

So, What Went Wrong with HS2?

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Date:

February 2025

The Productivity Institute

Productivity Insights Paper No.052

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Key words

Productivity, HS2, infrastructure, investment

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Suggested citation

G. Winch (2025) *So, What Went Wrong with HS2?* Productivity Insights Paper No. 052, The Productivity Institute.

The Productivity Institute is an organisation that works across academia, business and policy to better understand, measure and enable productivity across the UK. It is funded by the Economic and Social Research Council (grant number ES/V002740/1).

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Abstract

The HS2 story is dire. According to one calculation, estimated costs to complete Phase 1 rose 134% in real terms over the 10 years 2012-2022 with the estimate in current prices in the region of £67bn (Financial Times 10/01/24). This rampant budget escalation provided the political justification for cancelling of what remained from Phase 2 of the programme. While this decision is understandable politically, it has left HS2 as a massive £50bn+ investment with a negative ratio of benefits to costs and the prospect of poorer connectivity than now with London for those living north of Birmingham.

The aim of this Insights Paper is to investigate how HS2 got into this mess in order to learn the lessons and ensure that they are never repeated. For the analysis we draw on a review of published sources – especially National Audit Office Value for Money Reports – and attendance at a Westminster Forum conference in November 2023, shortly after the announcement of the cancellation. The initial conclusions of this analysis were presented at Chief Executive Officer's dinner, at which leading players in HS2 over the last 20 years were present, organised by the Major Projects Association under Chatham House rules in January 2024.

So, What Went Wrong with HS2?

One of my first jobs as Transport Secretary has been to urgently review the position I have inherited on HS2. It has long been clear that the costs of HS2 have been allowed to spiral out of control, but since becoming Transport Secretary I have seen up close the scale of failure in project delivery – and it’s dire. Taxpayers have a right to expect HS2 is delivered efficiently and I won’t stand for anything less. I have promised to work fast and fix things and that’s exactly why I have announced urgent measures to get a grip on HS2’s costs and ensure taxpayers’ money is put to good use. It’s high time we make sure lessons are learnt and the mistakes of HS2 are never repeated again.

Louise Haigh, Transport Secretary, October 20th, 2024

Introduction

The HS2 story is, indeed, dire. As shown in table 1, according to one calculation estimated costs to complete Phase 1 rose 134% in real terms over the 10 years 2012-2022 with the estimate in current prices in the region of £67bn (Financial Times 10/01/24). This rampant budget escalation provided the political justification for cancelling of what remained from Phase 2 of the programme. While this decision is understandable politically, it has left HS2 as a massive £50bn+ investment with a negative ratio of benefits to costs and the prospect of poorer connectivity than now with London for those living north of Birmingham. The aim of this Insights Paper is to investigate how HS2 got into this mess in order to learn the lessons and ensure that they are never repeated. For the analysis we draw on a review of published sources – especially National Audit Office Value for Money Reports – and attendance at a Westminster Forum conference in November 2023, shortly after the announcement of the cancellation. The initial conclusions of this analysis were presented at Chief Executive Officer’s dinner, at which leading players in HS2 over the last 20 years were present, organized by the Major Projects Association under Chatham House rules in January 2024.

Year of Estimate	Cost (£bn 2022 prices)
2012	21.6
2015	33.4
2019	45.8
2020	46.3
2022	50.5

Table 1: Headline HS2 Phase 1 Cost Escalation. (Source: Gilligan, 2022: 17)

We first provide a timeline for the development of HS2 over the last 20 years or so before turning our focus more analytically to the principal generators of this cost escalation: the mismatch between the strategic and economic business cases; over specification of the system; schedule compression; commercial arrangements; and finally, owner project capability where we identify the most important lessons of this debacle. While there has been considerable scrutiny of the business case for HS2, particularly from the House of Lords Economic Affairs Committee (HoL, 2015, 2019), this report focuses on the weaknesses in the organization of the HS2 programme, referring to the issues around the

business case when then impinge on the effectiveness of project organization. It draws on sources published up to and including December 2024

The HS2 Timeline

The idea of a new north/south railway line was first mooted by the then Strategic Rail Authority in the early noughties (SRA, 2002). The concept lay dormant, and indeed was explicitly rejected in a 2006 transportation policy review (HMT, 2006), until picked up by the then Minister of State (later Secretary of State) for Transport, Andrew Adonis (Glaister, 2021). As a result, HS2 Ltd was formed in 2009 to act on behalf of the Department for Transport (DfT) to shape and deliver the UK high speed rail network north of London. Its principal recommendation was a Y-shaped network connecting London, Birmingham, Manchester and Leeds via Sheffield which would release capacity on all three of the north-south rail lines out of London¹ was accepted by the Labour government in 2010 (DfT, 2010). New rail routes were seen as the only sustainable option for increasing train path capacity in north/south travel within England, and onwards to Scotland, releasing capacity on the existing network for commuter and freight traffic development². It also noted that while the capacity issue could be addressed by building new conventional lines, the marginal cost of high-speed lines brought significant additional benefits in terms of improved connectivity through reductions in journey times and hence further the potential to attract traffic from the roads and airlines. The substantial benefits for regional economic growth were also identified. The specified delivery date of the London to Birmingham leg was 2026.

