BUILDING INFORMATION MODELLING: ASSET MANAGEMENT IN CIVIL INFRASTRUCTURE

ROADS AUSTRALIA FELLOWSHIP 2017

WORKING GROUP 4

Andrew Ackerman

Belinda Gibbs

Justin Lowe

Mario Saliba

James Williams

Kake Wong
Introduction

The road network in Australia and New Zealand comprises of over 900 000 kilometres of pavement with a value exceeding 200 billion dollars.\textsuperscript{1} Inherently, the asset management required to support this infrastructure is vast with funding currently provided at Federal, State and Local Government levels within Australia.

Infrastructure, particularly the road network keeps Australia running. Roads ensure mobility, between our neighbourhood, your municipality region and beyond, and much more. The quality of the road network affects almost everybody in daily life. Users, residents, consumers, employees, businesses or taxpayers, all care that roads are managed efficiently and are able to deliver good service to society.

Expectations for personal mobility have grown in the past and will still do in the future. Today more than 80% of motorised inland passenger transport is using the road – not taking into account cycling and walking. Public transport and the access to other transport modes are highly dependant on roads. With very minor exceptions, every passenger or freight transport using other modes has to use the road, on or from the way to stations, terminals, airports and ports. With so much freight and personal business movement depending on the road networks, our daily life would literally be hampered without them.

From the perspective of the asset owner, maintenance as proponent of asset management, is a contributing factor to whole life cycle costs. Maintenance further impacts critical objectives with respect to safety, user costs, travel times and pavement life durations.

With reference to Australia, the capacity and cost associated with maintenance is interdependent on locality as 83% of the road network is defined as regional infrastructure.\textsuperscript{2} Maintenance on regional local roads grew nationally from 1.1 billion dollars in 2006-2007 to 1.6 billion dollars in 2011-2012 with analysis providing per capita funding data in regional centres of $1700 as opposed to $200 in urban centres.\textsuperscript{3}

With a growing network and escalating costs, it is imperative that innovation in the maintenance sphere be explored. The use of digital technology is one such area that can be assessed to provide efficiencies in asset management processes during maintenance phases in both urban and regional localities.

\textsuperscript{1} ‘Austroads Strategic Plan 2016-2020’ (Strategic Plan No AP-C29-15 -2020, Austroads, December 2015) 2.
\textsuperscript{2} Austroads AP-R526-16 ‘Reforming Remote and Regional Road Funding in Australia’ (Research Report No AP-R526-16, Austroads, August 2016) 6.
\textsuperscript{3} Ibid 5
Key to the implementation of BIM in the road sector will be a series of large scale changes to both organisations and authorities owning and maintaining roads as well as those designing, constructing and operating road networks across Australia. Several key requirements for the implementation of BIM are provided below:

**Strategy**

Necessary change starts with a desire to improve on the current practices and adopt BIM. This change will be heavily reliant on satisfactory business case(s) to justify investment in the adoption of BIM in the roads sector. An organisation or authority will require a clear strategy of what BIM capability they require and the benefits to be targeted.

**Information Needs**

Organisations and authorities should clearly define the information required as a clear set of data and Information Standards to ensure consistent standards and interoperability of information.

**Processes**

Decisions are required on what technologies are required and how they will be rolled out.

**Transition to Business as Usual**

Clearly articulated plan to implement this change.

We explore the Building Industry’s use of digital technology for building asset maintenance. It is this assessment that provides the concept of whole life cycle Building Information Modelling (BIM) with resultant benefits in the road asset maintenance sector.
Building Information Modelling (BIM)

Digital technology, namely the systems, tools, resources and devices used for data processing and evaluation, is becoming prevalent in all aspects of modern life. BIM is one such type of digital technology.

BIM is a digital representation of physical and functional characteristics of a facility. It allows for the definition, storage, sharing and maintenance of applicable information. As BIM is a shared knowledge resource for information about a facility, it can be used to form a reliable basis for decisions during its life-cycle; defined as existing from earliest conception, design development, construction phase, operations phase and ultimately to decommissioning and demolition phase.

