversion and motivates change using the principles of escalation of commitment in favour of the client. Performance data is also used to motivate using reduced acquisition costs from secondary competition, long held as an inefficient market overhead. Using recognised pragmatic academic techniques, and constructionism; choice architectures were remodelled into a new outcome and value focused procurement model. Using applied research, the team used processes and techniques to develop, build, test, and deploy the model in open market competition. It can be used by any infrastructure sector construction client to replicate a sector specific version of Regional Delivery Partnerships that changes trading choice architecture towards higher productivity.

Keywords: *Productivity; infrastructure; highways; procurement; behavioural economics; nudging; choice architecture.*

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Resumen

Durante décadas, la construcción global se ha visto arruinada por una inercia de productividad causada por sesgos conductuales. Mientras que en otros sectores industriales se ha multiplicado por más de quince desde 1960, en la construcción se ha estancado en no más de siete a diez por ciento. Según McKinsey Global Institute, la construcción de infraestructura para un pequeño grupo de subsectores del mercado con mejor desempeño se sitúa entre el 15 y el 20 por ciento.

El presente documento, traza el desarrollo de un modelo de contratación único en su tipo. Diseñado para una alta productividad, se basa en contrarrestar sesgos habituales y dañinos de comportamiento. El nuevo modelo cambia las relaciones comerciales utilizando una estructura de contrato de "exclusión voluntaria" que crea una dinámica de responsabilidad diferente entre cliente y proveedor.

Este modelo suigéneris permite mejorar la productividad mediante una economía del comportamiento y de la construcción. Highways England se creó para gestionar la red vial estratégica de Inglaterra en 2015. El modelo de adquisiciones desarrollado, las Asociaciones de Gestión Regionales, se puede perfeccionar para cualquier entorno de construcción de infraestructura y supone un paso clave para una gestión integrada de proyectos.

Combinando estrategias para contrarrestar sesgos a partir de la aversión a las pérdidas y la teoría del empujón, el nuevo modelo utiliza la opción de exclusión voluntaria para impulsar una mayor productividad. Mediante el establecimiento de un equipo de proyecto integrado, el modelo de Asociaciones de Gestión Regionales utiliza la aversión a las pérdidas para fomentar la innovación. Esto permite contrarrestar el sesgo de unicidad, así como también identificar y erradicar el desperdicio (tiempo y dinero de proceso) para mejorar la productividad. La recompensa depende tanto de un diseño optimizado, como de un trabajo de alta productividad. Como el 100% del presupuesto no utilizado se puede seguir utilizando para recompensar al equipo, ante la posibilidad de no lograrlo, se genera una aversión a las pérdidas y se motiva el cambio debido al escalamiento de compromisos en favor del cliente. El desempeño también proporcionar motivación mediante menores costos de contratación por la competencia secundaria, vista por mucho tiempo como una ineficiencia del mercado.

Utilizando reconocidas técnicas académicas pragmáticas y construccionismo; la arquitectura de opciones se remodeló en un nuevo modelo de contratación centrado en generar resultados y valor. Utilizando investigación aplicada, el equipo utilizó desarrolló, construyó, probó e implementó el modelo en una licitación abierta al mercado. El modelo puede ser utilizado por cualquier cliente de construcción del sector de infraestructura para replicar una versión específica y cambiar la arquitectura de opciones hacia una mayor productividad.

Palabras clave: Productividad; infraestructura; carreteras; obtención; economía del comportamiento; empujón; arquitectura de elección.

¹ *Corresponding author:*

National Highways Limited

Corresponding author: Perks2@nationalhighways.co.uk

1. Introduction

1.1. Background and context

In 2020 the UK Government, through HM Treasury, stated in its National Infrastructure Strategy 2020 (Gov, 2020). “The government wants to deliver infrastructure projects better, greener, and faster. That means addressing longstanding challenges such as complex planning processes, slow decision-making, and low productivity in the construction sector”.

In Build UK’s National Infrastructure and construction procurement pipeline 2021/2022 it projects investment of £200billion to 2024/2025 with 35% (£70 billion) in transportation. In this report is reiterated:

“The Government is committed to using its position as the single largest construction client to support adoption of a more productive, efficient, and sustainable business model within the UK construction sector. This innovation is a key part in reaching the Government’s goal of net zero emissions by 2050.” (Smallwood, 2021a).

Indeed, in Nick Smallwood’s introduction to Infrastructure Projects Authority Transforming Infrastructure Performance: Roadmap to 2030, he says:

“At the heart of the TIP Programme lies the need for a step change in productivity and efficiency in the ways we plan, design, manufacture, construct and operate infrastructure.” (Smallwood, 2021b).

And, in its review Highways England’s capability to plan and deliver its RIS2 capital enhancement programme in 2021, Nichols said:

“Our view is that Regional Delivery Partnerships (RDP) and Smart Motorways Alliance (SMA) delivery models are key to the successful delivery of RIS2 and will also have an overall positive impact on Highways England’s project development capability for sub-Tier 1 projects.” (Nichols, 2021).

Since 2015, the output of the construction sector in the United Kingdom has been escalating from its original £90bn. In the same year, Gross Domestic Product (GDP) was £2,044bn, which means that the sector accounted for around seven percent of GDP. However, construction has lagged in productivity improvement in the early half of this century. (Figure 1)