The incoming Conservative and Liberal Democrat coalition government enthusiastically endorsed the programme, with endorsement from Prime Minister David Cameron (Glaister, 2021). It published the report that would authorize the delivery of HS2 (DfT, 2013), splitting the overall Y-shaped project into Phases 1 (London to Birmingham) and 2³ (the Eastern and Western legs of the Y). This report reiterated many of the points from the 2010 document regarding capacity and regional growth benefits while placing noticeably greater emphasis upon connectivity through travel time savings. Additional research was commissioned to support the connectivity analysis in order to take into account the challenge that many business travellers worked on the train and so the effective time saved was generally less than the total saving in travel time (ITS, 2013). Despite the reduction in the value of time saved for business travellers, time savings amounted to over 70% of the business case (DfT, 2013: Figure 5.6). The report also noted the difficulties of measuring the capacity benefits, particularly with regard to the release of train paths on the existing network for commuters and freight. This led to the deposit of the Phase 1 hybrid bill in November 2013.

Further review of the overall programme took place as the programme evolved and budget and schedule pressures mounted. A report by the newly appointed chair of HS2

¹ West Coast Main Line (WCML) to Birmingham and Manchester, Midland Main Line (MML) to Sheffield, and East Coast Main Line (ECML) to Leeds.

² An earlier consultancy report led by Atkins had identified the development of very serious overcrowding on the southern portion of all three lines by 2016. <https://webarchive.nationalarchives.gov.uk/ukgwa/20100409090644/http://www.dft.gov.uk/pgr/rail/research/ech/research/hspedlinestudysummaryreport.pdf> (accessed 18/01/24). The evidence for this claim is much debated (HoL, 2015; 2019)

³ The 2010 report had recommended a single hybrid parliamentary bill.

(DfT, 2014) strongly re-emphasized the capacity and regional growth arguments and recommended accelerating the delivery of the Birmingham to Crewe section – designated as Phase 2a – to deliver these capacity and regional benefits more quickly. It also saw the opportunity to integrate the northern sections of Phase 2 into the redevelopment of the east-west rail links from Liverpool to Hull which later became designated as Northern Powerhouse Rail. A separate hybrid bill for 2a was, therefore, introduced to parliament in July 2017, and received Royal Assent in February 2021.

Royal Assent for Phase 1 was received in February 2017, some 23 months later than originally envisaged in 2013 on a schedule that was described with hindsight as “heroic” (Lagerweij & Knight, 2021). Work then began in earnest on more detailed engineering in preparation for the next key milestone for Phase 1 – the Notice to Proceed (NtP), and hence the actual start of construction of the main works. During this period, concerns mounted with respect to both schedule and budget and so the Oakervee Review was commissioned, reporting in late 2019 (DfT, 2019). This more critical report recommended proceeding with the whole network envisaged back in 2010, while making a number of important criticisms of how the project had proceeded to date. It reemphasized the capacity and regional development arguments, while arguing for much greater attention to be paid to the realization of those benefits. It also developed a fourth, net zero benefit, arguing that HS2 had considerable potential to reduce carbon emissions through modal shift from air and road travel for passengers and from roads for freight while being carbon neutral in operations⁴. The undervalued negative impact on the environment of construction and through life was also noted. The decision to proceed was strongly backed by the Prime Minister of the day, Boris Johnston.

On the back of this review, the Notice to Proceed⁵ for Phase 1 was granted in April 2020, and actual construction started in the September of that year despite COVID restrictions. However, progress was not good, and concerns regarding schedule and budget grew. Most of the eastern leg of the “y-shaped” network was cancelled as part of a strategic review of rail in the north of England in November, 2021 (DfT, 2021). Postponement for two years of Phase 2a followed in March, 2023, although the hybrid bill for the rump of Phase 2b for Crewe to Manchester had been introduced in January 2022. The final blow to the original 2010 concept came in October 2023 when the cancellation of the whole of Phase 2 was announced by Prime Minister Rishi Sunak. Arguably, this decision has resulted in the worst of all possible outcomes from the HS2 project. Billions will have been spent on the Old Oak Common⁶ to Birmingham “shuttle” which will relieve congestion on the southern leg of the WCML but do nothing for stimulating regional economic growth beyond Birmingham and little to improve connectivity⁷.

The escalation of the budget and schedule of the HS2 programme happened in three distinct phases. First, during the hybrid bill process, representations from environmental

⁴ In terms of both embodied and operational carbon, HS2 was expected to be carbon-neutral over its operational lifetime (Glaister, 2021).

⁵ This is also referred to as the Final Investment Decision by the National Audit Office.

⁶ While the construction of the tunnels from Old Oak Common to Euston was authorized in the October 2024 Budget, the final configuration of Euston Station remains unresolved (HoCCPA, 2023, 2024).