Designing utilising BIM in the Civil Infrastructure sector is moderately common however its implementation is only now in its infancy in the construction phase. The implementation during the construction phase has allowed the user to view the facility in three dimensions throughout the construction stages of the project. The introduction of time (commonly known as the 4th dimension) into the model allows for further staged simulations and construction sequences to be assessed from both a constructability perspective. The 4D simulations could also be utilised in planning for future upgrades, modelling how maintenance activities could be achieved and ultimately how the decommissioning/demolition phase would occur. A BIM that is available during the construction phase also offers benefits as a visual tool for health and safety considerations and also as a valuable visual tool to assist with community engagement and environmental modelling.  

The use of BIM in the operations and maintenance phases of infrastructure projects is limited at present. It is acknowledged that most assets were designed and constructed prior to the widespread implementation of BIM during design phase. Resultantly it is important to understand industry current practice to assess the viability of large scale implementation of BIM with respect to asset management activities.

---

4 BIM Presentation, PowerPoint presentation, Pacifico Acciona Ferrovial JV, Bridge over Clarence River at Harwood.
Current Practices

Typically in Australia, road infrastructure owners have strategies in place to seek to manage assets effectively. Numerous practices reference the ISO 55000 suite of asset management standards. For example, the objectives of the Tasmanian Government’s *State Roads Asset Management Policy* is, in part, to understand the risks related to asset management and to improve decision-making based on costs and benefits of alternatives, prioritisation of investments, interventions and asset care activities.\(^5\)

The challenge for road infrastructure owners is underpinning asset management strategies and polices with accurate, wide-scale, consistent and accessible asset information. Current tools used to identify and stocktake road assets are generally manual and provide outdated information. Current databases are rarely linked to other parts of the business, and this reduces the ability for infrastructure owners to identify risks and opportunities. For example, a precise, visual and comprehensive assets database linked to traffic operations could help identify where asset deterioration is negatively affecting traffic flow and speeds.

Road infrastructure owners have a complex and diverse mix of assets at various stages of ageing and quality. Some assets will deteriorate faster because of exposure to severe weather elements, or other external events (such as heavy vehicle traffic). Without a comprehensive and precise database of assets, there is a risk that the maintenance of assets is not strategic, targeted or holistic.

Furthermore, infrastructure owners do not always have precise location information of assets. For example, speed signs are not always installed precisely where they are planned to be on network maps. This means that infrastructure owners cannot always be confident of where speed zones begin and end, thereby undermining the accuracy and commercial value of speed zone data.

There are also improved maintenance opportunities. Maintenance units do not always have an accurate understanding of an asset prior to a site inspection. Without clear and precise data in relation to individual assets, maintenance groups have reduced ability to plan and prepare for maintenance site visits which results in service and maintenance inefficiency and increased business costs.

Finally, many infrastructure owners use multiple databases that are threatened by having multiple copies that degrade over time, do not have version control and multiple authors. This threatens the integrity of the data and could result in organisations having a poor or imprecise understanding of its assets.

Industry Case Study

The Building Industry is leading the way with the use of BIM and asset management for the complete project lifecycle, from design, construction, as-built and asset management phases. In order to investigate the use of BIM for Road Asset Management, we provide a case study on the current use and extent that BIM has become embedded within the Building Industry. There are many parallels that can be made and extensive experience to be called upon to implement BIM in other sectors.

The operational phase of a building is the main contributor to the building’s lifecycle cost. Estimates show that the lifecycle cost is 5 to 7 times higher than the initial investment costs and 3 times that of the construction cost. As a result, there is a considerable economic and environmental need to manage both new and existing facilities in an efficient way. Facility (or asset) management (FM) encompasses multiple disciplines to ensure optimal functionality of the built environment by integrating people, place, process and technology.

Building owners are widely embracing BIM as a core part of their design and construction process and are now are extending the value of BIM to the entire lifecycle of a building. Lifecycle BIM is the collaborative model based process for creating, maintaining and utilizing building information to effectively manage operations and maintenance of a building throughout their operational lifecycle. There are two primary methods for gathering and creating a data rich “model”. Both of these methods work in conjunction with one another to enable an owner to move to Lifecycle BIM for all of their facilities.