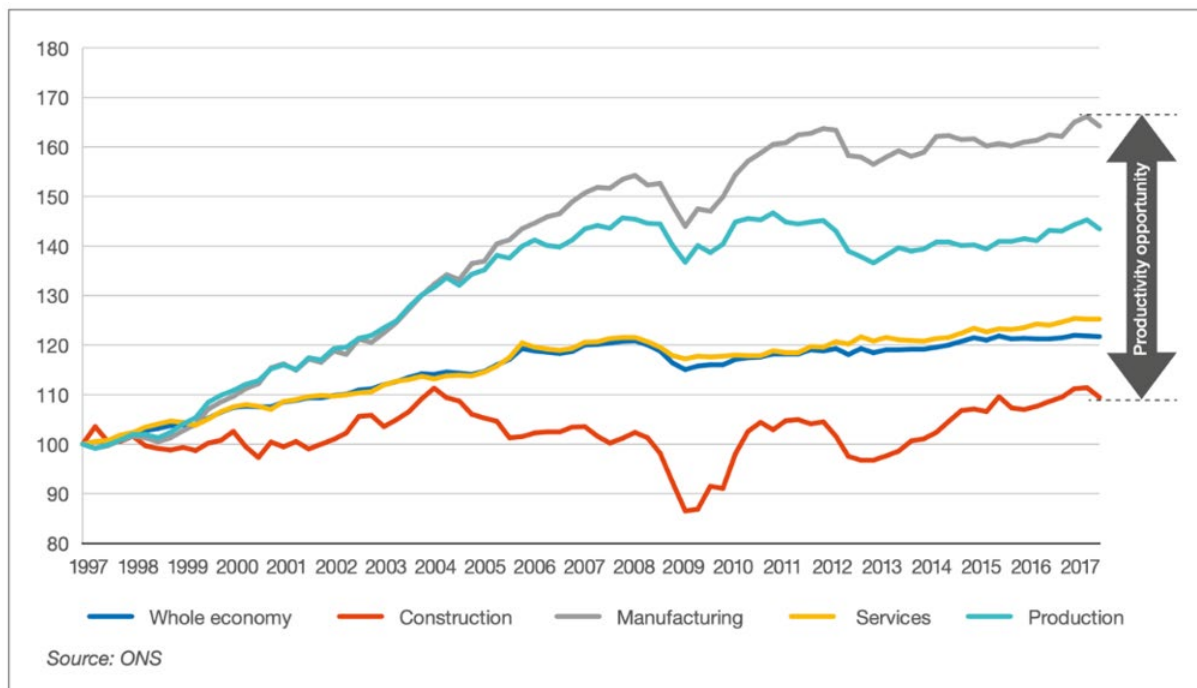


Figure 1. Productivity – output per worker – Transforming Infrastructure Performance (IPA, 2017)

By any analysis, the infrastructure sector including road, rail, and other forms of transport, accounts for a significant and important amount of the UK construction market. This paper focusses on the delivery of the UK Government Road Investment Strategy (DfT, 2015) in the period 2015 onwards.

The UK government commissioned a review of long-term infrastructure planning and investment in 2013 in: An independent review of long-term infrastructure planning (Armitt, 2013). In 2016, under the Nation Infrastructure Development Plan (IPA, 2016), it set out an intention to commit to £100billion of investment for the long-term, out to 2050. As part of this it set out an intention to commit investment of £88billion into transportation confirming investment of £15billion 2015-2020 into the strategic roads network.

In 2015 it set up Highways England Ltd granting it a license under the Infrastructure Act (UK Government, 2015). Informed by Alan Cook's review A fresh start for the Strategic Road Network (Government, 2012) the Act is the basis for 5-year Road Investment Strategies' (DfT, 2015) having an investment plan, and therefore market continuity through a committed pipeline of work. Highways England, in response, set up its delivery model, Collaborative Delivery Framework (Cuff et al., 2015) with a procurement cap of £5billion. This business wide route-to-market for all road network enhancement construction created streamlined access to its supplier market for five years. In 2017, at its mid-point, market wide research showed that after 2019 network enhancements would be better served by a new specific route to market for each of its four active enhancement programmes: Regional Investments, Smart Motorways, Complex Infrastructure, and the National Infrastructure Programme. This paper focuses on a procurement model for Regional Investment Programme.

The Regional Investment Programme was designed to deliver £7.6 billion of road investment and is arguably one of the largest programmes; equating to 12% of UK transport infrastructure spend 2015 - 2021 outside London (Armitt, 2013). When agreeing its delivery plan in 2015 totalling £15.2 billion, Highways England responded to a challenge to reduce actual expenditure by an efficiency target of £2.4billion over ten years (£1.2bn 2015-2020 and £1.4bn 2020-2025) (England, 2015).

The Regional Investment Programme was targeted to respond proportionately to this efficiency target (£116m 2015-2020 and £600m 2020-2025). McKinsey highlighted in its report Reinventing Construction (MGI, 2017) construction's productivity shift in western economies over the last 15 years has been constrained to an improvement of approximately one percent. This compares to the manufacturing sector that exceeds 600% for the same period. The challenge for Highways England, given the government's expectations on improved efficiency, was to accelerate the improvement in productivity on the projects it commissioned. Its response was to drive better value, through improved safety, improved customer service, and delivery of commitments.

In 2008, Highways Agency, Highways England's predecessor, introduced lean construction with the declared aim of improving project's delivery performance. The resulting lean interventions generated a significant amount of transferable knowledge and isolated productivity improvement. However, not at the rate needed to meet government monitor's expectations for its future investment (Nichols, 2017). Consequently, an innovative approach was needed to counter the inability of the construction industry to grasp the change in mindset needed to turn on the tap of latent productivity, highlighted in the Transforming Infrastructure Performance (IPA, 2017), and available from Design for Manufacture (DfM) thinking (Fernández-Solis, 2008), (Highways_England, 2017), (IoED, 2020).

Transport infrastructure enhancements involve large-scale complex projects. Enhancements to England's strategic road network are no different, with schemes typically ranging from £25 million, to hundreds of millions of pounds. Between 2014 and 2017 Highways England's trading model saw maturity improve from 'transactional' to 'simple collaborative' behaviour (ICG, 2017). This was driven by a procurement model called Collaborative Delivery Framework (Cuff et al., 2015). This maturity, while material, stagnated into an operational status quo: a way of working. To allow change, to deliver a planned work programme, this way of working needed to be un-frozen to meet a delivery ambition of integration. Analysis of the UK's highways construction sector workforce suggested that this status quo could result in failure of the planned programme to deliver sufficient productivity improvement. Primarily because of a visible skill demographic 'time-bomb'

combined with slow or no investment in supplier innovation to unlock this paradigm. This issue was confirmed by independent reviews of construction, seen in the Farmer review (Farmer, 2016), the Nichol's reports (Nichols, 2007), (Nichols, 2021), (Nichols, 2017), and various reports by Infrastructure Projects Authority (IPA, 2014) and National Audit Office (NAO, 2017).

A particular problem for highways was concentrated in the delivery of regional investment projects or operational capital enhancement schemes. A new procurement model was needed, before expiry of Collaborative Delivery Framework, in March 2019.

This conundrum is described as two issues:

1. *Can a new choice architecture change productivity behaviour and improve outcome performance?*
2. *How to find suppliers capable of embedding productivity change sustainably across design and delivery ecosystems.*
- 3.

1.2. Defining the problem

As a senior member of the commercial delivery team within Highways England the researcher had access to extensive data. This access was key to the effectiveness of this research.

The growing government ambition to improve England's strategic road network and speed economic growth focused in 2017 on investment in transport infrastructure (Transport, 2017). As productivity in construction has all but stagnated in the last half century (Renz and Zafra, 2016) a shift was needed in how transport infrastructure enhancement work is bought and delivered. This shift would allow the sector to meet the expectations set for it as a condition of continued investment, closing in on the productivity opportunity.

As trading agreements have evolved the impact of learned behaviour caused large-scale regression to a mean, based on the availability heuristic. This is exemplified by the highly specialised technical workforce and control exercised by professional institutions. Profit margins in the construction industry are typically around two to three percent (Corey, 2011), which leads to a low appetite for risk taking through innovation.

Poor productivity, output per worker, has been well known and defined since the mid 1940's (Simon, 1944), (Egan, 1998), (Latham, 1994), with insufficient change.

There is widespread rhetoric in transport infrastructure construction markets articulated in numerous reviews sponsored by government (Gruneberg, 2019) with no meaningful shift in productivity.

