HS2 Supply Chain BIM Upskilling Study

June 2014

Executive summary

High Speed Two (HS2) is committed to using Building Information Modelling (BIM) on a scale that is unprecedented in the United Kingdom. This includes achieving Level 2 BIM maturity by 2016 – the same target date as central Government. HS2 will use BIM for electronic storage and use of digital data, helping to deliver:

- collaboration across the entire programme; and
- optimised design for manufacturing and assembly opportunities.

In order to achieve these ambitions, the supply chain's capability must match HS2's requirements.

At the Industry Day in November 2013, it was evident that significant parts of HS2's potential supply chain are either unfamiliar with the aspects of BIM that HS2 wishes to deploy, or lack the skills to apply them. This Upskilling Study examines whether the supply chain can meet HS2's needs and recommends ways of closing any skills gap.

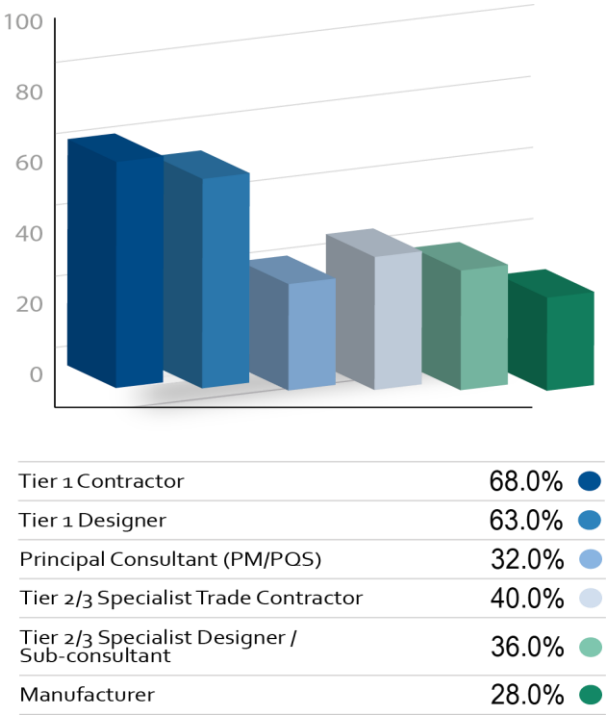
With no industry-wide BIM benchmarking tool available, the first part of the study concentrated on capturing UK industry's current levels of awareness, BIM capacity and, more specifically, Level 2 BIM maturity. The study's methodology consisted of:

- online self-assessment questionnaire (around 300 responses at an organisational level);
- facilitated BIM symposia: a supply chain symposium, rail symposium and BIM2050 workshop;
- selected interviews with symposia participants; and
- outreach activities, including an engagement stand at BIM Show Live 2014, in Manchester.

The quantitative and anecdotal evidence from this study, alongside other recent industry surveys, indicate an ever-increasing awareness and implementation of BIM within the UK supply chain.

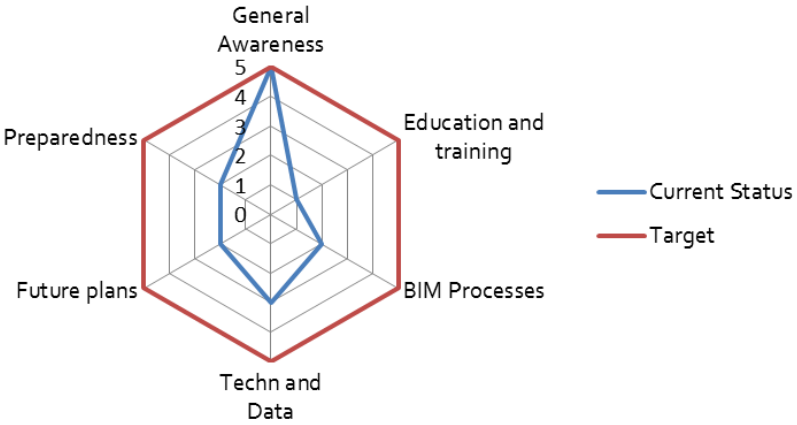
This can be further examined by maturity level and by domain:

Current BIM adoption levels by category:



Current levels of supply chain BIM maturity		
Maturity Level	**Description**	**Study Data**
Level 0 BIM	Unmanaged CAD typically 2D, with paper or electronic ink exchanged between participants	8%
Level 1 BIM	Managed CAD in 2D or 3D using BS1192:2007 with a common data environment	37%
Level 2 BIM	Managed 3D environment using separate discipline BIM tools with attached data	55%

Over half of the supply chain has some degree of experience within Level 2 BIM maturity, although it transpired that this is more on leading projects, as opposed to an overall organisational position. Tier 1 organisations were the most evolved; with the exception of a few early adopters, Tiers 2 and 3 are still constrained within Levels 0-1. It was observed that the maturity categorisation by the organisations was based more on "following the principles of" that level, as opposed to enacting all the relevant British Standards or other key enabling artefacts. The graph below illustrates an overall assessment of the current status, compared to the target status in relation to some key criteria. Despite good awareness, there are still key areas where the knowledge and skills gap needs to be closed.



The good news on awareness is tempered by the fact that these figures are weighted towards BIM for vertical assets - the same capacity is not evident in the rail or infrastructure industry. However, this is not essentially a capability issue, but has more to do with a lack of standards to support open data formats and classifications in the rail sector. These gaps can be closed quite quickly by HS2, by making some strategic decisions around required information standards and by reviewing its position on entirely open standards.

The authors of this study believe that Level 2 BIM maturity - as a minimum standard - is a realistic and achievable goal for HS2 and its future supply chain. However, in order to achieve this standard, HS2 will require some degree of upskilling intervention to meet its programme and projected capacity (especially with regards to Tier 2 and 3 organisations, which may not reach Level 2 without the support of HS2 and Tier 1). This is particularly relevant to procurement and the issue of engaging with organisations or individuals who are not committed to upskilling towards Level 2 BIM competencies. However, HS2 may also require internal upskilling to ensure that its staff have the competencies to buy, manage and transact on the basis of the digital data.

This study makes recommendations based on the following themes:

- organisational BIM assessment toolkits and scorecards;
- defining client BIM requirements;
- communication and knowledge share;
- BIM skills v knowledge – industry needs;
- current industry BIM capacity – building volume and new entrant pathways; and
- future-wise – emerging career needs (upskilling for Level 3).

BIM offers HS2 an exceptional value proposition. However, the scale of the project should not be underestimated. In order to unlock the benefits, HS2 must create both the ‘push’ and ‘pull’ factors for realisation of Level 2 BIM, and must help the supply chain to upskill. The upskilling processes will help UK industry as a whole in its continued journey towards digital leadership in the built environment.

David Philp
MSc BSc FRICS FCIOB FGBC
Study Director

Headline Messages

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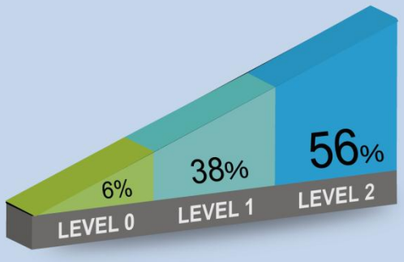
HS2 BIM Supply Chain Upskilling Study

INCREASING BIM IMPLEMENTATION

94% are already using BIM

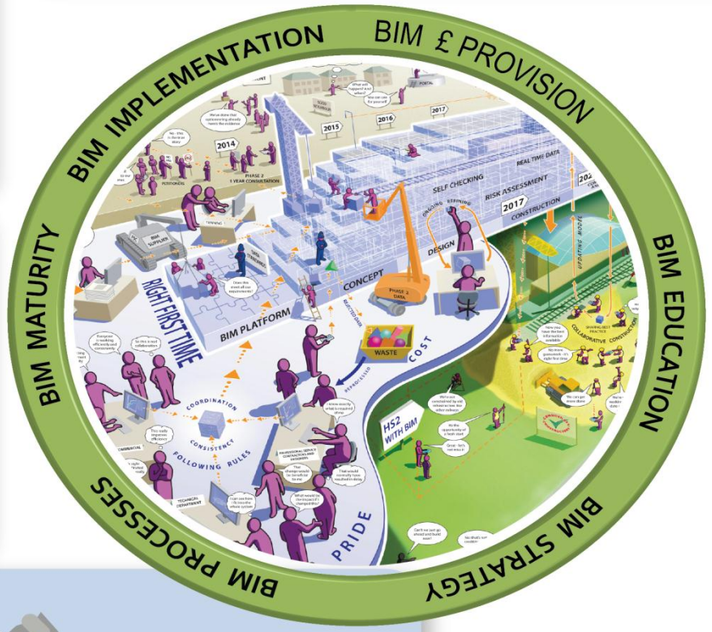
CURRENT BIM MATURITY



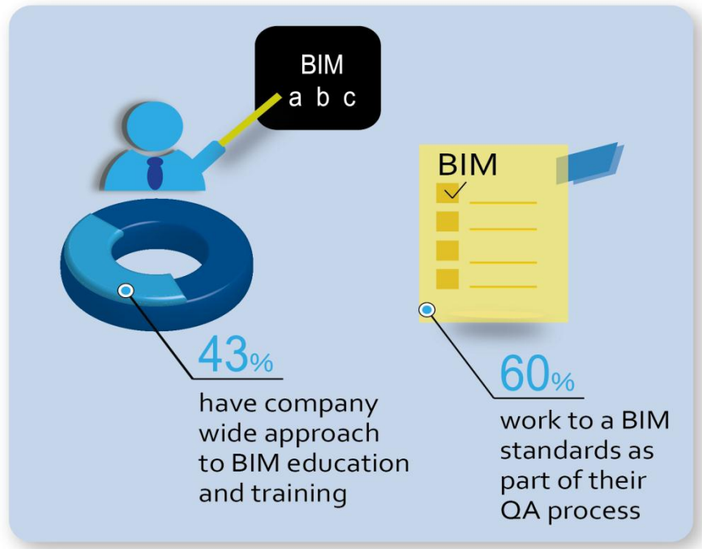
71% make financial provision within their organisation for BIM

BIM ROAD MAP

60% have a BIM strategy with defined goals



> *HS2 will implement Building Information Modelling to an unpredicted scale, digitizing its entire asset liecycle*
>
> *- Prof. David Philp*



43% have company wide approach to BIM education and training

60% work to a BIM standards as part of their QA process

57% use PAS 1192:2:2013

60% work within common data environment

80% use a soft landing approach

76% have used open data standards

44% have used COBie UK 2012 for information

LEVEL 2 BIM A MINIMUM STANDARD

enabling design for infrastructure + assembly

buy

DATA

- store
- use
- transact
- predict

COLLABORATION IS KEY

Section 1: Purpose

1.0 Purpose

High Speed Two Limited (HS2) has demanding commitments and aspirations for the use of BIM, and wants to ensure that the supply chain capability matches HS2's requirements.

At the Industry Day in November 2013, it was clear that significant parts of HS2's potential supply chain are not as familiar with, or skilled in, the aspects of BIM that HS2 wishes to deploy.

This Upskilling Study is to look at whatever gap exists between HS2's needs and the supply chain's current capabilities, and make recommendations for closing that gap.

The aim of the Upskilling Study is to examine the corporate ability of the supply chain to meet HS2's BIM needs as outlined within and presented at HS2 Supply Chain Conference in November 2013.

1.1 Limitations and Considerations

The limitations and consideration of this report are as follows:

- HS2 is looking for collaborative options for upskilling, working with supply chain's existing upskilling strategies.
- The study results will be used by HS2 to understand and develop the means of closing any gap between supply chain skills and HS2's needs.
- Participation in the study does not affect a company's position regarding future contracts - the results of this study will not be used in any part of future procurement processes.
- It does not look at individual companies or at individual people within companies.
- Make the best use of the time available between the completion of the study and the start of procurement.
- HS2 has only begun to procure the initial supply chain; it does not yet know all the members of its supply chain**.**
- Supply chain tiers are defined as per the HS2 Supply Chain Conference in November 2013**:**
    - Tier 1 - lead designer, main contractor, joint venture (JV) partner or supplier, contracting directly to client;
    - Tier 2 - designer, supplier or subcontractor to Tier 1;
    - Tier 3 - supplier to Tier 2; and
    - Other – specialist.

Section 2: HS2 BIM Objectives

2.0 HS2 BIM objectives

HS2 announced its BIM objectives at the HS2 Supply Chain Conference held in Birmingham, November 2013. HS2 outlined its BIM objectives to be:

- for BIM to be HS2's methodology for electronic storage and usage of data;
- for BIM to help collaboration, off-site, NEC, ECI;
- for HS2 to achieve BIM Level 2 by 2016; and
- to buy (and make best use of) data.

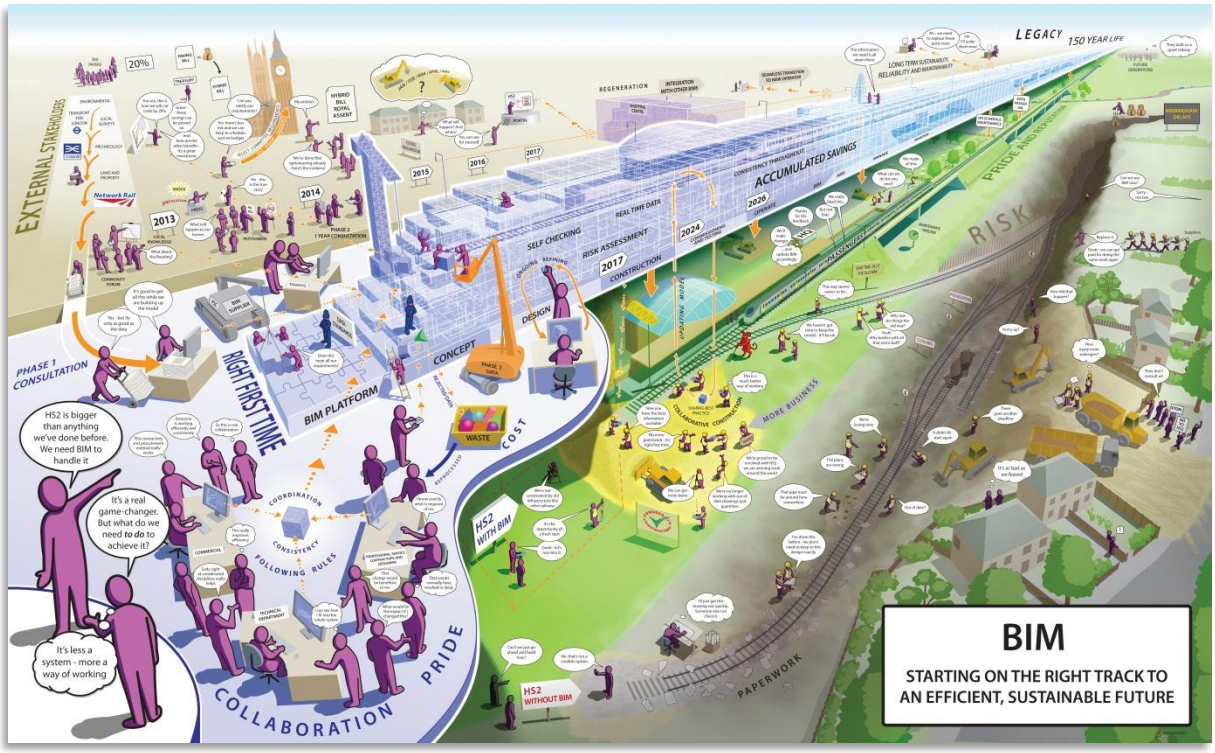


Figure 1 HS2 BIM Journey

2.1 HS2 BIM Challenges

HS2 aims to use Level 2 BIM maturity to an unprecedented scale in the UK. As such, HS2's challenges include the following:

- Level 2 BIM is a developing standard – is the supply chain ready to deliver it?
- Is there sufficient capacity / proficiency in the marketplace?
- Is there any variation in BIM adoption across the construction sector – vertical v horizontal?
- Does HS2 invest in upskilling interventions to help create capacity or buy it with each work package?
- What can HS2 do pragmatically to help the supply chain upskill?
- UK Government BIM Task Group moving to legacy from 2015.

3.0 UK BIM Standards in relation to HS2

The UK Government Construction Strategy (GCS) was published by the Cabinet Office on 31st May 2011. The report announced the Government's intended whole-sector approach to BIM, setting out requirements for collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its centrally procured projects by 2016.

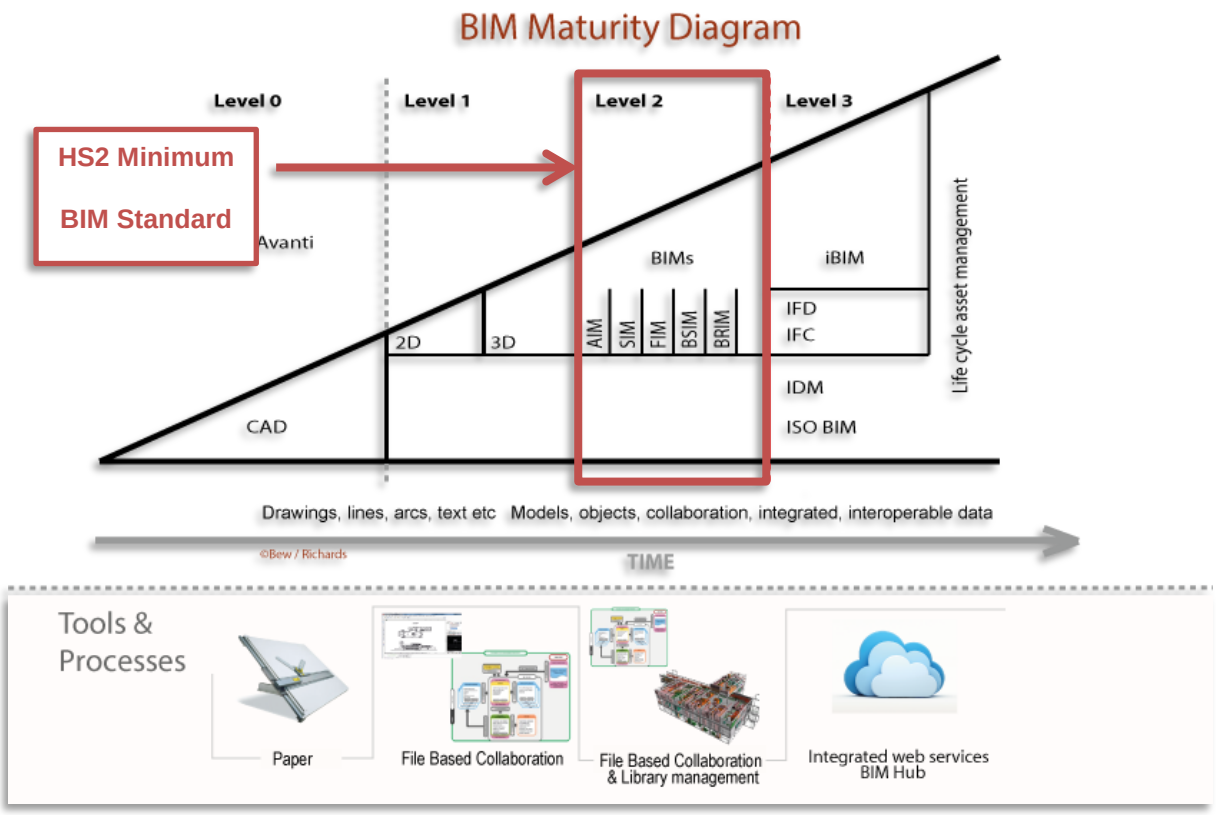


Figure 2 Bew/Richards BIM Maturity Diagram with HS2 minimum BIM standard overlay

To achieve the strategy, the Government identified the need to create a series of stepping stones for the industry; small but well-thought-out steps are intended to deliver significant benefits, including the creation of an industry standard for Level 2 BIM maturity.

Level 2 BIM maturity has been established as the minimum standard for the HS2 programme. The BSI Road Map written by the B/555 team specified the documents and standards that have been produced to support the BIM requirements for Level 2 maturity. The documents specified will continue to be added to until completion; expected by the middle of 2015 when BIM Level 2 is completed. These form an extensive body of work.

The Level 2 BIM documents have been defined under a number of headings as set out below:

1. **PAS 1192:2:2013** Specification for information management for the capital/delivery phase of construction projects using Building Information Modelling.
   Status: complete
2. **PAS 1192:3:2014** Operational Asset Management – Processes and data for the commissioning, handover, operation and occupation stages.
   Status: complete
3. **BS1192-4:2014** Collaborative Production of Architectural, Engineering and Construction Information Part 4 – Client information requirements (COBie).
   Status: due for completion summer 2014
4. **CIC BIM Protocol and Scope of Services for Information Management**
   Status: complete
5. **Digital Plan of Work**
   Status: due for completion March 2015
6. **Classification system**
   Status: due for completion March 2015
7. **Government Soft Landings**
   Status: complete

Level 2 BIM maturity can be described as: "*a series of domain and collaborative federated models, consisting of both 3D geometrical and non-graphical data, prepared by different parties during the project life-cycle within the context of a common data environment. The project participants provide defined, validated outputs via digital data transactions using proprietary information exchanges between various systems in a structured and reusable form.*"

BS1192:2007 Collaborative production of architectural, engineering and construction information. Code of practice should also be seen as a required document as it is the cornerstone of Level 1 BIM and the creation of the common data environment.

It is expected the central government "pull" for Level 2 BIM maturity will help drive capacity and capability within the marketplace by 2016 and this has been reinforced by various surveys such as the National Building Specification (NBS) 2014 survey which has showing in continued trend in BIM awareness and adoption.

Level 2 BIM resolves the methodology of:

- Working in a 3D environment
- Creating structured non-graphical data
- Data verification and validation
- Consistent data exchanges

- Working in a common data environment
- Connecting capex and opex

Commercial benefits of Level 2 BIM include:

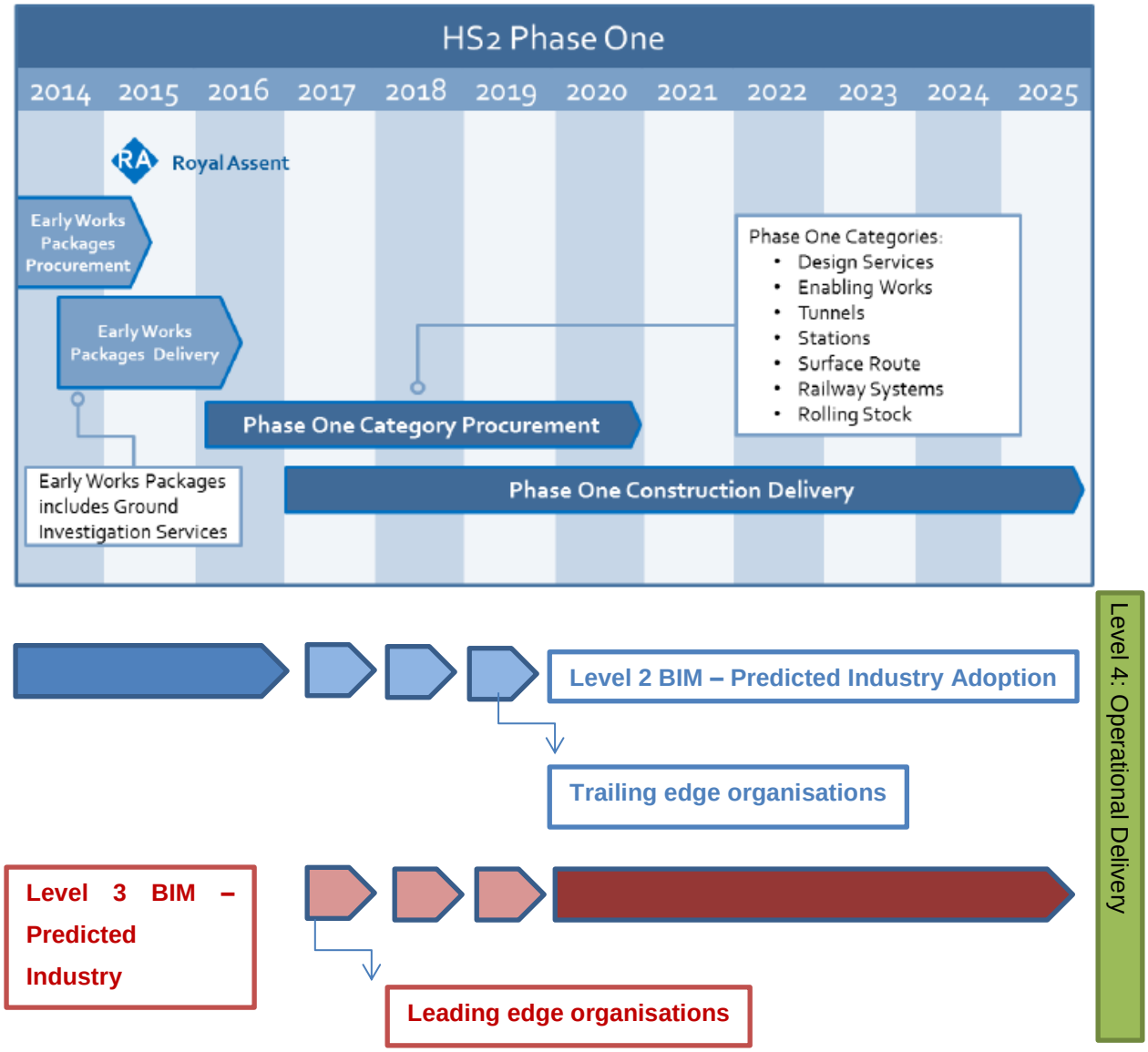
- Encourage collaborative working including early engagement of FM and operation
- Visualisation and lifecycle solution testing at pre-construction stage
- Accurate and complete data improving quality of bids - reducing risk allowances in target prices and lump sum bids
- 3D model input into the assessment of the impact of changes at all stages in a project lifecycle
- Input of a populated asset data set into CAFM systems – saving time and duplicated

HS2 will need to consider whether to take an 'oven-ready' approach to Level 2 or make tailored adjustments to suit the rail sector and any unique data classification or information exchange standards.

The indicative HS2 Phase One programme suggests that "Phase One category procurement" will be undertaken using Level 2 BIM maturity (collaborative BIM), likewise the construction and assembly of the initial packages. It is likely however that by 2020 Level 3 BIM maturity will be achieved within (indeed early adopters maybe in this zone by 2018) the industry with the last five years of construction being undertaken in an integrated environment. It is also likely that operational delivery will be executed in Level 4 "socio" BIM.

There will be a need for HS2 to consider what this transition looks like from a client perspective having bought the data as part of the procurement. It may be that the supply chain operates in the Level 3 environment with the data drops occurring in Level 2 transactions as defined by PAS1192:2:2013.

Figure 3 HS2 Phase One indicative programme and BIM maturity development during Phase One programme



Section 4: Study Methodology

4.0 Study methodology

Mace Ltd was appointed by HS2 to undertake on its behalf a study of HS2's potential supply chain in regards to their BIM capabilities and recommend potential upskilling pathways.

The Study involved an online questionnaire, supply chain engagement symposia and interviews. The intention of the engagement symposia and interviews was to encourage the supply chain to discuss their organisation's use of BIM and expand upon the themes discussed within the online questionnaire.

The target participants of the Study were Head of BIM / BIM Managers / BIM Co-Ordinations / BIM Specialists of HS2's potential supply chain. These roles have been targeted for the following reasons:

- Their knowledge and understanding of their organisation's practical application of BIM
- Their knowledge and understanding of their organisation's BIM strategy
- Their knowledge and understanding of the skills and training required to deliver BIM

4.1 Data Capture:

Quantitative data was collected via an online survey that was a self-assessment questionnaire aimed at organisational level. Controls were introduced to ensure only one response per organisation or a business unit within that organisation was submitted.