⁷ Indeed, it is suggested that travel times to Manchester will get worse because the HS2 trains will need to run for longer on existing track, but they do not tilt and so will need to run more slowly on more congested lines (HoCCPA, 2024).

groups and those living along the trace led to various mitigations to reduce its social and environmental (Lagerweij & Knight, 2021). The second phase was from the Royal Assent in 2017 through to the re-baselining in 2019. This was the phase where the implications of earlier decisions on the specification were worked through in engineering design as detailed information on ground conditions became available (NAO, 2020). This had a considerable impact on the main civil engineering works which were the responsibility of the four JVs, but also on the stations and preparatory works. Land acquisition costs also turned out to be higher than expected (NAO, 2018). The third period was from the Notice to Proceed in 2020 through to the cancellation in 2023.

The estimated budgetary increase⁸ in the first phase of escalation was estimated at £1.2bn against an original provision for mitigations of £245m (HoCCPA, 2020). In the second phase, budgetary escalation was £10bn. Nearly 50% of this escalation was due to the main civil engineering works (NAO, 2020: Table 7). In the third phase further escalation from £44.6bn including £10bn of contingency to a range of £49bn to £57bn was predicted principally in the civil engineering works, largely explained by a combination of COVID-19 restrictions which came into force just as project execution on site commenced, and high levels of inflation in construction materials of 27% over three years related mainly to the war in Ukraine (HoCCPA, 2024). Some of the escalation is clearly due to external shocks, and some is due to external stakeholder pressures. However, in this Insight Paper we will explore the contention that budget and schedule escalation is an organizational process explained by the interactions within the project organizational system rather than a failure of estimating technique or simply the result of the project being buffeted by external shocks. We argue that there are five main aspects of this organizational system: the mismatch between the strategic and economic cases; overspecification; schedule compression; commercial strategy; and project owner capabilities. We discuss seriatim.

The Mismatch between the Strategic and Economic Cases

A number of independent reviews (DfT, 2019; NAO, 2013) identified the mis-match between the strategic and economic cases⁹. The strategic case is about *why* the project is being done, while the economic case address *which* options best meet the strategic case usually expressed in cost benefit ratios (Winch, Maytorena-Sanchez, & Sergeeva, 2022). The strategic case for HS2 clearly revolves around capacity on the north/south rail networks, particularly in the approaches to London, and the benefits for regional economic growth (DfT, 2010, 2013, 2019). As Lord Patrick McLoughlin (the Secretary of State for Transport who launched the Phase 1 hybrid bill) said in 2024 “capacity was always the big issue”¹⁰ as argued by Andrew Adonis (*The New Statesman*, 24/08/13) 10 years earlier. Yet, in the first published CBA for the project, time savings for travellers amounted to 70% of the “total transport user benefits” of Phase 1, and 76% of those for Phases 1 and 2 combined (DfT, 2013: Figure 5.6). It was also noted how difficult it is to get

⁸ We have not attempted a detailed presentation of the budget escalation since 2010 because of shifts in the base years for prices and changes in scope, particularly whether Euston station is included in the figures quoted. Such an analysis will require significant forensic accounting work. Table 1 provides only an indicative overview.

⁹ This terminology refers to the 5 Business Cases model for investment appraisal developed by HM Treasury (HMT, 2020).

¹⁰ At the Northern Transport Summit, Manchester, 2024.

any measurable grip on the benefits of releasing capacity on the existing lines and the wider economic benefits for regional economic growth a difficulty also noted by the House of Lords (HoL, 2015).

This lack of specificity in the strategic case led to a much greater emphasis on the economic case where the benefits that could be measured were traveller time-saved, in line with standard DfT appraisal practice. This then, we suggest, led to an emphasis upon speed and frequency in the original specification of the network in order to gain enough benefits to outweigh the estimated construction costs. The simple arithmetic of time saved per traveller by number of passengers, we suggest, drove in additional costs and made estimating those costs more difficult through overspecification. As the House of Lords concluded:

We are concerned that the flawed appraisal method, where the vast majority of the project's benefits are reliant on faster journey times, is behind the Government's unwillingness to reduce the cost of the project by designing a railway to run at a lower speed. An appraisal method that took more account of the transformative effects of new infrastructure would be less sensitive to small changes in journey times (HoL, 2019: 40).

Overspecification

The specification from DfT for HS2 was and is very high compared to other high-speed lines around the world. In its initial appraisal of the London to Birmingham route, the Department for Transport specified a service speed of 360kph¹¹ for 400m trains in two sets at a frequency of 14 rising to 18 trains per hour with the route constructed to the European loading gauge. However, the trains would be "classic compatible" rather than to European loading gauge standard to enable through running onto the existing rail network (DfT, 2010, 2013). The argument for high speed was that specifying a new 200 kph conventional line on the same route would save only 9% over the 360kph option (HoL, 2019) yet would lose most connectivity benefits from time saved in travel between England's principal cities. While concerns were raised during the technical consultation process, the very high speed/high frequency specification was considered technically feasible using the prototype Alstom AGV as a "reference train" and was therefore confirmed (DfT, 2012; HS2L, 2012).

