

Line of Sight:
an Asset Management
Methodology to Support
Organisational Objectives

**Optimising asset management
to realise business success**

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Glossary

Asset Information Model (AIM) – an information model (set of structured and unstructured information containers) that relates to the operational phase required to support an organisation's asset management objectives.

Asset Information Requirements (AIR) – any information captured at an assets system, sub-system or product level of an organisation's asset classification system that is necessary to enable it to meet its OIR (see below).

Asset Management – this involves the balancing of costs, opportunities and risks against the desired performance of assets to achieve organisational objectives.

Functional Information Requirements (FIR) – information requirements developed at an asset's functional output level. These enable non-technical stakeholders to understand the performance needs of the assets and align them to the organisational objectives.

Line of Sight Methodology – a 'golden thread' of information to provide a line of sight between organisational objectives and asset requirements.

Organisational Information Requirements (OIR) – data and information required for an organisation to meet the needs of its organisational functions and its asset management system.

Organisational objectives – short and medium-term goals that an organisation seeks to achieve to reach overall strategic goals.

Unified Modelling Language (UML) – a general-purpose, developmental, modelling language in the field of software engineering intended to provide a standard way to visualise the design of a system.

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Foreword

The field of asset management permits organisations to optimise the whole life of their built assets and realise their connected business objectives. Better information planning and procurement will support this discipline especially within the context of Building Information Modelling (BIM) using the ISO19650 series. More complete and accurate asset data/information can support better decisions regarding operation and maintenance and achievement of wider organisational goals.

However, to achieve these benefits it is imperative that Organisational Information Requirements (OIR) are conveyed which support an organisation's asset management policy, strategy, plan and system along with other related policies and objectives.

Whilst defining information to support asset management systems such as an asset register or computer-aided facility management (CAFM), the relationship with wider organisational objectives is a chasm that needs to be bridged. This gap between the OIR and Asset Information Requirements (AIR) can be bridged through this innovative Line of Sight Methodology.

This novel approach builds a framework to help client organisations create a 'golden thread' of information to provide a line of sight connecting organisational objectives and asset requirements. The innovative use of Functional Information Requirements (FIR) helps create a direct connection between organisational objectives and AIR which often lack a clear line of sight.

I believe that the Line of Sight Methodology will support an information-led asset management methodology and better support the achievement of organisational objectives.

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Impact Director Digital, Construction Innovation Hub