Construction focus continues to be 'on time and within budget.' Other industries experiencing triple digit growth have focused on 'end user value', and 'failing fast: learning quick', as well as operational strategies (Syed, 2015).

Research included reflective practice (Schön, 2017) and action research (Erro-Garcés, 2020) amongst professionals in the highway's enhancement construction market. It reviewed elements of construction productivity, from inside and outside highways, and reviewed wider academic literature. It reviewed current practice to figure out what worked and what did not. It built the parameters of a solution using facilitated modelling. This captured practitioner contributions to develop the boundaries of ambition and finally developed and built a new procurement model. Using a select team, the model was tested before deploying it into a live market competitive tender with the aim of awarding Framework contracts to successful bidders.

Highways England faced a unique market segment problem when undertaking highways enhancement and highways operational capital replacement schemes. Research was based on detailed confidential reports. These hold practitioner experience and anecdotal evidence of potential causes of low productivity and high process waste. Themed analysis showed the potential for significant productivity improvement. Referencing civil engineering practice over the last 30+ years has recognised productivity constraints from across civil engineering infrastructure not just those confined to highways (MGI, 2017). It examined previous attempts to improve construction outcomes, especially in highways, and identify themes to constraint (Nichols, 2021). It showed how underpinning theories might contribute to a fresh and disruptive approach to a recognised problem.

The key to productivity transformation, as evidenced by other industries (MGI, 2017), is:

- *Recognition of, and learning from, failure*
- *Innovation in technique*
- *being value driven*
- *not using input-based performance metrics.*

As the highways supplier market is small, normal manufacturing market forces do not apply in the same way to drive down price or achieve transformative change in productivity. So, to drive productivity improvement the question was:

- *What form of new procurement model needs to be developed to use with the existing UK highways construction market, that will accelerate improvements in productivity of project design and delivery ensuring greater predictability of outcome?*

1.2.1. Aim and Objectives

To describe this the aim was:

Develop and deploy a new procurement model with unique choice architecture to motivate a change in decision making in the existing market hierarchical ontology to achieve tangibly higher productivity.

To deliver the aim the goals were:

1. *Establish the current state of practice, evaluate its performance, and define the problem.*
2. *Establish the current state of knowledge around cognitive bias in those areas that could help shape the new model.*
3. *Develop a prototype new high productivity procurement model.*
4. *Evaluate the model prototype, improve, and publish a new, higher productivity, procurement model.*
5. *Deploy the new higher productivity procurement model.*

1.2.2. The Oxford Handbook of Mega-project Management

In this seminal work relating to the principle behavioural theories around the success and failure of mega-projects, Flyvbjerg explores how and why schemes are started when there is so little fixed information. He goes on to ask why they so often fail against the investors ambition and hypothesises that the reasons have common themes he labels “sublimes” (Flyvbjerg, 2017). These commonly inform the drivers that, even at the start, cause people to make decisions in mega projects that result in failure. The four ‘sublimes’ are:

- *Technological: the excitement technologists get from the project*
- *Political: the associated power from political influencers being associated with the project*
- *Economic: based around how much economic value both public and private is associated with the project*
- *Aesthetic: the pleasure derived from being associated with something of a landmark status.*

The premise of Flyvbjerg’s research is that these sublimes overpower the thinking of planners and investors despite evidence that there are repeating and obvious blind spots in developing and delivering mega-projects. While Highways England’s portfolio of projects in regional Investment are not considered, in the context of mega-projects, they would receive help from use of the same iron-laws around sublimes.

The blind spots noted by Flyvbjerg are categorised as (Table 1):

Table 1. Blind Spots and Highways Equivalent

| Blind Spots | Highways equivalent |
|--|--|
| Large projects are inherently risky due to size, gestation, and delivery periods. | Highways projects take five to eight years from start to completion. |
| Projects are often led by people with only partial competence in similar schemes. | Availability of resource has become the basis of selection. |
| Decision making is by groups with conflicting interests despite a desire to be aligned. | The construction process is fragmented with trading agreement fragmenting risk and causing interface issues. |
| Solutions are considered unique due to size and grandeur provoking uniqueness bias. | Every project is in a different location which stimulates a feeling of uniqueness. |
| Fail fast does not happen due to the impact of escalated commitment – too 'locked in' to fail. | Not meeting commitments is prioritised as reputational risk. |
| Sums are so large that optimism bias becomes a prevalent issue | Typically schemes between £20 - £900million |
| Changing requirements over time disrupt or compromise the schemes goals being achieved. | Multi-faceted stakeholder groups with key representatives and policy change contribute |
| Managers tend to ignore the likelihood of 'black swan' events during the development and delivery timescales. | Complex schemes take allot of planning and management thinking and teams become insular. |
| Because project approvals look to avoid including provision for 'black swan' events, there is often insufficient provision for uncertainty. | Highways projects do include 'portfolio risk' which looks to aggregate black swan events across the portfolio, not within a project. |
| Because of the above, projects information and decision making is subject to strategic misrepresentation of both costs and benefits. | Additionally reporting culture tends to bury failure and lessons learnt are too infrequent across portfolios or even in programmes. |

The learning that can be taken from this is that large and mega schemes will break [fail] because of a combination of; 1) the sublims and biases present, and 2) too few competent people in control of schemes. The options are: get it right from the start and be more honest about the process, or become more competent at fixing schemes when they inevitably break [fail].

Many of the biases referenced in this book were those reflected from practice in highways during Collaborative

Delivery Framework. They have resonance in this sector and so the thinking and description of the bias into discrete categories will be useful when building a prototype procurement model.

1.3. Conclusión

Across the UK highways construction sector, it is recognised that poor productivity persists despite ever increasingly long-term pipeline commitments. The industry is littered with rhetoric relating to the principles and characteristics of what needs to be done. Reviews and reports consistently cite the same aspects of the construction market that detract from productivity improvement. The infrastructure construction market in the UK is no different, albeit a little more responsive to investment in change based on visible pipeline. Highways England's challenge to create added capability and capacity is matched by enablers; a release from annualised funding; a five-year Road Investment Strategy; delegated powers with oversight from a monitor. Over the years spectators have continually changed focus, from clients needing to change delivery environments to suppliers needing to invest in, and initiate, change.

Since the reports of Simon, Banwell, Latham and Egan; procurement models have evolved. Organisational theory has evolved. Supply chain approaches have evolved. Technology and construction techniques have evolved. Materials and plant have evolved. But practice shows all appear to have evolved either in isolation from each other or without the behavioural drivers to change the production outcome.

To stimulate this long aspired for change in productivity, a gap exists to combine guidance, principles, characteristics, and rhetoric to find common and all-important behavioural connections. A common but poorly explored thread, across all this aspired for change, is people and the way procurement models motivate decision making.

The answer to this gap may exist in combining knowledge from social science, behavioural economics, and construction economics, where human factors create the dynamic for a unique way of motivating decision making.