Study Questionnaire

The Study's questionnaire was issued online and communicated to HS2's potential supply chain via digital media, including but not limited to:

- HS2 website
- media partners
- professional institutions
- UK BIM Task Group website and newsletter
- UK Regional BIM Hubs
- Mace website
- Twitter

An informal pilot study conducted with a group of potential HS2 supply chain members and the UK BIM Task Group confirmed the requirement to sectionalise questions into these headings. The focus

group identified these sections as being key areas the HS2's supply chain will need to address and focus within a BIM environment.

The Study's questionnaire sectionalised questions into the following key areas:

- Organisational information (Generic)
- Organisational BIM adoption
- Organisational approach to BIM
- Education and training
- Organisational BIM processes
- Technology and data
- Future Gazing
- Organisational challenges to BIM adoption
- Organisational BIM upskilling needs

Symposia

To gain further anecdotal evidence and support data collected within the Study's questionnaire, three structured and one semi-structured supply chain engagement symposia were held at Mace Business School and a leading BIM conference in Manchester, April 2014.

The structured symposia consisted of the following:

- *Supply chain symposium:* this symposium was an 'open invite' industry-wide symposium open to all participants of the Study's questionnaire to discuss their organisation's BIM capabilities and identify areas of upskilling needs and requirements.
- *BIM2050 symposium:* this symposium engaged with the Construction Industry Council BIM2050 group to discuss the future BIM processes, technology, education and skills throughout the duration of the HS2 programme. Details of the BIM2050 group can be found (http://www.bimtaskgroup.org/bim2050-group/).
- *Rail symposium:* this invite-only symposium consisted of members of the rail sector only, from client bodies through the tiered supply chain.

The semi-structured symposium consisted of an engagement stand at a leading BIM conference in Manchester April 2014. Its aim was to encourage supply chain members to identify areas of upskilling, training, innovation, and processes throughout the HS2 programme.

Interviews

Semi-structured interviews were held with a select sample of the Study's questionnaire respondents. Interviews were undertaken with organisations across the supply chain spectrum to allow respondents to elaborate upon their organisation's completed survey.

Section 5: HS2 Symposia and outreach

5.0 HS2 Symposia and outreach

Mace Ltd. hosted multiple supply chain engagement symposia during the course of the Study. The outcomes of these symposia are detailed within this section.

5.1 HS2 BIM Supply Chain Symposium

Figure 4 HS2's supply chain BIM upskilling symposium workshop activities

The first of three facilitated symposia was held at Mace Business School on 9th April 2014 with the purpose of understanding supply chain capability and discussing with the potential supply chain community its upskilling requirements for a large infrastructure project such as HS2.

As the HS2 supply chain has not been fully procured, an open invite to this symposium was issued. Targeted towards the supply chains BIM managers / co-ordinators and information managers, this was to ensure delegates were able to fully participate and engage with the key areas of the symposium.

This first supply chain symposium attracted over 65 delegates from multiple disciplines and sectors, including product manufactures, consultants, and Tier 1 and 2 contractors. The symposium's discussions and workshops covered the following key areas:

- BIM Maturity – where are we now?
- Level 2 BIM – Challenges and barriers
- BIM – Future proofing (data and infrastructure towards Level 3 BIM)
- BIM Upskilling
- Open discussion on achieving HS2 BIM vision

To ensure all delegate perspectives were acknowledged and to avoid siloed thinking and group delegates choose their own seating in table groups of 10 – 15 around 6 table clusters, which during each session / workshop discussed individual topics / themes / ideas. Each table consisted of delegates from different disciplines, skills and levels of BIM maturity.

After introductions from Professor David Philp, Study Director and Head of BIM (Mace Ltd), Bill Grose, Technical Strategy Advisor (HS2), set the scene of the symposium to delegates advising of the purpose of the Study and the neutrality of the Study:

- To understand and look at any gaps between HS2 needs and the supply chains current capabilities (corporate ability),
- Advised HS2 are looking for collaborative options for upskilling, working with the supply chain's existing upskilling strategies and making best use of the time available between the completion of the Study and the start of procurement.
- Clarified the study results are to be used to understand and develop the means of closing any gap between supply chain skills and HS2 needs.
- Chatham House Rules were also observed during the symposium.

Figure 5 HS2 addressing delegates at supply chain at symposium

Jon Kerbey, Head of Management Systems (HS2), outlined HS2's BIM aspirations and visions for the project. Prior to the symposium it was agreed that to ensure full neutrality and confidentiality of the members of the supply chain, the HS2 representatives would not observe or participate within the symposium.

The first facilitated workshop required delegates to plot on the Bew-Richards BIM Maturity diagram (1 per table group) where they believed their organisational BIM maturity was at this moment in time. Professor Philp invited delegates to openly discuss, and share their BIM maturity in the context of linear / rail infrastructure projects.

The direct translation of table notes for workshop 1 are detailed overleaf:


BIM Maturity – Where are we now?
Purpose: To establish where delegates believe their organisations BIM maturity lies on the Bew-Richards BIM Maturity Diagram
Q: Where is your organisations overall BIM maturity?
• Level 0 / CAD: 6% of delegate organisations
• Level 1: 27% of delegate organisations
• Borderline Level 1/2: 10% of delegate organisations
• Level 2: 37% of delegate organisations
• Borderline Level 2/3: 7% of delegate organisations
• Level 3: of delegate 13% of delegate organisations
Q: Where is your organisations BIM maturity in relation to Buildings?
• Level 0 / CAD: 6% of delegate organisations
• Level 1: 56% of delegate organisations
• Level 2: 25% of delegate organisations
• Level 3: 13% of delegate organisations
Q: Where is your organisations BIM maturity in relation to Infrastructure?
• Level 0 / CAD: 41% of delegate organisations
• Level 1: 59% of delegate organisations
• Level 2: 0% of delegate organisations
• Level 3: 0% of delegate organisations
Table Comments:
• "We are doing bits of everything Level 0 – 3"
• "We're at the sharp end of collaboration"
• "The supply chain needs to understand HS2 Ltd.'s requirements to ensure they have the ability to deliver at the required level"
• "Level 3 BIM is real time process of data"
• "Models must have contractual Weight"
Workshop 1
Session 1

The second facilitated workshop required delegates to discuss and present the challenges and barriers to Level 2 BIM adoption within the supply chain. Each table group were given an individual theme to review, discuss and report back to the wider symposium group on their table discussion / findings:

- Culture of collaboration
- Digital tools and interoperability issues
- Education and training
- BIM processes and standards
- Commercial issues
- 3D and COBie data creation, exchanges and collaboration

The direct translation and summary of the table notes for workshop 2 are shown on the following pages:

Challenges and Barriers to Level 2 BIM?

Purpose: To establish what delegates believe are the challenges and barriers to Level 2 BIM adoption within the UK

Culture of collaboration:

Challenges / Barriers

- Unable to understand the supply chain capability with regards to collaboration
- You have to 'convince' people that BIM is a good idea. Often if they are not interested they will not listen and will not work collaboratively
- BIM is often imposed upon a person
- Siloed roles
- Working environments not conductive to collaborative working environments
- Global working is a risk
- Recommendations to overcome challenges / barriers towards achieving collaboration:
- Provide collaborative working environments or multidisciplinary offices for supply chain to work together within
- Incentivisation
- Clear brief and deliverables
- Ground up success through embedded knowledge in HS2 employees and supply chain

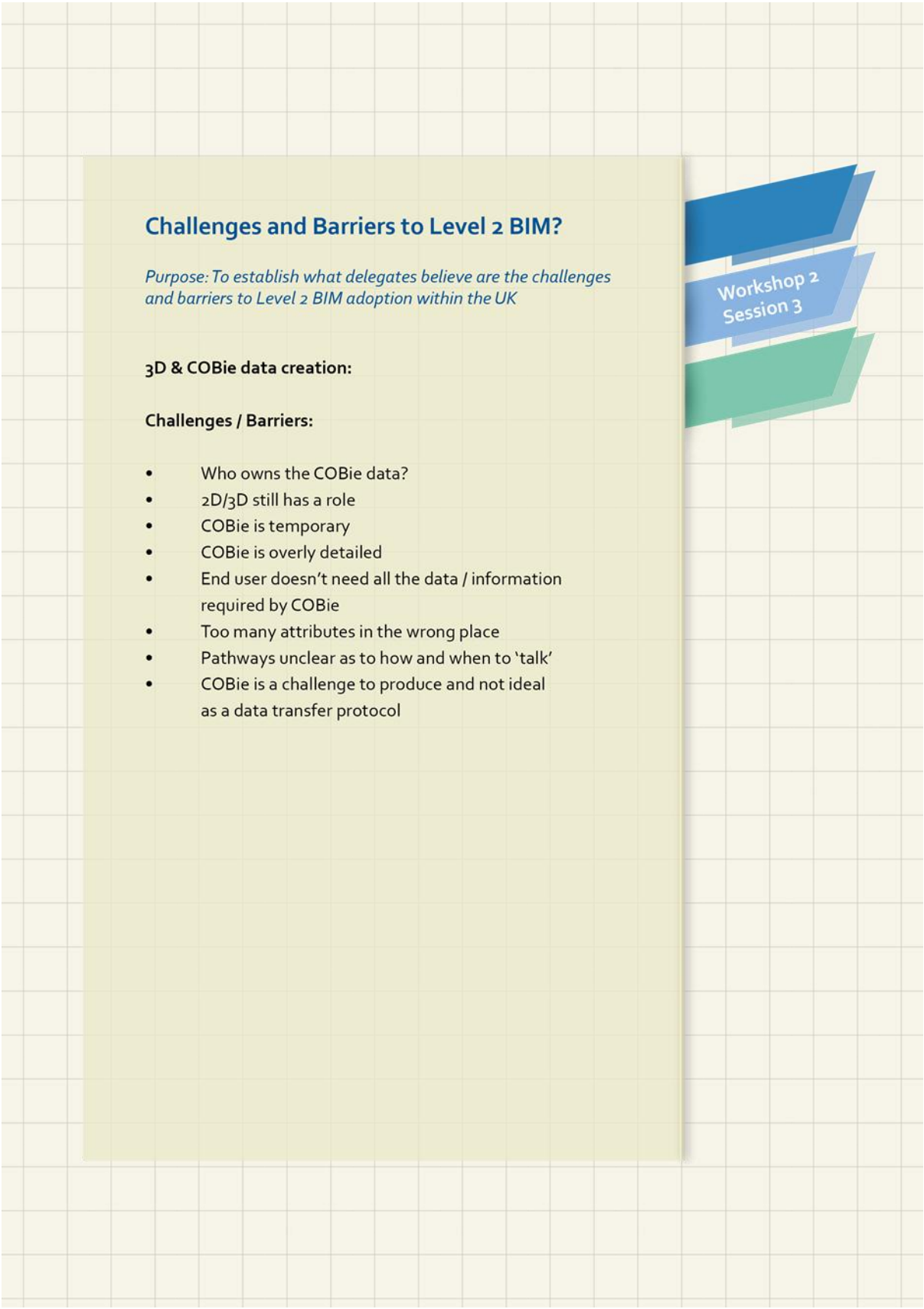
Challenges and Barriers to Level 2 BIM?

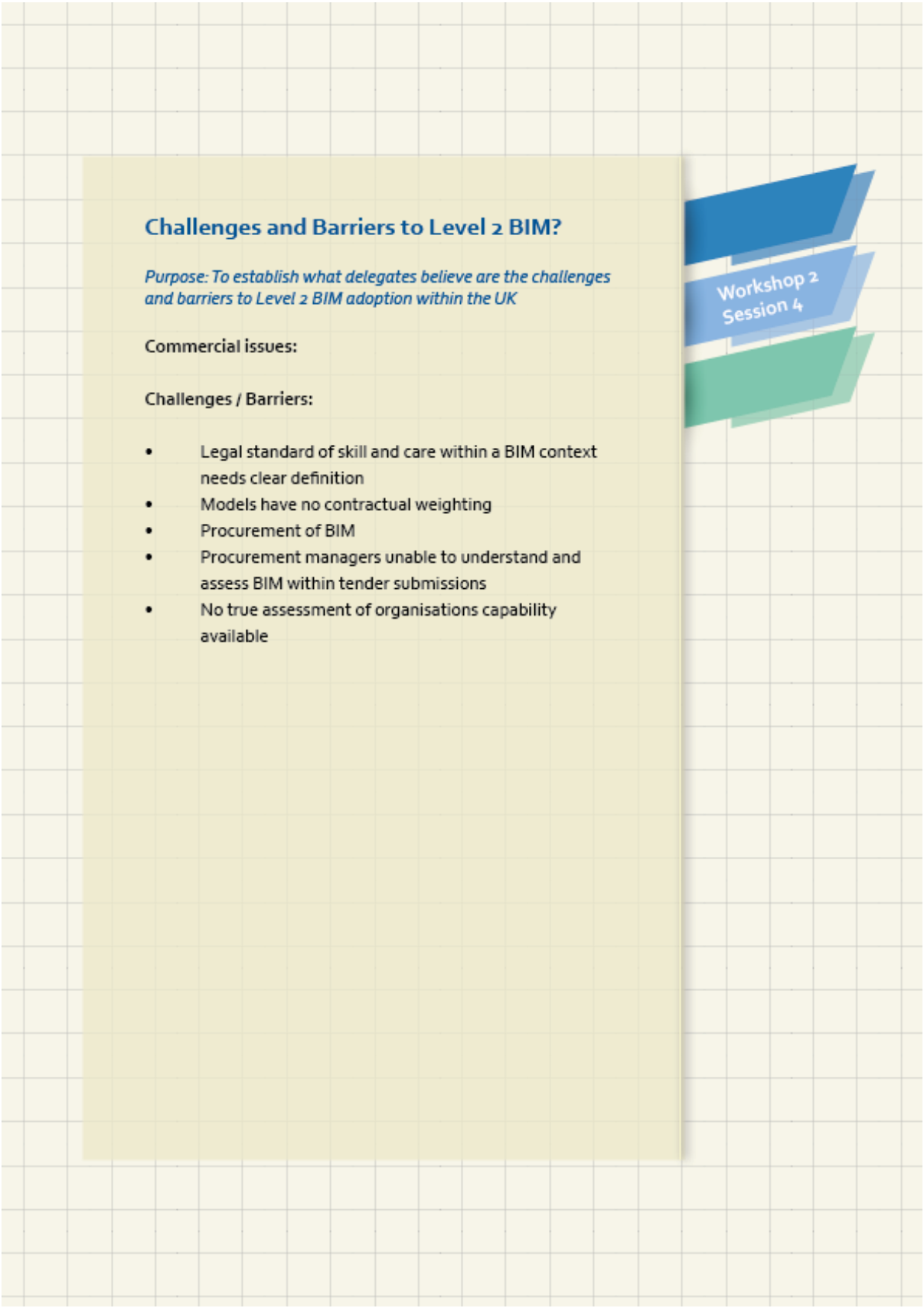
Purpose: To establish what delegates believe are the challenges and barriers to Level 2 BIM adoption within the UK

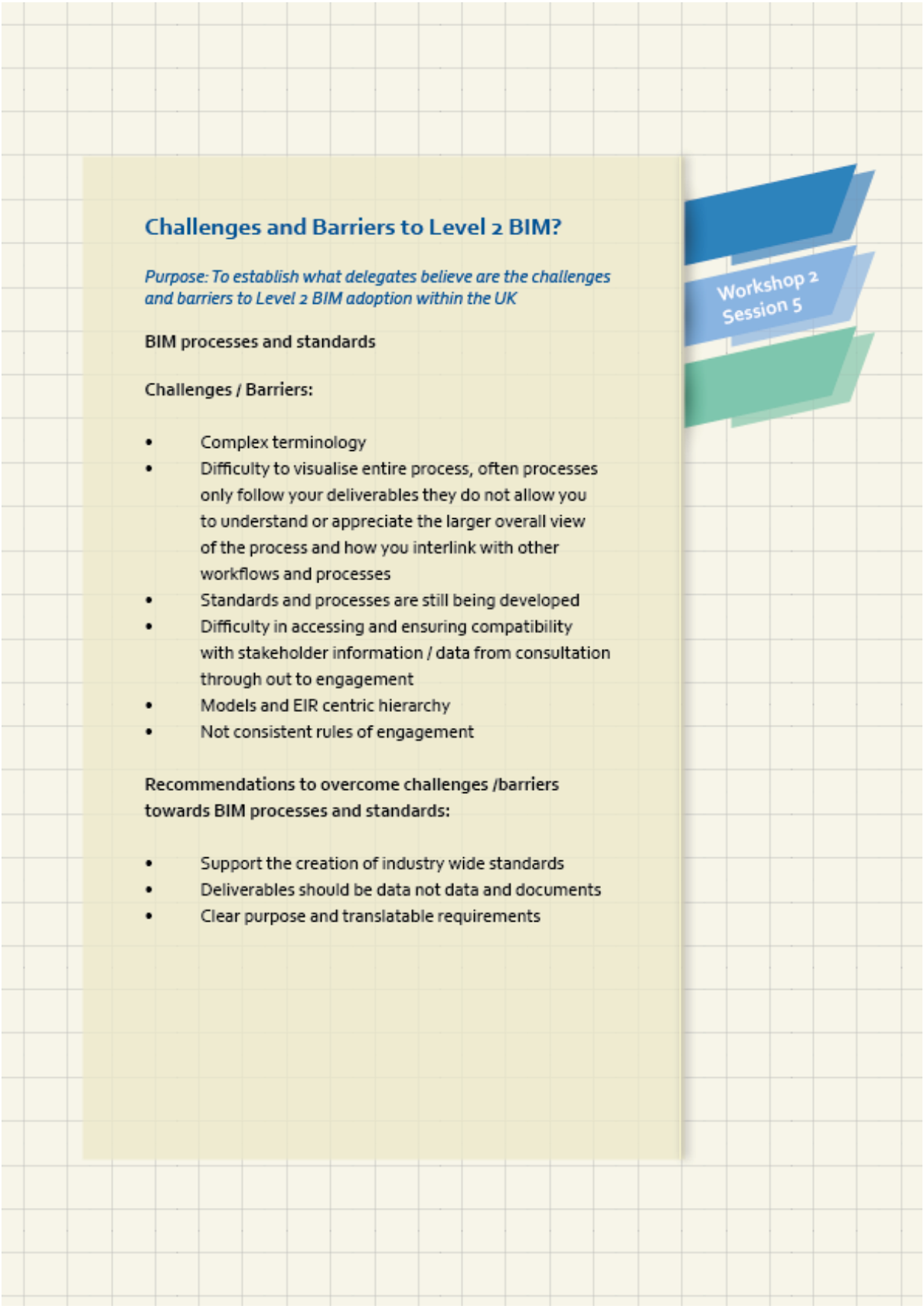
Workshop 2
Session 2

Digital tools & interoperability issues:
Challenges / Barriers

- Identification and classification is either too complex or not developed enough. The supply chain needs to understand software compatibility and who reads what
- Move from construction to software, you lose your supply chain
- Best proactive guidelines are not all encompassing
- Software cost is a barrier
- The language used within the context of BIM is complex and riddled with acronyms
- No standard Employers Information Requirement (EIR) tools, often leads to unclear BIM Execution Plan (BEP) and project information
- IFC is good however it needs investment and further development for infrastructure
- Choice of software for function is best left to the supply chain to determine
- Change management use
- How will BIM keep up with change whilst keeping data exchange manageable (intra/inter)
- Interface issues with Crossrail and Network Rail and their regional variations


Challenges and Barriers to Level 2 BIM?
Purpose: To establish what delegates believe are the challenges and barriers to Level 2 BIM adoption within the UK
3D & COBie data creation:
Challenges / Barriers:
Who owns the COBie data?
2D/3D still has a role
COBie is temporary
COBie is overly detailed
End user doesn't need all the data / information required by COBie
Too many attributes in the wrong place
Pathways unclear as to how and when to 'talk'
COBie is a challenge to produce and not ideal as a data transfer protocol
Workshop 2
Session 3


Challenges and Barriers to Level 2 BIM?
Purpose: To establish what delegates believe are the challenges and barriers to Level 2 BIM adoption within the UK
Commercial issues:
Challenges / Barriers:
Legal standard of skill and care within a BIM context needs clear definition
Models have no contractual weighting
Procurement of BIM
Procurement managers unable to understand and assess BIM within tender submissions
No true assessment of organisations capability available
Workshop 2
Session 4


Challenges and Barriers to Level 2 BIM?
Purpose: To establish what delegates believe are the challenges and barriers to Level 2 BIM adoption within the UK
BIM processes and standards
Challenges / Barriers:
Complex terminology
Difficulty to visualise entire process, often processes only follow your deliverables they do not allow you to understand or appreciate the larger overall view of the process and how you interlink with other workflows and processes
Standards and processes are still being developed
Difficulty in accessing and ensuring compatibility with stakeholder information / data from consultation through out to engagement
Models and EIR centric hierarchy
Not consistent rules of engagement
Recommendations to overcome challenges /barriers towards BIM processes and standards:
Support the creation of industry wide standards
Deliverables should be data not data and documents
Clear purpose and translatable requirements
Workshop 2
Session 5

Challenges and Barriers to Level 2 BIM?

Purpose: To establish what delegates believe are the challenges and barriers to Level 2 BIM adoption within the UK

Education & training

Challenges / Barriers:

- Educating roles and scenarios yet to be defined
- Unable to understand or predict what new roles or skills will be needed between 2014 – 2016
- Education system, particularly in relation to higher education and BIM, is haphazard, not systematic and is different depending upon area of study.

Recommendations to overcome challenges / barriers to BIM education & training:

- ISO standard in training
- Standard training
- Training in Electronic Project Management (EPM), analysis and material understanding
- Standard syllabus available to all to use in training, thus providing a consistent level of training
- HS2 Ltd University with undergraduate programmes delivered in appropriate context and format.
  Use HS2 project team members as lecturers to ensure courses are both academic and practical

Mace Ltd's IT Director, Guy Miller, facilitated a discussion regarding future-proofing digital data and infrastructure.

Under the title "Future proofing for Level 3 BIM and beyond" the following items were discussed:

- What do we mean by future proofing?
- Should we also be considering past proofing?
- Openness v Security
- Business Continuity v Recover to a point in time
- Managing Big Data
- Testing and assurance v agility and interoperability
- Shared ownership v Individual ownership
- Rear view mirror (-10 years) and future wise

Figure 6 Mace Ltd. facilitating "future proofing for Level 3 BIM and beyond" discussion

Key messages

- Supply chain agreed that ensuring data created in the present is capable of being reformatted and reused in the future (past proofing). This was discussed in the context of both data format and media on which it resides
- Discussion around security and openness was largely anchored to Level 3 maturity and the need for cyber security to be considered both for data and intelligent connected devices
- Acknowledge the challenge of the wider federated data set is kept in balance when considering data recovery to a previous fixed point of time. The conclusion centred around the need for resilience and redundancy

- Discussion surrounded bringing in transferable and new roles and skills to the construction industry from computer sciences, and data analytics to analyse and manage big data
- Acknowledgement and understand that they key is having right data at the right time rather than 'Infobesity'. It is essential therefore that the client and supply chain information needs are fully articulated within the contract as early as possible
- Questions from delegates included the dichotomy of structured vs. unstructured data and the relevance of this as HS2 shifts from Level 2 to Level 3 BIM maturity. Whilst the desire is to have as much structured data as possible to aid analysis. It is inevitable that some data will be unstructured such as passenger information. It was noted that semantic data will be a key component of the Level 3 programme

The final workshop of the symposium required delegates, in their table groups, to review and discuss upskilling asking the delegates to provide responses to the follow 3 questions:

- How can HS2 help the supply chain upskill?
- What would help drive Level 2 BIM adoption across the supply chain
- How important is capability assessment / accreditation schemes and creation of new job roles

HS2 returned to the symposium to close out the session.

BIM Upskilling Exercise?

Purpose: To engage with supply chain and present them with an opportunity to advise HS2 Ltd on any upskilling needs or requirements. Key areas discussed: ***1)*** *How can HS2 Ltd help the supply chain upskill?* ***2)*** *What would help drive level 2 BIM adoption across the supply chain?* ***3)*** *How important are capability assessments / accreditation schemes and the creation of new job roles?*

How can HS2 Ltd help the supply chain upskill?

- Upskill HS2 Ltd.
- HS2 Ltd have an unique opportunity to upskill UK PI due to project size, scope and duration
- Collaboration before building
- Joint ventures
- Open HS2 BIM community of practice
- HS2 BIM Champions / facilitators / BIM liaisons between HS2 and individual supply chain members
- Long-term processes tied to future skills
- Involvement of professional institutions
- Be clear, concise and prescriptive in requirements
- Start procurement early to allow supply chain time to upskill
- Capture and share existing asset data
- Get BIM into early education
- Put a HS2 Ltd representative into each of the UK Regional BIM Hubs
- Clear data strategies
- Enable and de-mystifying the supply chain
- Push hard for innovation
- Financial rewards on savings / efficiencies achieved through BIM and/or innovation
- Content generation / consortiums / assistance
- Cloud document management systems
- Open data
- Make working for HS2 Ltd inclusive
- Free model viewing software

BIM Upskilling Exercise?

Purpose: To engage with supply chain and present them with an opportunity to advise HS2 Ltd on any upskilling needs or requirements. Key areas discussed: 1) How can HS2 Ltd help the supply chain upskill? 2) What would help drive level 2 BIM adoption across the supply chain? 3) How important are capability assessments / accreditation schemes and the creation of new job roles?

What would help drive level 2 BIM adoption across the supply chain?

- Define what Level 2 BIM is to HS2 Ltd.
- Top management commitment and understanding
- Early engagement of the supply chain
- BIM deliverables and models to have contractual importance
- Legal obligations clearly defined
- Community of excellence via mediums such as hubs or high profile leaders
- Baseline capability and capability assessments
- Accreditation – organisations and or individuals
- Sell data skills abroad
- Tender documentation with as much asset information as possible
- Train / upskill HS2 Ltd.'s own internal BIM experts to outreach and help supply chain. Have a discipline or tier champion for engagement
- Establish Tier 1,2 & procurement requirements (BIM)
- Create a legacy learning portal that shares best and not best practice, has bulletin boards and social media tools
- Explain the potential return of investment for BIM from a client and end user perspective


BIM Upskilling Exercise?
Purpose: To engage with supply chain and present them with an opportunity to advise HS2 Ltd on any upskilling needs or requirements. Key areas discussed: 1) How can HS2 Ltd help the supply chain upskill? 2) What would help drive level 2 BIM adoption across the supply chain? 3) How important are capability assessments / accreditation schemes and the creation of new job roles?
Workshop 3
Session 3
How important are capability assessments / accreditation schemes and the creation of new job roles?
• Capability assessments are very important however one capability statement will not suit all organisations
• HS2 Ltd need to 'map' and 'discover' capability to their project and both project and contract deliverables
• This programme should be used to develop the assessment and accreditation of the supply chain. These assessments / accreditations should be made as a requirement of the output specification and should inter-link the supply chain
• HS2 Ltd should refer to other industry performance assessments such as Network Rails 'Route to Gold' and Crossrail BIM performance assessment
• Include capability assessments / accreditation schemes as part of framework and/or PMO orders
• HS2 Ltd should define and share job titles and responsibilities both within organisation and supply chain
• HS2 Ltd should ensure they no not elevate CAD Managers to BIM Managers, they do not have the full skill set required
• The supply chain need a robust government endorsed scheme to asses all competencies for the (PAS1192:2) BIM roles

5.2 HS2 supply chain BIM upskilling: BIM2050 symposium

On 28th May 2014 the second of three symposia as part of the Study occurred with members of the Construction Industry Council (CIC) BIM2050 group. The BIM2050 group are a working group of the UK BIM Task Group, located within the 'future gazing' stream.