Method One

The first method is applicable for new buildings and involves the implementation of BIM throughout the project lifecycle. It includes leveraging BIM data for post construction use within facilities systems by having close coordination between D&C teams who have chosen to design and construct new facilities with BIM and the building owner’s project team for which the building is being constructed. This requires creating an interactive operations and maintenance manual between the BIM model and an Integrated Asset Management System. A general overview is shown below of how BIM is implemented through the project lifecycle phases for method 1.

---

6 Virtual Barangaroo, Lendlease, Barangaroo.
Design model

Developed by the design team with a Level of Detail (LOD) to relay design intent and generate documentation and details used during construction.

Construction model

Contains a high level of detail used before and during actual construction to reduce uncertainty, improve safety, eliminate conflicts, and simulate real world outcomes.

As-built model

Contains both construction and fabrication data with detailed geometry and multiple disciplines aggregated into a single model that facilitates turnover from D&C to owners.

Facilities BIM

Contains a level of accuracy that reflects the design model but with updated as-built conditions for space and assets used for operations and maintenance.

One of Australia’s largest infrastructure projects is the upgrade of 156kms of the Pacific Highway. This is being managed by Pacific Complete and a key partner is Laing O’Rourke. Pacific Complete are following the steps outlined in Method 1 and are leading the way for the implementation for digital engineering throughout the design, construction and operations phases.

Method Two

The second method involves the as-built modelling existing facilities and is more complex and does not offer the same level of information as method 1. It is still however an important aspect of embracing a holistic and comprehensive approach to Lifecycle BIM for the entire portfolio. For owners who own and operate a number of facilities within their building portfolio, only taking advantage of a BIM based lifecycle approach for buildings, which are newly constructed, inherently limits the value that building information modelling can provide.

Both the first method for the D&C approach and also the second method of modelling of existing facilities can be applied for the civil infrastructure and the creation of a road asset maintenance system.
BIM Models for Operations and Facilities Management

Preventative Maintenance Scheduling

Preventative Maintenance Scheduling is the tracking and maintaining lifecycle information about the building structure (wall, floors, roof, etc.) as well as the equipment serving the building (mechanical, electrical, plumbing, etc.) to plan and schedule a program of maintenance activities that will improve building performance, reduce repairs, and reduce overall maintenance costs. Preventive maintenance scheduling enables facility managers to plan maintenance activities proactively and appropriately allocate maintenance staff, as well as reducing corrective maintenance and emergency maintenance repairs. Using this information, facility managers can evaluate different maintenance approaches, analyze data to make repair vs. replacement decisions, and document the effectiveness of a reliability-centred maintenance program.

Building Systems Analysis

Building Systems Analysis is the measurement of how a building’s actual performance compares to design model predictions. Tracking performance data from the building systems and comparing these values to design model predictions enables facility managers to ensure that the building is operating to specified design and sustainable standards and identify opportunities to modify operations to improve system performance. Building designers can also use this data to validate and refine their prediction models and evaluate the impact of proposed materials and system changes to improve performance. Building systems analysis typically focuses on mechanical systems and building energy use, but it can also include ventilated facade studies, lighting analysis, airflow analyses using computational fluid dynamics, and solar analysis.

Asset Management

Asset Management is the linking data of in a BIM record model to a database of building assets to assist in efficiently maintaining and operating the facility. These assets often include the building elements, systems, and equipment that must be maintained and operated efficiently to satisfy the facility users’ requirements in a cost effective way. Asset management systems are used to support financial decision-making, short-term and long-term planning, and maintenance scheduling. Using information in a BIM record model, facility managers can: evaluate the cost implications of changing or upgrading building assets; track the use, performance, and maintenance of a building’s assets for the owner, maintenance team, and financial department; produce accurate quantity take-offs of current company assets for financial reporting and estimating the future costs of upgrades or replacements.
Benefits

The Civil Infrastructure industry is now starting to adopt and mandate the use of BIM throughout the design and construction phases of major projects. The benefits of BIM across the lifecycle of construction and maintaining highways and roads cannot be understated, and that having information stored in a single model ensures decisions about the project are adequately informed and made in context. The Civil Infrastructure Industry can learn from and use the Building Industry as a guide for the successful implementation of BIM into the asset Management and maintenance part of the project lifecycle.