In several studies throughout the last 15 years, suppliers have been urged to trigger a change and improve production outputs. Why then have they remained elusive? If as the rhetoric proclaims it is in everyone's interests, why so ineffective? In many industry reviews, despite there being a looming demographic time-bomb, productivity inertia persists. Market fragmentation focused on by Latham and Egan, still, after 30 plus years, exists and there is no integrated team. Several factors are cited, competing interests, isolationism, and lack of a disruptor; UK construction market is notoriously difficult to access by European competition, education has not changed, and corporate self-interest persists. The industry continues to teach vocational entry to this market and use a market wide conscious, or unconscious, bias towards new entrants. If the paradigm does not change, we will continue to get what we have always got, to paraphrase Einstein. The questions are:

- are forms of contract wrong or, the way people react to them caused by a misperception of outcome and value?*
- Are participants allowed to make the right choices for productivity improvement, or are they unintentionally constrained by the very agreement designed to release them?*

To formulate answers to these questions we considered clear elements of current practical behaviour and postulated reasoning for that behaviour. (Table 2)

Table 2. Relationship between current practice behaviour and postulated reasoning

| Practice | Reasoning |
|---|--|
| Incentive models should closely reflect a visible link between risk and reward. | If an incentive model is not balanced it will stimulate an asymmetric outcome including predictably irrational behaviour |
| Incentives work in integrated project delivery ONLY when the client is engaged. | The Clients actions in a project are critical to any supplier being able to perform and redeem an incentive. |
| Integrated project delivery is more efficient than transactional trading. | Transactional trading generates waste in large schemes as the fragmentation and transfer of liability causes transaction points which incur non-value adding activity. |
| Performance must play a major part in incentivisation and linking performance to future opportunity is a powerful incentive in a market driven by consistent turnover and low acquisition cost for its sustainability. | Whilst the allure of addition cash from undertaking a scheme efficiently may appear attractive, it is not. Sustainable business through lower future work acquisition costs is much more motivational to suppliers and sub-suppliers. |
| 'Opt-in' procurement models do not work. | Psychologically asking for compliance has been set up as less motivational than assuming compliance and providing a loss for non-compliance. |
| Simplicity of delivery structure, rule change, and outcome connectivity aid the people engaged in delivery to understand how to enact change. | Construction projects are complex and setting up a procurement model that is effective requires simplicity to enable it to be understood by the thousands of people that will be engaged in its delivery. |
| Contracts are not read by the majority, so strong messaging needs to reinforce key themes on the intent. | While the contract is there as a record of the agreement that was signed, most people involved in the scheme never read it. The themes of change need to be relatable to widespread practice but with strong key messages to how they are different. |
| Incentivisation must release innovation opportunity to remove people from processes to: | To improve productivity (output per worker) any incentive must support reducing hours worked to achieve the outcome. |
| Avoid compromise in sustainability due to a demographic time-bomb | Reducing numbers of people in the construction sector has been forecast, any new procurement model must recognise the ability for suppliers to innovate to reduce reliance on worked hours in favour of modern methods of construction. |

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A new model was designed and procured to improve on ten plus percent productivity shift (MGI, 2017) to change the way people work overtly and significantly.

To achieve this effective change several key issues were drawn from current practice (Table 3)

Table 3. Topics of interest for effective change

| Investigate | Why? |
|--|---|
| Biases impact outcome, how? | Counter damaging bias. |
| Management of change must be controlled to be successful. | Transition is a complex thing and structured and organised change will be needed to shift a critical mass of decision making. |
| Transition from ‘opt-in’ to ‘opt-out’ and the wider use of nudge theory. | Behavioural economics around the power of loss aversion may have some answers to drive a change in decision making. |
| Use of loss aversion rather than gain as an incentive mechanism. | Opt-out case study |
| Means of countering predictable irrationality by reducing remoteness between action and consequence. | Creating a golden thread between action and consequence is essential as part of any motivational strategy |
| Harnessing the power of self-organisation. | Once the model is released and in action there is too greater scope in its use for command and control, the application must drive self-organisation. |
| Understanding the impact of social norms and tribal behaviour – seeking acceptance from group familiarity with decisions. | People make the best decisions when they feel safe. So, the changed decision-making pathways need to be social norms for the community. |

These required a rethink to shift engrained decision making, both corporate and individual. These changes must be supported by proper contracting agreements within a new procurement model to stimulate the will to change by all parties.

So, the problem was how, in the existing ontology, to improve productivity on major infrastructure projects. Earlier attempts only had marginal success. Studies show that individual behaviours can negatively affect productivity and a new procurement model was needed to address this problem.

Project teams are set up as a temporary management organisation and then disbanded regularly. Interaction between actors and groups of actors is the basis of project delivery. To change the habits of these communities, built up over many years, requires time. However, to enable it to begin a new procurement model must help it.

So, the question is refined, can knowledge, drawn from behavioural sciences, be applied to, and incorporated in a new procurement model with the expectation that this will enable improvement in productivity?

To discover the answer to this, several underpinning theories were reviewed to figure out if effective mechanisms might be translated around an existing complex ontology.

2. Underpinning Theories

To investigate the questions arising from practice and the market response in principles of practice, a series of underpinning theories were reviewed to see if they explain sub-optimal performance in practice. Analysing data revealed procurement agreements consistently underplay the importance of prompting and motivating behavioural change. This is clear from contractually irrational decision making. Sub-optimal performance results from poor, contractually irrational, decisions made when carrying out construction works. The survey data clearly shows that what is procurement model failure is in fact a failure by practitioners to follow the model. Underpinning theories might offer some insight into how to structure and motivate more compliance decision making. This may create the difference between high and low productivity while protecting investor, client, and supplier working under a public sector construction contract?

Behavioural insight 'Nudges' can create measurable impact when used to changes UK government policy (Halpern, 2015). Our research investigated if productivity-based decision making can be changed in this market by learning from the field of behavioural science. The review looked for underpinning theories to influence how to redefine decision making pathways, that lead to behaviour, to improve productivity. Social science and herd, or tribal, behaviour was also investigated to understand why people seek social approval before being able to change behaviour and embed a sustainable shift in output per hour worked.

Whilst embedding a new way to work is important, how we work, and why we work also informs behavioural choices. To illustrate this the review again reached into behavioural economics to assess what drives collaboration and informs the context of integrated working. It also looked at why people do things, take decisions, and what motivates or not, people to act. Looking at theories, to better align risk and reward through incentive mechanisms, also touches on the importance of motivating the right things, at the right level, and creating visibility through the community. Individual motivations are important but so are corporate motivations. Investigating if they are different also informed the procurement model towards improved productivity

One attribute of the defined problem is a need to manage change more effectively when shifting behaviour. So, we also looked at the basics of change management through change theory. We looked at the principles of self-organisation by groups as a more, or less, effective way of making changed ways of working sustainable. And finally, to avoid repeating past failure, we looked at research done into why mega projects fail or succeed, what are recognised sublimines and biases and how they inform key decision making.