The BIM2050 group strive to develop a culture which enables a digitally integrated approach to positively impact the built environment. The group consists of a collection of industry leading young professionals representing most corners of the industry; from architects, engineers and contractors, to legal professionals and surveyors representing their respective professional institutions. The scope of this group is to not only focus inwards within the construction industry, it is also encouraged to reach out to other sectors and industries to integrate any parallels they find. The BIM2050 are tasked to help improve image and efficiency of the construction industry, develop and review strategic scenarios for the future of the construction industry, promote shared knowledge and research what an interdisciplinary scope of work may look like as technology develops. To facilitate these objectives the BIM2050 group are categorised into three work streams:

- Education & Skills
- Culture of Integration
- Technology & Process

This symposium, hosted at Mace Ltd, was facilitated by Study Director Professor Philp, and attended by Jon Kerbey, HS2 Head of Management Systems, and Bill Grose, HS2 Technical Strategy Advisor. During this symposium discussions were held around the following areas:

- Transition through BIM maturity levels during programme length and the development of data transactions from analogue to artificial intelligence, moving towards real-time digital based transactions. With the development and establishment of a digital landscape, and experience in reviewing building use data; frameworks and algorithms will be developed and integrated to allow the built environment to read and react to its own data with minimal human intervention.
- The combination of the development of artificial intelligence and data telemetry will allow HS2 assets to be responsive, efficient and connected to the people and environment that they interact with. Rapid automated decision making and physical adaptations to the built environment and building conditions will be highly dynamic and almost instantaneous
- The subsequent impact on movement towards digital based transaction over HS2 programme will see a reduction in 'traditional' analogue skills, with new skills and job profiles in areas such as data analytics, and the ability to manage, mine and use information/data being desirable
- BIM2050 group predict that Moore's Law will end in the decade 2040 – 2050 due to the current/anticipated rate of change of processing power. Technology will move towards quantum computing

Following these discussions HS2 tasked BIM2050 to identify 5 key considerations that HS2 should consider over the duration of HS2's design and construction programme. The BIM2050 group provided the following 5 key considerations:

1. Embedding sensors into asset to monitor performance data
2. Workflows and operational solutions allied to operation and performance data
3. HS2 upskilling requirements based on integrated working needed for Level 3
4. Cyber security in the context of Level 3 BIM
5. Future job roles and the need to attract new skills for outside the construction area i.e. data scientists

5.3 HS2 Rail BIM Symposium

The final HS2 supply chain BIM upskilling symposium was held at Mace Business School on 29th April 2014. This symposium consisted of members from the UK rail industry from client to Tier 1 and Tier 2 supply chain members. The delegate list was carefully considered to ensure all members present were able to talk and fully describe their experience and use of BIM on their own rail infrastructure projects.

The purpose of this symposium was to provide HS2 with the opportunity to discuss and observe with similar organisations and their supply chain their use of BIM in the context of the rail infrastructure industry.

Professor Philp, Head of BIM (Mace Ltd) welcomed and thanked delegates for their attendance. Jon Kerbey, Head of Management Systems (HS2), proceeded to outline HS2's BIM aspirations.

Professor Philp invited delegates to share their knowledge, lessons learned and recommendations covering the following key areas:

- Session 1: Where are you now?
- Session 2: Technology challenges
- Session 3: Supply chain upskilling
- Session 4: Future proofing data

5.3.1 Session 1: Where are you now?

Purpose:

- To establish where the rail industry is on the Bew-Richards BIM Maturity Diagram
- To understand what level of BIM maturity rail infrastructure clients are procuring and what level of BIM maturity are their supply chain delivering
- To understand and share lessons learned with regards to BIM in rail infrastructure

Discussion Notes:

- Across all delegates level of BIM maturity their organisations are achieving ranged across Level 1 & Level 2
- Of those delegates who stated their organisations were achieving Level 2 BIM maturity it was acknowledged that the use of Level 2 BIM was in its infancy

Q: Are rail clients good at procuring BIM?

- Delegates stated the most important item when procuring BIM is to ensure HS2 has its organisational information requirements (OIR), asset information requirements (AIR), employers information management (EIR) clearly defined and communicated to the supply chain
- Delegates advised that HS2 will need to establish where it positions its resources for asset information management
- Information is a resource
- Delegates recommended to make 'information' a project deliverable within scope of services
- The rail industry is disciplined and used to working with rigid workflows and processes
- Due to the longevity of the HS2 programme, HS2 should look to procure services from those within the supply chain who reduce their fees / costs and will manage the asset information on behalf of HS2

Q: What lessons have you learned with regards to BIM implementation and use within the rail infrastructure sector?

- Understand both your own internal BIM capabilities as well as your supply chains
- Allow time within your programme for BIM, i.e. time to design model correctly, reviews etc.
- Promote BIM internally within your organisation, via media such as PR to ensure the purpose and message of what BIM is and why you are using it is communicated clearly to all employees not just the 'BIM' team
- Create an environment where all stakeholders and supply chain members contribute to a common goal, create an ethos of collaborative purpose
- Provide a collaborative working environment for all supply chain members to work within, e.g. digital rooms, libraries
- Incentive schemes. HS2 should use the supply chain to help drive innovation
- Supply chain alliance strategies
- HS2 needs to plan and over-provide for IT systems with focus on future use and legacy, make the investment now
- IT and data security has to have the robustness to the same standard as financial institutions

4.3.2 Session 2: Technology challenges?

Purpose:

- To understand the challenges faced by the rail infrastructure industry to achieving Level 2 BIM

Discussion Notes:

Q: What are the challenges for the rail infrastructure industry in achieving Level 2 BIM?

- Direction and support for the embedment/integration/adoption of BIM throughout the project. Ensure it is not treated as an additional 'bolt on' by management and staff
- The size and scope of rail projects. The multiple stakeholders involved on rail infrastructure projects create large workflows and can take a long time for issues to be resolved or approved
- Linear ownership needs to be outlined clearly
- Programme allowances for BIM approval gateways is required
- Technology tools and software must be mapped across all stakeholders and must ensure relevant software and tools can 'speak' / interact with each other as and when required
- Understand the BIM capabilities of stakeholders
- Ensure data requirement is included within the performance requirements within scope of services. Be prescriptive as of what you need from the supply chain.
- Ensure data is organised aiding the supply chain to visualise the data set and workflows throughout the project and beyond their own services
- Create an environment for collaborative working and learning
- Ensure collaborative behaviours at project level
- Put the database at the centre of the project and advise supply chain/ stakeholders on how to connect/interact with database

Q: Is COBie fit for purpose for rail infrastructure projects?

- To achieve Level 2 BIM, COBie must be used. The rail infrastructure industry will not be able to use COBie by 2016. The rail infrastructure industry has established its performance and maintenance requirements over a vast number of years, and is consistently refined in a controlled manner. COBie the UK has been developed to apply consistency and standard in an area/sector where this is needed, its growth has been rapid and uncontrolled.
- Delegates had experienced large issues with classification data and creating a commonality for classification of data
- Is COBie needed for Level 2 BIM for HS2? The use of COBie may be too much of a requirement from the supply chain. HS2 will be required to map existing vehicles for loading information into a COBie database for procurement and initial design etc. This 'mapping process' may not be of value to HS2 due to programme duration and IFC development/superseding COBie. Does COBie bring value to HS2 at this stage of the project?
- COBie is not seen as individual data drops but is looked at as a progressive collection of data
- What is critical about COBie is the data itself

Q: Is IFC fit for purpose for rail infrastructure projects?

- Open shareable asset information is important

- Delegates advised that HS2 should invest in good and purposeful standard contents and libraries that are able to be used via any software platform. Flexibility and adaptability for interoperability is key
- Ensure as a client, HS2 understands what information it needs and when it needs it, as data needed for design is different from data needed for procurement and construction as it is from information needed for asset management

5.3.3 Session 3: Supply chain upskilling

Purpose:

- To understand how the rail infrastructure industry is preparing/upskilling their own supply chain for the use of BIM on projects.

Discussion Notes:

- Delegates advised that as a client HS2 will want to get the most value out of supply chain contracts, particularly if this benefits the wider project. Methods for how this can be achieved were discussed as:
    - Alliancing projects and supply chain to create a sense of pride and belonging to the project
    - Establish, monitor and maintain key performance indicators and skills assessments at individual, project and organisational levels
    - Ensure all upskilling routes/methods are tailored to the overall HS2 project characteristics. This should also be considered for the individual projects that make up the overall master project programme
    - Facilitate the migration of skills sets and teams
    - Define roles and responsibilities, monitor whether the individuals/organisations are best for the role
    - Ensure that the BIM Manager/Information Manager has equal importance as the Project Director
    - BIM apprenticeships

Q: How is the rail infrastructure industry upskilling their supply chain in BIM?

- Academies, such as the Crossrail Academy, to aid the supply chain to understand information, its flow, and its interaction with different parties
- Carefully plan upskilling, ensuring the right knowledge and learning is being given at the correct and most appropriate time. Look within the supply chain tiers and functions and ask them what they need

Q: In terms of BIM upskilling, what would you do differently?

- Avoid assumptions and asking incorrect questions
- Ensure a consistent and clear message of what BIM is, and its benefits to the project is communicated to all stakeholders, both internal and external
- Educate internal staff as well as the supply chain as to what the EIR's actually mean; particularly in relation to the overall project, the individuals function and their scope of services/deliverables
- Define/dictate file formats and stipulate to the supply chain that as a client you want the script to create the data
- Provide clear EIR's
- Assess supply chain capability to ensure it is working to same BIM maturity as the client
- Encourage buy in and development from all supply chain members
- Ensure a healthy balance is maintained between permanent and contract employees/workers

5.3.4 Session 4: Future proofing data

Purpose:

- How does the rail infrastructure industry future-proof its data?

Discussion Notes:

- Delegates briefly discussed how they future proof their organisation workflows, data and IT infrastructure. The key themes and comments were:
    - Programme and overprovide IT to accommodate the anticipate data growth. Failure to do so will restrict growth and capability
    - Consider outcome based contracting ensuring the supply chain provide the actual data outcome required
    - Consider the industry's potential growth from product creation to service provider

In conclusion to this symposium Professor Philp asked delegates to identify the key challenges to BIM within this rail infrastructure industry and recommend how HS2 could upskill its supply chain.

The headline items were identified as the following:

- Need an industry standard to assess and benchmark supply chain capability
- Clear HS2 OIR, AIR and EIRs are essential for the supply chain to respond to
- Educate and train not just for 'traditional' roles but for future roles
- Clear BIM communication and branding throughout HS2

- Strict compliance with the requirements of Level 2 BIM is not feasible for rail infrastructure projects. Redefine what BIM means to HS2, potentially changing the lexicon from Building Information Modelling to something more appropriate to rail and infrastructure
- Look beyond traditional construction skills, look to difference sectors or international skills
- IFC and COBie are not yet mature enough for rail infrastructure projects
- Whilst BIM adoption and capability is on the increase. The lack of standardisation in the rail sector suggests that this benchmark is lower within the infrastructure sector generally
- It was agreed that Tier 2 and 3 would struggle to reach Level 2 maturity without intervention on training and education by HS2. If HS2 makes no interventions on training and education, it is likely that it will have to buy upskilling within each of its commissions/work packages, which would be detrimental to the overall project value

5.4 HS2 BIM Show Live 2014

Figure 7 HS2 BIM Show Live engagement

BIM Show Live (BSL) is a two day conference that brings together over 600 construction professionals from across the globe to learn, discuss and interact with current and future BIM technologies. The event comprises seminars, lectures and workshops covering four stages of a project lifecycle:

- Define and validation
- Design and prototype
- Manufacture and assemble
- Operate and maintain**.**

It is the UK's leading BIM event delivering detailed, business critical content, alongside forward thinking suppliers and inspirational features that showcase real life BIM application. This year the event was held in Manchester which allowed HS2 to achieve more regional engagement as part of the Study.

As part of the supply chain BIM upskilling study, HS2 hosted an engagement stand at BSL to engage with the supply chain and understand the supply chain's understanding of its own upskilling needs.

Using HS2's drawing of its anticipated BIM journey, delegates of the conference were invited to map against the HS2 visual what they believed the supply chain's upskilling needs are and how HS2 could support the supply chain on their upskilling journey. Key themes of the study were used as themes on which delegates were invited to provide answers.

These themes consisted of:

1. Data
2. Innovation
3. Training / upskilling
4. New roles
5. Procurement

Key messages:

1. Data; as with the supply chain symposia there was a clear desire for client information needs and formats to be promulgated early as practical including detailed and clear EIR documentation. File exchange formats such as IFC and COBie would benefit from HS2 training programmes to help upskill at a technical level
2. Innovation; the supply chain saw BIM as an opportunity to drive innovation within HS2 for example the sharing of HS2 data sets could be used for a 'Hackathon' to exploit value of this rich information
3. Training / upskilling; participants especially Tier 2 and 3 said they would benefit from support from HS2 especially guidance documentation on how their deliverables can be achieved relative to their domain. Delegates also expressed a desire for HS2 to provide environments, such as an academy, for which the supply chain can learn and engage with other members and promote digital apprenticeships
4. New roles; there was a desire to understand how HS2 BIM requirements would impact upon current job roles. Could they be upskilled or would their role be redundant and replaced with new skills such as programming, coding and data mining?
5. Procurement: participants expressed caution as to how BIM would be used in relation to cost based digital transactions e.g. would the tender packages be analysed using data within COBie

The image below summarises the key messages / trends of responses provided by delegates.

Figure 8 BSL delegate engagement overall comments

The following visual represents day one of BSL and delegates responses

Figure 9 BSL delegate engagement day 1 comments

The following visual represents day two of BSL and delegates responses

Figure 10 BSL delegate engagement day 2 comments

Under the key themes delegates made the following recommendations

Theme: Data

- BEP standards
- Bespoke software development
- Big data
- Capture technical processes for data designers
- Choses data platform
- Cloud
- Data centric – performance – integrity – analysis – maturity
- Engage with augmented reality
- How do you handle information – what do you keep?
- Hyperlinked model information
- Information required for lifecycle management
- Information requirements
- Intelligent knowledge used by client
- Link data to model
- Live and flexible not finite
- Multi-purpose consistency
- Open data and technology platforms
- Preferred vendor lists
- Simulation
- Stakeholder visuals
- Standard objects & digital specification
- Traditional methods are inadequate for digital use
- Understand 3D data
- Visit and validate
- What will BIM look like in 2026?
- What will the linear grid look like?

Theme: Innovation

- 'Google glass' wayfinding
- Allow supply chain to innovate and develop
- Ask people other than 'BIM' people
- BIM Holodeck
- Build data from starting lean operation needs
- Crowd source the design
- Data set for future use

- Drive engagement down the supply chain
- Enable wearable technology
- Financial incentive
- Flexibility for future use
- Fostering innovation
- Give data away
- Good information – hackathon
- Hackathon – open data set to drive innovation
- Identify problems and allow supply chain to resolve
- Incentive
- Innovation circle
- Innovation competition
- Innovation framework
- Keep open data and see improvements
- Kick starter
- Learn innovation promote
- Live data
- Money
- Non-proprietary data set
- Open
- Plant innovation ‘seeds’ and allow supply chain to develop
- Profit share
- Project collaboration and role play days/workshops
- Research future transport is able to adapt to future needs
- School competitions
- Shared collaborative displays
- Sharing lessons via forums, open data and allowing people to learn
- Structured data and reporting
- Two way information

Theme: Training/upskilling

- Abolish self-assessment – create assessments with actual answers
- Academy
- Accreditation
- Better university teamwork and engagement
- BIM focused apprenticeship
- Common understanding with senior management and project management

- Continuous professional development leading to lessons learned
- Create a place where people want to work
- Curriculum
- Education and training
- Education investment in youth with contract conditions supporting this
- Engage schools and universities
- Generation Y don't need to retain knowledge; they need to know how to find and retrieve information
- In order to have skilled professionals you need to train the team
- Learn engage train
- Management to gain working knowledge of operative workflows
- Pan industry
- Project specific training
- Reasonable standard of skill and care
- Regional centre of excellence
- Rotational training
- School engagement
- Set up an industry learning academy for supply chain
- Site exposure for colleges and students
- Site academy
- Social community for staff
- Specific role academy
- Staff identity
- Top-down and bottom-up buy in
- Training academies to develop young apprentices
- Training programmes
- Understanding my role in information use and provision
- Work placements
- Youth integration

Theme: New roles

- Coding
- Be willing to engage
- Career spans will be shorter and specialising in many different areas
- "Data jockeys"
- People who can speak the digital language
- People who understand connections

- Persons who are able to learn and relearn
- Programmers
- Right people for the right decision
- Safety
- Stop singularity of careers broad knowledge and de-siloed roles
- T-shaped professionals
- Think best of breed i.e. all round capability

Theme: Procurement

- 'BIM' impossible to measure
- Ask people to prove their capability
- Best practice case studies
- Broader stakeholder engagement with industries outside of construction
- Capability assessments
- Capable sustainable workforce
- Provide common data environments
- Clear needs defined
- Data team responsive but standards maintained
- Define best practice
- Employer Information Requirements must be clear
- Fair pay
- Financial support
- Honesty
- How can HS2 ensure BIM standard/capability within its supply chain
- Integrated project insurance
- Learn integrated project delivery
- Ongoing energy monitoring and optimising
- Only focus on the information
- Planning
- Retrospective fix is costly
- Show what best practice looks like
- Simplify the message
- Stakeholder engagement
- Target value design
- The supply chain is the project
- Think practical
- Total cost transparency

- Transparency
- Understand bigger picture and flow of information
- Understand BIM
- Upskill procurement team to understand BIM
- Use ‘expert’ resources
- Use current best resources
- Value not cost
- What is the desired outcome

5.5 Interviews

Interviews were held and conducted with a sample selection of respondents to the online questionnaire. These interviews were conducted to provide anecdotal evidence and elaborate further upon responses and statements made within the online questionnaires. To ensure a fair representation of study participant's interviews were conducted with a sample of 20 participants made up of:

- 5nr specialist suppliers
- 5nr Tier 1 supply chain members
- 5nr Tier 2 supply chain members
- 5 nr Tier 3 supply chain members

In summary the key messages of the interviews were as follows:

5.5.1 Organisational BIM Adoption

HS2 supply chain tier level	Comments
Specialist Suppliers	• Often there is no direct requirement for product manufacturers to provide BIM or COBie information; it is not something that is currently being asked contractually. The pull from industry is minimal • Taken decision to create object data for specific products to pre-empt demand • On the start of BIM journey however, hard to determine what will be required from product manufacturers
Tier 1	• It is the individual(s) with the BIM knowledge that are driving BIM adoption within the company. We have Director buy in however it is the individual/team that is the driving force. • Director support and report to a project delivery board
Tier 2	• Upskilling within the company on a role by role basis
Tier 3	• We don't have a formal BIM adoption, it's currently ad hoc but we are looking to incorporate BIM policies • Dependent upon demand for BIM

5.5.2 Organisational Approach

HS2 supply chain tier level	Comments
Specialist Suppliers	• Support towards BIM within organisations; 'push/pull' effect. • Organisational BIM Champions and internal communications disseminate information regarding BIM throughout the business
Tier 1	• Organisational differences in attitude: we have those who just want to get the job done regardless of tools used and those who want to get job done right • We need to ensure time provision is allowed for within programmes for BIM. Project and Programme Managers need to understand the 'bigger' picture of BIM and get them to understand the impact BIM has on the process and team • Resourced BIM roles • Strategy being developed to achieve an ISO accreditation
Tier 2	• We establish the projects appetite for BIM before we commence with BIM i.e. does the overall client want BIM, will BIM bring a benefit to us and/or the project?
Tier 3	• We currently don't have a formal organisational approach to BIM. It is generally completed on an ad-hoc basis. This is due to demand from our clients and our own minimal knowledge of what is required.

5.5.3 Education & Training

HS2 supply chain tier level	Comments
Specialist Suppliers	• Training is currently only provided to those with direct contact / interaction with BIM • Currently product manufacturers are unconvinced of the benefit of formal 'BIM' qualifications for their employees due to the current lack of demand for BIM from their clients etc.
Tier 1	• Forums are a good way to help upskill the individual • Technical education for designers usually provided by resellers of software then developed and maintained via online e-learning portals • Co-location of offices to share information as team works together and transfer knowledge and skills between team members • Create a league table of companies and open competition of training
Tier 2	• We are currently recruiting staff with existing BIM skills that can be used and knowledge disseminated throughout organisation • We are trying to implement same level of training across the business
Tier 3	• Training only those who need to know and predominately self-taught • Unsure what is / will be needed so no formal investment has been made in BIM training • Summer and work placements offered

5.5.4 BIM Processes

HS2 supply chain tier level	Comments
Specialist Suppliers	• BIM processes are tailored and dependent upon client needs and specifications • Currently outsource the creation of BIM library objects and attributes as not enough demand for this information to justify resource being brought in house • See a need for BIM object libraries to be created
Tier 1	• Identify excellence in a particular area for an organisation or project • Workflows and procedures in place • Workflows map process and design journey • Adhere to processes defined within documents such as the BEP
Tier 2	• We have documented BIM plans and processes in place • HS2 should provide what standards they wish the supply chain to work to
Tier 3	• Developed as and when required • We understand we have the information however understanding how this is to be presented can be challenging; we usually wait to be told what is needed and allow our client to disseminate and use the information provided as they require

5.5.5 Technology and Data

HS2 supply chain tier level	Comments
Specialist Suppliers	• Production of COBie data can be difficult depending upon the anticipated lifespan of a product • Currently researching as to what is required to input this information into relevant fields • Doing COBie because they have to when specified or instructed
Tier 1	• HS2 investment in standards and IFC development • HS2 should ensure that standards are flexible enough to evolve and develop over time • Ensure we have right technology available for current use and needs
Tier 2	• We have invested in only a few digital software tools to ensure we can meet BIM requirements. This software is allocated to our 'BIM' enabled staff
Tier 3	• We only invest in additional software (i.e. over and above our daily function) only when required to by our clients • We make use of the free software tools on line

5.5.6 Future Gazing

HS2 supply chain tier level	Comments
Specialist Suppliers	• Currently establishing what is needed for both short and long term BIM needs / requirements and how this is incorporated within business plan • Need to consider / visualise what data and information is needed both now and in the future, particularly as procurement become more and more intelligent • Currently developing KPI and targets • Looking to become a key partner to clients and other supply chain members
Tier 1	• Pioneering solutions and forums.
Tier 2	• Online training and industry literature • Semi structured however it is predominately left up to the individual • Lessons learned feedback
Tier 3	• Training is predominately self-learning with some continuous professional development (CPD) financial support offered

5.5.7 Main upskilling needs

HS2 supply chain tier level	Comments
Specialist Suppliers	• Early support and engagement needed • Clear requirements and be capable to understand project/client requirements • Able to benchmark off competitors or clients learning and knowledge
Tier 1	• Biggest upskilling need is broad awareness and commitment to processes • Information Management and understanding the flow of information and understanding broader project scope. • The understanding of scaling of information and also the size and scale of project – we need to question whether our existing systems and processes are ready for large scale projects and label components correctly. • Upskilling staff in the creation of non-graphical data • HS2 need to ensure all employees and contractors can visualise and understand the project in relation to its overall project goals • Upskilling of staff in rail specific classification and data sets
Tier 2	• Upskilling staff in understanding what is meant by Level 2 BIM • Upskilling staff in general regarding BIM classification • Financial support in funding software upgrade / compatibility and training
Tier 3	• Financial support and incentives for training and technology • Upskilling staff in use of proprietary BIM tools • Upskilling staff in regards to BIM Level 2 processes

Section 6: HS2 BIM Survey results and analysis

6.0 HS2 BIM Survey: Results and Analysis

We present here a detailed analysis of survey responses for each question individually. An overall summary is also provided at the end which lists the key findings of this survey. It should be pointed out that the questionnaire design for this survey, in our opinion, was more comprehensive in breadth and depth compared to any other UK-based comparable survey. A comparison with other surveys is provided in a separate section. The questionnaire was divided into eight major categories, viz. Organisational Information, Organisational BIM Adoption, Organisational Approach, Education and Training, BIM Process, Technology and Data, Future Gazing and Summary Questions. The analysis carried out has been organised into different sections based on these categories and for each category an overall view is provided.

6.1 General Organisational Information

Q1-4. General Organisational Information

This set of questions deals with general information about the organisations and the personnel responding to the questions.

- Name of organisation
- Name of person completing assessment
- Job Description
- Contact email

Q5. Please indicate the main type of work undertaken by your organisation (tick only one) Consultancy

Project Management	32.1%
Technical Adviser	21.4%
Cost Management / Quantity Surveyor	4.8%
Sustainability	3.6%
Ecological	0.0%
Safety	1.2%
Measured survey	6.0%

This question relates to the kind of work each organisation is involved in among the consultants. The vast majority of the organisations who took part in the survey belong to two categories, viz. Project managers and BIM consultants. Between them constitute some 63% of the participant organisations. The next largest group is that of Technical advisors 21%). The rest of the 16% are made up of QS (4.8%), sustainability, safety and measured survey organisations.

Q6. Please indicate the main type of work undertaken by your organisation (tick only one) Design

Rail Engineering	23.8%
Civil / Structural Engineer	20.2%
Architect	38.1%
Building Services Engineer	10.7%
Utility Services Engineer	3.6%
Landscape Architect	1.2%
Product Designer	2.4%

This question relates to the kind of work each organisation is involved in among the designers. The largest groups are those of Rail Engineering (23.8%), Civil/Structural Engineering (20.2%), architects (37.1%) and Building Service Engineers (10.7%). The remaining 8% is split between Utility Services Engineers, landscape architects and product designers.

Q7. Please indicate the main type of work undertaken by your organisation (tick only one)
Contractors / Manufacturers

Tier 1 - Lead designer, main contractor, JV partner or supplier, contracting directly to client	55.0%
Tier 2 - designer, supplier or subcontractor to tier 1	26.6%
Tier 3 - contracted with or supplier to tier 2	6.7%
Specialist Suppliers	11.7%

This question gives the breakdown between Tier 1, 2 and 3 suppliers and the vast majority (55%) of the respondents were Tier 1 organisations with Tier 2 being 26.7% and Tier 3 and Specialist Suppliers constituted just fewer than 20% of the respondents.

Q8 and Q9. Please state your organisations 2012-13 annual turnover (£):

Number of full-time staff:

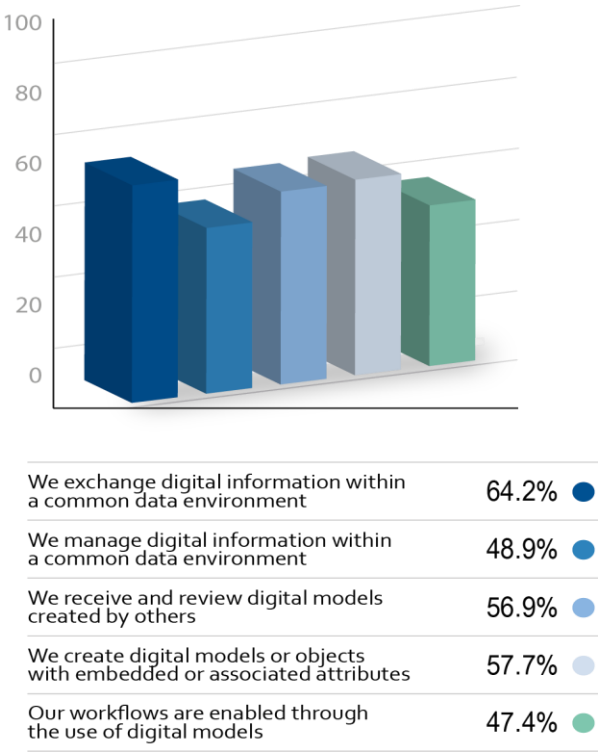
These two questions give an idea about the size of the organisation in terms of turnover and staff numbers.

5.2 Organisational BIM adoption

Overall view:

The responses in this category of questions are highly significant as this gives an idea of the current state of affairs vis-à-vis BIM adoption by the responding organisations. Interestingly, this question was responded by every single organisation and thus gives a very clear snapshot of where they currently stand in relation to BIM adoption. Generally speaking, the findings of this section are very encouraging and indicate a high quality and relatively BIM-aware supply chain. The level of detail of the question is much more comprehensive compared to other comparable surveys and hence one gets a more clear and representative view of the respondents' position vis-à-vis BIM.