The challenge for the Civil Infrastructure industry is the adoption of the outlined process for development of BIM models for the 900,000 kms of as-built Civil Infrastructure outlined in method 2 above. Both the first method for the design and construction approach and also the second method of modelling of existing facilities can be applied for the Civil infrastructure and the creation of a road asset maintenance system.

The benefits of the implementation of BIM are clear - having easily accessible data about the project and how it has been built is invaluable when making decisions about the asset long after it is built, with the ability to tie schedules back to the intelligence in the (BIM) model being useful in terms of eliminating inefficiencies in road maintenance. The benefits of preventative maintenance, Network Systems analysis and Asset management could be realised in the Civil Infrastructure industry.

The application of BIM with respect to road maintenance provides the following benefits:

- 3D modelling combined with a digital asset registry enables infrastructure owners to save money, increase maintenance and service efficiency, and to accurately register and monitor a complex and diverse asset-base.
- 3D modelling and digital asset registry achieves this by providing:
  - One database – “one source of truth”
  - Accurate visual representation of assets
  - Real-time imaging to ensure data reflects quality and quantity of assets
  - Cloud-based data storage protects the data from security and storage risks.
Challenges

The application of BIM with respect to road maintenance has the following challenges:

- cost to establish
- cost, time and resources to input and maintain
- to gain the maximum benefits, should be supported by cloud-based data storage and digital asset registry, which has additional cost and complexity
- skills and capability to input, service and use the digital technology
- Organisational change adopting new technologies, changing systems and processes and integrating them with existing operations. This includes appropriately resourcing this effort to implement the changes and support its ongoing implementation and management as well as train and support existing staff and supply chain
Implementation

Developing the Business Case

A Business Case articulating the justification for investment in BIM to manage road assets will no doubt have to be performed by each organisation. Australia may seek the benefits and learnings in adopting BIM and in particular recent examples related to Transport for London’s Surfaces BIM Program

(Refer Department for Transport, UK Roads Liaison Group, BIM, Better Information Management, Guidance for Infrastructure Bodies).

A BIM business case will require extensive research into the organisation, their current operations and what their needs are and may contain the following information:

- A high level description of the project scope
- Context – the rationale and need for the project
- Scope of proposed BIM Program and range of options
- Constraints and dependencies
- Benefits management strategy and plan for realisation
- The estimated capital and operating costs
- An evaluation of options including the “do nothing” option, which incidentally will also identify the cost and consequences of not adopting BIM
- The target schedule
- Investment appraisal
- Key assumptions used
- Project success criteria including Key Performance Indicators (KPIs)
- The impact of the project on business as usual operations

With the robust nature of the business case required, to conclude this example the outputs of the exercise conducted above for the Transport for London’s Surfaces BIM Program Benefits Map is provided below in Appendix 1.

Given the varied approach of the many asset owners and organisations ranging from Federal Government, State Government, Local Government or private operators provides a key challenge in itself, with some consistency between organisations essential. In order to implement BIM with a clear strategy in place, it’s important to focus on the key challenges perceived to be the current impediment to utilising BIM in Australia for asset management of the road network. The main impediments to implementing BIM our outlined below with further discussion on each:
• Business Case development across multiple organisations and operators Australia wide
• The sheer volume of data required to establish the 3D model of the existing road network
• Costs associated with the above and funding source
• Cultural/ organisational change to implement BIM

Creating BIM for new and existing assets

Developing complete and up to date models will be particularly challenging when considering both the extent of roads and the manner in which data has been recorded to date. This is more than likely to be done progressively from a series of pilot projects, before obtaining data for the entire road network.