For the purposes of this paper, the underpinning theories were contained to the direct relationship between client and primary supplier. Other theories such as supply chain management, complexity theory, uncertainty management theory, motivational theories, or theories contained under management science, were not reviewed. Whilst in the context of their influence on the theories reviewed, they are acknowledged, this paper does not try to investigate them. It is contained in its focus on influencing productivity-based decision making to counter-act known bias (Kahneman, 1982). It does not review judgement making, psychology in general, or the cognitive abilities for decision making in general. It was focused on how to create specific nudges within a UK highways construction specific community.

Specifically, the paper looks at issues highlighted from practice, namely:

Generating buy-in to a new way of working through the use of an opt-out policy rather than traditional procurement models based on opt-in.

Loss-aversion as the basis for motivation. Traditional incentives based on stimulating opt-in to improved outcomes are seen not to be working. To support the opt-out policy, stimulating better performance and productivity using loss-aversion may be more successful in changing ways of working

Cognitive dissonance and damaging biases appear to be widespread and every project that does not achieve its goals is riddled with reasons why all party's involved could not perform. When setting up a procurement model all party's purport to understand the decisions and behaviours necessary to succeed. Following the rules in an agreement would show rational behaviour. Contemporary evidence shows that commercial advantage is sought by gaming the outcome of contracts (Ahmed et al., 2016). This can be labelled predictable irrationality. Seeking strategies and thinking in the correction of predictably irrational behaviour may transform performance under any new procurement arrangements.

Once the procurement process has run, and the suppliers selected, all decision making and behaviour management transfers to contract administration. The people behind the model become less influential and operational teams take charge, growing to 40 – 50 times the people involved in modelling and bidding. At this point delivery teams need to be able to support the ethos of the procurement model for it to work. As such the idea of self-organisation, running contracts, in temporary (project) management

organisations, over many iterations, is important. Reaching into the self-organisational theory from industry may help the development of this.

People deliver everything in construction. People are herd animals at origin and follow the traits of needing social acceptance. Looking into the science of tribal or social norms as well as the influence of well recognised sublims, and bias may illuminate some of the tensions experienced in the multi-faceted decision making under a construction trading agreement. To be able to motivate performance, predictability, and productivity it is important to be able to understand how these sublims, biases, and social norms play a part in enabling or constraining change.

2.1. How did we use this?

The opportunity to use nudge theory to set policy to change independent choices is well documented. The social science theories in this paper all have proven implementation in other social settings. There was an opportunity to take these theories and apply them to a new setting of highway infrastructure construction. Effective changes to productivity related decision making appeared to be available by exploring the symptoms of poor decision making and finding root cause. By using thematic data analysis and auto-ethnological data from groups of practitioners a new decision architecture, that complements a standard form of construction contract, was crafted.

Careful selection and design of a complex system of choices, and the architecture to guide practitioners away from poor productivity habits, had potential. The challenge was to take the thematic analysis of data from case study surveys and interviews and combine it with learning from the underpinning theories. This offered the opportunity to design nudges that, when acting independently or as a suit, result in nudging the community away from habits of irrational decision making and into new higher productivity. Nudges designed to achieve new levels of production output needed to be supported by new commonly understood social norms. These, as with any induced change, will be put under severe pressure by tribal or social mores and the habits or sublims of the mean activity, and can be seen in case study data. As changing these social habits and commercial sublims will take time, management of the expectation of the extent of change in the short term, will be needed from the sponsors of this change.

The development of a new highway high productivity procurement prototype from this, to stand up the rigour and testing of independent review and then market testing, was unique.

2.1.1 . Approach

The primary data set is a contemporary record from the highway sector describing the positives and negative gaps recognised from operation of Collaborative Delivery Framework. Cluster group analysis was interpreted to qualitatively show root cause and effect of current decision making. The changes contained in the prototype, and final new procurement model's choice architecture, used findings from secondary data to nudge decisions as mapped from this interpretive process.

2.1.2. What have we found from practice?

What differentiates historic procurement models success or otherwise, when implemented, are:

- Choices made by individuals at key points.
- Alignment of procurement model environment to goals and integrating project delivery
- Poor management of change
- .

To improve the chances of success in implementation of a new procurement model to the highway's community, adopting Lewin's 3-step change process was considered helpful. Theories around behavioural insights and economics, why people do what they do, is commonly based on socially influenced habit, personal drivers, perceived benefit, and informed by emotional response rather than fact. Infrastructure construction is perceived as being highly engineered, with deterministic systems thinking with high volume but moderate complexity. In terms of the choices decision makers make, little work has been done to systematically nudge emotion driven irrational choices to improve productivity. The findings showed

that several ideas from literature may contribute to resolving problems prevalent in construction procurement models.

Rational-legal authority (Weber and Rheinstein, 1954) is a premise upon which all contracts are drafted and take effect. But to be more effective they need to describe a story (the project in an agreement). This is turned into a common 'imagined reality' amongst all members of the extended integrated project team community. The story must be clear and relevant to influence aligned participant decisions so that a designed temporary management organisation can achieve the commonly imagined reality of the asset enhancement. To be effective the procurement model must reduce remoteness from consequence of risk and responsibility transfer. Creating a short and visible 'Golden Thread' between action and consequence.

Several guiding thoughts appear from these underpinning theories:

1. Directly aligning the decision makers choice to a commercial outcome, good or bad, may be the key to sustainable productivity improvements.

Reviewing practice highlighted that success is all about how connected to the consequence, aligned, motivated, and engaged the people involved are. And the ability of suppliers to connect people to behavioural change and innovative ways of higher productivity working that leads to improved delivery performance. Expected value theory is a tool used by people judging the value of a decision. This judgement contributes to the emotional response needed as a part of loss aversion.

2. Therefore, loss aversion has potential to improve incentivisation modelling by connecting an individual's emotional response as well as a perceived commercial one.

Incentivisation in this regard could be focused not only on loss of cash, but also loss of trust and reputation that leads to loss of access to future work. If the power of loss aversion, found in Kahneman's social experiments, transposes to the procurement models we use in construction, it could double the effort made by decision makers to improve productivity. By connecting decisions directly to avoid losing profitability and jeopardising sustainability through accessible work pipelines. The ability, for a procurement model, to create and communicate a new way of working across a wide range of people for a sustained period will play an important part in improving sustainable productivity improvement.

3. For successful operation of any new procurement model participants must simplistically be encouraged to focus on four key areas: efficiency, predictability, scheme outcomes, and customer value improvement.

The need for change is clear but the means of achieving it is not. Building on learning from social experimentation in the field of behavioural economics and extrapolating findings into this field has potential. The validation of someone's actions or decisions, through perceived social compliance, enables each person to be more comfortable that their choice conforms with its tribe's social beliefs, even more so if it follows traditional or charismatic authority.