Q10. Which statements best describe how your organisation interacts with BIM? (tick all that apply)



This question deals with the mechanisms for creation, receipt, management and exchange of BIM models and embedded/associated information used by each organisation. It is quite encouraging to note that the vast majority (64.2%) of respondents do have a formal approach for BIM data exchange using a CDE (Common Data Environment). Investigating a little further into the data, clearly this is not confined to just the Tier 1 suppliers and at least some significant proportion of other lower tier suppliers also fall into this category. It is also clear from the other responses that at least half of all respondents which clearly span across all tiers of suppliers at least create and store digital BIM models even if they are not fully geared up yet to implementing the entire lifecycle of creating, managing and exchanging these models through a CDE.

Q11. Which option best describes your organisations approach to BIM implementation:

We use BIM on project(s) where our client requests it as a contract deliverable	35.6%
It is our standard approach to all projects	49.6%
We use BIM only if there are existing models in place for us to develop or interact with	8.9%
We do not have an organisational approach to BIM implementation	5.9%

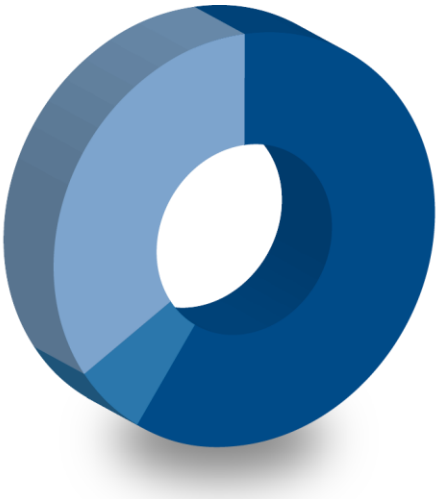
This question deals with the universality of BIM adoption within the organisations. Again, a highly significant piece of information and yet again it is encouraging to note that only a relatively small proportion (5.9%) of the respondents do not have an organisational approach to BIM implementation. The vast majority of respondents (almost 50%) have BIM as their standard approach to all projects. Analysing the figures further, this does suggest that this includes at least a small proportion of Tier 2 and Tier 3 suppliers. This is very interesting as it compares favourably with the NBS survey. The other two categories of responses cover the possibilities where an organisation may use BIM if asked for by the client or if there are existing models in place to develop or interact with and constitute the other half (almost 45%) of respondents. This, at least, seems to suggest that even these organisations are geared up for BIM adoption and are able to quickly respond to any such requests.

Q12. Projected future adoption of BIM

We intend to adopt BIM within one year	50.0%
We intend to adopt BIM within two to three years	50.0%
We intend to adopt BIM within four to five years	0.0%
Never - we don't think BIM is relevant to our organisation	0.0%

This question deals with those respondents (5.9%) from the earlier questions that do not have any approach to BIM adoption yet. All of them appear to have BIM adoption on their radar within one to three years. This is again typical of many organisations in the industry, particularly the smaller ones. These are the organisations that need more help and support than the others in this particular supply chain.

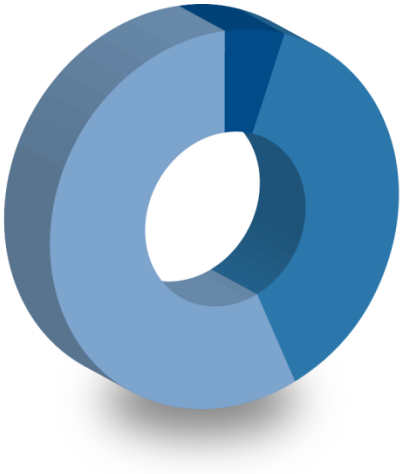
Q13. How does your organisation deliver BIM?



Entirely in-house using our own staff	59.5%
We deliver BIM via specialist external BIM providers / consultants	6.3%
A mixture of in-house delivery supported by external specialist BIM providers / consultants	34.1%

This question deals with the availability of BIM expertise within the organisations. Again, the vast majority (just short of 60%) have an in-house capability. This does not align with NBS survey which concludes that 77% of larger organisations and 62% of smaller organisations lack in-house expertise. Only a relatively small proportion (6.3%) are entirely dependent upon external expertise and the rest (34%) have a mix of in-house and external expertise. This is a high proportion for a supply chain and reflects on the generally high levels of BIM expertise available within this supply chain.

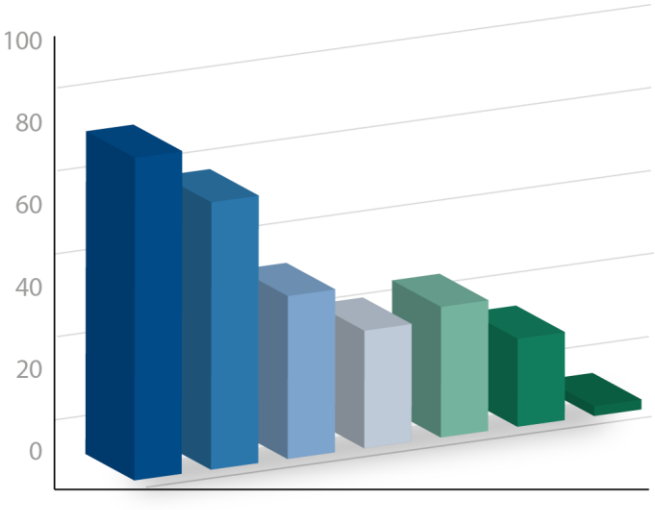
Q14. What level of BIM maturity does your organisation typically deliver?



Level 0 BIM - Unmanaged CAD typically 2D, with paper or electronic ink exchanged between participants	5.6%
Level 1 BIM - Managed CAD in 2D or 3D using BS1192:2007 with a common data environment	37.9%
Level 2 BIM - Managed 3D environment using separate discipline BIM tools with attached data	56.5%

This question gives an idea of the BIM maturity levels that the organisations are typically delivering projects to. A significant proportion (56.5%) is already delivering at Level 2 BIM. This is marginally higher than the findings of other comparable surveys (NBS survey concluded 51%). Again a small proportion (5.6%) is delivering at Level 0, which arguably is not BIM anyway. A significant number (37.9%) are delivering at Level 1, which is also arguably CAD and not BIM. This is important information from an upskilling perspective.

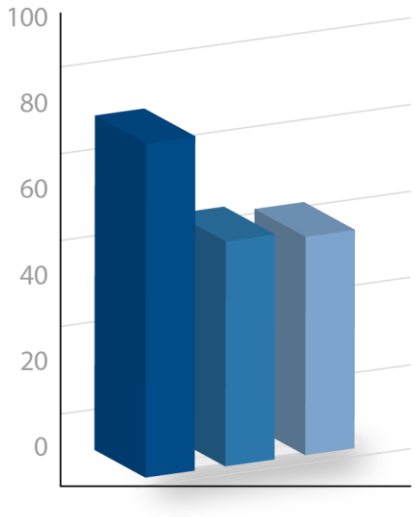
Q15. What BIM outputs has your organisation achieved and developed workflows for?



3D digital design or construction models with embedded or linked attributes / non-graphical data	81.8%
Federation of 3D models	67.8%
4D time simulated models - programme and logistical simulation	41.3%
5D costs for elements or systems attributed to the model data, providing quantification, cost forecasting etct	29.8%
6D 'As Built' model with operational information such as manufacturers data (model, serial numbers etc.) and operation and maintenance requirements.	33.1%
We supply product information data for others to use in the models	22.3%
We supply product information data for others to use in the models	2.5%

This question deals with the BIM outputs that the organisations have achieved and developed workflows for. This is a question that aims to dig a lot deeper into the low level details of BIM adoption. Interestingly, an overwhelmingly high proportion of the respondents do have workflows for not only 3D models but 4D, 5D and 6D as well. This is somewhat surprising as it indicates that these extend to all tiers of suppliers which include a number of SME organisations. A very small number (2.5%) of respondents do not have any workflows for any kind of BIM outputs.

Q16. What type of work has your organisation undertaken using BIM workflows? (tick all that apply)



New build vertical assets	81.0%
Refurbishment of vertical assets	54.5%
Civil or infrastructure projects (including rail or highways)	52.9%

This is a question on the kind of projects that the organisations have used their BIM workflows whether on new builds, refurbishments or civil/infrastructure projects. The clear front-runner is the New build vertical assets (81%) but more importantly some 54% projects were refurbishment projects and a similar number (52%) were civil/infrastructure projects. This is again significant as this question (probably for the first time) suggests that the myth that BIM only is relevant to building assets is not entirely credible and the industry out there is 'breaking' this quite strongly. This should be of particular significance to HS2.

6.3 Organisational Approach

Overall view:

This set of questions attempts to elicit important internal organisational attitude to BIM adoption. This gives an indication of how important BIM adoption is to the organisation and where does it fit in terms of the organisation's relationship with BIM at different levels within the company. Responses to these questions give an unprecedented view of the parts of the supply chain who are clearly way ahead in terms of having a forward thinking and progressive outlook towards BIM adoption and who lag behind. This level of detail is not available from any other comparable surveys so far. The overall findings are encouraging in that a very significant proportion of the supply chain not only have a clear strategy and defined BIM roles within their organisations and have financial provisions within their budgets earmarked for BIM. Equally importantly, significant numbers of organisations are already making investments in upskilling their staff in developing BIM expertise and have several feedback mechanisms in place to constantly improve on their capabilities. Besides, such progressive organisations do not seem to be limited to the larger Tier 1 suppliers but on most criteria, a significant proportion of lower tier companies also share many of these positive attributes.

Q17. Does your organisation have a BIM and/or Information Management policy signed by a board level director?

We have a board approved BIM and/or Information Management policy	56.7%
We do not have a BIM and/or Information Management policy in place at present however we are looking to develop a strategy in the near future	27.5%
We do not have a BIM and/or Information policy in place	15.8%

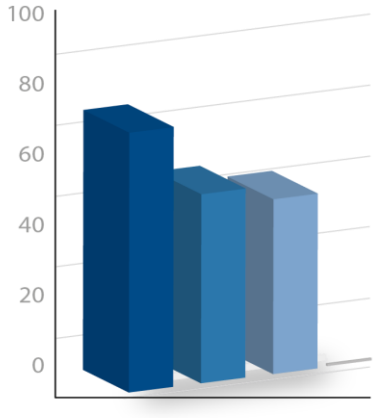
Although this is simple question about BIM's perceived importance within the hierarchy of the organisation, it gives a hugely important indication of how seriously BIM is taken within the organisation. Again, a significantly high proportion (56.7%) of respondents has a Board level policy for BIM. This is very important as these are the organisations more likely to succeed in their BIM endeavours going forward. Quite encouragingly a large proportion of the remaining respondents (27.5%) do have plans to have a BIM policy quite soon. But, quite worryingly, a significant proportion (15.8%) does not have any policy nor do they seem to have any plans for one in the near future.

Q18. Does your organisation have a published BIM strategy, goals and an implementation road-map?

We have published a BIM strategy with defined goals and an implementation road map	60.0%
No we do not have a published BIM strategy with defined goals and implementation road-map	40.0%

This question is yet another indication of the organisation's ethos and culture with regards to BIM. A very healthy 60% appear to have a published BIM strategy whereas the remaining 40% do not. This is highly significant and gives an indication of the strength of the supply chain's conviction to BIM.

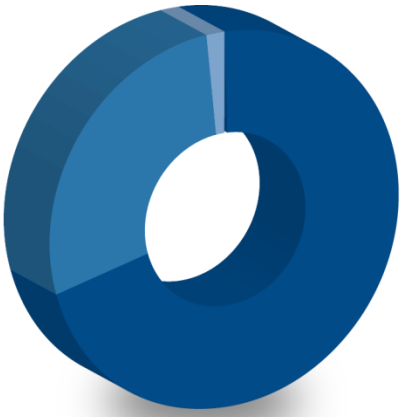
Q19. Do you have someone within your organisation who is responsible for delivering your organisations BIM strategy? (tick all that apply)



We have explicit BIM roles within our organisation to help implement and delivery our BIM strategy	76.4%
We have defined BIM 'champions' within each of our offices or business units	55.6%
We have an individual who is our organisational BIM 'champion'	51.4%
No we have not yet structured the delivery of BIM into our organisational hierarchy	0.0%

It is generally an indication of not only an organisation's attitude towards BIM but the strength of the importance that it attaches to BIM adoption if there is a senior enough person championing or leading BIM initiatives within the organisation. It is this aspect that this question addresses. A very significant proportion (from just over half to high 70%) of the respondents have well defined roles for BIM strategy and delivery either in their central office or devolved down to regional offices. It should, however, be pointed out that the response rate was relatively low for this question (171 out of 303) and hence may not be taken as representative of the entire supply chain.

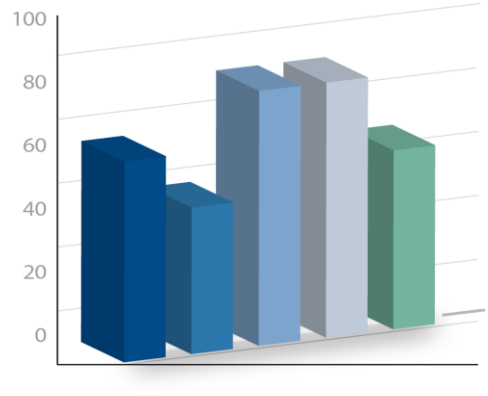
Q20. Does your organisation currently make financial provision(s) for delivering your organisations BIM strategy?



We have financial provision within our organisational budget for BIM	70.8%
We build BIM costs into our project tender allowances	27.8%
No, we intend to invest over the next 1-2 years	0.0%
No, we intend to invest over the next 3-5 years	1.4%

This question is linked to the earlier question in many ways and hence the same respondents responded to this question and it deals with the intent of the organisation for making investments for BIM delivery. Almost 71% of the 171 who responded did confirm that their organisation does have financial provisions for BIM within their organisational budget. Most of the remaining respondents build their BIM costs into their project tender allowances.

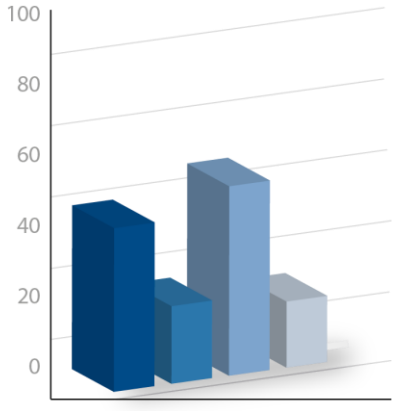
Q21. Does your organisation measure levels of BIM adoption and/or benefits realised? (tick all that apply)



We have metrics in place to measure BIM benefits across our projects	52.9%
We have metrics to measure the benefits we have realised through BIM across our organisation	38.6%
We have developed case studies and user stories for our BIM projects	67.1%
We share BIM lessons learned within our organisation	67.1%
Yes we measure levels of BIM adoption throughout our organisation	47.1%
No	0.0%

This question is a reflection of the organisation's attempts at having a feedback mechanism in place for measuring and consequently improving upon their existing approaches to BIM adoption. Again, the responses are encouraging and a considerable 53% have metrics in place to measure BIM benefits across all their projects. Another response with a very high responses rate (67%) was companies who have developed case studies and user stories for their BIM projects and also those who share BIM lessons learned within their organisation. Considering the number of responses, this clearly spreads across the different tiers of suppliers.

Q22. Does your organisation have a BIM community of practice? (tick all that apply)



This question continues with the theme of reflection and feedback mechanisms for improvement of existing practices and specifically relates to BIM community of practice. About 80% of the respondents do have some form of BIM community of practice already in place.

We have a company wide active BIM community of practice within our organisation	48.3%
We have multiple business unit BIM communities of practice within our organisation	22.9%
We have specialist BIM working groups within our organisation	55.9%
We do not have a BIM community of practice within our organisation	19.5%

Q23. Has your organisation started undertaking a BIM upskilling programme for employees?

In response to this question, almost 90% confirmed that their organisation has started undertaking BIM upskilling programme for employees. Again, this is a highly encouraging trend within this particular supply chain.

Yes	89.8%
No	10.2%

Q24. Will your organisation be undertaking a BIM upskilling programme for employees?

Yes, within 1- 2 years	50.0%
Yes, within 3 - 5 years	16.7%
We do not intent to undertake a BIM upskilling programme for our employees	33.3%

In response to this question which was put to those who do not have an upskilling programme in place yet, half of them have plans to have an upskilling programme within 1-2 years, another 16% or so have plans to have one in place within 5 years but more significantly almost a third do not intend to have any such programmes in place ever!

6.4 Education and Training

Overall view:

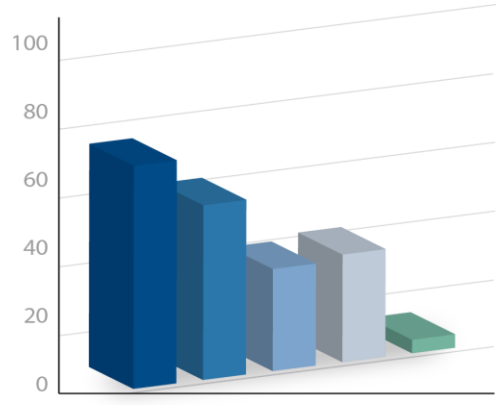
This set of questions attempts to establish the supply chain's approach to training and education of their staff in relation to BIM. The responses are varied and interesting. However, compared to responses to other sections, it is clearly an area of greatest weakness and a lot of the responses do not tie in well with some of the responses to questions in the earlier sections. It should also be pointed out that the response rate is also relatively lower in this category of questions (256 out of 303) which itself is an indicator of weaknesses in relation to BIM training and education and suggests there is work to be done in this area. The findings of this section are not surprising as they do align with findings of other comparable surveys.

Q25. Does your organisation have a structured approach to education and training for BIM or Information Management?

We have a company wide approach to BIM education and training	43.0%
BIM education and training is undertaken at project level on an ad-hoc basis	15.8%
BIM education and training is targeted only to our organisations BIM champions & specialists	11.4%
We are currently developing our BIM education and training programmes	26.3%
No	3.5%

This question is related to the company-wide policy on education and training of their staff on BIM skills. Almost a quarter of the organisations did not respond to this question. This probably indicates that these companies do not have any structured approach to training and education for BIM. Even out of those who did respond, less than half (43%) confirmed that they had a company-wide policy and a structured approach to BIM training and education for their staff. Some 54% have a completely ad-hoc approach to training and education and 3.5% had absolutely no approach at all! This is a disappointing set of results and a worrying one. In some ways, it does not tie in with some of the findings of the Organisational Approach section above. A considerable number of companies do appear to be quite progressive and have the board level support for BIM and one would expect this to reflect in training and education policies as well. But that does not appear to

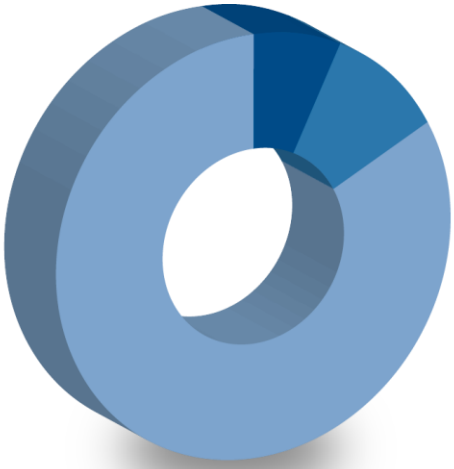
Q26. How is/will your BIM / Information Manag



Delivered in-house by our own staff and or BIM champions	72.8%
Courses delivered by external training partners	57%
Courses delivered by on-line e-training providers	33.3%
Self taught via intranet modules	35.1%
We do not provide BIM / Information Management education and training to employees	4.4%

On the question how training is delivered, the vast majority (72.8%) say it is done in-house. One wonders how this is possible when only 43% (in the last question) seemed to suggest they had a proper policy in place for training and education. Having said that, most of the 256 respondents appear to use mixed methods (external and internal) for training and education. This is clearly an area that needs attention.

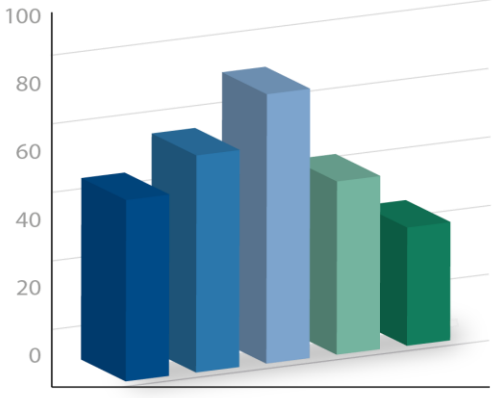
Q27. What is your approach to BIM / Information Management education and training?



Only skill based approach - use of proprietary digital toolsets	7.3%
Only knowledge based - BIM awareness, processes management etc.	10.0%
Blended approach to skills and knowledge	82.7%

Again, on this question regarding organisational approach to BIM / Information Management education and training, the responses are very interesting indeed! Only 10% provide knowledge-based training on processes etc. and 7% on skill-based but almost 83% provide blended training on skills as well as knowledge-based processes. It would be interesting to find out what is the split of skills and knowledge-based training in the blended approach category (83%) as it is well known that skills-based training is readily available however knowledge based and blended training is not easily available. Such information would also highlight how much do the supply chain appreciate the importance of knowledge-based training of processes, standards, protocols etc.

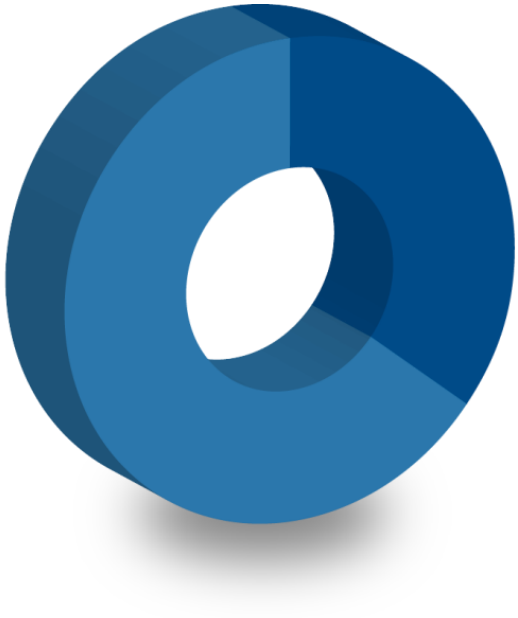
Q28. What level of employee do you provide BIM tr



Strategic level - (Partner, Board Directors, Business Functional Leads. Principal Designers etc.)	60.0%
Managerial level - (Project / Commercial Managers, Design Consultants etc.)	71.8%
Technical level - (Technologist / Technicians, Designers, Technical leads etc.)	89.1%
Operative level - (Workforce etc.)	57.3%
Administration level - (Organisational support staff)	39.1%

On the question of who receives training on BIM, the results are again quite interesting. Whilst it is clear that training is being provided at all levels (Strategic, managerial and technical) by a large proportion of the respondents, it is also clear that the supply chain, as a whole, is not providing training at all levels. There are around half the supply chain providing training to at the strategic level and a slightly higher proportion (71%) are providing training at the managerial levels and by far the largest proportion are providing training at the technical level. This may be acceptable at this stage but things certainly need to improve substantially quite quickly.

Q 29. Do any of your staff have formal BIM or Information Management qualifications?



This question relates to formal qualifications for BIM. Although a minority (35%) responded in the affirmative, it is hard to square this up with any such formal qualifications that are available at the moment. Either they are including the likes of non-formal CPD course attendances in their responses or they do not fully appreciate what is being asked. This is the only sensible conclusion that could be drawn from this set of responses.

Yes	35.7%
No	64.3%

Q30. Please list the formal qualifications and the name of the provider.

No response from supply chain.

Q31. Has your organisation mapped BIM / Information Management skills and competencies to all relevant job profiles?

This question is about defining roles and profiles to different BIM related jobs within their organisations. This is an important question and 46% have responded in the affirmative while 54% have not. This clearly indicates an area of weakness within the organisations and more thought into the mapping of BIM and Information Management skills and competencies needs to be done.

Yes	46.0%
No	54.0%

Q32. Are BIM or Information Management capabilities a sought after competence for new entrants into your organisation?

Yes across all new entrants	27%
Yes at graduate level only	5.6%
BIM or Information Management capabilities are a sought competence only if they are relevant to the role	56.3%
This is not a sought competence for new entrants into our organisation	11.1%

The vast majority do not seek (56.3%) BIM capabilities unless relevant for the role. More encouragingly, a significant proportion (27%) seek BIM capabilities across all new entrants and 5.6% only seek this at graduate level recruitment while 11% simply so not seek BIM capabilities for any new entrants. This is a mixed but not surprising set of results. In some ways, this does map easily on to the earlier responses under the 'Organisation approach' category. One would have expected those organisations that do have a strategy and policy at the highest levels of the organisations to have more progressive attitude towards recruitment of new entrants too. Perhaps some of these organisations are included in the 27% mentioned above but based on the findings of the earlier section; this should have been closer to 50%. This clearly means that there is more work to be done in this area.

Q33. Does your organisation work to a BIM standard as part of its quality assurance process?

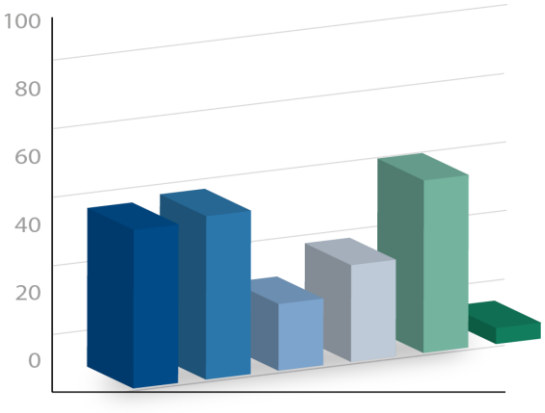
On the question of having a company-wide BIM standard, some 60% responded in the affirmative. Although this is encouraging, it is hard to square this up with any other findings of this survey.

Yes	59.5%
No	40.5%

Q34. Please list what BIM standards your organisation work to as part of its quality assurance process

No information provided. However, interestingly only 74 (out of 170 who said that they had BIM standard) responded to this question on providing information on which standards they used. This implies that either the remaining 96 either did not actually have a standard or they misunderstood the question.

Q35. What process(es) does your organisation use for managing a common data environment?



BS1192:2007	55.6%
PAS1192:2:2013	57.3%
PAS 1192:3:2014	23.4%
We use our own bespoke common data environment and processes	33.9%
We work within a common data environment defined by our client and work in line with their processes	60.5%
We don't use any processes	5.6%

This is a question on the processes organisations use for managing a common data environment. The largest group (60%) work within a common data environment defined by our client and work in line with their processes. However, well over 50% use BS1192:2007 (CAD) and PAS1192:2013:2. Interestingly, a sizeable proportion (23.4%) also uses PAS1192:2014:3. This is a surprise as this document was only published a few weeks ago. However, this can be seen to be an encouraging sign as it at least conveys a strong awareness of these key documents and their role in BIM delivery.

6.5 BIM Process

Overall view:

Many of the responses to questions within this section appear to be positive when taken in isolation. However, there are anomalies between the responses and those of the NBS 2014 National BIM report.

Examples of inconsistent/unexpected responses are; 23% using PAS 1192:3, 14.8% of organisations supplying BIM info only at the end of the contract, anomalies in the response to BIM PEPS, surprisingly high responses to GSL and COBie data.

The significant deviations from expected results, by organisations purporting to use BIM, including comparisons with the NBS survey brings into question the general level of understanding and application of the BIM processes. CPD activities hosted by Glasgow Caledonian University and the academic research undertaken indicate that the level of understanding and adoption implied in the survey is higher than is actually being achieved in industry.