Introduction

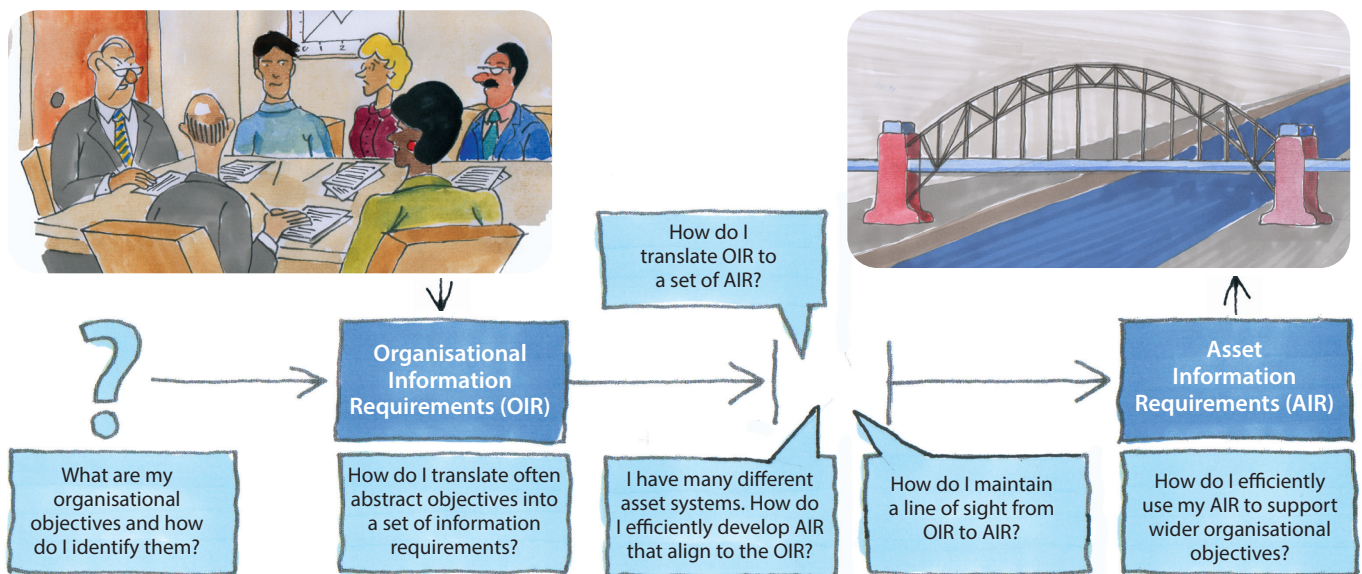


Figure 1: The gap between the Organisational Information Requirements (OIR) and Asset Information Requirements (AIR) that the Line of Sight Methodology aims to address

The success of any organisation is dependent on its ability to realise the full potential value of its assets. However, those assets often form diverse and complex portfolios within complex systems of systems. Realising their full potential means finding ways to view assets within the concept of whole-life management – creating a ‘golden thread’ of information to provide a line of sight between organisational objectives and asset requirements. This can only be achieved once it has been established what information is required to optimise performance and manage risk throughout the whole life of those assets.

The ongoing and inevitable digitalisation of our world means there is no shortage of information and opportunities for its acquisition. Business success depends on planning and procuring the right information at the asset level to support delivery of operational requirements. Nevertheless, asset information requirements are often formed without direct connection to, or sight of, the organisational objectives they aim to achieve. Therein lies the disconnect that must be addressed to allow full realisation of asset potential.

Industry standards (such as the UK Building Information Modelling (BIM) framework and its ISO19650 suite of international standards) have been developed to inform how to define Asset Information Requirements (AIR) and Asset Information Models (AIM). However, there is not yet a method by which the AIR are informed by the Organisational Information Requirements (OIR) and how these arise out of organisational objectives. This is critical to address the value an asset brings to an organisation rather than solely focussing on the physical asset itself. Considerations of cost, opportunity and risk must be balanced against the asset performance required to fulfil organisational objectives.

A new top-down methodology has been developed by the Centre for Smart Infrastructure and Construction (CSIC) at the University of Cambridge to support the development of asset information in relation to organisational objectives, specifically addressing the disconnect between AIR and OIR. This ‘Line of Sight’ methodology provides an information management approach to enable data to be

effectively aligned to decision-making in support of organisational objectives and provides an important underpinning for the realisation of digital twins. Aligning data to decision-making is essential in the context of achieving the UK government’s 2050 net zero carbon target as data is critical in understanding how to mitigate carbon emissions while still delivering an organisation’s objectives.

The novel aspect of this approach is the development of Functional Information Requirements (FIR) to bridge the gap between OIR and AIR. This is achieved by identifying and understanding the ‘functions’ of the asset systems that help address or have an impact on achieving organisational objectives, to then identify the assets that support each function.

The Line of Sight Methodology uses BIM processes to tackle information management challenges within asset management, and it supports the development of an AIM and its integration with asset management systems. BIM is defined as the “use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions” (BS EN ISO 19650-1:2018). While this definition is helpful, little support is given on how an AIR (or OIR) should specify an AIM and how a BIM model should contribute to an AIM. The Line of Sight Methodology resolves this by adding a new set of information requirements to bridge the gap from OIR to AIR.

The effectiveness and benefits of the Line of Sight Methodology have already been put to the test in real-world organisations, including a university estates management organisation and a public transport provider. The methodology was used to isolate the organisations’ high-level objectives and connect them to their Asset Information Requirements.

This paper demonstrates the urgent need for this methodology and illustrates how, through industry application and engagement, it can redefine asset management and realign it with organisational imperatives.

¹Hackitt: Building a Safer Future – Independent Review of Building Regulations and Fire Safety: Final Report

Why do we need the Line of Sight Methodology now?

Where are we now?