4. To succeed tribal social norms must align with the desired outcome.

Otherwise at best an asymmetric decision will occur and at worst, there will be a complete misalignment between decision taking and a project's goals.

5. Countering predictable irrationality by nudging, using a series of specific and disruptive nudges,

Could create a sustainable productivity shift so desired by clients, commentators, and practitioners alike. However, where a nudge, created by a decision architecture, is designed to change one behaviour it may also change others. Scenario testing will be needed to identify similarities and test and challenge prototype choice architectures for unintended outcomes.

An intimate contextual knowledge of commercial strategy, contract documentation and operating behaviours of many "tribes" within this community will be needed to affect an efficient procurement model. Development and delivery of road enhancement schemes engages large numbers of people. There are a myriad of relationships, tribes, social norms, authorities, and rules.

6. The model should test tribal behaviour against a system thinking strategy; how do each set of mores work within itself and with each of the other tribal mores.

There is a constant call by construction deliverers for environments that deliver self-determining early involvement to influence solutions and share in rewards from innovation and disruptive thinking. A new procurement model supplies opportunity to create a group dynamic that 'raises the bar' of acceptable decision making. It must respond to existing social group ontology, client, and suppliers at every level, and

7. Through self-organisation, embed self-policing based on incentivised outcomes within the ecosystem.

There is opportunity to selectively transpose empirical evidence from social and behavioural experimentation to focus on more consistent, and continuous improvement of, productivity. Focusing on changes to decision making within the procurement model has, if used with surgical precision, potential to achieve a sustainable step change in productivity.

2.2. Process Map and Timeline

Research was carried out across a cross section of the market between January 2017 and April 2018 (Figure 2).

Process Time Line

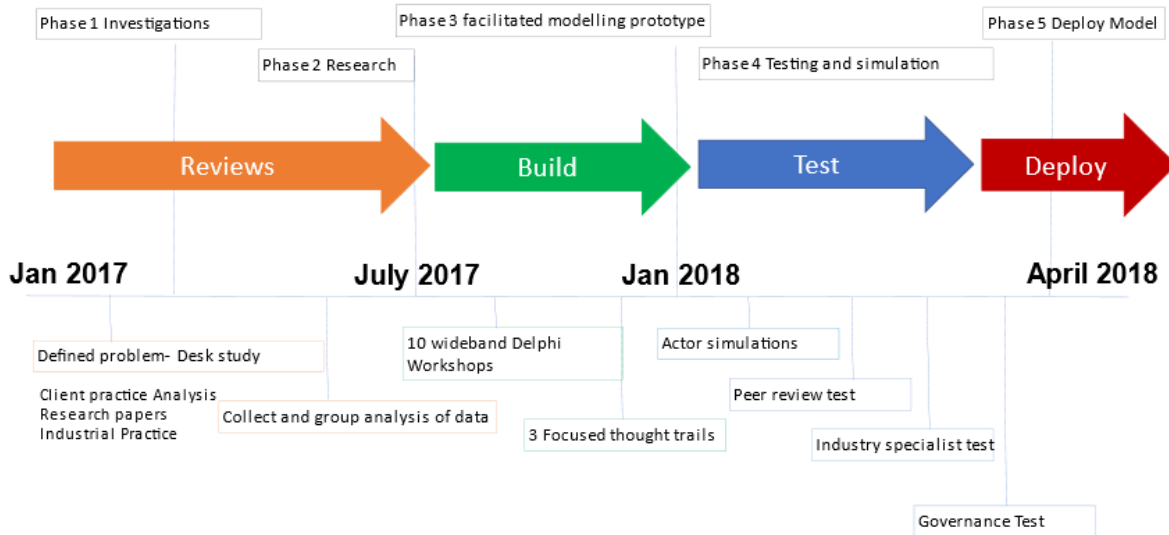


Figure 2. Process Timeline

3. Delivering the aim

3.1. The process

Throughout development of the prototype and then final model the constant themes derived from underpinning theories were supported. Loss aversion combined with opt-out choice pathways were predominant in the designers' minds.

The use of grouped data from analysed cross sectional data was used to effectively help the wideband Delphi workshops. The outcome from the workshops along with underpinning theories was used to guide the facilitated modelling and thought trials. This led to the assembly of a suite of documentation that form the procurement model. These then combined individual architectures using case study-based prediction frameworks and simulations of decision making. When combined the finished procurement model structure focuses decision making differently to motivate different behaviour, through designed choice architectures, integrating outcomes through opting-in to the philosophy of the model to help higher productivity.

3.1.1. How we used workshops?

Using selected participants from Highways England focus groups including people from functional groups delivered a coordinated outcome. The diversity of the groupings in workshops was effective. The workshops were led by a facilitator for focus and pace. This strategy effectively supported the pace of discussion and estimation from the group. It concluded significant numbers of advisory discussions enabling the sequence of events to become meaningful. Using the first part of each workshop to brief the panel on the outcome of findings so far, within the sequence, was an effective way of progressive assurance around the constructed boundaries within which to hold thought trials.

3.1.2. Facilitated modelling as a method and its impact

Modelling was conducted as sprints (Scrum.org, 2022) and were undertaken over a three-month period in parallel. Development was led through three separate scrum sprint teams each focusing one strategy:

1. Delivery Model / Commercial Strategy
2. Legal / Contract strategy
3. Procurement strategy

Each sprint team was run in parallel with a lead overseeing focus, boundary constraints, and timeliness. Regular

alignment to business strategy, progress, and key decisions were sought from a Management Steering Group.

At points during the development of a strategic response to the workshop boundaries sprint teams were regularly faced with an interface point across boundaries. As all thought trials were happening in parallel, using the same core team, each was able to collaborate with all other sprint groups, worked. This collaboration ensured core sprints were not disrupted. 3-month strategy sprints were fragmented into a series of 12-weekly sprints. All sprints, run by the same facilitator, kept focus and pace by retaining the principal that the facilitator was the guiding mind of the trials. Each thought trial team leader collaborated regularly and through consensus meetings resolved interfaces issues.

Choices, options, and gaps were considered at each bi-weekly design steering group. These included decisions relating to commercial strategy, procurement strategy, and legal contract issues requiring further detailed technical and business consideration. Process decision points to complete the model were pinpointed by work stream sprint teams and drove resolution of any dependencies for micro decisions.

The construction of virtual and imagined decision makers for each of the trials themes was highly empowering and enabled a common imagined reality of the impact of a choice pathway feature. It enabled each sprint team to simulate the potential quickly and effectively and to predict irrational decision making. Each sprint team described a decision maker to understand the potential agenda of that decision maker from a different perspective. The common facilitation of the sprint teams enabled a degree of commonality across of imagined decision makers agenda.