Q36. Does your organisation treat BIM as an iterative process with a defined 'level of information' at each of the project delivery stages?

We create information production tables aligned with defined key stages	67.2%
We deliver information (including BIM deliverable's) only at the end of our contract rather than via a series of defined key stages	14.8%
No	18.0%

67.2% responded that BIM is an iterative process with defined key stages

14.8% supply BIM information at the end of their contract. If these respondents are in the design/construct stages of a project there is a potential lack of understanding of the BIM process. This approach may be acceptable for some supply industries.

Q37. Does your organisation develop and implement BIM Execution Plans for relevant projects?

Yes we use BIM Execution Plans on all our relevant projects	59.8%
We contribute to BIM Execution Plans prepared by others	23.8%
No we do not use BIM Execution Plans	16.4%

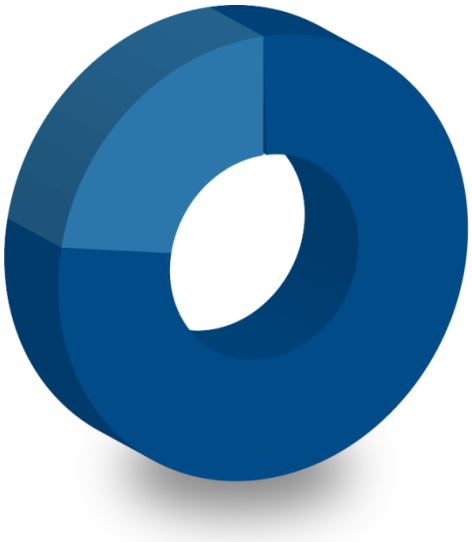
It is positive that 83.6% of respondents use or contribute to BIM execution plans. However, this is a high figure and it would be interesting to see if these are true BIM project execution plan (PEP).

For the 16.4% who do not use BIM PEP's it is difficult to see how they are able to effectively deliver BIM.

More organisations use/contribute to a BIM PEP (238) than deliver BIM at Level 2 (161). This raises questions about the PEPs they are using.

The NBS survey has only 19% of respondents using the CIC BIM protocol. Whilst there are several PEP's that could be used, plus bespoke plans, there appears to be a very significant anomaly between the survey and the NBS survey.

Q38. Does your organisation have workflows to ensure reliable information exchanges during the project life-cycle?



Of the 285 respondents (organisations who use BIM) 63 do not have workflows to ensure reliable information exchanges during the project life-cycle. As this is a cornerstone of BIM it is difficult to see how they are using BIM.

Yes	77.9%
No	22.1%

Q39. Does your organisation have workflows for testing and validating your digital data?

77.9% validate the data which is encouraging.

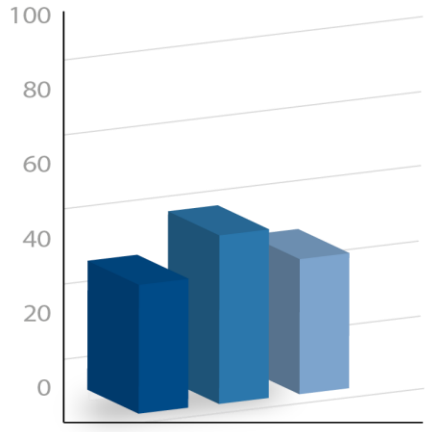
Yes we have workflows for validating 3D geometrical data e.g. clash detection	57.4%
Yes we have workflows for validating non-graphical data sets e.g testing COBie for completeness	20.5%
No we do not have workflows for testing and validating digital data	22.1%

Q40. Which statement below best describes your organisations approach to (Government) Soft Landings?

Whilst GSL is industry best practise it is surprising to see that 79.5% (227) of the organisations who believe they use BIM also do GSL to some extent.

We do this by default	26.2%
We do this when required by our Client	40.2%
We do this only when there is an FM component as part of our contract	13.1%
We do not do this	20.5%

Q41. Has your organisation developed workflows for the creation of non-graphical data from a 3D model e.g. COBie 2012? (tick all that apply)



231 organisations (76%) have workflows for creation of non-graphical data from a 3D model. This would appear to be quite high.

We have developed workflows for the manual creation of non-graphical data from a 3D model	35.0%
We have developed workflows for the automated creation of non-graphical data from a 3D model	45.8%
We do not have workflows for the creation of non-graphical data from a 3D model	36.7%

6.6 Technology and Data

Overall view:

The first two questions in this section relate to standard industry practises that have been widely adopted for many years and it is unsurprising to see a high response to these questions. This confirms that the supply chain respondents do conform to industry standards.

The use of IFC data exchange and COBie is much higher than reported in the NBS survey results. It is possible that organisations may have explored these areas and perhaps carried out a small test which has allowed them to answer the question positively.

The lack of software solutions and IT infrastructure plans by a significant number of organisations is perhaps not surprising in itself but is strange considering that some of these organisations purport to use BIM.

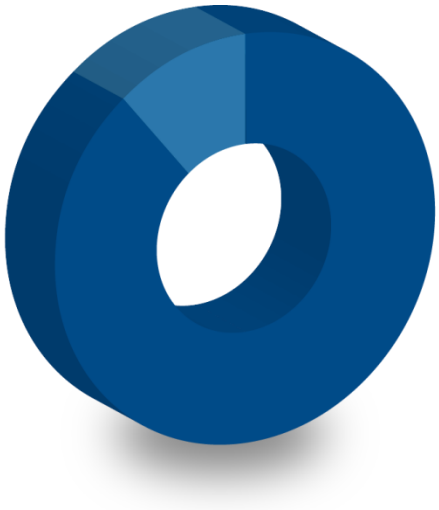
The responses to this section of the survey again raise some issues about the deeper understanding of the BIM process and its application.

Q42. Is your organisation well-rehearsed in the use of project collaboration tools or working with client web enabled information management systems?

We have a default project collaboration system or web enabled information management systems that is used on our projects system	45.4%
We use project collaborations or web enabled information management systems when asked for by our client	28.6%
We use project collaboration or web enabled information management systems when provided by others	19.3%
No	6.7%

The high response to this question is not surprising as such facilities have become the norm in the industry.

Q43. Does your organisation have a data security and disaster recovery plan as part of its standard operation procedures?



Yes	89.1%
No	10.9%

The high response to this question is not surprising as such facilities have become the norm in the industry.

Q44. Does your organisation have default BIM software solutions aligned with its principal workflows e.g. model viewing, authoring, analysis, co-ordination, simulation etc.

Yes, defined at organisational level	50.3%
Yes, tailored and procured at a project level	30.3%
Yes, when software solutions are provided for by our client	3.4%
No	16.0%

230 organisations (75%) have organisational or project level software solutions which would be expected. However, 10 organisations only use solutions prescribed by clients and 46 do not have software solutions. The latter two responses raise significant questions about their capability to deliver BIM. Seventeen 'other' (unknown) responses were returned.

Q45. Has your organisation developed an IT infrastructure plan to support its BIM strategy?

Whilst it is encouraging that 70.6% have an IT infrastructure plan, it is difficult to understand how the remaining 29.4% of organisations will be able to continue to adopt the wholesale use of BIM without an IT infrastructure plan in place.

Q46. Has your organisation ever used open data standards such as Industry Foundation Classes (IFC) as a means of information exchange?

Yes	76.5%
No	23.5%

A high proportion (76.5%) of responses were positive and is much higher than the 45% in the NBS survey for the same question and is, therefore, encouraging and indicative of a more IT savvy supply chain.

Q47. Has your organisation ever used COBie:UK:2012 as a means of information exchange?

Yes	43.7%
No	56.3%

43.7% positive responses are much higher than the 23% in the NBS survey for the same question. This is either very encouraging or indicative of misperception of issues involved.

Q48. Does your organisation use standard classification and/or indexation systems e.g. Uniclass / NRM as part of its data strategy?

Yes we tailor classification and/or indexation systems to individual project needs	48.7%
Yes we have a default structure for classifications	29.4%
No	21.8%

This is a very important question from a BIM perspective. Almost half (48.7%) of the respondents do use a tailored classification and/or indexation systems to individual project needs. Another 29.4% have a default structure for classifications while the remaining 21% or so do not use anything. This is highly significant as almost 80% of the supply chain appear to have an appreciation of the importance of classification and indexing system which is one the key elements in seamless data/information exchange. This is highly encouraging.

Q49. Does your organisation create or manage G

Yes	52.9%
No	47.1%

This is interesting as the whole sample is almost evenly split between those who do and those who don't use geospatial datasets. In our opinion, this is also encouraging and generally indicates a relatively more IT-savvy supply chain.

Q50. Does your organisation have a strategic business plan that looks beyond 5 years?

Yes, we have developed a strategy with a horizon of over 5 years	52.9%
No, our strategy is constrained to under 5 years	40.3%
We have no long term strategic business plan	6.7%

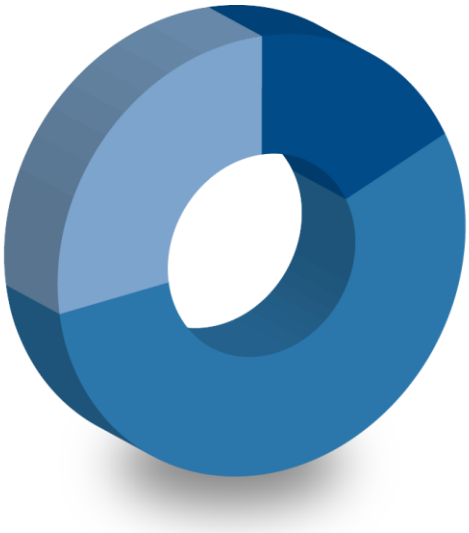
20 respondents stated that they had no long term strategic business plan. This aligns with the responses to Q14. Likewise it would be interesting to see the 13 'other' responses.

6.7 Future Gazing

Overall view:

There are anomalies within the results of this section which may be expected for 'future gazing'. The main area of discrepancy probably relates to IPD (Q58) where over half of the respondents stated that they have, or are preparing, to switch to IPD. This level of activity does not match that seen by the university through CPDs, KTPs or research projects. This level of these responses again suggests that there is a misunderstanding of the processes associated with the various levels of BIM adoption.

Q51. Does your organisation have a 'big data' strategy?



249 respondents have or are planning a big data strategy. This could be closely linked to an IT infrastructure plan (Q45). However, only 201 respondents had such a plan. Further inferences may be drawn if it was known how individual organisations answered question 45 and 51.

We have not heard of this term before	17.8%
This is a planned future activity	55.1%
We have an organisation 'Big Data' strategy	27.1%

Q52. Has your organisation developed a strategy or roadmap for "cloud" based working?

We use "cloud" based working but as of yet do not have a strategy	58.5%
We have a strategy in place	26.3%
No experience of "cloud" based working or strategy in place	14.4%
We have never heard of this term before	0.8%

The responses are again quite mixed and this is not surprising considering “cloud” based technologies are relatively new. However, it is encouraging to note that well over half (58%) do use cloud in some way or another although do not have a strategy yet. A relative minority (42%) do not use it nor do they have a strategy on cloud computing. This is in line with what one would expect and overall the supply chain, yet again, is ahead in the game compared to other comparable ones within this industry.

Q53. Has your organisation made a strategy for future proofing its digital data?

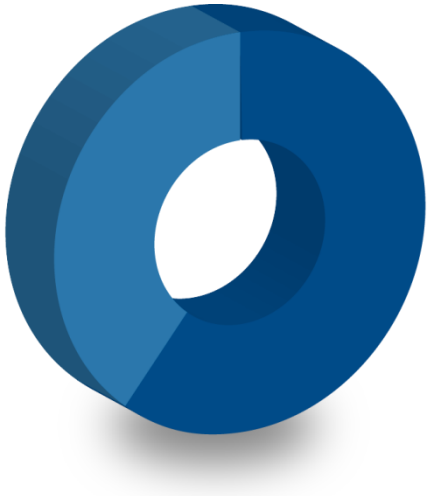
This is a key aspect of using digital data. It would be beneficial to see examples of the 67 strategies that are in place.

Q54. Does your organisation intend to develop a strategy for future proofing its digital data?

Yes	61.5%
No	38.5%

It is difficult to assess the accuracy of the answers to this question as it could be considered a ‘leading’ question.

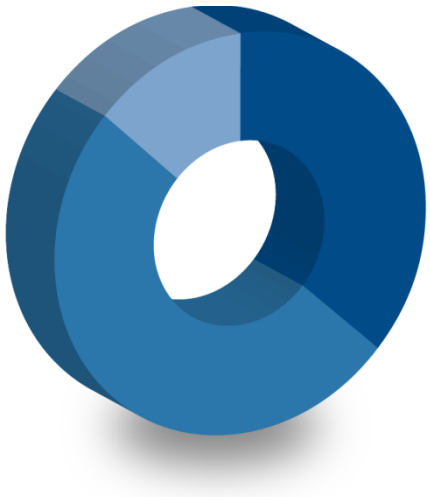
Q55. Has your organisation developed education and training pathways aligned to future needs?



Yes	60.7%
No	39.3%

The NBS survey highlights that 77% of organisations with more than 6 people identified lack of in-house expertise as a barrier to the implementation of BIM. It is somewhat surprising that only 60.9% of the organisations have developed a training pathway. As expected, this aligns with the responses to Q12 and 14.

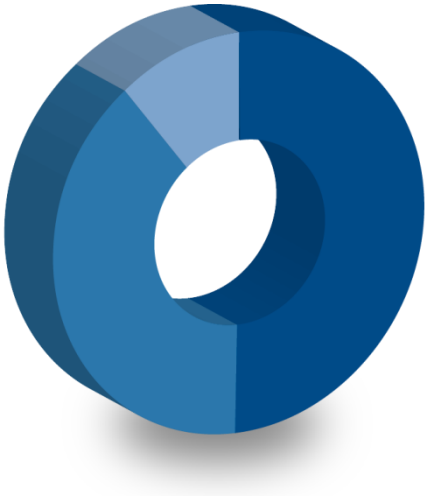
Q56. Does your organisation have experience of relational data bases or semantic data?



We understand this concept but yet to have experience	36.8%
Yes, we have experience of one or both of these	50.4%
We have never heard of these terms before	12.8%

Not surprisingly, the responses are mixed and a sizeable chunk (38%) has no idea of what these technologies might be. It is interesting and encouraging to note that almost half of the respondents (50.4%) have experience one or both of these. These organisations are clearly the more progressive ones and are well ahead of the pack for the industry as a whole.

Q57. Does your organisation have a forward plan for IT investment aligned with future trends?



An IT forward plan has been developed	50.4%
We are currently developing our forward plan for IT	39.3%
No we do not have a forward plan in place	10.3%

This is similar to Q45, yet only 50.4% have a forward plan for IT investment compared to the 70.6% in Q45.

Q58. How well prepared is your organisation for a shift from collaborative to integrated project delivery (IPD) and Level 3 BIM (single model working)?

We have started to develop integrated, concurrent processes	53.8%
We have a planned roadmap routing on our key level 3 BIM / IPD enabling activities	37.6%
We have never heard of IPD or level 3 BIM	8.5%

The implementation of Level 2 BIM on Government procured projects is almost two years hence. This is one of the main drivers for BIM and it is therefore surprising to see 177 organisations have started or have a roadmap to shift to IPD. This either indicates a lack of understanding of Level 2 BIM or is a misperception of issues involved.

6.8 Summary Questions

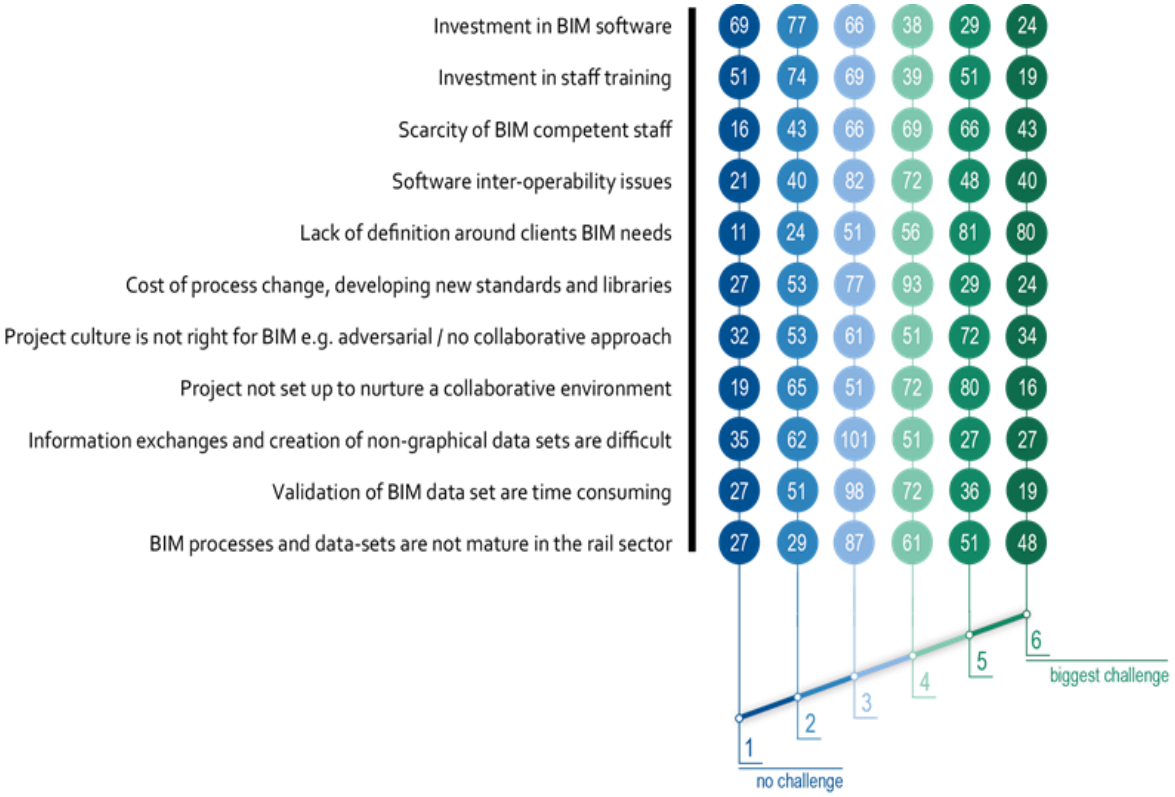
Overall view:

The two questions in this category attempt to sum up the supply chain's main challenges and upskilling needs. The responses are a bit mixed but overall encouraging. The response to the question on main challenges is slightly at odds with the NBS survey which seems to suggest that this particular supply chain is either of superior expertise relatively speaking or at least some sections of it lack proper understanding of real BIM issues.

Q59. With regards to the statements below, please rank what you perceive are your organisations challenges to BIM adoption?

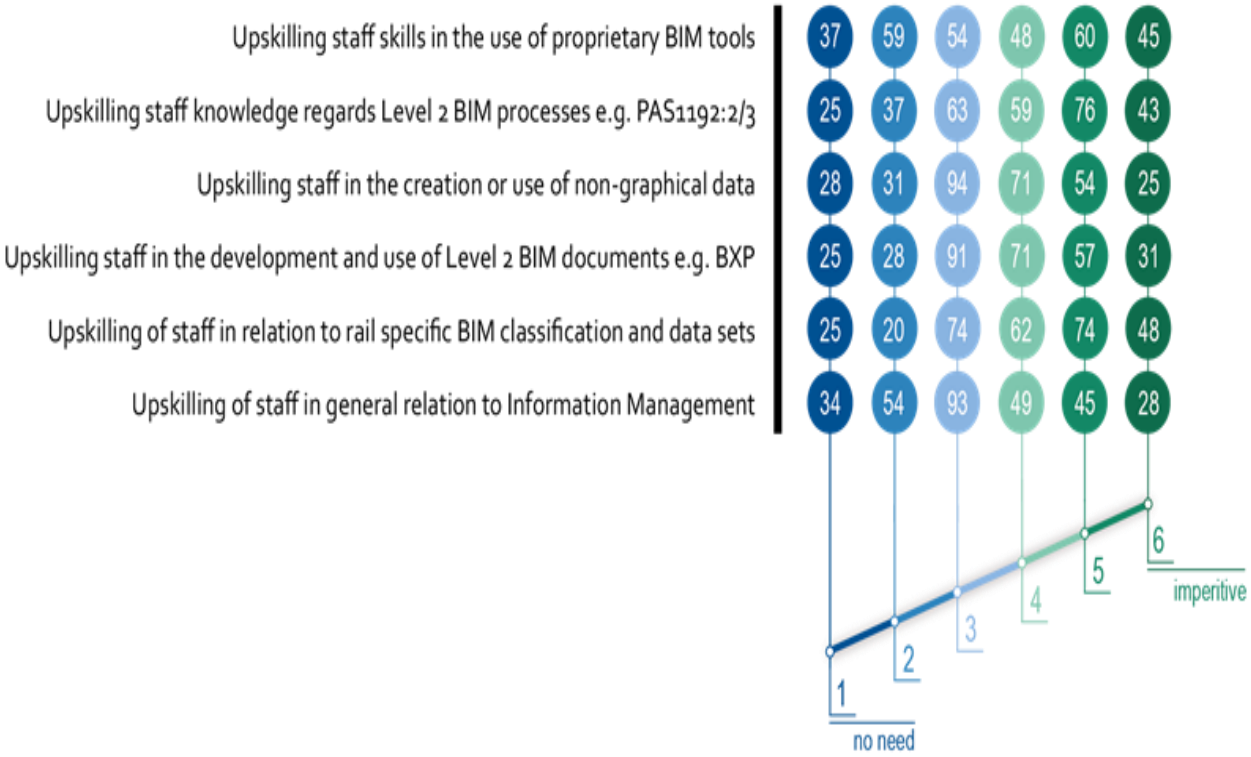
Lack of client definition is seen as a major barrier which aligns with NBS survey.

Investment in staff training and competent staff are seen as quite a low barrier whereas the NBS survey identified this as the main barrier for firms with 6 or more employees.



Q60. With regards to each of the statements below, please rank what are your organisations main upskilling needs?

Most of the responses were in the range of 3-4 being in the midrange of 'no need' and 'imperative'. The main exception to this related to the question 'Upskilling staff knowledge regards Level 2 BIM processes e.g. PAS1192:2/3'. For this question 119 respondents (39%) identified this as either category 5 or 6. This response may still show that there is still a significant lack of understanding relating to the BIM process.



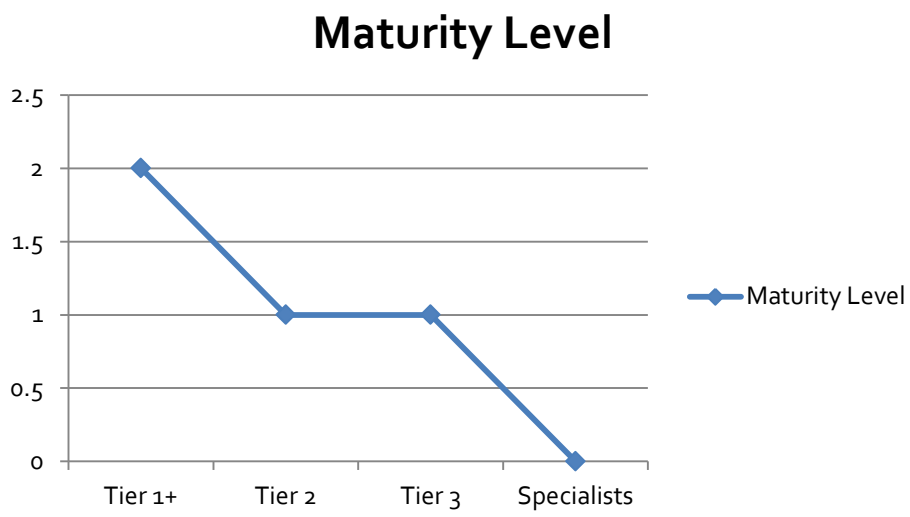
6.9 Overall Summary

The survey is based on 303 responses altogether from the entire cross-section of HS2's potential supply chain. However, a significant number of respondents were involved in more than one cognate area of activity (design, management etc.) within their organisation.

1. The most important headline finding of this survey is that the a large section of the supply chain consisting of almost all the Tier 1 and some of the even lower tier suppliers say they are either already delivering to Level 2 BIM or are well on their way to it. Because of the granularity of data provided, it is difficult to break this down any further and be more precise. This group appears to have a good grasp of key issues in relation to BIM processes, standards, protocols and technologies. They also appear to be forward looking and are receptive and adaptive enough to embrace new technologies on the horizon (viz. cloud, semantic and geospatial data, big data etc.).
2. It is also clear that there is another group only slightly behind the 'top' group which probably consists of Tier 2/Tier 3 and Specialist consultants (please refer to graph 1 overleaf). However, as indicated by responses in the Technology and Data category, this group could achieve Level 2 maturity relatively quickly with some upskilling in some key technological and data exchange standards like IFC, COBie 2012 UK Dataset etc.
3. There is a relatively small group of few organisations who are not currently delivering BIM at any level and would require the most amount of upskilling to achieve the required levels of competence.
4. Interestingly, items 1-3, do not fully align with the only other somewhat comparable survey like the NBS. As stated earlier (Question 55), according to the NBS survey, 77% of the large organisations are finding it harder to gear up to BIM due to lack of in-house expertise. This survey shows that this particular supply chain's largest organisations (Tier 1) are actually way ahead in BIM competence in relation to their smaller counterparts. It should also be pointed out that it is likely that these larger organisations will 'pull' their smaller partners in the supply chain to come up to the required levels of expertise in their own firm's interest. This all bodes well for HS2.
5. In relation to graph 1, it should be pointed out that the different groups of suppliers mentioned here generally apply to the majority of organisations in the respective and not necessarily the entire group. Also, Tier 1+ includes Tier 1 plus some other organisations in the lower tiers.
6. The vast majority (almost 94%) of the respondents are using BIM already. The remaining 6% intend to use BIM in 1 to 2 years. This is considerably higher than indicated by other comparable surveys (e.g. NBS BIM Survey 2014) which put the proportion of the industry using BIM at the moment in the region of 54%.
7. The survey drills this further down by asking about the maturity levels that the organisations may be delivering at. A considerable 56.5% believe they are delivering projects at BIM maturity Level 2. This is broadly in line with comparable surveys. Another 36% believe they

are delivering projects at Level 1. However, it may be questionable if Level 1 is BIM in the first place.

8.