Optimising the opportunities of digital transformation requires the planning, collection, curation, integration and analysis of data. Despite the potential benefits, many organisations responsible for infrastructure assets lack effective information management, not only restricting informed and data-driven decision-making to reach organisational objectives, but also hampering the capacity to exploit emerging and interoperable technologies and tools such as digital twins. More often than not, the right information is not reaching the right people at the right time. Such organisations are in danger of being left behind.

Where do we want to be?

Industry must recognise the value of information, and the need to capture and curate it to make it accessible and useful throughout the whole life cycle of an asset or system. This is vital because asset performance impacts on the financial, environmental and social requirements and objectives of organisations.

For example, data asset management organisation Anmut recently completed a data valuation for Highways England, the government-funded company charged with maintaining motorways in England. It states: *"The total economic value of Highways England is £311bn – this includes £115bn of physical asset value (the strategic road network) and £196bn of value created by users of the strategic road network. In Highways England's case we [Anmut] have calculated that the total value created through data is £39 billion, that's around 30% of Highways England's physical asset value."*

Given the value of data, the need for a direct line of sight from asset information to an organisation's policy, objectives and aims becomes ever more urgent. Organisations must be able to establish their through-life information requirements clearly, linking information capture to organisational objectives, and reducing the risk to business performance caused by inadequate or missing information. A line of sight will create a 'golden thread' for data and information and enable better-informed decision-making.

Being able to classify data is essential in the context of the UK government's commitment to achieving net zero carbon by 2050. Data transfer and storage entails carbon cost, making classification and curation vital to reducing the energy and hence the carbon cost of data.

What are the challenges?

This line of sight from organisational objectives to asset performance is currently missing.

Failing to collect asset information in alignment with organisational objectives can restrict the performance and efficiency of capital investment decisions, risk management and operational performance throughout the whole life of an asset, and ultimately impact productivity.

In the context of the Line of Sight Methodology, an asset is a physical item that provides a functional output, such as a rail signal, ventilation system or a bridge. This is a refinement of the definition from the ISO 55000 standard, describing an asset as *"an item, thing or entity that has potential or actual value to an organization"*. Many organisations still struggle to identify what information should be collected to support the efficient management of these physical assets throughout their whole life.

The ISO 19650 series of standards for BIM describes the approach organisations should take to define their Asset Information Requirements (AIR) and the Asset Information Model (AIM). The AIR should be informed by the Organisational Information Requirements (OIR) which in turn are defined based on organisational objectives. However, standards do not currently provide tools or processes to aid in the development of AIR, AIM and OIR. As a result, ad-hoc processes have been adopted that are often resource intensive and lacking in data quality features.

Furthermore, in order to justify the financial commitment required, organisations need to identify the business benefits of changing their approach.

How the Line of Sight Methodology works. What is the solution?

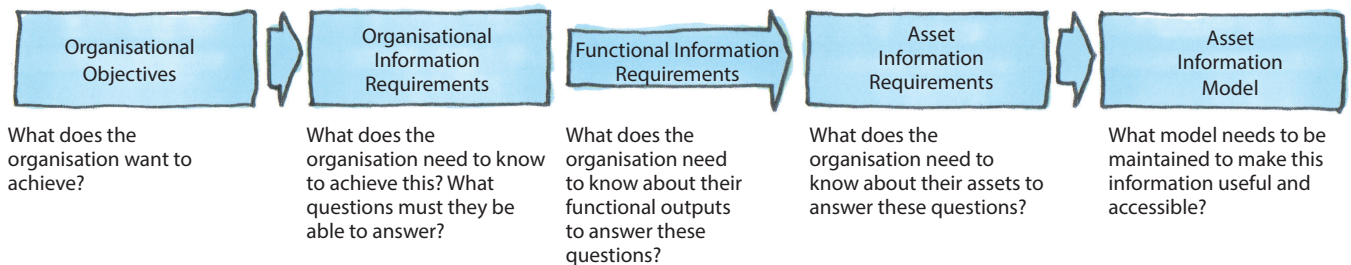
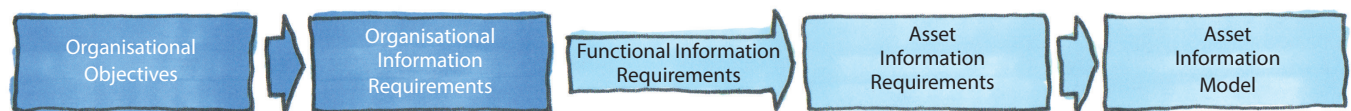