While technically feasible, this technology choice was unwise; others have called it "close to ludicrous" or "silly" (HoL, 2019: 37). Around the world, the vast majority of high-speed lines run at around 300kph with an hourly frequency in single figures (DfT, 2019; NAO, 2020), and the 360 kph requirement meant that it moved outside the existing European Technical Standards (PwC, 2016), turning it into an innovation project without significant experience of constructing earlier high speed lines to build upon. The implications of this technology choice include using slab¹² rather than ballast track beds which are noisier and therefore require more noise mitigation; higher specifications for bridges and viaducts; deeper cuttings to improve noise mitigation (NAO, 2020); more costly track alignments; more grade-separated junctions; challenges in the Euston

¹¹ The design speed for the route was 400kph to allow for upgrades.

¹² Slab track beds require less operational maintenance than ballast beds (DfT, 2019)

approach and generally more platforms at stations (DfT, 2019). In addition to noise mitigation above 300kph,

Higher operating speeds are known to drive cost higher in two ways. Firstly, dynamic loading and aerodynamic effects drive marginally greater costs in assets such as viaducts and tunnels. Secondly, a higher speed reduces flexibility in the vertical and horizontal alignment of the railway, making it more difficult to avoid costly assets like tunnels and viaducts, driving more significant costs (PwC, 2016: 35).

We have been unable to find a report on the rationale behind this very high specification, but it is difficult to avoid the conclusion that this very high level of specification it was driven largely by the requirement to make the economic case add up. Moreover, the lack of operating comparators for the proposed line meant that reference class forecasting was rendered challenging for the programme, making the estimation of costs even more difficult than it need have been. It is unclear how much additional cost overspecification induced in the budget, but promoters of the privately financed proposal to take Phase 2a/b from Birmingham to Manchester forward believe they can deliver for between 60% and 70% of the existing Phase 2a/b estimates by optimizing the technical specification (Arup, 2024b).

A further element driving uncertainty and complexity into the project is the importance of capacity in the strategic case. This meant that the standard European practice of using existing lines to enter city centres could not be used, and this is a particular issue at the highly constrained Euston terminus (NAO, 2023; DfT, 2020). Similarly, more frequent intermediate stations than on comparator lines on the Eastern leg such as Sheffield were required to ease capacity on the MML and ECML. Regional economic development objectives similarly added additional stations at locations such as Manchester Airport. More generally, the density of existing infrastructure, and hence the costs of avoiding it, were identified as greater in the UK than many, but not all, EU countries (PwC, 2016).

Schedule Compression

Royal Assent for the Phase 1 hybrid bill was received some 23 months late in February 2017, against an original milestone of March 2015, yet the opening date originally set in 2010 remained 2026. Additionally, the deadline for completing construction was brought forwards by 12 months so as to allow more time for commissioning (NAO, 2016). This schedule compression had a number of perverse consequences that surely drove in escalation to the budget. Prior to the hybrid bill becoming law, HS2 did not have the legal powers to acquire the land along the trace, and hence to carry out detailed site investigations on ground conditions (NAO, 2016). The budget estimates prior to Royal Assent were, therefore, necessarily based on limited real data.

The perceived immovability of the 2026 deadline despite schedule compression then drove a number of project governance failures. The construction schedule required that construction actually start in 2018, and a prerequisite for this was the appointment of the contractors. So, HS2 Ltd was given permission to start the procurement of the main civil engineering works in June 2016, some three months after the award of the Engineering Delivery Partner contract and Enabling Works contracts in March of that year. The award of two-stage tender design-build contracts to four international joint ventures (JVs) was in March 2017, just one month after the receipt of Royal Assent. This series of milestones

can only be described as rushed, with engineering of the Phase 1 as a whole underdeveloped prior to contract award, and detail design reliant on the acquisition of data on ground conditions which turned out to be worse than expected.

The objective of two-stage tendering is to allow further information to be acquired that would allow the agreement of a target cost for the physical construction to be agreed between the parties (HS2 Ltd and the four JVs), but as stage one progressed estimates of the target costs mounted, and in June 2018 the JVs warned that costs were likely to rise by 50% and the schedule could be extended by 12 to 18 months (NAO, 2020). Despite this news, DfT authorized £84m of investment in construction equipment so as not to place the 2026 deadline under further threat. By October 2018, main civils costs were 83% higher and concerns were mounting within government. In March 2019, HS2 formally notified DfT that the original budget and scheduling date were unachievable, a view confirmed by the Infrastructure and Projects Authority (IPA) in June 2019. Despite this, HS2 was authorized to make an additional £500m investment in equipment and detailed design because to stand down the JVs at this point and then remobilize them later would incur additional costs of £350m. Moreover, the programme remained government policy (NAO, 2020). The programme was finally “re-baselined” in November 2019, and this, with the positive Oakervee Review, supported the issuance of the Notice to Proceed.