3.1.3. Theoretical Prototyping into a prototype model

A prototype procurement model was built by compiling features from the sprint teams. The sprint teams had to consider each feature's implications across all elements but focused on a single operational strategy to shape the prototype model supporting its foundation points. Using the concept of a thought scaffold or predicting framework (Dietrich and Haider, 2015), enabled the overall model to be virtually sketched and then cemented in place as the features were considered, subject to a prediction, and finally constructed. This method of creative thinking, used to bring the sprint teams to a common imagined outcome that could be communicated to the contract drafting team, was powerful. It allowed simulation which informed trial and error in a safe environment. The sprint and scrum mentality underpinned the fail-fast / learn-fast approach which supported not only the individual sprint but the other parallel sprints. This strategy also informed the progressive assurance of the procurement model and allowed it to succeed through governance right first time.

3.1.4. Building Regional Delivery Partnerships

From a prototype model for procurement, including its delivery and commercial principles, a set of refined and streamlined documents were compiled. These described the structure of the model's ecosystem, its agents, their rights and obligations, and the control mechanisms of its operation. It set the landscape for a change of culture in the way enhancement projects are delivered.

Woven into this was a choice architecture that describes commercial decision points that are designed to motivate an integrated project team to focus on: efficiency, predictability, outcomes, and customer value. Specifically, efficiency and predictability are designed to focus decision making around protecting and outperforming the planned levels of productivity.

Any procurement model is the rational activity needed to delivery highways enhancement schemes that "exceed the expectations of the investor." It reflects transfer of rights and obligations described as needed to improve productivity by practitioners and missing from earlier models. It was a shift from opt-in, to op-out. Motivation to outperform uses the potential pipeline of Highways England work to focus decisions on delivery against its ambitions. It changes the role of a supplier from deliverer of a client's design to originator of a solution and integrator of the outcome. It shifts decision making around the mitigation of threats and realisation of opportunity to the party most likely to get the best scheme outcome. And it creates the leverage for promises made prior to becoming a supplier to be integral to the choices made in development and delivery and a critical part of commercial success.

3.1.5. Assurance and review

When built, this new procurement model was tested in sequential assurance reviews to supply confidence to investors that despite being new it had a high likelihood of success. In a rigorous multi-layered assurance process, it underwent four assurance stages. (Figure 3)

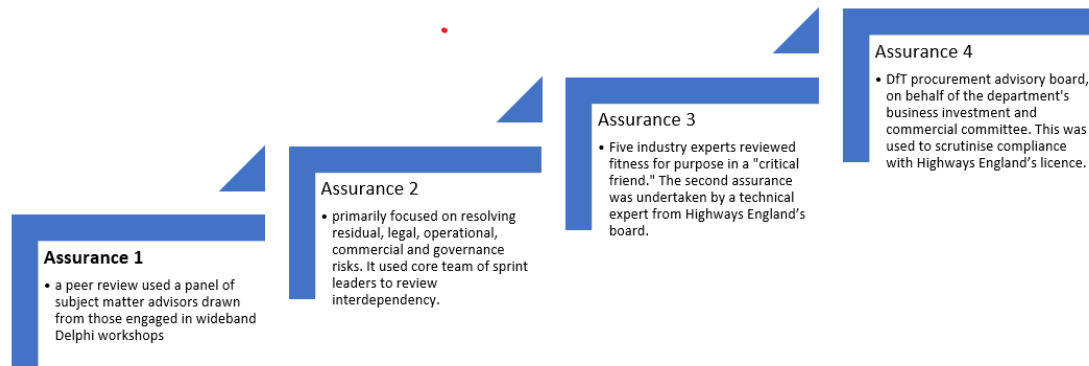


Figure 3. Assurance stages

This level of external assurance was important to the follow-on stage of deployment. It was essential to succeed through business and investor governance. Building time for this assurance into the project's timeline was essential for quality management and to reduce any consequential re-work time during the tender period.

3.2. Deployment

3.2.1. Tendering and Award

In April 2018, the procurement model had undergone its final reviews, refinement and was ready for deployment. It was published and an open market procurement was run. Tender returns were August 2018.

During the first 4 weeks of the tender period several engagement and training sessions were run to condition the market and evaluators. Throughout the 21-week procurement period similar practitioner training was undertaken with people responsible for acting as client project managers following award.

Following a rigorous evaluation of all the bids sent in. 18 packages of work were awarded to 13 individual bidders (Smale, 2018). No legal or process-based challenges were successfully raised by any bidder. All bidders were given detailed feedback of their bid response compared to the most successful bidder response to each question.

All successful financial bids were verified as sustainable. All bidders completed a tender commitment register; post-award this formed a contractual requirement. In total across 18 packages of work, 1,075 commitments around safety, efficiency, quality, predictability, localised sourcing, talent, outcome focus, and value-based decision making were enacted into contracts.

3.2.2. Limitations of this paper

This paper was specific to design a procurement model for the enhancement and renewal of major network assets forming part of the strategic road network of England. Focused on achieving an outcome to meet a defined and prescribed timescale driven by business need. Added time and research resource may have supplied a more exhaustive data analysis that may have led to a greater level of simplification in the delivery and commercial model.

Specific limitations were:

- *The delivery model was not to be enabled for use outside of Highways England.*
- *Highways England is licenced under the 2015 Infrastructure Act and granted defined five-year investment strategies putting it in a unique position to know its forward five-year capital investment.*
- *During development Highways England experienced and was forecasting stable fiscal policies, inflation, and labour availability.*
- *Scheme value under the model had no top end limit but a minimum scheme size of £20million.*
- *The model recognised a geographic spread across England which, while significant, is contained within travel distances capable of being achieved within one day's surface travel.*
- *Strategic Road Network is recognised, and highway construction in it, as a mature UK market sector.*
- *Central UK government mandated the use of NEC 4 suit of contracts as the basis for trading, so no other standard forms of contract were considered.*
- *The model is subject to English law pertinent to public sector procurement and expenditure.*
- *Value under the model is measured in accordance with HM Treasury Green Book (HMTreasury, 2018a),*

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value for money terms.

- Financial returns from the tender process relied on Highways England’s historic cost record and analysis. This is unique to its scope of operation and would not be relevant to other clients.
- Feedback from practitioners undertaken by Highways England and used in the development of the model was based on experiences under Collaborative Delivery Framework, it being the predominant procurement model prior to Reginal Delivery Partnerships.
- Behaviour economic theory was used in to construct a prediction framework to emulate future decisions of imagined actors in the UK Highways construction supply market. Those predictions were used to design a network of nudges aimed at nudging predicted practitioner behaviour.

3.2.3. Implications for Practice

Regional Delivery Partnerships was deployed by Highways England in 2018 as its chosen procurement model for regional capital enhancement and replacement works (Figure 4). The model is being used to deliver £9.0billion of enhancement and replacement work between 2019 and 2026. Highways England’s Regional Investment Programme equates to circa 12% of UK infrastructure spend outside of the London area. As such it is a strategic change in procurement and delivery method. Based on a pre-tender estimate of delivery costs for the schemes included in the framework, an overall efficiency of circa £1.692billion will have been achieved (18.8%) by the time the framework is exhausted. This compares to the productivity improvement plan of £1.235billion made in 2018 to map the potential of the new procurement model to enhance value through the Region Investment Programme.