Figure 2: The Line of Sight Methodology and how it bridges the gap from organisational objectives to the Asset Information Model

To address these challenges, the Line of Sight Methodology has been created to support a structured approach to the development of useful and useable asset information from organisational objectives. Specifically, to generate Asset Information Requirements (AIR) from Organisational Information Requirements (OIR), the

Line of Sight Methodology proposes a new set of information requirements to bridge the gap from OIR to AIR. The methodology calls these Functional Information Requirements (FIR). The following sections present the key features of the Line of Sight Methodology.

Step 1: Establishing Organisational Information Requirements



Organisational Information Requirements (OIR), are defined in ISO 19650-3 as "data and information required to achieve the organisation's objectives".

When used together, the steps set out below enable a structured and repeatable approach to the development of OIR. The steps include defining organisational objectives, developing a set of Critical Success Factors (CSF) for each of these, creating a set of Plain Language Questions (PLQ) that align to the CSF and finally, answering the questions, which in turn gives us the OIR.

Organisational objectives

Regardless of organisation type, organisational objectives can be arranged into six broad categories. These are: financial, environmental, operational, customer, health and safety, and reputational.

Understanding assets within the requirements of organisational objectives is crucial to management of physical assets in the context of the wider organisation and the development of an asset management system.

Asset management focuses on the value an asset can provide to an organisation, taking into account whole-life costing, risk management and resource management. A key requirement of asset management is the development of a set of goals and plans that align with organisational objectives focusing on physical assets. Asset management and the development of an asset management system is governed by the ISO 55000 standards.

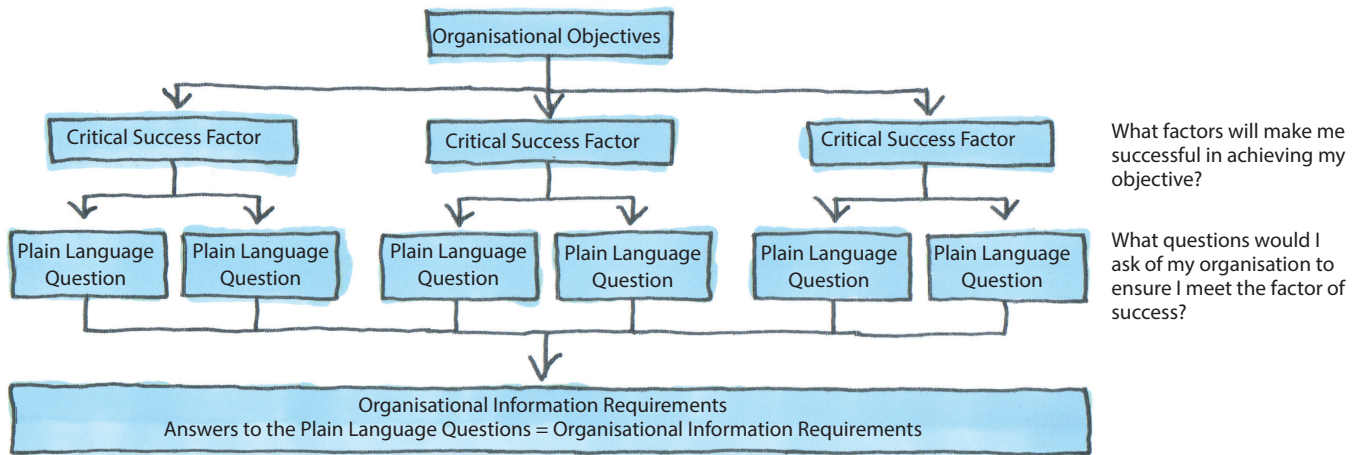


Figure 3: The development of Organisational Information Requirements that align to an organisational objective

What are Critical Success Factors?