Commercial Strategy

One of the major weaknesses identified in HS2 Ltd was its commercial capabilities (DfT, 2019). The main civil engineering works for the Phase 1 route, not including stations or enabling works, were split into four design and construct contracts won through competitive tender by international JVs. Procurement was on a two-stage process of award against an initial tender followed by the agreement of a target cost contract at stage two as the basis for Notice to Proceed. In the original invitation to tender for the main civil engineering works for Phase 1, the first stage was to be on a cost-plus basis while the detailed design was worked up following full site investigations which had been impossible prior to starting procurement because the programme had not received Royal Assent. This development work then formed the basis for the negotiation of a target cost contract for the second stage based on the significant transfer of risk to the JVs which were to be responsible for 60% of any forecast cost increase against the target during actual delivery. As a result, external evaluations of the JV’s designs found significant “gold plating” with “much of the design seemingly done on a worst-case risk-averse scenario” (DfT, 2019; 8.2)¹³. The commercial strategy also led to greater fragmentation of the design process across the four JVs resulting in a lack of standardization of structural elements such as bridge and viaducts and hence missed opportunities for engineering cheaper solutions (ICE, 2023).

In preparation for NtP, HS2 Ltd revisited its commercial strategy having realized, rather late in the day, the issues with its 2016 approach. It removed the high level of risk for the JV member companies to their balance sheets and switched to paying the JVs a fee to construct Phase 1 against performance incentives to improve performance and a share of whatever contingency remained in the budget at the end of the contract. However, this

¹³ See also testimony before the Transport Select Committee of the Chair of Network Rail High Speed, reported *New Civil Engineer*, 09/11/2023.

approach required the development of even greater commercial capability by HS2 Ltd to manage this more complicated incentive framework (NAO, 2020). Later commentary derided this decision as reverting to what was, in effect, a cost-plus commercial strategy (HoCCPA, 2024). While the present Labour government is proposing to review the commercial relationships again, it is difficult to see what can be done at this stage of the programme to mitigate these earlier errors.

Owner Capabilities

Commercial capabilities were not the only area of weakness in the HS2 Ltd organization. Schedule compression placed considerable strains on the two principal organizations (NAO, 2020: Figure 3) in the owner domain¹⁴ on the megaproject – HS2 Ltd and Department for Transport. Around them are a number of other owner-side stakeholders including HM Treasury as the source of finance, and local government authorities along the route which are responsible for the achievement of regional growth benefits, but it was with the two principal members of the project owner domain where issues were raised about the organizational capabilities. HS2 Ltd is the “arm’s length body” responsible for both shaping and delivering the programme as a delegated project owner, and DfT is the departmental “sponsor” accountable to Parliament for the programme, and the channel for finance from HM Treasury. The Senior Responsible Owner (SRO) for the programme sat within DfT.

Concerns around the organizational capability of the DfT to sponsor the programme were raised early on (NAO, 2013). As the programme developed similar concerns were also raised because “HS2 Ltd is building its capability at the same time as starting to deliver the programme” (NAO, 2016), including developing the project management information systems that would be required to control the project once construction began. It recruited 500 staff during 2015 in a period of high competition for such staff across the infrastructure sector, while also moving the staff already employed from London to Birmingham. It also appointed an Engineering Delivery Partner in March 2016 to support these in-house staff. By 2020 it had 1250 staff in post, but there remained a lack of external confidence that enough had been done to develop organizational capability (DfT, 2019; NAO, 2020). Further capability weaknesses were identified in the areas of system integration, network integration with the existing rail network, and project planning and control. There was a high turnover of chairs of HS2 Ltd. Turning to the senior leadership team, there was no Project Director, Commercial Director, nor Chief Operating Officer in post in 2019 (DfT, 2019). In summary, there was “not convincing evidence that HS2 Ltd, especially the Phase One construction team, have the level of control and management of the construction normally associated with major projects” (DfT, 2019: 10.21) despite the successes of the earlier HS2 Improvement Programme. Concerns in this respect were still being raised after the cancellation of Phase 2 (HoCCPA, 2024).

This perceived lack of organizational capability was compounded by the pressures on HS2 staff to find savings as budget and schedule pressures mounted during the 2016 to 2019 period. Managing design development, land acquisition, procurement, and mobilization for construction under a compressed schedule as well as supporting the

¹⁴ The owner domain is the cluster of organizations on the demand side for a project, only one of which acts formally as contractual owner (client) with the supply side for the project (Winch et al, 2022). On megaprojects, the owner domain is itself frequently complex organizationally.

Phase 2a hybrid bill's passage through Parliament would have been challenging enough for HS2 Ltd. However, the continual escalation of budget following the award of contracts for the main civils works motivated repeated rounds of searches for additional savings without altering scope and the 2026 deadline. This diverted attention from actually delivering the project while making no discernible difference to budget and schedule escalation. Even in 2017, when it was internally accepted that a full opening of Phase 1 in 2026 was not achievable, DfT still insisted upon HS2 trying to find a way of keeping to the 2026 opening date (NAO, 2020), diverting resources from actually delivering the project.