The system can be setup as a ‘shell’ or framework with some part available across everything, and some extra information available on more recent projects. There are therefore several categories of information to gather:

• Gathering historical data from pervious projects, say prior to 10-15 years ago where digital records would not be sufficient to get into 12D or OpenRoads etc.
• We assume that projects of recent times (say 10-15 years) have relatively good as builts and could be collated into a model
• We assume that current projects are working in 3D and models with all available information will be available
• We assume that all future projects have a requirement for this information to be provided into a commonly shared and usable format

The road network is the backbone to the economy of our nation. The information on our roads, if collected, stored and managed using 3D models and technology can ensure road users benefit from an efficient system.

Constructing a 3D model of an object in the world can be achieved by measuring the object directly, or, measuring the distance to different points on the object from a scanning device, and then using these points to construct a model of the surface corresponding to the size and shape of the object. A programmable robot travelling scans and transmits a detailed 3D map of the entire location to the other side of the world.
Real-time information can now be collected using laser LIDAR (Light Detection and Ranging is a remote sensing method used to examine the surface of the Earth) with a colour camera(s) installed with several long-short ranged radar sets. LIDAR’s relatively small units and can be mounted on top of standard cars (refer to Figure 2 below) with an application software installed. Fleets of Ford Robocars are roaming streets to map data collected from LIDAR cameras. Street maps are detailed to within 2 centimetres of accuracy.

Figure 2: Survey camera units mounted on top of standard cars

Figure 3: Accurate and real time 3D model

3D modelling and its advancing technology if embraced by the industries and interest groups will reap the productivity and economic benefits.

3D modelling has the ability to collect accurate, detailed real time road information as illustrated in Figure 3 above. These models benefit the following interest groups:

- Road authorities who are road asset owners
- Autonomous vehicle industry
- Heavy Freight/ High Productivity Freight Vehicles

Roads are huge economical asset. Lack of maintenance can threaten the production and trade of goods and services as well as mobility for all citizens, with a potential to compromise safety of road users.
Regional roads are very often remote hence regular access is limited leading to reduced levels of routine and reliable maintenance. This is largely because of the lack of reliable data, particularly because historical information and records are lost or misplaced, and have not been retained and/or well managed. Authorities are increasingly providing little and limited as-built information of road widths, associated infrastructure and road furniture such as bridge, culverts, kerbs, pipes and pits, noise walls. The ability to get current survey and condition of road pavement, kerbs, safety barriers, drainage pits and pipes requires time and funding which are very often no readily available.

With current technology, asset owners have the option to obtain high definition large scale 3D surveys with sub-metric accuracy of the roads and all its surrounding features. A survey scanner attached to a vehicle driving through the roads gathers not only inspection and repair inventory, it has the ability to also accumulate data on pavement quality, bridges, drainage, road signs, signalised intersections, street lighting, speed restrictions, traffic levels, traffic accident details, traffic noise pollution calculation and abatement, roadwork maintenance planning and project management for each asset owner. GPS locations enable digital positioning of every sub-asset, and generate real time display of all infrastructure objects. 3D surveys enables 3D modelling of road assets and its storage as a record using digital and web based cloud systems. Access to records is available from various locations and devices. Real time views of drive throughs and condition survey can be conducted from an office location.

The automotive industry is already embracing this movement with driver assistance systems that includes parking assistance, autonomous driving in “stop and go” traffic and emergency braking.

Autonomous vehicles rely on having a 3D model of the world around them. One of the techniques currently used in detecting distances to objects surrounding an autonomous vehicle is LIDAR, in which a laser is used to accurately detect the distance to a nearby object. But recognising visual imagery also has an important part to play in the control of autonomous and “AI-enhanced” vehicles. The car they used for the experiment looked entirely like a production car and used most of the standard sensors on board, relying on vision and radar to complete the task. Similar to other autonomous cars, it also used a crucial extra piece of information to make the task feasible – it had access to a detailed 3D digital map to accurately localise itself in the environment.