Efficiency Targets

Initiatives targeting programme efficiency are key elements of the short and medium term horizons for the RIP Strategy. They are expected to be delivered over RIS 1 and RIS 2 as building blocks to enable further RIP Strategy delivery and benefit realisation.

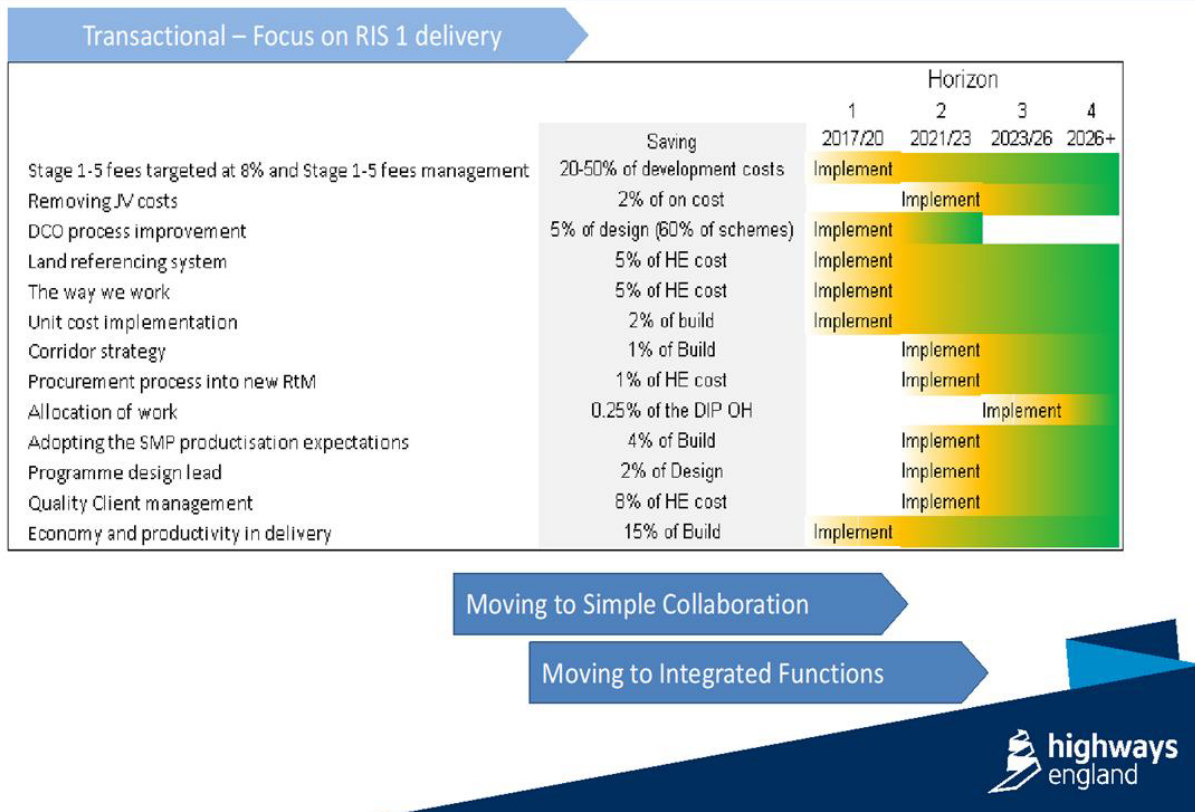


Figure 4. Predicted heads of efficiency and implementation timeline 2018 (Highways England Ltd)

The UK Government's direction of travel is to implement a value toolkit across government client bodies through the constructing excellence group of Infrastructure Projects Authority. Regional Delivery Partnerships adopted this strategy prior to these initiatives becoming government policy. Regional Delivery Partnerships also piloted many aspects of UK Government Infrastructure Construction Playbook (Chrisholm, 2021) and Constructing the Gold Standard for Frameworks (Mossey, 2021) three to four years before this guidance was published as best practice.

Key aspects of Regional Delivery Partnerships that will have a wider impact are:

- *Designing a procurement model based on “opt-out” psychology. This shows the total post-efficient budget available to the supplier community to deliver a scheme. Outperforming the budget is motivated by access to 100% of budget savings.*
- *Basing a motivational model on loss aversion. By presenting the budget total and making savings available from the start of a contract the motivation is visualised to the supplier. Acting against the incentive model results in loss of opportunity. This model does not try to motivate suppliers to opt-in to a delivery philosophy but lays out the loss if a supplier chooses to opt-out.*
- *Using customer and economic value within a motivational strategy. Regional Delivery Partnerships motivates based on outperforming the expectation of an investor. This is based on investment decisions comparing benefits to costs. To exceed the expectation of an investor a supplier must use smart decisions to improve the ratio between cost and benefit.*
- *Using access to future work, based on performance only, within a motivational strategy. All suppliers in the construction market seek sustainability for their business through predictable returns from a visible pipeline of work. Highways England was, under the infrastructure Act, granted a licence with five-year investment strategies. This unique Investment horizon in public sector funding allows access to future work to be used as part of its strategy to motivate suppliers to invest in capability to change productivity. The mechanics of this can be used in any client situation, however without visibility of construction work this may lose its motivational ability.*
- *Transferring tender promises into contractual commitments linked to disallowed cost. As a direct result of historic tender promises not being carried through into delivery, Regional Delivery Partnership requires bidders to convert a select number of promises into commitments. Failure to meet these commitments supplies Highways England the ability to disallow resulting costs from the defined costs paid to the supplier.*
- *Contracting major infrastructure delivery based on an asset performance specification and ‘fitness for purpose’ liability transfer. Under Regional Delivery Partnerships the integration supplier is engaged to deliver a scheme to satisfy a set of asset performance criteria only. Single point design responsibility is transferred with a ‘not to be exceeded’ targeted outturn cost set by the client. This model relies on Highways England’s Design manual for Roads and Bridges (England, 2020) and a detailed scope describing policy, procedural, and methodological constraints. Holding the supplier to a single point design liability, changes the culture to one where the whole ecosystem can outperform, bring innovation, and contribute to platform design for manufacture thinking, collaborative design, pricing, and planning as well as sharing in the rewards for outperformance.*
- *Contracting with an integrator to integrate project delivery. It requires the integrator to create an ecosystem environment that allows all participants, including the client, and sub-suppliers to act effectively and efficiently when designing, planning, pricing, and delivering to meet asset performance requirements described in the contract.*
- *Focusing delivery performance on predictability of achieving a contracted outcome. Amongst metrics to measure a supplier’s performance Highways England measures how predictable a supplier is in terms of time and value generation when compared to cost incurred. This metric is designed to measure variance from planned productivity. Its ambition is to support delivery of an integrators obligations to meet a client’s expectation while realising more sustainable rewards than under transactional trading agreements.*

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