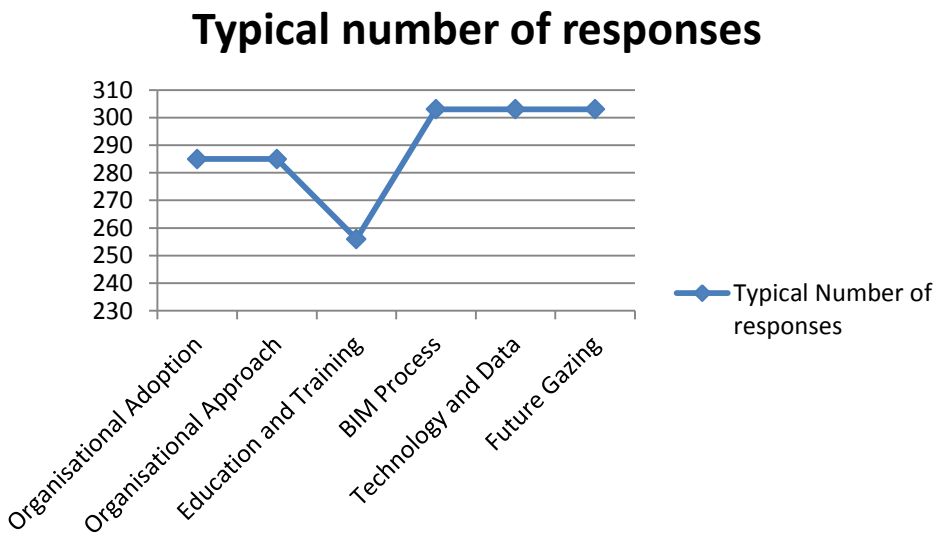


Graph 2: A snapshot of BIM maturity level capabilities for different categories of the supply chain

9. In terms of training and education, the numbers again broadly align with other surveys. However, interestingly the highest number of respondents (just under 73%) relies on in-house training. This is interesting as these must be the organisations where BIM upskilling must have been achieved to a degree in order to be able to have the capacity to train staff internally. These organisations are likely to be the ones who should be further ahead in the BIM journey than others.
10. On the question of recruitment policy vis-à-vis BIM, some 27% of respondents seek BIM competence in new recruits. This can be seen to be an encouraging trend. However, it would be interesting to find out what is the success rate of these organisations in finding new recruits with BIM skills.
11. One interesting result from the survey is that 23.4% use PAS 1192, part 3 to manage a common data environment. This is interesting as this means these are highly progressive organisations with a very close eye on the developments in this field and a willingness to adopt new guidelines and standards being published by the BSI or BIM Task Group. Considering PAS1192: Part 3 was only published in March 2014, these organisations must have started using the document when it was circulated for consultation in 2013. Alternatively, it may even be a case of a misplaced perception about what they might actually be doing.
12. In response to the question on whether their organisation treat BIM as an iterative process with a defined 'level of information' at each of the project delivery stages, it was interesting to note that just under 68% appear to follow something like RIBA Plan of Work. This is encouraging. However, the remaining 32% appear not to deliver all the information including

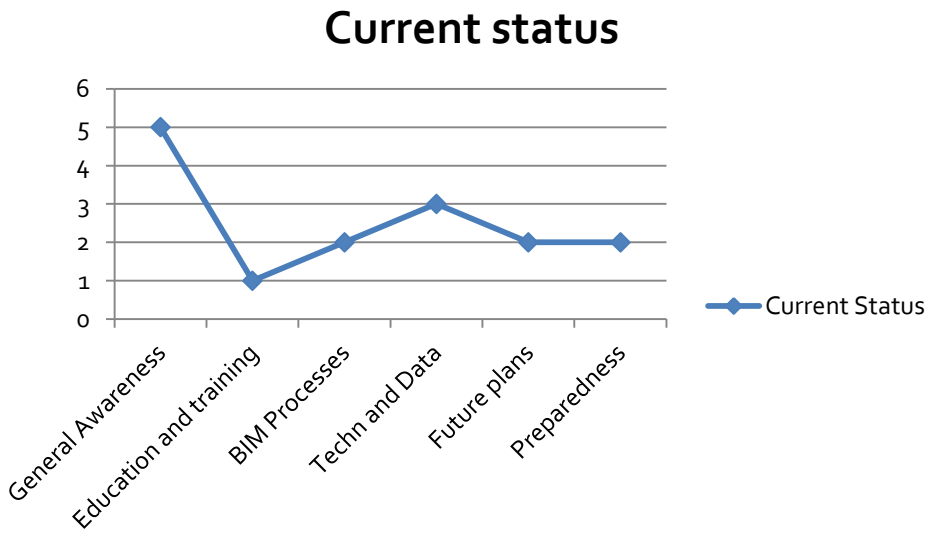
the BIM deliverables right at the end, which seems to suggest that they do not follow any plan of work aligned to defined Data Drop points as proposed by PAS1192: Part 2.

13. Another encouraging result from the survey is in relation to GSL (Government Soft Landings). Almost 80% of the respondents comply with GSL in some form or another. Another question indicates that some 41% have used COBie for information exchange. This is lower than 80% respondents using GSL. This means that a significant number of these organisations are not using COBie for exchanging information at handover whilst they may well be compliant with GSL using other ways of information exchange.
14. Overall, these are some of the main findings so far which paints a relatively encouraging picture of the HS2 supply chain. Having said that, it is not entirely clear if all the respondents share a common understanding of BIM and its associated processes, protocols, technologies and standards for information exchanges.
15. The following three graphs give the reader an overall feel for the strengths and weaknesses of the supply chain vis-à-vis BIM capabilities. They indicate that the area that requires more attention than others as Education and Training. As shown in graph 2, the fact that there were fewer responses for the Education and Training category seems to suggest strongly that even where there are strategies and policies in place the implementation of these policies is lagging behind particularly in relation to training and education. For a detailed analysis of the questions within the education and training category, please refer to the individual question based analysis in the section above. This reinforces that although that the supply chain is strongly aware of BIM issues, the translation of this awareness into solid implementation of strategies and policies have some way to go yet.

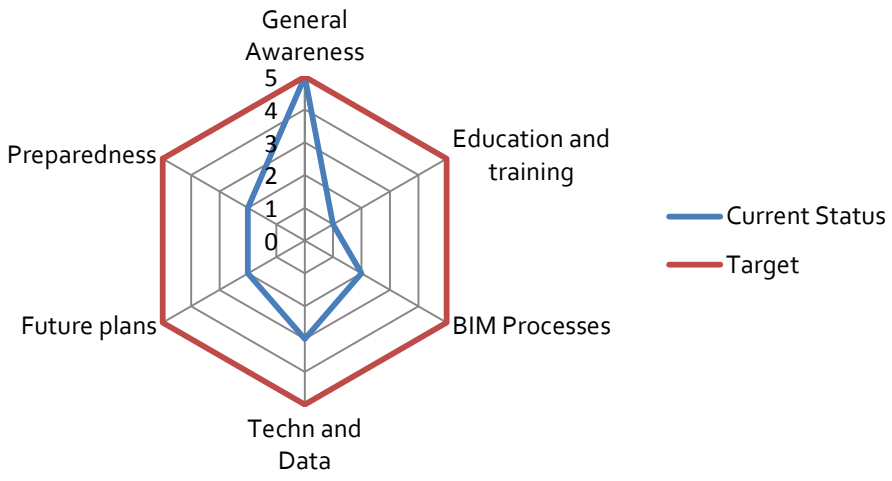


Graph 3: Relationship between survey questionnaire categories and typical number of responses

16. Based on this survey, the following chart (Graph 3) is an overall assessment of the supply chain along five criteria on a scale of 1 to 5 where 1 is low and 5 is high. This again aims to indicate the areas that the supply chain appears to be highly competent in and the ones where there is more work to be done. In line with the survey results discussed in the preceding sections, the area that appears to require more attention than others is the education and training activities. This is borne out by the earlier graph where there was a relative dip in number of responses. In fact, in one of the questions (question 34) in this category the response was as low as 74 out of 303! This would indicate a lack of understanding in terms of BIM standards and therefore a reluctance to even respond.



Graph 4: An overall assessment of the current state of affairs in relation to some key criteria



Graph 5: An overall assessment of the current status as compared to the target status in relation to some key criteria

17. The spider diagram above aims to show the gaps between the current status (1 to 5) and the target status (5) against the key criteria used in the earlier graphs. It is clear that although there are areas of strengths (i.e. awareness, technology etc.), other areas of relative weakness like processes and education and training require a lot of work to be done yet. This should be considered together with Graph 1 to get an idea of where in the supply chain these areas of weaknesses (and strengths) might lie.

6.10 Comparison against other surveys, such as NBS, Pinsent Mason, NFB, CIOB, BIM4SME, ICE Heat Map and any noticeable trends

- There are several other BIM-related surveys that have been published in the recent past. Some of these are mentioned below:
- ICE Heat Map – This was conducted by the Institution of Civil Engineers in 2013. It is a relatively smaller snapshot of the views of ICE member organisations. It is not very comprehensive and conveys some very high level information.
- NFB – This was conducted by the National Federation of Builders and was also a relatively small survey (173 respondents) and was focussed on SMEs.
- NBS – NBS carry out a survey every year since 2010. The latest in the series (NBS BIM Report 2014) has just recently been published and is based on more than 1000 respondents. This survey is perhaps the most comprehensive and comparable to the HS2 survey in terms of depth and breadth of its coverage. As mentioned in the earlier section, a number of results from this survey align with this HS2 survey but there are some divergences.
- CIOB – This was conducted by CIOB in 2012 with 1346 respondents. This survey was not entirely focussed on BIM but did include questions on BIM technologies. It, therefore, not comprehensive in its depth and breadth as it does not cover on much (if anything) else than BIM technologies.
- RICS – RICS conducted on of the first surveys on BIM back in 2011.
- Pinsent Mason – This survey is focussed almost entirely on procurement routes and contractual issues in relation to BIM and most of its findings relate to that. In that respect, it is fair to say that this is not a comparable survey to the HS2 Supply Chain survey in its entirety and any comparisons made will be limited. A key overall finding of the Pinsent Mason survey was that the 2016 deadline for BIM Level 2 for all public sector projects was unachievable as two-thirds (66%) of those surveyed believed that the existing forms of contract used in the industry were inadequate for Level 2 implementation. This is highly questionable and does not align with several guidance issues by the BIM Task Group and others.

One should point out that it is not clear if there is unanimity in terms of what is actually meant by BIM in the different surveys, e.g. NFB (2012) appears to be entirely focussed on BIM technologies, Pinsent Masons understandably focus on contractual issues and procurement routes. It would appear that all except NBS do not devote much of their survey on processes, data/information capture and exchange standards (including COBie) and protocols etc. Therefore, it would be reasonable to suggest that this HS2 survey is more comprehensive than most other surveys currently available and gives a more holistic picture of BIM upskilling issues in its supply chain.

Section 7: Supply chain BIM maturity and segmentation

7.0 Supply Chain BIM maturity and segmentation

It is important to note that the categorisation of study participants is based upon where they (organisations) observe themselves as being and in the absence of an industry benchmark for measuring capability there is likely to be an error of margin with the perceived point of departure relative to professed BIM maturity versus actual. Discussion with participants also revealed that their scoring was based upon an average of their BIM project maturity as opposed the organisation as a whole.

The survey revealed that just fewer than 50% of organisations are using BIM (in some manifestation) as a standard approach on all projects even where clients were not prescribing it. In addition a further 35.6% were using BIM only when a client requests it as a contract deliverable.

Overall normalising the data from both the survey and the symposium revealed an aggregated:

46% using BIM as default and a further 28% implementing BIM only when the contract dictated.

Awareness of BIM is being seen as almost “universal” in the UK and the 2014 NBS BIM report illustrated an adoption level of 54%.

Interviews and the supply chain workshop would suggest that this was mainly in the context of geometrical modelling with information exchanges being limited to the sharing of domain models for federation and subsequent clash detection. Very few were transacting upon non-graphical data such as COBie:UK:2012 other than the final drop prior to handover when they were delivering asset information.

This can be broken down into the various maturity tiers, whilst the question was “what level does your organisation typically deliver in” the workshop processed revealed that in most cases that this was their leading BIM projects.

Maturity Level	Description	HS2 survey	HS 2 workshop	HS2 normalised	NBS 2013 survey (highest BIM level)
Level 0 BIM	Unmanaged CAD typically 2D, with paper or electronic ink exchanged between participants	5.6%	11%	8%	11%
Level 1 BIM	Managed CAD in 2D or 3D using BS1192:2007 with a common data environment	37.9%	35%	37%	31%
Level 2 BIM	Managed 3D environment using separate discipline BIM tools with attached data	56.5%	55%	55%	51%

These results can further be broken down by disciplines

Organisations using BIM as default	
Tier 1 Contractor	**68%**
Tier 1 Designer	**63%**
Principal Consultant (PM/PQS)	**32%**
Tier 2/3 Specialist Trade Contractor	**40%**
Tier 2/3 Specialist Designer / Sub-consultant	**36%**
Manufacturer	**28%**

Maturity Level	Domain placement						HS2 normalised
	Tier 1 Contractor	Tier 1 Designer	Principal Consultant (PM/PQS)	Tier 2/3 Specialist Trade Contractor	Tier 2/3 Specialist Designer / Sub-consultant	Manufacturer	
Level 0 BIM	**6%**	**6%**	**10%**	**10%**	**8%**	**10%**	**8%**
Level 1 BIM	**25%**	**30%**	**50%**	**48%**	**36%**	**34%**	**37%**
Level 2 BIM	**69%**	**64%**	**40%**	**42%**	**56%**	**56%**	**55%**

Notes:

It should be noted that this was largely in the context of BIM and vertical assets these adoption and maturity %s would drop if infrastructure only was isolated.

Data should also be considered as an average of an organisation BIM project maturity as opposed the organisation as a whole.

7.1 Tier 1 Contractor:

Discussions with the Tier 1 main contractors illustrated a high level of BIM maturity within these organisations. Most had a developed a strategic BIM roadmap, introduced associated job roles and had a training programme in place. Whilst most had been reliant upon external support for BIM they were now bringing this in house and becoming more self-sufficient.

It was evident however that this BIM maturity was mainly weighted in favour of vertical assets and there was much less in their portfolio for infrastructure. Limitations in COBie and IFC were amongst the barriers for adoption in infrastructure. BIM software offerings in infrastructure were again perceived as not being as well developed as in the world of vertical construction.

The main challenges in this community were around information being poorly defined both from a client perspective (EIRs either non-existent or poorly defined) and designers who were producing design models that took no account of information requirements or LOD for procurement, sequencing etc. The classification and non-graphical attributes that they received were also limited.

7.2 Tier 1 Designer:

Tier 1 designers were likewise increasingly developing their BIM capability and most had now been on their journey for a couple of years. It was evident however that these organisations were primarily focused on the geometrical models and less on data transactions and information management. They again highlighted that the lack of "rail standards" for classification and the general immaturity of IFC for infrastructure were a barrier.

When discussing education and training it was marked that design organisations were concentrated on the skills around their digital tools and less on knowledge based learning around information management. There was a recurring conversation around COBie:UK:2012 and whilst there was growing awareness there was still limited knowledge as to how they could use this as data schema and exchange format.

Whilst many designers believed that they were in the Level 2 'sweet spot', they were when interviewed missing many of the Level 1 components and were not using BS1192:2007 for a common data environment or BS:7000 for design management.

7.3 Principal Consultants (PM/PQS):

The principal consultants other than a few at the leading edge were still largely trying to ascertain what their role was relative to Level 2 BIM. Most still saw BIM as being a bolt on to their offering as opposed to being a core ingredient. There was limited knowledge especially from Project Managers and Technical Advisors around how they would support their clients especially around AIR/EIR and protocol production. There was an evident knowledge gap with regards the Level 2 artefacts and how this would be enacted as part of the contract hierarchy.

Most of the quantity surveying community had however positively commenced on their BIM journey and were using digital tools to help automate quantity take-off. They did however note that the lack of knowledge in the design community was a barrier as models were not being set up appropriately to fully automate this process. There was a feeling that the design community need better understanding of information needs from others and how the RICS New Rules of Measurement (NRM) can be applied.

7.4 Tier 2/3 Specialist Trade Contractors:

Overall Tier 2/3 specialist trades were in the Level 0-1 maturity zones with very few implementing Level 2. The main issues in the group were "how much is this all going to cost me" and "we already do 3D CAD." There was a real desire for general upskilling around the core aspects of Level 2 BIM

how it works and where the opportunity was for them. They also believed that they would move quite fast once they had this basic grasp of what they needed to do.

Of note was concern around proprietary software and they noted that whilst clients may be agnostic in their approach to open data standards the Tier 1 contractors and consultants still wanted information in a proprietary file format. This dictated that they had to invest in training around many different digital toolsets.

7.5 Tier 2/3 Specialist Designer / Sub-consultant:

There was real bandwidth in this community with digital natives including several specialist SMEs that were very well advanced and were operating in the Level 2 space and at the other end there many who were locked in Level 0 and only aware of BIM.

It was visible that the "Geomatic" community and building services designers had very mature workflows and were well positioned on the BIM maturity wedge.

Overall however similar to Tier 2/3 specialist trades there was a desire and need for both simple guidance and knowledge based training at a foundation level.

7.6 Manufacturer:

There was a good news story emerging from the manufacturing community that despite being slow to start using BIM many were beginning to digitise their product range. Those that had started on this journey had been reliant however on specialist library providers to create and host their data which meant an investment. This was an issue as not all could make this upfront investment.

The participants from the manufacturing community noted that they were well rehearsed as a sector in the use of computer readable data (CNC information etc) however the current BIM structured formats were new and generally there was little consistency with regards to information requirements from the supply chain.

Most were however providing this data in a variety of proprietary file formats with a few providing IFC formats however only a very small sample providing COBie information. It was noted that this is where the demand was.

It was agreed that the Digital Plan of Work (DPoW) on its completion will help adoption by illustrating client information needs and bring clarity with regards classification systems etc.

Generally the recommendation was for HS2 to create manufacturer information demand matrices in a COBie format and support the DPoW on its completion.

7.7 International perspective:

The concept of BIM and use of digital tools have now proliferated globally across the construction industry. This can be evidenced by the comparative results of BIM adoption rates reported through a number of industry surveys such as Hill-McGraw and the NBS International BIM report 2013.

Again due to a lack of benchmarking it is difficult to categorise standards and repeatability of BIM on a like for like basis. Generally within Europe the Nordic countries such as Finland are mature in their capability especially in IFC and standards.

Of significance is the modernisation of the European legal framework for public procurement, the European Parliament agreed on 15th January to allow and encourage BIM as part of its e-procurement measures.

Whilst it does not mandate BIM across member states it will be key to helping drive awareness and building capability.

EU Public Procurement Directive

Article, 22 *Rules applicable to communications* provides that:

"For works contracts and design contests, Member States may require the use of specific electronic tools, such as of building information electronic modelling tools or similar."

During the currency of the symposia and interviews the design community noted that they are frequently outsourcing their modelling to India and other countries. Follow up conversations with a sample of these outsource organisations with most having a relatively good understanding of UK processes and data standards such as COBie. However as was generally the case they struggled to evidence good examples in the rail sector.

Overall the international community has growing BIM capacity and capability and because of the UK Government efforts also has generally good awareness of our standards. The main recommendations that came from these groups were a need for good communication and simple guides so they could understand the taxonomy and requirements more fully. US organisations also suggested HS2 implementing e-learning modules around each of the Level 2 artefacts as they were very much used

to using the AIA standards, they believed this would be particularly pertinent with regards the future release of the DPoW as they were very used to US levels of development (LOD) as per their Consensus documents.

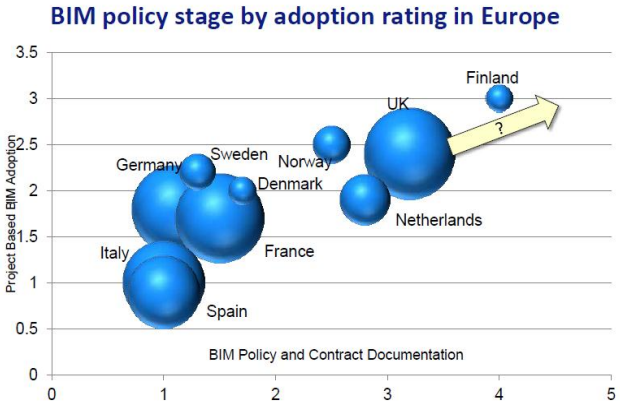


Figure 11 BIM policy stage by adoption rating in Europe. Source: Autodesk 2012

Skills and knowledge gaps	
Tier 1 Contractor	The Tier 1 contracting community generally had a good appreciation of the BIM processes however this was generally within a context of vertical assets (+30%). Also little over 50% were fully aware of or implementing BS1192:2007 and or PAS1192:2 the bedrock of Level 1 and Level 2 BIM maturity. There was a perceivable knowledge gap on how the Level 2 works in the context of a rail project, especially with regards to COBie and classifications systems. This was amplified if COBie was to be used for digital transactions to answer Plain Language Questions (PLQs) Defining adequately their data needs and associated LOD was also still inconsistent – a simple guide and good templates should help ameliorate this however. The production of COBie was seen as a general domain weakness and this should be seen as a priority upskilling theme for this community. Upskilling and awareness on the use of BS1192:2007 and PAS1192:2 is also needed as a key knowledge theme.
Tier 1 Designer	Overall the Tier 1 design community had an ever increasing ability to create a 3D dynamic model relative to their domain and expressed little concerns around skills allied to the digital toolset. They were concerned however that the open data formats would see main-contractors asking for lots of different proprietary formats which could potentially cause skills issues. There was a knowledge gap relative to understanding data requirements allied to the supply chain and felt that some simple guidance would be useful again backed up with default templates. Their major concern was around IFC / COBie for infrastructure works and believed that there was a skills gaps here due to lack of maturity in this file format for linear works. This was the main priority area. As with the main contractors there still a need for whole-scale upskilling and awareness on the use of BS1192:2007 and PAS1192:2

Principal Consultant (PM/PQS)	The project management and technical advisory community were still very much in the early stages of the BIM journey and attempting to understand their roles and responsibilities with regards to Level 2 BIM. With this group there is more a precedence demand for knowledge upskilling as opposed training or skills on the digital toolset. The priority need was for basic core competencies around client information requirements (DPoW) and creation of BIM AIRs / EIRs / Protocols and tender clauses for buying digital data.
Tier 2/3 Specialist Trade Contractor	There is much heavy lifting to do in this category with a real need for general upskilling around the core aspects of Level 2 BIM processes and opportunities. In addition to the knowledge upskilling there is also a need for basic awareness on the digital tool-kits and impact on their business.
Tier 2/3 Specialist Designer / Sub-consultant	Because this community was split into two categories there were two distinct needs: Early adopters were similar to their Tier 1 peers with a need around IFC / COBie and the PAS suite of BIM documents. The balance were indeed again in need of more basic skills based training especially on the digital tool set and model authoring. In support of the above there was also a desire for good guidance for investment (software, hardware and training).
Manufacturer	From the manufacturers perspective there was a need to upskill in three distinct areas: IFC and COBie for digitisation of their objects Classification of objects Understanding information needs

Section 8: Upskilling Pathways

8.0 Upskilling Pathways

From our analysis we have identified four pathways, three from current state to a stable Level 2 BIM capacity followed by a second future tranche from post 2016 to Level 3 BIM maturity. Figure 12 (overleaf) is based upon HS2 interventions to assist the supply chain in their upskilling needs.

Anticipated pathways (trailing edge based upon anecdotal evidence)	
Tier 1 Contractor:	Domain average: pathway 3 Trailing edge: pathway 2
Tier 1 Designer	Domain average: pathway 3 Trailing edge: pathway 2
Principal Consultant (PM/PQS)	Domain average: pathway 2 Trailing edge: pathway 1
Tier 2/3 Specialist Trade Contractor	Domain average: pathway 2 Trailing edge: pathway 1
Tier 2/3 Specialist Designer / Sub-consultant	Domain average: pathway 3 Trailing edge: pathway 1
Manufacturer	Domain average: pathway 3 Trailing edge: pathway 1

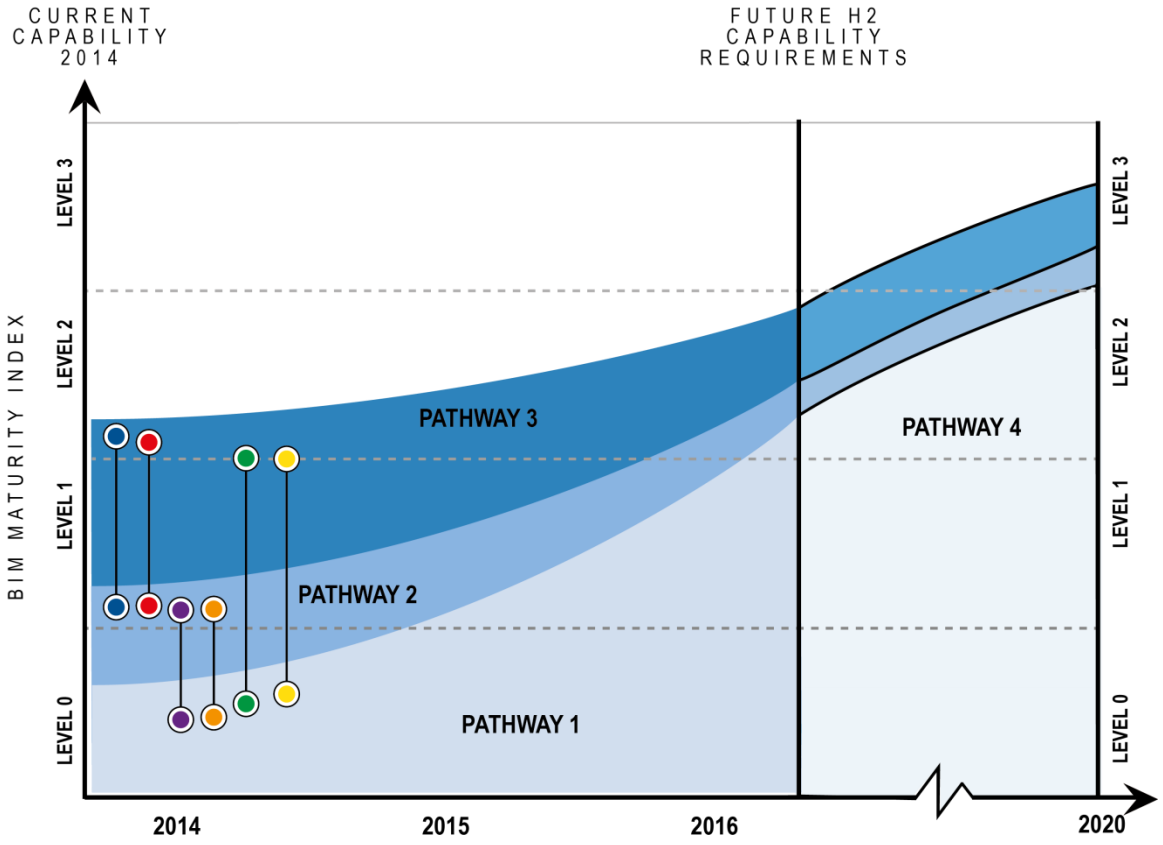


Figure 12 supply chain BIM maturity with HS2 upskilling pathway aid

As illustrated above we have identified four potential pathways of upskilling. The first three recognise the need to elevate the supply chain from their current state to a future "to be" consistent with Level 2 BIM maturity to allow design and procurement to be consistent with these requirements. Following this convergence there will be a potential impending need for further upskilling towards Level 3 maturity, pathway 4. Pathway 4 is dependent upon HS2's judgement as to whether it wants a transition from Level 2 to 3 for the construction and operational delivery stages.

8.1 Pathway 1:

This swim-lane is based upon a current state of Level 0 maturity and is aimed at organisations that are at the trailing edge and have not as yet embarked upon their BIM journey. This pathway has several stepping stones:

- General awareness on BIM requirements relative to their domain
- Organisational assessment to identify gaps in their current capability
- Upskilling from Level 0 to Level 1 which will necessitate training around BS1192:2007 and the principles of working in a common data environment
- Once this milestone has been achieved it should be considered a launch pad to Level 2

- Upskilling on the Level 2 artefacts – BIM PAS suite etc and how these will be executed relative to their commission.
- Whilst the above is knowledge based there will be a potential need for organisations to consider their own explicit training on proprietary digital tools relative to their works.

8.2 Pathway 2:

This corridor is aimed at organisations that are either operating within Level 1 maturity or have early adopter projects in this zone, essentially it assumes that they understand or are using a common data environment to manage their information flow.

As with the second part of pathway 1 there will be a need to understand the Level 2 suite especially PAS1192:2:2013 and COBie requirements where pertinent. Again there may also be a skills need around some of the digital tools that the organisation uses or intends to deploy.

8.3 Pathway 3:

This lane is looking at organisations that are in, or perceive they are in this category or have some leading edge projects at Level 2.

From our analysis we would again suggest that those that believe they are operating fully in this category may not actually be and would advocate that the first step in the category would be an audit on their processes and data standards to determine any misalignment.

Any gaps would clearly needed up skilling, however this would likely be more related to a hands on "how to use" as opposed to awareness. Most of the upskilling will be around digital transactions, IFC and COBie information.

As Level 2 is not fully complete (BS1192:4:2014, DPoW, Classification system still outstanding) as with the other two categorises there is a need for organisations to understand the implications of these data sets and tools and ensure that they upskill accordingly.