Issues were also identified in the governance interface between DfT and HS2 Ltd. DfT established a series of gates for determining the organizational capability of HS2 Ltd to allow further delegation of responsibilities (NAO, 2016), but as HS2 struggled to meet the criteria for those gates during 2016 and 2017, DfT apparently dropped the implementation of those gates without offering HS2 Ltd any additional time to develop those capabilities (NAO, 2020). The lack of DfT representation on the board of HS2 Ltd. was also of concern. The SRO only had an observer position on the board, indicating weak oversight of HS2 Ltd, and there was no other Departmental representation on the board, leaving a heavy reliance on DfT's independent Project Representative (P-Rep) for assurance which was an external consultant.

Where are We Now

Civil engineering works on Phase 1 continues apace, and tunnelling through to Euston from Old Oak Common will commence shortly. However, construction was paused in 2023 on the main Euston station works awaiting the formation of a development corporation to raise private finance. Enabling works continue on a "no regrets" basis. The proposed development corporation for the Euston station area using private investment has not yet been established. Trains are expected to run from Birmingham Curzon Street to Old Oak Common by 2033, but it will likely be after 2035 when they finally run into Euston. What is vital here is that potential platform capacity be safeguarded during the redevelopment process for Euston to accommodate trains should the Birmingham to Manchester line eventually be built.

The hybrid bill for Phase 2b¹⁵ (Crewe to Manchester), introduced in January 2022, survived the end of parliament "wash up" in June 2024 and is presently in the Committee Stage. Phase 2b is, of course, redundant if Phase 2a is not built, but much of its route will be required for the proposed Liverpool Manchester Railway via Manchester Airport as part of the Northern Powerhouse Rail programme (Arup, 2024a). Its passing will also significantly reduce risks for any plans to revive Phase 2a both by fully safeguarding the currently consented route and potentially allowing the Liverpool Manchester Railway to take on the risk of tunnelling through to Manchester Piccadilly.

A consortium of private interests sponsored by the mayors of Greater Manchester (Andy Burnham) and West Midlands (Andy Street, now Richard Parker) is presently working on ways to revive phase 2a (Arup, 2024b). The proposal for the Midlands-North West Rail

¹⁵ "A Bill to make provision for a railway between a junction with Phase 2a of High Speed 2 south of Crewe in Cheshire and Manchester Piccadilly Station; for a railway between Hoo Green in Cheshire and a junction with the West Coast Main Line at Bamfurlong, south of Wigan; and for connected purposes". (<https://bills.parliament.uk/bills/3094> accessed 04/11/24)

Link (MNWRL) is based on a significant re-thinking of the technical specification, reducing the operational speed to 300kph, switching to ballasted track, and UK loading gauge which they estimate would reduce estimated costs to 60-70% of those estimated by HS2 Ltd. It would be built sequentially in two phases: the Staffordshire Connector along the route of Phase 2a and the Cheshire Connector along the route of Phase 2b until it joins Northern Powerhouse Rail near Manchester airport. Such a relatively simple, in engineering terms, line would be attractive to international investors to finance construction in a Public Private Partnership (PPP). Essential to this initiative is the maintenance of the powers granted under the Phase 2a hybrid bill and continued safeguarding of the Phase 2b route until that parliamentary process can be completed. Such a proposal would yield all the capacity gains for the WCML expected from the original proposal; maximize utilization of Curzon Street Station in Birmingham; and only extend Manchester-London journey times by 15 minutes over the original HS2 business case.

The cancellation of Phase 2a will cost £100m (2024 prices) in remediation of the work already done on Phase 2a additionally to the £1.7bn (2019 prices) that has already been spent on Phases 2a and 2b to Manchester. This is mainly design work, but also some physical enabling work on 2a. Against this is the potential income from the sale of the land acquired for Phase 2 for £592m¹⁶ (NAO, 2024). Of course, if the MNWRL went ahead, a significant proportion of that otherwise sunk cost could possibly be recovered by sale to the proposed special purpose vehicle.

What are the Principal Lessons?

We identify here three very important lessons from the preceding analysis which we hope the UK government will take forwards. We suggest below one way in which that might be done. In identifying these three lessons, we draw on the broader range of research literature that has helped us to pull out these particular lessons.

Our first lesson is on the tension identified between the strategic case and the economic case, and the vital importance of a clear project narrative. The narrative for HS2 was not clear. While rail insiders fully understood the importance of the strategic case for adding capacity to the UK rail network going north of London which would ease predicted congestion and release new paths for freight, regional and commuter traffic, this was not communicated clearly and consistently. In particular, there were considerable difficulties in valuing the benefits of the released capacity due to the difficulties of predicting how the decongested lines could best be used. A significant part of the problem here is the lack of an overall strategy for the development of UK rail, and indeed UK inter-urban transportation more generally (DfT, 2019; Glaister, 2021; NIC, 2023). Only in the context of a much wider strategy can the strategic case for HS2 be effectively articulated as part of the UK rail network.