The organisational objectives are viewed in the context of Critical Success Factors (CSF). In this context, CSF are defined as factors within organisational objectives that are critical to achieving each objective. Generally, a set of four to six CSF should be developed for each organisational objective. Examples might include:

- Reduction in operational cost
- Less reactive and more planned maintenance
- Increase in renewable operational energy
- Faster response to customer engagement.

When developing CSF, it is also important to consider the reasons why information is needed to support in their development. For example, several organisational related purposes are summarised below:

- Measure success in meeting objectives
- Address the needs of stakeholders (including staff, end-users, shareholders)
- Satisfy regulatory requirements (including building control, planning, auditors, inspectors)
- Develop policies (including quality management)
- Support business operation tasks (including corporate reporting, applications, auditing, procuring maintenance contractors, analysing space utilisation).

The UK BIM Framework Guidance provides a wealth of knowledge on information management processes within BIM, among other things².

What are Plain Language Questions?

Plain Language Questions (PLQ) are used as a simple but powerful tool to develop a set of questions that align to the CSF; a set of questions to ensure that the organisation will achieve this success.

Usually four to six of these are developed for each CSF. Examples of PLQ include:

- What is my total operational cost?
- What proportion of my maintenance tasks are reactive?
- How much of my power is currently sourced from renewable sources?
- What is the average time to respond to a customer query?

PLQ form part of the BIM ISO 196590 standards and were originally designed as a tool to aid clients in gaining relevant information requirements from the supply chain. However, PLQ are used within the context of this methodology to aid the organisation in developing their own information requirements.

Organisational Information Requirements (OIR)

By establishing organisational objectives, informed by Critical Success Factors (CSF) and interrogated by Plain Language Questions (PLQ), we can define Organisational Information Requirements (OIR). The answers to each PLQ develop the individual information requirements that as a collection form the OIR. Furthermore, the structured approach to OIR allows them to be easily referenced and support the future development of Asset Information Requirements (AIR) and an Asset Information Model (AIM).

²www.ukbimframework.org/standards-guidance/

How the Line of Sight Methodology works. What is the solution?

Step 2. Establishing Asset Information Requirements through Functional Information Requirements



The Line of Sight Methodology and how it aids the establishment of Asset Information Requirements from Organisational Information Requirements

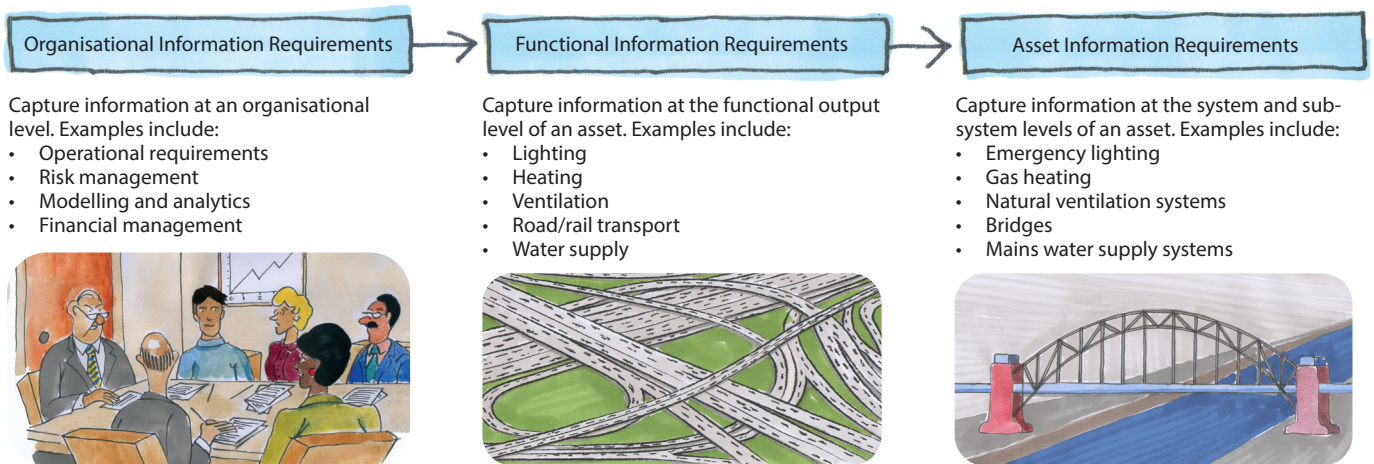


Figure 4: The use of Functional Information Requirements as a means to support the development of Asset Information Requirements

A key challenge for many organisations is translating non-technical OIR into generally more technical Asset Information Requirements (AIR). This is crucial to fully understand the whole value an asset brings to an organisation.