**Anticipated costs for implementation**

With over 900,000 kilometres of roads in Australia across 7 states and territories and various jurisdictions at Federal, State and Local Government as well as private operators, both the costs for implementation and the complexity in administering these requires further definition during business case development and ideally would be lead as a Federal Government initiative, thereby leading the entire road network on a common path to adopt BIM.
There will likely be upfront costs in enabling organisations and road networks across the country to adopt BIM:

**Upfront Costs**

- Internal project staff costs including the implementation team
- External consultancy and support
- Enabling technology, software, document management systems including their upgrade and integration (or replacement) with existing systems

**Operating Costs**

- Ongoing staff costs for implementation to drive and support the new way of working and lead continual improvement
- Ongoing technology cost, bearing in mind the cycle of refreshing technology periodically

The technology and skill sets required to be adopted for these projects is readily available and proven technology internationally. Assumed costs for implementation, prior to business case being completed, have been assumed to gain an order of magnitude for assessment of this topic.

Our team have made some assumptions on the larger value items for implementation on BIM including:

- 900,000 kilometres of roads in Australia. Therefore the magnitude of the task as a starting point is to conduct 3D surveys of the entire network.
- And then combine this with other available information to create a “shell” of the entire road network.
Funding

Considering an upfront investment of $1 - $2 Billion, when comparing this to current asset values and maintenance and operating costs it seems comparatively low in value.

Traditional funding occurs through Federal, State and Local Governments with budget allocated from revenue earned through road tolls, taxes, vehicle registration amongst others.

Alternative funding

When considering funding models we thought there was some opportunity for designated vehicles who travel the nominated routes (couriers, trucks, interstate commuters etc) to fit cameras onto their vehicle and perform this task as they do their work. This could contribute to minimising their own road tolls or rego fees etc as compensation for the collaborative approach to gathering data for the road authority. Furthermore it could

An idea generated by the team includes discussion about the rise of autonomous vehicles and the fact that they are constantly scanning the road surface etc and comparing to GPS info for not only their direction but to avoid hazards. What if these could log information and report back on current issues, maintenance requirements, pot holes, degradation of pavement etc or asset damage?

Extending again to funding sources, possibly if this requirement became part of the specs for the autonomous vehicle, then the second part of the equation, the ongoing data gathering to inform maintenance of the assets.
Conclusion

The traditional approach to maintenance through routine and periodic road side inspection is common practice by road authorities throughout Australia.

- Long response times to maintenance and repairs, leads to increased scope and cost of the repairs.
- The quality and standard of our road has a direct relationship to road user safety.
- The quality and reliability of our road network has a direct impact on the cost and efficient movement of freight and people.

The building industry has long used BIM to understand and manage the entire life cycle of the building asset, from design through to operation and demolition. Building systems analysis allows the facility manager to ensure that the building asset is performing efficiently as per the design intent and that the user of the asset is receiving the level of service expected.

This same whole of life asset management approach is being introduced into the road transport infrastructure sector. Laser LIDAR technology is currently being used to capture 3D survey of existing road infrastructure assets to enable the design and construction of new or upgraded assets.

This same technology and data could be used to create a digital asset system, where on-going, real time LIDAR data capture informs our decision making to road asset maintenance, ensuring that the asset is performing as per the design intent and that the user is receiving the level of service expected.

The challenge ahead is that Australia has a road network of some 900,000km. Roads are managed and maintained by numerous local and regional municipalities, state road agencies and private road operators. Organisational and industry change and acceptance is never smooth, is expensive and takes time.

We recommend to following way forward to implementing BIM into the civil / transport infrastructure industry;

- Set up a panel to conduct a thorough review of the current best practices around the world and also understand the cost of doing nothing based on our current practices.
- Sell the benefits to road user groups and road managers/operators and get their buy-in.
- Establish a standard for implementing BIM and its use in asset management to be implemented on all new civil and transport infrastructure projects.
• Introduce a requirement where all business case submissions, seeking funding for transport infrastructure projects are to include budget for the implementation and upkeep of a BIM asset management system.
• Collect existing asset data through LiDAR by initially mounting cameras on freight vehicles and taxis.
• Ensure that autonomous vehicles are capable of collecting and transferring 3D data, real time, to enable upkeep of the asset data base.
• Set a date for organisational and industry change over to utilising BIM for asset management.
Appendix 1

<table>
<thead>
<tr>
<th>Business Needs</th>
<th>BIM Objectives</th>
<th>BIM Work Streams</th>
<th>BIM Outputs</th>
<th>Outputs Influence</th>
<th>BIM Enablers</th>
<th>Key Outcomes</th>
<th>BIM Benefit Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Information Standards**
- Object based modelling capability
- Employer Information Requirements (EIR)