Research on effective project narratives (Sergeeva & Winch, 2021) has shown that they need to articulate our aspirations for desired futures, rather than calculate present benefits as the Elizabeth Line and Channel Fixed Link show well. Narratives are how we stabilize the future in a world of radical uncertainty to allow the mobilization of financial and other resources to investment projects (Kay & King, 2020). Hence aspirational project

¹⁶ The figure quoted is for all of Phase 2, but as only Phase 2a has Parliamentary consent for compulsory purchase, most of this sum will have been spent on that phase.

narratives are required to motive the “animal spirits” that stimulate the major capital investments that shape our future, not quantitative comparisons of benefits against costs (Keynes, 1961). The reliance of the justification of HS2 largely on an economic case based on time saved made it easy, and justifiable, prey for critics (Gilligan, 2022) and a Prime Minister who was not personally committed to the project as budget escalation turned already marginal benefits negative. Getting business travellers who were likely working on the train to London faster was always a rather unconvincing narrative to the public for such a massive and disruptive investment.

The second very important lesson is, do not compress the schedule. Projects should be scheduled from the left at “natural pace”¹⁷, not from the right backwards from an arbitrary deadline. Compressing the schedule beyond natural pace will not actually get the project delivered any faster, because it will inevitably overrun, but it will cost more due to the more tightly bound complexity driven into the project by the compression. This is a lesson from the Channel Fixed Link (Winch, 2013) which was not learned by either Crossrail¹⁸ or HS2 Ltd. It was unwise to set a target opening date in 2010 of 2026 for Phase 1, but on a balanced assessment it could have been achieved if they had not chosen such a challenging technical specification. What is inexplicable is the decision to not reset the target date to 2028 once it was known in 2016 that the Hybrid Bill was delayed by 23 months. While politicians are understandably wary of not being seen to keep their promises, it would surely not have expended very much political capital to make this reset on the grounds that the democratic scrutiny of the project through the hybrid bill process had been particularly thorough which led to the reset of the deadline. Instead, this lack of political acumen drove escalatory stresses into the project by forcing HS2 Ltd to contract with the supplier JVs before there were adequate data on ground conditions along the route; by generating considerable stresses within the HS2 Ltd organization which was already struggling; and by DfT allowing HS2 Ltd to crash through governance stage gates.

The third very important lesson is about project owner capability. This is central to the effective management of major projects (Merrow, 2024; Winch & Leiringer, 2016). There appears to be a general weakness amongst UK project owners in this regard on evidence from the private sector (Merrow, Sonnhalter, Somanchi, & Griffith, 2009) with, for instance, UK owners not having adequate capability to develop detailed costs and schedules independently of their suppliers, which make it difficult for them to engage in detailed negotiations on these key performance criteria. With regard to engineering, the project lacked a “guiding mind” which resulted in reliance on each JV to develop their own detailed specifications for the structures such as bridges and embankments (ICE, 2024). Only a technically capable project owner working with independent advisors can provide this guiding mind. This led to a lack of standardization across the four JVs and hence lost opportunities to reduce costs because “with no effective design authority holding everything together, there were not the required checks and balances to ensure a good, value-engineered design and manage costs” (ICE, 2024: 10).

¹⁷ We take the concept from BP plc

¹⁸ The problem on Crossrail was that the leadership team tried to accelerate the project to catch up on lost time which then drove complexity into project delivery with inevitable schedule and cost escalation (Winch et al., 2022).

A lack of adequate technical capability appears to be behind the decision to opt for two-stage tendering. The rationale supporting such an approach is that the owner and its tier one suppliers can work together during project definition to reduce uncertainty enough to enable the agreement of an incentive contract to motivate consummate performance through project execution, which is when the big money is actually spent. However, to be effective, two stage tendering needs high levels of capability from the owner organization to engage deeply with the suppliers to ensure that costs are optimized during design development and that budget and schedule agreed are genuinely challenging for the suppliers. Even with a strong, capable owner the benchmarking evidence suggests that two-stage tendering results in higher capital costs because of the inherent incentive for suppliers to negotiate for themselves higher target costs (Merrow, 2023).

As on many megaprojects around the world, the designated project owner, HS2 Ltd, was a start-up organization in 2009. Even the most capable project owners are sometimes involved in major projects that exceed their capacity. HS2 Ltd had to hire in the open market from a highly specialized pool of competencies at a time when there were other megaprojects in delivery, such as Crossrail (now Elizabeth Line) and Thames Tideway. We were told that restrictions on salary levels because HS2 Ltd is wholly owned by the Department for Transport hampered recruitment in this competitive market, and the move of the headquarters to Birmingham from London in 2016 cannot have helped recruitment either because the competence pool is largely based in the South East region.

Another learning is that the implications of environmental mitigations during the hybrid bill process for budget escalation were relatively modest at around £1bn. While this is a lot of money, it is relatively insignificant in the overall level of escalation shown in table 1. However, this figure for escalation does not take into account any planned additional costs in order to meet environmental and other stakeholder requirements, only the unexpected ones.

What is to be done?