According to BIM, an AIR is “any information that is captured at an asset system, sub-system or product level of an organisation’s asset classification system that supports the organisational requirements for their assets, including operational and maintenance management, spares management and risk assessments”³. However, the standards do not currently provide tools or processes to aid in their development.

The jump from OIR to AIR is a leap too far for most organisations, resulting in a set of AIR that don’t meet the OIR and therefore fall short of delivering organisational objectives.

Bridging the gap with Functional Information Requirements (FIR)

The novel aspect of this Line of Sight methodology is the development of Functional Information Requirements (FIR) to bridge the gap between OIR and AIR.

In contrast to AIR, which capture information at an asset system or

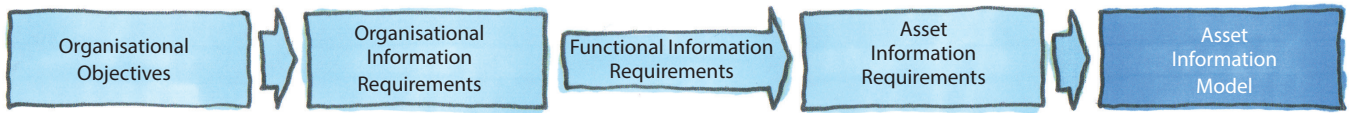
subsystem level, for example for a gas boiler or hard-wired lighting, FIR capture information at an asset’s functional output level, such as heating and lighting. This enables non-technical stakeholders to understand the performance needs of the assets and align them to the organisational objectives.

The Line of Sight Methodology defines FIR as: “Information requirements developed at an asset’s functional output level. These enable non-technical stakeholders to understand the performance needs of the assets and align them to the organisational objectives.”

Organisational objectives will be met when Asset Information Requirements (AIR) align to Functional Information Requirements (FIR) and Organisational Information Requirements (OIR) are addressed. FIR and AIR aim to answer the plain language questions developed within the OIR. This enables the gap between the OIR and the AIR to be bridged.

³ISO 19650-2 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling

Step 3: Design and development of an Asset Information Model (AIM)



The Line of Sight Methodology results in the development of an Asset Information Model (AIM) that aligns with organisational objectives

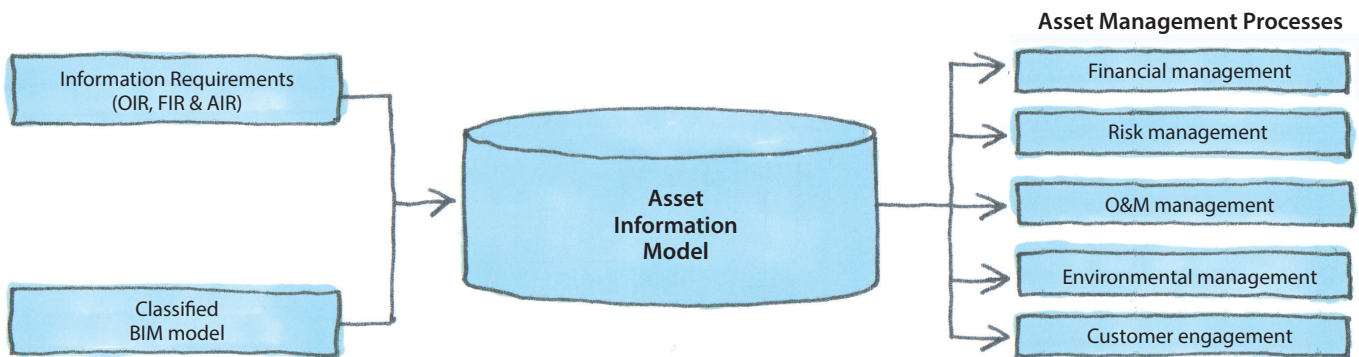


Figure 5: The development of an Asset Information Model derived from a classified BIM model and the structured approach to the development of OIR, FIR and AIR

Adopting BIM within asset management is complex, with multiple managerial and technical challenges. One of the key issues is that BIM models – developed during the design and construction phase – are generally not developed from an operational perspective and therefore are rarely fit for purpose within the operations and maintenance phase that follows.