**Technology**
- WIP and share process
- CDE enabling technology

**Mobilisation**
- To-be working processes
- Roles and Responsibilities (RACI)

**Process**
- Internal stakeholders upskilled with the new ways of working, relevant technology and processes for the project as a whole and their individual role
- Stakeholders encouraged and motivated to adopt the BIM principles

**People**
- Change Management Programme (culture and behavior)
- Staff development and training support

**Stakeholders**
- Internal communications and engagement
- External communications and engagement

**Supply Chain**
- Supply chain contracts updated for BIM arrangements
- Supply chain engaged and mobilised for new ways of working

**Outcomes Influence**
- Detailed and understood information requirements by all internal and external parties
- Improved and appropriate modelling on all projects
- Technology that provides quick, easy access to data and information
- Identified and delivered of benefits Management across Projects

**Key Outcomes**
- Reduction in the initial cost and delivery timeframe of Capital Projects
- Areas of saving on Major Capital Projects and Capital Renewal Schemes
- Reduced overall scheme duration, time in project stages, and bringing projects to site quicker
- Improved survey over programmes, processes and approvals
- Reduced surveys and investigations, design iterations and errors, and the costs associated with Main Works
- Improved budgeting, tendering and realisation of savings on Capital Projects
- A greater clarity of information and requirements provided to and expected from the supply chain and the potential risks
- Improved procurement process with reliable and accurate tenders
- Greater leverage of supply chain data management capabilities
- Greater transparency on works progress and supply chain performance
- Client improves visibility of works closeout and works closure
- A collaborative working environment with a competitive supply chain minimising risks and maximising opportunities
- Improved asset knowledge and reporting
- Improved visual representation and collaboration on asset data
- Routine updating of asset data throughout asset lifecycle
- More accurate evidence base to support design and operational decisions
- An improvement in the source, accuracy and reliability of the asset data quality
- Well managed, accessible and professional storage of information
- Automated transfers of data from one system to another at handover points
- Removal of data duplication, re-collection costs or wasted productivity in data validation
- Collaboration internal/external working environment to drive cost reduction over life of asset
- Common standards, format and requirements used for data collection and storage to improve engagement, visibility and management of asset/works
- Ability to share and utilise data and information between projects
- Removal of data link within Supply Transport
- Case studies, examples and evidence of BIM improvements and benefits
- Lessons Learned translated more easily to future projects and development of best practice
- Improved decision making at internal and external touch points
- Accurate, verified and complete data and information that can be relied upon
- Confidence in information provided and reported upon and assessment of associated risks
- Data linked to TL’s H&S, legal and regulatory obligations defined and thoroughly collected
- Confidence in best practice ways of working
- Robust ‘As Built’ vs. ‘As Designed’ information put in place
- Greater understanding and insight as to design and elements of asset and asset data
- Appropriate transfer of responsibility and accountability to the supply chain
- Data requirements of the supply chain consistently met
- Asset data routinely updated during operational activities (inspections, maintenance, renewals etc.)
- Accurate recording of asset data for reliable operational processes
- Improved information to support operational decisions (e.g. condition and performance data)
- Improved asset data and accuracy to improve operational planning
- More ‘intelligent’ maintenance and renewal programmes developed
- Reduced frequency of emergency interventions or critical asset failures
- Competitive supply chain with accurate tenders and improved processes and reduced waste
- Improved ability to link customer service information to assets
- Improved customer experience
- Retention of information to improve customer experience on future project design and construction
- TL1 able to demonstrate to DfT and wider audience that capital projects are developed and managed in accordance with BIM Level 2

**BIM Benefit Themes**
- B1. Reduced capital costs and risks
- B2. Improved supply chain management
- B3. Improved asset data quality
- B4. Reduced whole life costs of asset data management
- B5. Improved information sharing and collaboration
- B6. Improved assurance
- B7. Improved operational processes
- B8. Reduced operational costs
- B9. Improved customer experience
- B10. BIM Level 2 Compliance