8.4 Pathway 4:

Pathway 4 illustrates a potential future shift from a convergence around Level 2 (collaborative, domain based BIM) to Level 3 (integrated BIM). Depending upon HS2's aspirations this may not be required

and it will be left to the supply chain to move into this space if they see fit with any client data transactions being undertaken in Level 2.

The BIM Task Group is currently scoping Level 3 at the moment and will start to define requirements relative to this integrated approach. Once this work has matured it will be practical to review same in the context of HS2.

8.5 Pathways (based upon HS2 not intervening):

The previous graph illustrated potential pathways based upon HS2 making some interventions to help the supply chain upskill. We must also consider what the impact would be if HS2 had no involvement in the BIM upskilling agenda and let the supply chain to be self-sufficient.

Figure 13 below illustrates what we believe the impact would be: this is based upon anecdotal evidence.

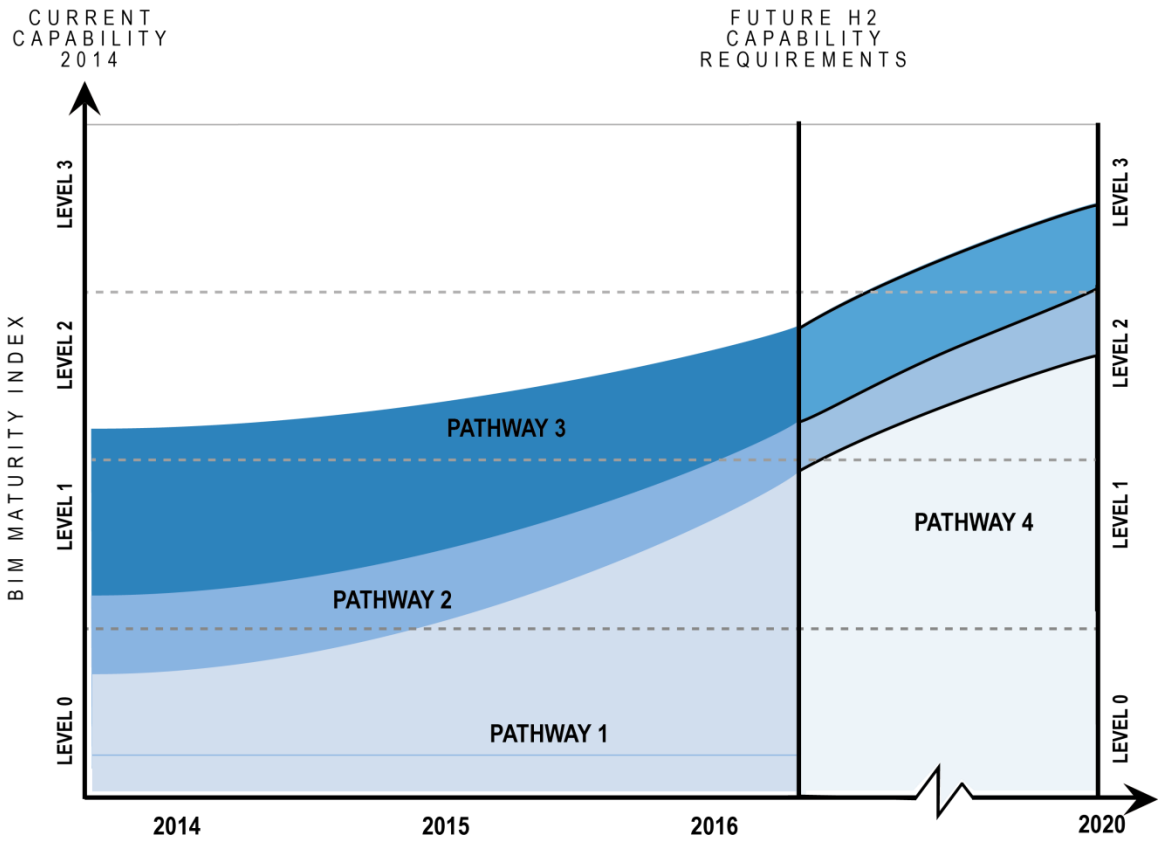


Figure 13 supply chain BIM maturity without HS2 upskilling pathway aid

It is likely that the Tier 1 contractors and designers would get to Level 2 maturity but it would not be as quick or consistent as with the HS2 interventions. There is also a likelihood that they would be reliant upon external consultants to support them with these costs being potentially stepped up to HS2 as part of their subcontract price or fee. Additionally there would be a higher likelihood of off-shoring design works to smooth any short-falls in BIM capability resulting again in additional costs and potential quality issues.

Despite the increasing BIM maturity in the marketplace it should again be reinforced that this is largely in the context of vertical assets, additionally the HS2 open standards both will provide challenges to industry and there is a danger that whilst these players will get there it maybe a tortuous route without some degree of coaching and support from HS2.

With the Tier 2 and 3 organisations there is a clear danger that without raising awareness and helping support them on their journey they will not get there fast enough precluding them from entry or they are wholly reliant upon external consultants to support them.

Even with the lightest touch from HS2 a client intervention will assist them accelerate their journey and ensure that the BIM and Information Management agenda is adequately met.

8.6 Tiered knowledge and skill requirements

It was evident from the study engagement that there is a need to establish a balanced capability scorecard approach to both HS2 BIM knowledge and skills. From our consultation this can be broken down into a minimum standard based upon a tiered framework:

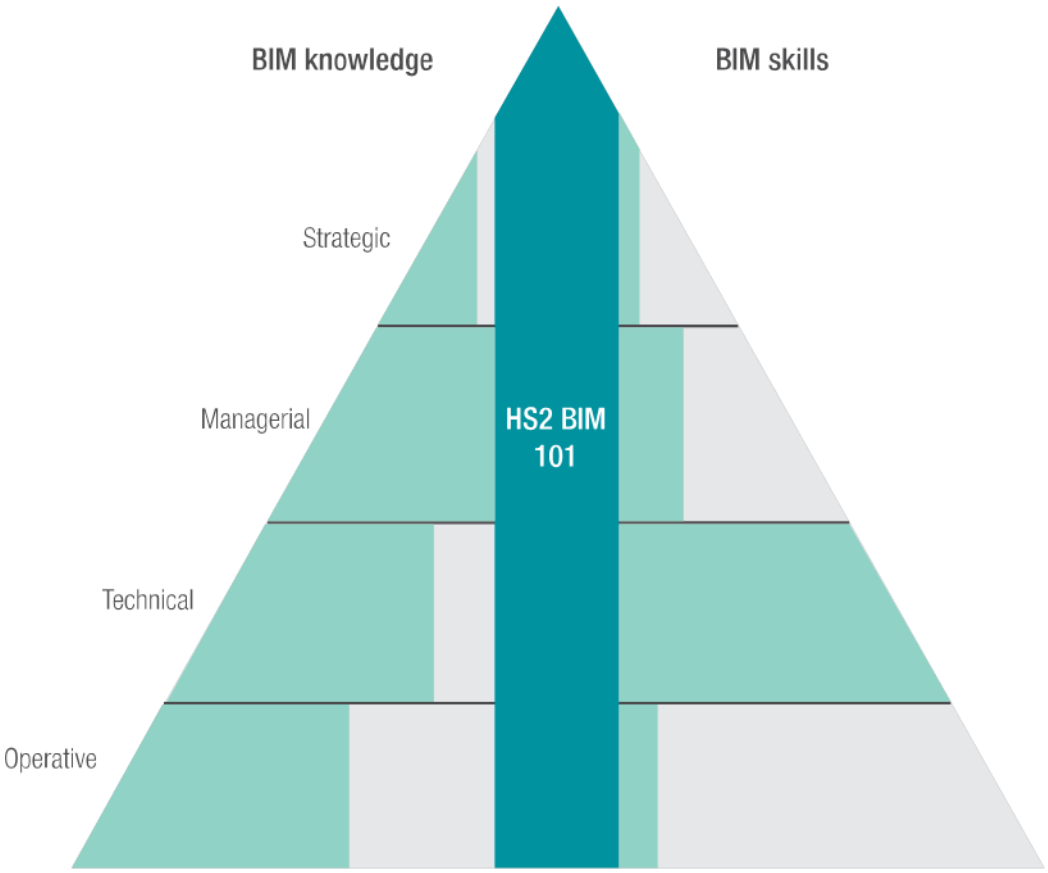


Figure 14 Tiered knowledge and skill requirements

Predominantly there is need to establish a core HS2 'BIM 101' (BIM core) foundation that, irrespective of what your job role is you will understand what BIM is and HS2's aspirations are in the context of its overall information management strategy. This should form part of the HS2 BIM communications plan (see recommendations).

Additionally for each tier within a supply chain organisation there is a need for organisations to adopt a minimum standard as illustrated overleaf:

Tier	BIM Knowledge	BIM Skills
Strategic	Understands the need for their organisation to align with the HS2 BIM and Information - Management requirements. Establishes an appropriate framework for their organisation to deliver on the HS2 BIM EIR.	Capability assessment of organisation's current capability and capacity relative to BIM.

	Has appropriate mechanisms to plan for future business change in the context of maturing BIM levels.	
Managerial	Understands the impact of BIM relative to their tender submission and execution of their commission. Appreciates the impact of Level 2 processes and deliverables relative to their work activities. Ensures that their organisation has adequate means of testing project and individual capability relative to Level 2 BIM maturity. Understands organisational training and upskilling needs relative to their point of departure.	Conversant with BIM protocols and EIRs and can populate same relative to their commission.
Technical	Conversant with the associated BIM processes and standards relative to their workflows. Understands the principle of BS1192:2007 and their organisations responsibilities with regards the common data environment.	Trained in appropriate digital tools relative to their job role and project deliverables. Understands IFC/COBie and data classification systems. Can undertake necessary digital transactions and queries.
Operative	Understands the impact of Level 2 BIM relative to their job role and has adequate training to support their responsibilities.	Basic model viewing.

Section 9: Upskilling options and recommendations

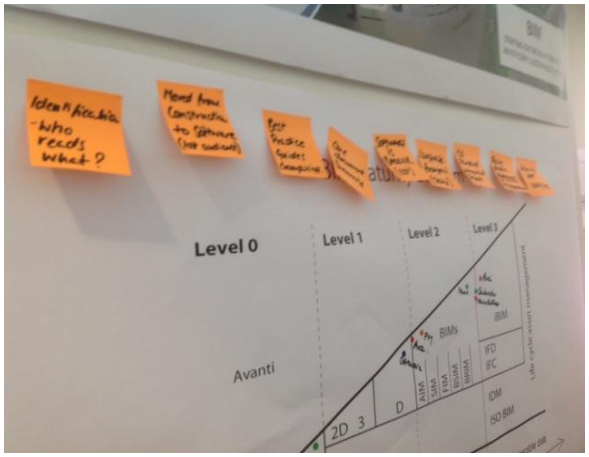
9.0 Upskilling options and recommendations

9.1 Upskilling Theme: Organisational BIM Assessment

Undoubtedly the strongest theme that emerged throughout the study was organisations were struggling to benchmark where they were currently with regards categorisation of their current point of BIM departure "*where are we now?"* The lack of an industry BIM benchmark scheme meant many organisations were restricted to *"supposing"* where they were with regards to BIM maturity. It was also evidential that their assessment was not fully considered in terms of overall organisational capability but based on an average amount of leading projects.

"Desired: Organisational capability - A standardised methodology for assessing (and benchmarking) the standards, methods and procedures used within an organisation and/or project."

Significantly it was visible during the "Supply Chain" symposium that many organisations who believed they were undertaking BIM Level 2 were only doing this in what they believed to be in the "spirit-of" this level and were missing enacting key components such as PAS1192:2 and or COBie:UK:2012. This misalignment meant that in terms of upskilling most organisations believed that they, falsely, had no need for further action.



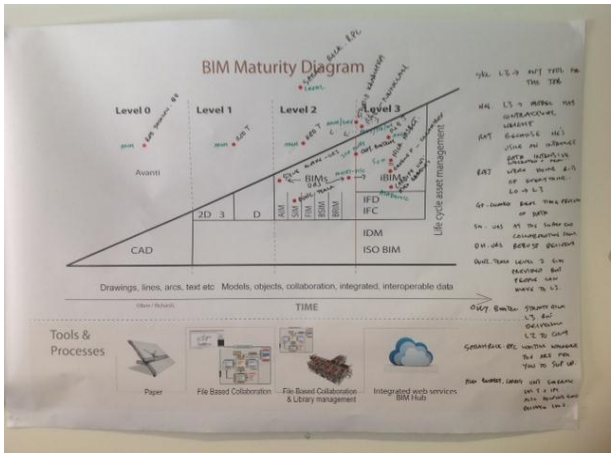


Figure 15 HS2 supply chain engagement symposium workshop

Additionally several organisations who believed they were operating in the Level 2 (or indeed Level 3) space had missed out the bed-rock artefacts of Level 1 maturity, especially BS1192:2007 which is integral to the process.

Organisations also voiced frustration that they habitually have to undertake BIM pre-qualification questionnaire PQQ) assessments that are: *"time consuming"* and *"don't properly assess capability"* especially for an individual project needs. Likewise they felt that there was no current proper means of evaluating or accrediting staff, either at organisational or project level. It was also noted that this

challenge is amplified for organisations out-with the UK that are unfamiliar with our levels of BIM maturity.

Recommendations:

- Creation of a simple, highly visual guidance document illustrating the BIM maturity wedge which is understandable to all, describing simply the processes (desired / required) and artefacts for each stage tailored to the HS2 project. This on-line document would also link through to each of the relevant supporting documents. The document would also illustrate proposed headline needs and pathways in terms of closing the capability gap

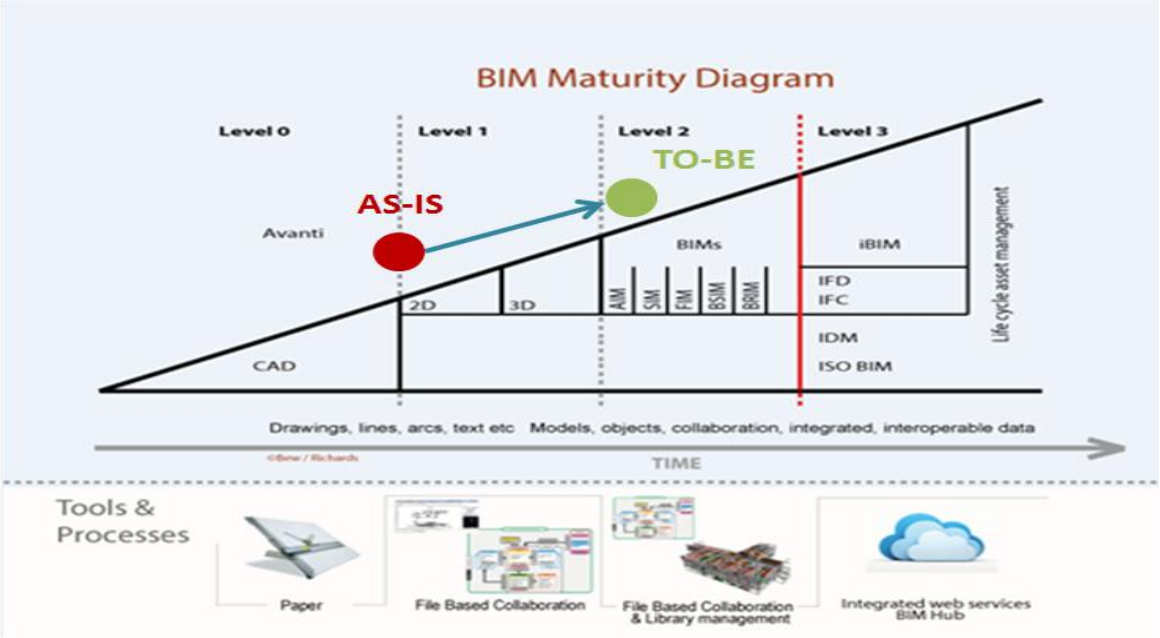


Figure 16 identifies upskilling pathway 1-2

- Development of a straightforward “BIM readiness ready-reckoner tool” for the HS2 website. This tool would allow an uncomplicated organisational self-assessment with regards to current positioning. The reference point would be based upon the Level 0-3 artefacts e.g. the suite of relevant PAS documents and the like. Assessment would be undertaken as a RAG report against each of the artefacts and their placement as a whole. This would again determine any areas of weakness within their current levels of adoption and advocate potential up skilling needs at a top level
- Establishment of a well-informed on-line PQQ document relative to HS2 BIM, information management requirements. PAS 91:2013 the BSI / HM Government “Construction prequalification questionnaires” is currently used by the public sector as Table 8 – Optional Question Module O4: Building information modelling, policy and capability. Additionally the CPIx BIM / Resource and IT Assessment Form provides a method of assessing a project member’s

BIM competence and maturity. These toolkits would help form the basis of assessment question sets developed in the context of HS2 BIM and information management outcomes encompassing organisational policy, process, systems and professional development. The tool or electronic form would at this stage still be based upon a self-assessment. It is essential however that those completing the form understand the requirement for the responses to be backed up by appropriate evidence (case studies etc.) if required. The output would generate an organisational BIM spider similar to the diagram below mapping out the calculated "as-is" capability versus "to be." This would allow a well informed decision to be made regards qualifying parties and a report issued highlighting areas of potential improvement

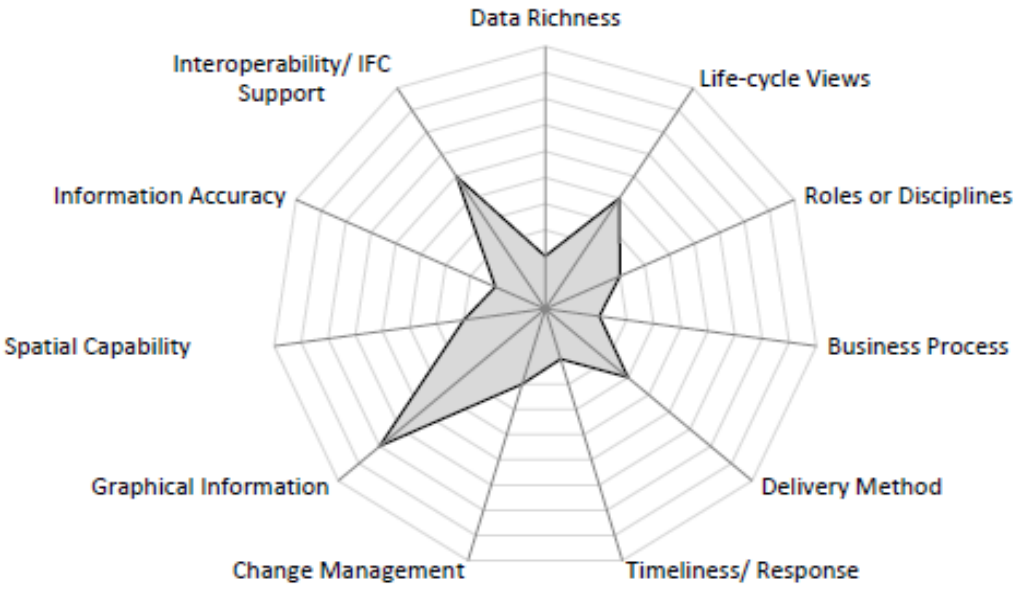


Figure 17 example supply chain capability assessment diagram (Source: Manchester City Council BIM Final Report www.bimtaskgroup.org)

- Creation of a BIM Employers Information requirement (EIR) assessment tool – it is essential that organisations be assessed with their capability to respond to a project BIM EIR. This would look at specifics in the context of staff proficiency and how the organisation looks to deliver and manage the requirements at the "data drops" and "plain language questions. The tool would again identify any process gaps that need closed prior to formalising a contract
- Assessment of the HS2 internal staff and current commissions relative to Level 2 BIM and any immediate needs to upskill

9.2 Upskilling Theme: Defining client BIM requirements

"HS2 will need to be very clear in terms of how they interpret Level 2 BIM Maturity especially data schema and asset classification systems"

The subsequent theme that emerged during symposia and interviews was the need for HS2 to be explicit in terms of defining its BIM requirements, especially:

- Desired BIM outcomes and measurement criteria to determine if these outcomes are being achieved
- BIM maturity levels and principal artefacts e.g. PAS1192:2:2013 / data and information exchange standards
- Unambiguous AIRS and EIRs (including PLQs)
- Capability of staff – especially allied to Information and BIM management roles

It was suggested that these requirements should be "realistic" and "easily understood" using simple language and backed up where possible with hard data e.g. briefing requirements backed up with a client COBie:UK:2012 requirements spreadsheet.

Early promulgations of these foregoing would allow potential supply chain members to understand any gaps they would have (when used in conjunction with the assessment tools) and allow them to develop their own upskilling strategies aligned with these requirements. It was advocated that if the requirements were well defined then the complexity of how the outputs can be delivered should be left to the supply chain to manage and innovate.

This was an important point that came across at all the events: that if the supply chain have a deep understanding of HS2 needs and outcomes and the requirements are enacted by a BIM protocol then largely the majority of participants in the engagement process felt that they would be able to position themselves to achieving Level 2 maturity other than some issues around some of the open data technical standards (see interoperability theme).

Recommendations:

- Organisational Information Requirements (OIRs) made very clear and available to all bidders
- Asset Information Requirements (AIRs) clearly articulated, including asset classification from early as possible. Including appointment of a HS2 Soft Landings Champion for each project
- Employers Information Requirement (EIR) issued with each tender with clearly defined information and level of detail for the clients information needs
- Standard Plain Language Questions (PLQs) developed and disseminated on HS2 website early as possible
- Templates and worked examples plus associated guides produced for the BIM requirements and PLQs

9.3 Upskilling Theme: Communication and Knowledge Share

"Industry Communications - Agreement of a consistent message for suppliers and stakeholders defining the context by which 'BIM' will be implemented within the Rail Industry As things stand the rail industry do not have a clear government BIM obligation and even if it did it would need a shift in our Asset Information areas of the business to move us to Level 3."

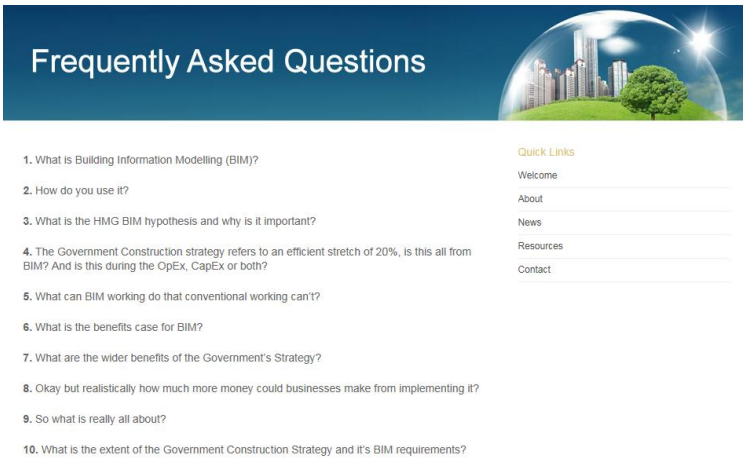
"We need to develop a consistent message for suppliers and stakeholders defining the context by which 'BIM' will be implemented within the Rail Industry."

This category unquestionably generated most suggestions from study participants. There was a positive response from the supply chain regards the interventions from HS2 regards the BIM symposia and outreach especially regionally e.g. the "BIM Show Live" stall. It was recommended that this should not be a one-off and HS2 should continue to engage with the supply chain throughout key stages of the project life-cycle to determine if outcomes are being met and re-calibrate with regards to education and training outcomes over a rolling programme of audits, lessons learned and changes to levels of BIM maturity e.g. moving form Level 2 BIM to Level 3.

Recommendations:

- It was accepted that with a project of this size and nature there would be much learning at the coal face and the creation of an HS2 BIM Community of Practice (COP) would help connect organisations implementing BIM on HS2, learn from doing and share non-commercial information and lessons learned. This would also act as a bi-directional communication conduit between HS2 and the supply chain to continually monitor areas of further up skilling requirements and shape any further interventions
- It was also suggested that HS2 should interface with the Construction Industry Council BIM Regional Hubs http://www.bimtaskgroup.org/cic-bim-regional-hubs/ during the currency of the procurement process to help ensure that this large community can understand and help cascade the HS2 BIM education and skills messaging throughout their network
- The BIM Task Group Newsletter was cited as a good example of communication being used to help up skill and build capability through regular (fortnightly) publication featuring technical spotlights. It was also suggested that regular worked through examples of an AIR/EIR and Plain Language Questions would be useful to help build understanding
- An online moderated forum was suggested as a good means of helping supply chain upskill, with many, especially those internationally or starting their BIM journey being able to post questions or queries potentially anonymously that they might not want to formally ask for fear of sounding incapable. This would offer a good space for supply chain to practically discuss issues and build capability through a networked community

- It was taken for granted that HS2 would dedicate a section of its website to BIM or, even further, create a microsite that would establish its requirements, reference documents, assessment criteria and the like. Furthermore it was suggested similar to the BIM task group that a labs space could be established with some basic training application such as capability quizzes and sample data such as COBie:UK:2012 and IFC models for the supply chain to learn from within a sand-pit environment. The website would also have a language translation function to suit the potential international supply chain
- Other key collateral that was suggested be created and included on the website include:
    - Domain specific BIM guidance documents which are easily understood, highly visual and highlighting specifically through the lens of that group e.g. Main-Contractor, Designer etc. what is required as a minimum standard for BIM and digital information management
    - A set of frequently asked BIM questions:



    - An investment guide illustrating potential BIM training routes for the supply chain based upon their on-line assessment, likely return on investment and tax incentives etc.
    - Case studies from early packages to illustrate practical lessons learned
    - Standard presentations for each of the key areas e.g. open data standards
    - Feedback portal to allow questions to be raised at a technical level

- The creation of a BIM / Information Management induction video-cast was also suggested several times as a good source of up skilling for all, starting with a simple 101 orientation and a suite of more technical bite-size chunks again the BIM task group videos were seen as a reference point. The RSA Animate videos were also suggested as being useful as they can explain a complex topic quickly and simply, again useful for an international supply chain http://www.youtube.com/watch?v=u6XAPnuFjJc

- The Tier 2 and 3 community suggested the formation of the BIM Clinics (a similar model has already been set up by the BIM4SME community) where regular drop in sessions are held where potential supply chain members can come in and discuss any issues or concerns around their requirements and upskilling needs / options
- Publication of the HS2 forward BIM pipeline will help drive BIM investment within the supply chain especially at strategic level
- Development of a strong visual identity and branding around HS2 BIM and Information Management that the supply chain will identify with
- Creation of a comprehensive social media strategy including Twitter and LinkedIn. We propose a 'tweet up' upon launch of this report to share findings, gander feedback and questions from the supply chain
- Upskilling report launch to share findings and illustrate needs of the supply chain to align with HS2 BIM aspirations and requirements

9.4 Upskilling Theme: BIM skills v knowledge

There was overall a varied response to awareness around BIM maturity levels however there was still a degree of uncertainty as to the processes and data requirements that were anchored to delivering these levels. This was especially evident from the HS2 BIM supply chain symposium and BIM Show Live outreach session.

Additionally most of the study participants that understood the requirements felt they were inclined towards vertical assets and that these standards were not contextualised towards linear projects especially rail.

It was noted especially during the HS2 BIM Rail Forum that the open BIM standards *(platform neutral, open file format specification that is not controlled by a single vendor or group of vendors)* that the project would require: COBie:UK:2012 *(a key deliverable of Level 2 BIM which will become BS1192:4:2014 in summer of this year)* and Industry Foundation Classes (IFC) data models *(which are intended to describe building and construction industry data)* which are not fully developed for the rail industry and that there would be a significant skill and knowledge gap in these areas due to limitations in the maturity of these formats. The same concern was also raised in the context of classification and asset dictionaries for the rail sector. The classification system for Level 2 will not be complete until March 2015 (this is currently part of a Technology Strategy Board completion for a Digital Plan of Works). There was an immediate need identified for a standardised classification system for rail infrastructure assets (aligned with BS6100-0:2010).