Arguably there is very little that the review commissioned by Louise Haigh can do little about the underlying dynamics of budget escalation on HS2 Phase 1. The project's success was put at significant risk around 2009/10 when the decision was made to overspecify and not to use standard, proven technology. This error was seriously compounded around 2015 when the decision was made to compress the schedule by not extending the 2026 deadline once it was realised that the Phase 1 hybrid bill process would take much longer than expected. This schedule compression is, arguably, the principal proximate cause of both the poor choice of commercial strategy and the broader problem of the lack of project owner capability.

The first set of lessons revolves around project appraisal and the ways in which HM Treasury Green Book supports that process. Much has been done over the last 10 years to improve the ways in which Green Book requires government investment projects to be appraised, and the latest revision was published in 2022. It now gives much greater weight to the strategic case than earlier versions. However, the basic problem that cost-benefit analysis was developed to enable the comparison of functionally similar projects to allow prioritization between them for investment (Porter, 2020) but that its application to functionally unique investment projects is much more problematic. We have seen how

the principal benefit of HS2 – capacity release on existing lines – was near-impossible to appraise and the project was obliged to fall back on much weaker set of benefits related to time saved. This does not mean that these more valuable benefits do not exist; it merely means that they cannot be rigorously measured. More work needs to be done to ensure that cost-benefit analysis does not distort the strategic case for infrastructure investment.

Part of the way forward here is to place much greater emphasis upon the strategic case in the context of a much more developed and coherent national strategy for transportation. The National Infrastructure Commission has been doing much of this strategic work summarized in its quinquennial National Infrastructure Assessment (NIC, 2023). The obligatory response from the government in the form of the National Infrastructure Strategy is eagerly awaited. The proposed merger between the NIC and the Infrastructure and Project Authority (IPA) to form the National Infrastructure and Service Transformation Agency (NISTA) will hopefully strengthen this strategic work.

The second set of lessons around the dire consequences of schedule compression will hopefully be easier to learn: plan projects at their natural pace, and if time is lost, don't try to catch it up except by removing scope from the project. Perhaps one issue here is the way in which cost benefit analysis treats the time cost of money to price benefits longer in the future less than those nearer in the future. For assets that will continue to deliver value beyond 60 years, this is a rather short-sighted approach. While there are many commercial environments where project delivery time-to-market is competitively critical, that does not apply to infrastructure projects generally, and to rail projects in particular. Later completion does delay the benefit stream, but it also delays expenditures required for asset delivery and mitigates against budget escalation undermining the economic case. More work in the context of an overall national transportation infrastructure strategy is required here to ensure that complex major projects are delivered at natural pace.

The final lesson perhaps requires the most challenging institutional work to address. HS2 Ltd was a start-up organization and was never given enough time or resource to establish itself properly. It was clearly struggling from as early as 2015 (NAO, 2016), while concerns were raised about the sponsoring department, DfT, even earlier (NAO, 2013). On the evidence, this project owner capability problem was never successfully addressed despite its centrality for the successful delivery of any major project (Morrow, 2023, 2024; Winch & Leiringer, 2016). Although the IPA has been doing much good work over the last 10 years or so to strengthen the capabilities of government departments as project sponsors and owners, there remains a serious problem around larger infrastructure projects identified by the Comptroller and Auditor General. He argued that projects such as HS2 were beyond the capability of a single government department to oversee and that different approaches were needed across government¹⁹. More specifically, the problem is that

The arms-length bodies that oversee delivery are very often bespoke organisations created (at significant cost) for individual projects, and without a plan to transition

¹⁹ Speech to Parliament, 16th January 2024.

to subsequent projects, hard-won experience and institutional knowledge is not effectively carried forward to subsequent programme (Arup, 2024: 41).

A notable feature of the UK institutional landscape is the lack of a standing agency responsible for infrastructure delivery. Looking abroad, we can identify agencies as diverse as the US Army Corps of Engineers, Rijkswaterstaat in The Netherlands, and the relatively newly formed Sund og Bælt A/S in Denmark. Urgent consideration should be given as to whether the UK should establish an infrastructure delivery agency along similar lines to address the issues identified above to deliver the strategies developed by NISTA. Arguably this should be separate from NISTA, because an important part of NISTA's role – inherited from IPA – is project governance and it would generate a conflict of interest if the organization responsible for project delivery were also responsible for governing that delivery. Establishing this agency as a public-private partnership would also be worth considering easing the payment of market-competitive employment packages to attract the right talent.

Concluding Thoughts

The HS2 story is a Greek tragedy in which high aspirations were dashed by avoidable human failures to achieve those aspirations. There is much to be learned as we move towards developing the next tranche of infrastructure projects to address the challenges of rail transportation in the north of England; reconfigure our water supply systems to meet a growing population more resiliently; and totally reconfigure our electricity supply networks to enable a carbon-free future. These are the underpinnings – literally the infrastructure – of our future prosperity. Much can be learned from the HS2 debacle, and we have identified some of the key ones in this review. Hopefully this provides a useful contribution to the current debates and hence to the future of infrastructure development in the UK.

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