Crossrail noted that they had addressed this through use of a proprietary vendor solution and creation of their own asset dictionary and had not used COBie:UK:2012 (it was noted that therefore they were not fully Level 2 compliant). Study participants noted that work was being undertaken on initiatives such as “COBie for all” and the Infrastructure Asset Data Dictionary for UK Working Group however they were still concerned around their skills and knowledge in these areas. They furthermore noted that the software vendors had done little to help automate the import and export of especially COBie data from their proprietary BIM toolsets.

Whilst skills with regards these digital tools set are undeniably important to BIM success on HS2 it was evident that discussions with the study participants were skewed in this direction with a bias towards creation of 3D data using proprietary toolsets. When discussion centred on BIM knowledge, especially around Information Management, non-graphical data and commercial factors there was a perceivable weakness in their response or consideration with regards to education.

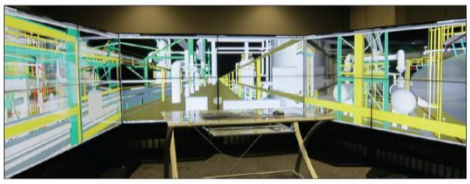
It was agreed at the BIM for Rail Symposium that creation and governance of a programme Information Management and the creation of a well-managed common date environment was the key to success.

Overall there was a perceivable knowledge gap around the Level 1 and Level 2 artefacts, whilst there was a general awareness there was still limited “hands-on” experience of their implementation. This was especially true of the international organisations we met during our discussions who were more sued to the American AIA suite of standards.

Recommendations:

- It is pivotal, as mentioned earlier in this report, that HS2 defines its BIM requirements for the project at the outset, especially around the open data, classification systems, data dictionaries and exchange formats. A study is also recommended as to what needs to be done to ensure IFC will meet HS2 needs.
- Unquestionably there is an up skilling piece of work that needs to be undertaken at all levels within the supply chain with regards to getting all disciplines capable of delivering consistently Level 1 and 2 BIM. Options:

HS2 BIM E-learning modules	Development of a knowledge based e-learning portal for the supply chain when can be undertaken to suit a discipline and role (strategic, managerial and technical). These would be centred around the seven Level 2 BIM artefacts, the Common Data Environment (BS1192:2007), digital security and IFC
Creation of a HS2 digital campus for supply chain and new entrants	Building upon the success of the “Crossrail Information Academy”, the formation of a HS2 digital campus that will not be limited to BIM but the overall Information Management and Digital Workflows agenda including geomatic data sets. The campus would support supply chain orientation, awareness on the above along with regular themed upskilling sessions e.g. production of COBie, PAS suite of BIM documents. These sessions would also provide CPD points. Become a hub for the aforementioned BIM clinics and knowledge share sessions. Offer taster sessions for potential new entrants. Test centre for new workflows or interventions – this will be especially important during the potential move from Level 2 to Level3.

	Offer a space for integrated concurrent working sessions with immersive environments such Oculus glasses and interactive surfaces or a CAVE (Computer Assisted Virtual Environments)  Figure 1. BIM CAVE system developed at Texas A&M University using NavisWorks
Technology Zone	Separately or as part of the proposed academy it was suggested that as HS2 will be vendor agnostic there will be a wide array of digital tools used on the project and it would be useful for organisations especially those starting their journey to see what is "in the market" especially "free viewers and tools." Through the Technology Vendors Alliance Working Group there could be space set aside for these parties to showcase and offer free skill seminars on their products. This potentially could be on a rolling programme so it is not vendor biased.
Passport to HS2 BIM scheme	Development of capability both at organisation level and people within that organisation will be pivotal to the project success as longer commissions may transcend a step change in BIM maturity levels during the currency of the HS2 project. We would therefore propose, following feedback from the study participants, a "Passport to HS2 BIM scheme." Similar to a CSCS card the passport would build up evidence based information on an organisation or persons within same. Certification could be offered through audits, evidence in practice - CPD at the individual level, or indeed certifiable HS2 BIM examination process set up with external training and certification partners. It should be noted that at the time of writing this report there is currently no Level 2 BIM accreditation available in the UK however it is likely that UKAS will be issuing guidelines later in 2014. Successful levels of the passport completion would fast track BIM PQQ questions for organisations working on HS2 projects.
Education and	It is essential that organisations are not reliant wholly on HS2 to

training framework	upskill them but provide them with the correct framework to build their BIM journey around. It was suggested that the BIM Education and Training Framework which was initiated with the BIM Task Group and now under the stewardship of the BIM Academic Forum be reviewed and be repurposed to suit HS2 needs. http://www.bimtaskgroup.org/wp-content/uploads/2013/04/Initial-BIM-Learning-Outcomes-Framework-v1-0.pdf This outcome based document would then become the basis for organisations and external providers to base their BIM learning and training around.
Level 2 BIM "Big Picture" App	There was a desire, especially from the Tier 2/3 community, for the creation of a simple highly visual application to walk through each of the key Level 2 artefacts with a quiz at the end of each section that shows how all the components come together and what deliverables they have at each of the key stages in the HS2 plan of work. This would also include a HS2 BIM lexicon for the various acronyms.
COBie apps	It was noted that if HS2 or the marketplace develops plug-in tools or applications that support COBie export and important functionality there will be less need for upskilling in this area. This could potentially be developed as part of a competition funded by HS2 and targeted towards students and developers.
Supply chain support network	Tier 1 supporting adoption of BIM within their Tier 2 / Tier 3 supply chain – what are they doing to help pull their own community. This should be given consideration as part of the procurement qualitative scoring.
Development of a standard HS2 library of digital objects	The creation of an HS2 digital library of repeatable objects would help reduce design fees, drive consistency of data and reduce resource requirement (both design and construction) for the programme. This would particularly assist Tier 2 and Tier 3 organisations that would otherwise require to upskill purely to create these objects.

9.5 Upskilling Theme: Current industry BIM capacity including new entrants and emerging career needs

"Roles & Responsibilities – need to be careful that we don't create new roles here, really need to look at how the information management functions are discharged (and their implied level of skill) within projects. Perhaps an agreed framework needs to be in place first?"

Discussions from the symposia intimated that the size and nature of the HS2 project will likely create a constraint in terms of skilled BIM resource, especially regards experienced "Information Managers" and "BIM Technologists." In recognition of this it is essential that capacity be grown within the UK and consideration being given to the fact that the potential supply chain or their sub-consultants will come from beyond these shores.

Whilst there is an ever growing capacity in the UK (arguably over 50% of organisations surveyed having a Level 2 capability) there is, in addition to the up skilling of organisations, a need to attract new entrants into the HS2 supply chain that support these current digital information needs.

Historically professions within the sector have not had any dedicated pathways that encourage young people to explore careers within a digitally enabled construction sector. Opportunities for young people to engage with these professions during their secondary education, for example as work experience, are very rare.

Additionally enrolment on undergraduate construction degrees illustrates a decline of 43% since 2008. This is against the backdrop of an overall 4% increase in total undergraduate degree enrolments. University built environment departments have faced major restructuring since 2010, losing large numbers of teaching staff with many being incorporated into other departments, such as engineering, which have a perceived higher value. Concurringly, forecasts indicate that approximately 406,000 of the UK construction workforce aged 55 or over are set to retire in the next 5 to 10 years.

This undoubtedly means that, in the near future, the industry and therefore HS2 will face a serious skills threat from the retirement of a large proportion of the existing workforce and the scarcity of qualified graduates entering. This poses a threat to the ensuring that the digital skills needed for the HS2 BIM programme can be cemented.

In reality there is very little understanding of these digital professions and very few of our young people aspire to a career in this extremely important sector of digitally transactions across the built environment.

It is imperative to the both the HS2 BIM and Information Management agenda that new pathways be created that will attract new entrants and offer pathways from other industries especially computers science and mathematics.

Recommendations:

- There are many opportunities for cross curricular learning allied to BIM and Information Management including explicit opportunities for Computer Sciences, Maths, and Science as well as for other aspects of the wider built environment curriculum. An outreach programme should be taken with academia to raise awareness and highlight career opportunities within the HS2 supply chain. A meeting should be arranged with the BIM academic forum to start raising career awareness and a brochure produced illustrating the opportunities for new entrants within the digital built environment
- Industry champions need to be engaged to help get the message out to young people and inspire them to pursue a career within an innovate and digital construction sector. It was suggested that HS2 needs Digital Ambassadors to get into schools, colleges and universities to engage those who are about to start their journey. Professor Brian Cox was cited as being a good example of making a sector appealing and increasing capacity in modern sciences – lead by example can HS2 provide a similar figurehead?
- BIM careers such as BIM Manager, Information Manager, BIM Technologist are still quite new and there is limited information around what they do and what qualifications, experience and career opportunities are available. A simple digital career pathway / framework with “real-people” reference points would be useful to entice new entrants into this category and create a wider talent pool for HS2
- Organisations should be encouraged to include, as part of their offering, digital apprenticeships within the work-package or commission. This could become part of the quality scoring criteria and would demonstrate commitment to increasing capacity and their BIM journey
- In addition to the new entrants, thought must be given to those that want to switch career paths or integrate BIM into their current role. It was advocated that a document be prepared which illustrates the effect of BIM and the digitization on current job roles and responsibilities and what the individual should consider in terms of personal upskilling. This should include real life examples especially in the context of a infrastructure environment
- BIM for a day initiative where supply chain partners are encouraged to have one day BIM taster workshops with students and young adults to raise awareness of BIM and signpost potential career pathways

- Additionally and via external partners it would be practical to create a City and Guilds accredited BIM foundation training course with successful participants going into a pool which HS2 supply chain could potentially draw up
- This would help useable and relevant BIM skills that are instantly transferable into the workplace and which will enable young people within the construction industry to make a valued contribution to a potential employer at a very early stage in their career

9.6 Upskilling Theme: Future-wise – emerging career needs (upskilling for Level 3)

Looking to the future; the symposium with the BIM2050 group considered that as HS2 moves from Level 2 towards Level 3 and indeed beyond that:

"The development and focus on integration and proactive use of data will see the skills profile of the construction industry start to subtly shift towards workers who are able to 'make sense' of the data and information flow and providing contextual feedback with targeted global interactions. Business models will develop to leverage open data, innovation and complex asset networks creating asset user / asset manager industry. Skills within the industry will focus on the 'flow and process of information procurement and transactions throughout the supply chain. Sought after skills within the asset management field will surround analytics, the ability to understand 'big data' and make decisions across global asset portfolios. This will also be affected by the wave of digital data transaction which will ultimately focus on skill requirements which involve predictive data analysis rather than reviewing the data itself."

It is axiomatic that we will see an emergence of new job roles during the currency of the HS2 project that will need to be considered in terms of competency. The ones that we consider particularly pertinent are: data analytics, cyber-security and asset telemetry.

Recommendations:

HS2 will need to make an early decision on whether it is likely to surpass Level 2 and move towards a Level 3 BIM environment. A roadmap should be determined early as possible illustrating the stages that both HS2 and their supply chain will need to move

Section 10: Study Conclusion

10.0 Conclusion

"HS2 will implement Building Information Modelling to an unprecedented scale digitising its entire asset life-cycle"

Quantitative and anecdotal evidence from this study, alongside other recent industry surveys, indicates an ever-increasing awareness and implementation of BIM within the UK supply chain. Over half of the supply chain has some degree of experience within Level 2 BIM maturity, although it transpired that this is more on leading projects, as opposed to an overall organisational position.

The good news on awareness is tempered by the fact that these figures are weighted towards BIM for vertical assets - the same capacity is not evident in the rail or infrastructure industry. However, this is not essentially a capability issue, but has more to do with a lack of standards to support open data formats and classifications in the rail sector. These gaps can be closed quite quickly by HS2, by making some strategic decisions around required information standards and by reviewing its position on entirely open standards.

The authors of this study believe that Level 2 BIM maturity - as a minimum standard - is a realistic and achievable goal for HS2 and its future supply chain. However, HS2 will require some degree of upskilling intervention to meet its programme and projected capacity (especially with regards to Tier 2 and 3 organisations). This is particularly relevant to procurement and the issue of engaging with organisations or individuals who are not committed to upskilling towards Level 2 BIM competencies. However, HS2 may also require internal upskilling to ensure that its staff have the competencies to buy, manage and transact on the basis of the digital data.

Some of the people who will work in HS2's supply chain will still be in education. It is essential to inspire these young people to pursue an academic or vocational path that will build future capacity, so that the supply chain can use and develop their skills. Communication and interaction are the key to this opportunity for both the project and its legacy.

BIM offers HS2 an exceptional value proposition. However, the scale of the project should not be underestimated. To unlock the benefits it is essential that HS2 create both the push and pull for realisation of Level 2 BIM and help the supply chain help them to upskill. This upskilling processes will also help UK industry as a whole in its continued journey towards digital leadership in the built environment.

Annexe 1: Costed execution plan

HS2 Supply Chain BIM Upskilling Study - BIM Execution Plan

Ref	Score / RAG	Clarity Learning Assessment	Deliverable:
1	100	L	Creation of a HS2 digital campus for supply chain orientation, upskilling and new entrants. Context: both BIM and Information Management
2	90	A	HS2 website “BIM readiness ready-reckoner assessment tool”. Where are we now checker - based on implementing the artefacts associated with Levels 0-3
3	90	C	Employers Information Requirement issued with each tender with clearly defined information and level of detail for the clients information needs. Standard template used across the HS2 programme with uniform requirements for standards and processes. Action: HS2 Training, Develop standard template and EIR guidance document
4	90	L	Development of a knowledge based e-learning portal for the supply chain which can be undertaken to suit a discipline or role.
5	81	C	On-line PQQ document relative to HS2 BIM requirements.
6	81	C	HS2 BIM Microsite
7	81	L	Standard presentations for each of the key BIM/IM areas e.g. open data standards
8	81	L	BIM / Information Management induction video-casts (orientation).
9	72	C	Organisational Information Requirements (OIR) and Asset Information Requirements (AIR) clearly articulated, including asset classifications from early as possible. Including appointment of a HS2 Soft Landings Champion for each project.

10	72	L	Supply chain HS2 BIM guides tailored towards key domains
11	72	L	Online HS2 BIM Forum (moderated) - discussion threads of a non-commercial nature especially technical lessons learned.
12	72	L	Form an HS2 BIM Community of Practice (COP) including interface with CIC Regional BIM Hubs / BIM4 Groups such as BIM4SME
13	72	L	Development of a "City and Guilds" accredited BIM foundation training course with successful participants going into a pool which HS2 supply chain could potentially draw up.
14	64	C	HS2 BIM and Info Management Monthly Newsletter
15	64	C	HS2 BIM investment guide for supply chain
16	64	L	HS2 BIM Clinics (regular drop by surgery days)
17	63	A	Passport to HS2 BIM scheme.
18	60	A	BIM Employers Information requirement (EIR) assessment tool
19	56	L	Visual guide to BIM maturity levels and domain checklist of supporting processes and standards relating to HS2 BIM objectives. Created as downloadable content for the HS2 website
20	56	C	Publication of the HS2 forward BIM pipeline (to encourage supply chain investment)
21	56	L	Outreach programme with academia to raise awareness and highlight career opportunities within the HS2 supply chain. Meeting should be arranged with the BIM academic forum to start raising career awareness and a brochure produced illustrating the opportunities for new entrants within the digital built environment.
22	56	L	Creation of HS2 Digital Ambassadors to get into schools, colleges and universities.

23	54	C	A study examining what requires to be done to ensure IFC / COBie will meet HS2 needs
24	54	L	HS2 Education and training framework.
25	54	L	BIM for a day initiative where supply chain partners are encouraged to have one day BIM taster workshops with students and young adults to raise awareness of BIM and signpost potential career pathways.
26	49	C	BIM feedback e-account and helpdesk
27	49	C	Standard HS2 Plain Language Questions (PLQs) developed and disseminated on website early as possible with worked examples and associated guidance note.
28	42	C	Early HS2 commission / projects – BIM case studies and user stories
29	42	L	Digital career pathway / framework with “real-people” reference points.
30	42	L	Report illustrating the effect of BIM and the digitisation on current job roles and responsibilities and what the individual should consider in terms of personal upskilling
31	40	C	Develop tender clauses encouraging digital apprenticeships within the work-package or commission.
32	40	C	Creation of a HS2 BIM digital library of repeatable objects.
33	36	L	HS2 BIM Technology Zone – vendor demonstrations and CPD sessions.
34	36	C	Creation of a roadmap illustrating the upskilling stages that both HS2 and their supply chain will need to move from Level 2 to Level 3.
35	35	L	Development of a BIM / Information management social media strategy and brand identity
36	32		Creation of free “COBie” export and import applications /

			plug-ins
37	25	C	Level 2 BIM “Big Picture” Application with quick links to key documents and guides
38	18	A	Audit of HS2 staff and current commissions relative to Level 2 BIM
39	16		Launch of HS2 BIM Upskilling Study
40	8		HS2 BIM Study - findings tweet-up #hs2bimskills Q&A

Legend:

High priority

Medium priority

Low priority

Annexe 2: Lexicon

Annexe 2: Lexicon

3D Model	A model with objects having 3D dimensional properties which are moving in nature
Attribute	A piece of data forming a partial description of an object or entity
Big Data	*"Big data is the term increasingly used to describe the process of applying serious computing power—the latest in machine learning and artificial intelligence—to seriously massive and often highly complex sets of information."* - Microsoft
BIM	There are many definitions for Building Information Modelling (BIM) and it depends upon your point of view, however for the purposes of this survey BIM can be defined as: Is a digital representation of the physical and functional characteristics of an asset A collaborative process, for generating, managing and using digital data to design, construct and operate the asset during its lifecycle The "Building" in BIM is a verb and describes the act of creating and managing model data both for infrastructure, civil and vertical assets
BIM Execution Plan	Plan prepared by the supply chain to explain how the information modelling aspects of a project will be carried out.
BS1192:2007	BS 1192:2007 Collaborative production of architectural, engineering and construction information. Code of practice. BS 1192 establishes the methodology for managing the production, distribution and quality of construction information, including that generated by CAD systems, using a disciplined process for collaboration and a specified naming policy. BS 1192 is applicable to all parties involved in the preparation and use of information throughout the design, construction, operation and deconstruction throughout the project lifecycle and the supply chain
CDE	A common data environment is a single secure source of information for any given project, used to collect, manage and disseminate all relevant approved project documents for multi-disciplinary teams in a managed process.
Classification	Systematic arrangement of headings and subheadings for aspects of construction works including the nature of assets, construction elements,

	systems and products.
Cloud computing	Cloud computing is computing that involves a large number of computers connected through a communication network such as the Internet. Cloud computing is a synonym for distributed computing over a network, and means the ability to run a program or application on many connected computers at the same time.
COBie	Structured information for the commissioning, operation and maintenance of a project often in a neutral spreadsheet format that will be used to supply data to the employer or operator to populate decision making tools, FM and asset management systems. More information on COBie can be found at: http://www.bimtaskgroup.org/cobie-uk-2012/
Federated Model	Federated Model means a model consisting of linked but distinct component models, drawings derived from the models, texts, and other data sources that do not lose their identity or integrity by being so linked, so that a change to one component model in a federated model does not create a change in another component model in that federated model.
Geospatial data	Geospatial data, GIS data or geodata has explicit geographic positioning information included within it, such as a road network from a GIS, or a geo-referenced satellite image. Geospatial data may include attribute data that describes the features found in the dataset
Government Soft Landings	Government Soft Landings is about adopting a mind-set and a process to align design and construction with operational asset management and purpose. This alignment means that the needs of the end-user, will be considered and addressed throughout the design process. Designers and contractors will be involved with the building beyond its construction completion to ensure that handover becomes a smooth process, operators are trained, and optimum performance outcomes become a focus of the whole team.
IFC	The Industry Foundation Classes (IFC) model is intended to describe construction industry data focusing on ease of interoperability between software platforms. It is a platform neutral, open file format specification which is object-based. IFC was developed by buildingSMART to facilitate interoperability in the architecture, engineering and construction (AEC) industry, and is a commonly

	used collaboration format in BIM-based projects
IPD	Integrated project delivery (IPD), is a collaborative alliance of people, systems, business structures and practices into a process that harnesses the talents and insights of all participants to optimise project results, increase value to the owner, reduce waste, and maximise efficiency through all phases of design, fabrication, and construction.
Information Exchange	Structured collection of information at one of a number of pre-defined stages of a project with defined format and fidelity.
Level 0 BIM Maturity	Level 0 BIM maturity is unmanaged CAD, in 2D, with paper (or electronic paper) data exchange
Level 1 BIM Maturity	Level 1 BIM maturity consists of managed CAD in 2D or 3D format with a collaborative tool providing a common data environment with a standardised approach to data structure and format. Commercial data will be managed by standalone finance and cost management packages with no integration
Level 2 BIM Maturity	Level 2 BIM maturity is a series of domain and collaborative federated models, consisting of both 3D geometrical and non-graphical data, prepared by different parties during the project life-cycle within the context of a common data environment. The project participants provide defined, validated outputs via digital data transactions using proprietary information exchanges between various systems in a structured and reusable form.
Level 3 BIM Maturity	Level 3 BIM maturity is a developing concept crudely defined as a fully integrated and collaborative process enabled by 'web services' and compliant with emerging Industry Foundation Class (IFC) standards.
NRM	'New' Rules of Measurement (NRM) is a an indexation system and set of measurement rules designed to map onto a variety of different classification systems, including Uniclass.
PAS119:2:2013	PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling The requirements within this PAS build on the existing code of practice for the collaborative production of architectural, engineering and construction information, defined within BS 1192:2007. PAS 1192-2 focuses specifically on

	project delivery, where the majority of graphical data, non-graphical data and documents, known collectively as the project information model (PIM), are accumulated from design and construction activities.
PAS1192:3:2014	PAS 1192-3 Specification for information management for the operational phase of construction projects using building information modelling focuses on the operational phase of assets, being about the availability, integrity and transfer of data and information during this phase. The document specifies how information from the Project Information Model (PIM) is transferred to the Assets Information Model (AIM) or how an AIM is created for an existing asset. Of equal importance is how information is then retrieved and passed on to an existing enterprise system such as a data base.
Relational Database	A database that has a collection of tables of data items, all of which is formally described and organised according to the relational model. A relational database allows you to easily find specific information. It also allows you to sort based on any field and generate reports that contain only certain fields from each record.
Stage	Project Stage is a period of time in the duration of a construction project identified by the overall character of the construction process which occurs within it
Uniclass	Uniclass (Unified Classification for the Construction Industry) Published by the Construction Project Information Committee (CPIC) this is a UK standard for classification

Annexe 3: Table of figures

Annexe 3: Table of figures

Annexe 4: HS2 Digital Campus

Annexe 4: HS2 Digital Campus

It is recommended from the findings of this report that HS2 create a "digital campus" as part of its wider Information Management (IM) strategy drawing upon both the learnings of the T5 project and the "Crossrail Information Academy." Whilst the campus would have a central location it would be a hub out to smaller regional HS2 satellites that would share the information and communication channels.

Key themes to be delivered via the digital campus would include:

- Lecture style supply chain orientation sessions on HS2 IM strategy and objectives – including BIM and GIS (run weekly as induction sessions)
- HS2 BIM group awareness sessions for potential supply chain members – at pre-qualification stage (run fortnightly)
- Executive briefing sessions for supply chain members – business change / investment themes (run monthly during the procurement stages)
- Classroom based HS2 BIM CPD upskilling pathway sessions aligned with e-learning module themes – these would be potentially certifiable. (run weekly)
- HS2 BIM for a day taster sessions for schools and colleges and other outreach partners (run monthly)
- Supply chain BIM knowledge sharing sessions – around the HS2 parish BIM user stories (run fortnightly)
- BIM drop in clinic – at regular intervals to help understand and ameliorate supply chain issues with regards BIM issues (run monthly)
- A space for Tier 1 suppliers to train their Tier 2, 3 partners etc. (as required)
- Update sessions for developing standards around interoperability (as required)

Additionally thought should be given to the inclusion of:

- BIM Research and development "centre of excellence" for the supply chain to test out innovative digital work-flows. This will be particularly pertinent during the move from Level 2 to Level 3 BIM data transactions and queries
- A technology zone – allowing vendors to showcase latest offerings on a rolling programme especially their free tools and apps such as model viewers along with free to attend CPD sessions
- Self-tuition pods where participants can undertake the e-module training
- City and Guilds training academy for school and university leavers
- Pre-employment training to help local people access digitally enabled construction jobs
- Project / Task Information and BIM Manager competency training
- Digital career advice centre for potential new and future entrants

A key feature of the campus would be an Integrated Concurrent Engineering (ICE) lab which the supply chain can book out to test workflows or demonstrate virtual solutions to the wider HS2 project stakeholders. At the heart of the ICE lab would be an immersive environment using Computer Assisted Virtual Environments (CAVE) with potentially more scalable solutions in satellite locations such as Oculus glasses and interactive surfaces. The CAVEs would also be used at the start of each project where teams can rapidly simulate and interrogate the project 4D simulation and logistics sequence. The ICE sessions could also be used as part of the HS2 risk management strategy to virtual simulate scenarios especially those in the high impact categories.

Figure 18 Cave Simulation

The CAVE simulation gives users the experience of viewing 3D asset data full-size.

Figure 19 Occulus Rift immersive glasses

Oculus Rift Immersive Glasses and Large Format Touch Screen Surfaces.

Annexe 5: HS2 E-Learning modules

Annexe 5: HS2 E-Learning modules (proposed structure):

We would propose that the HS2 BIM passport scheme be underpinned by a series of customised on-line modules for the potential HS2 supply chain to access and utilise. The modules would aid in raising awareness of core themes within the HS2 Information Management (IM) and BIM strategy and through short online quizzes assess individuals completing it. When a module is completed an individual will receive a digital competence stamp on their passport. A navigation system should also be introduced to sign post the individual to their relevant modules:

Proposed HS2 e-learning modules:

- ***Module 1: HS2 Information Management induction***
  A short orientation module giving a headline overview of the HS2 Information Management and Building Information Modelling goals and objectives for the project.

- ***Module 2: Level 2 BIM Maturity***
  An overview of the key BIM artefacts, processes and data standards that will be used as part of the HS2 information management strategy

- ***Module 3: Getting ready for BIM on HS2***
  Key considerations for an organisation preparing to pre-qualify or submit a bid for an HS2 project or commission. What do we need to do to get ready? Training considerations? Completing the BIM assessment, capability form, EIR and TIDP

- ***Module 4: Working in the HS2 Common Data Environment (CDE)***
  A more detailed technical module that focuses on the structured HS2 CDE requirements with specific regards to BS1192:2007 and its standards for information exchange, naming conventions, origin points etc.

- ***Module 5: Information management for the capital / delivery phases of HS2 using BIM***
  A detailed management module that looks explicitly at BIM and how the information delivery cycle and exchanges will work within the context of a PAS1192-2:2013 environment

- ***Module 6: HS2 Data exchange formats and classification systems***
  A technical module that will look at the creation and management of HS2 information exchange formats such as IFC and BS1192-4:2014 for COBie UK

- ***Module 7: Creation and management of Geomatic data on HS2***
  A technical module that will look at the GIS data needs and standards for the HS2 projects

- ***Module 8: HS2 BIM strategy and its commercial fit***

A commercial module that will look at how BIM fits within the HS2 contract hierarchy, the purpose of the BIM protocol, the Information Management role and IP within Level 2 BIM.

- ***Module 9: HS2 and the Digital Plan of Works (DPOW)***
  This module will be developed following release of the DPOW in March 2015 it will focus on Levels of Detail and Levels of Information allied to HS2 data needs.

- ***Module 10: Information management for the operational phases of HS2 using BIM***
  This module will look at what information is needed for the operational stages of HS2 based on Asset Information Requirements and the principles of PAS1192-3:2014

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