The Line of Sight Methodology addresses the information management challenges of asset management by using BIM information management processes to support the development of an Asset Information Model (AIM) that aligns with organisational objectives and its integration with asset management systems.

According to ISO 19650, an AIM is defined as “data and information that relates to assets to a level required to support an organisational asset management”⁴. It notes that an AIM can relate to a set of assets (such as a railway network) or a single asset (such as a street light pole), also that it is specified by AIR and developed from a BIM model. While this definition is helpful, little support is given on how an AIR (or OIR) should specify an AIM and how a BIM model should contribute to an AIM. The Line of Sight Methodology resolves this.

From information requirements to an AIM

Taking the suggested approach to the development of the information requirements (organisational, functional and asset), the next step is to design an AIM database making use of Unified

Modelling Language (UML) diagrams to capture the relationships between the different asset functions and systems. UML diagrams in this context are figures that visualise the ‘parent-child’ relationships that enable development of the AIM database. This ensures the capture of non-technical requirements within the OIR and technical requirements within the FIR and AIR.

In effect, this enables the transformation of a BIM model into an AIM, by utilising the approach used in the development of the information requirements to classify a BIM model. This in turn supports the development of an AIM database that is populated with information directly from the BIM model, therefore allowing for the BIM model – and associated information – to be exploited within asset management systems.

The Line of Sight Methodology provides a structured approach to the development of information requirements to enable the development of an AIM, and supports a direct line of sight (golden thread) from organisational objectives to asset performance. This enables better-informed decision-making processes for operational, financial, social and environmental outcomes while providing the foundation for the realisation of digital twins to support whole-life asset management.

⁴ISO 19650-3 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling

Case Study: Network Rail, Transpennine Route Upgrade

The Line of Sight Methodology has been tested through a variety of industry initiatives facilitated by the Centre for Smart Infrastructure and Construction (CSIC) at the University of Cambridge. Here we take a look at one of those, the Transpennine Route Upgrade (TRU), a railway connectivity project between York and Manchester for Network Rail.

One of the Asset Management Team from CSIC Industry Partner, Jacobs, who is working with Network Rail on the TRU, tested the methodology on the project.

The process

To identify Network Rail's organisational objectives quickly, a huge volume of strategic documents were data-mined using a newly developed algorithm-based tool.

More than 60 organisational objectives emerged but for the purpose of testing the methodology in a narrow timeframe, only one was chosen: improve customer satisfaction.

By applying the top-down methodology, a two-way line of sight from organisational objectives to asset requirements could be established, with functional requirements connecting them. Once the organisational objective was identified, examples of Functional Information Requirements (FIR) and Asset Information Requirements (AIR) aligned to it could be established, providing a systems perspective to replace the data silos that hamper so many organisations.

Value to Network Rail

Senior Network Rail staff were invited to workshops to understand and test the methodology and consider its worth in relation to the TRU Programme and Network Rail. To maximise user accessibility, CSIC and Jacobs developed a web app to streamline the process and this was used at the workshop to note information requirements. The app was developed with the intention of being used for the whole of the TRU project and is expected to find future purpose beyond that.

The benefits of applying an information management framework to support organisational objectives were evident to Network Rail. The methodology demonstrated that specific asset information will lead to data being gathered that is relevant to optimising value.

The methodology also means that data can be classified and curated throughout the whole life of the asset, and is accessible to all asset managers and operators for a more holistic approach. This data and information 'golden thread' informs better decision-making and whole-life risk management of assets.

The Line of Sight Methodology ensures data collected and collated has a clear purpose making it possible to optimise value while also facilitating the longer-term possibility of a digital twin of the TRU.

Case study contributor

Aaron Johnson – Senior Strategic Consultant & Data Scientist, Jacobs

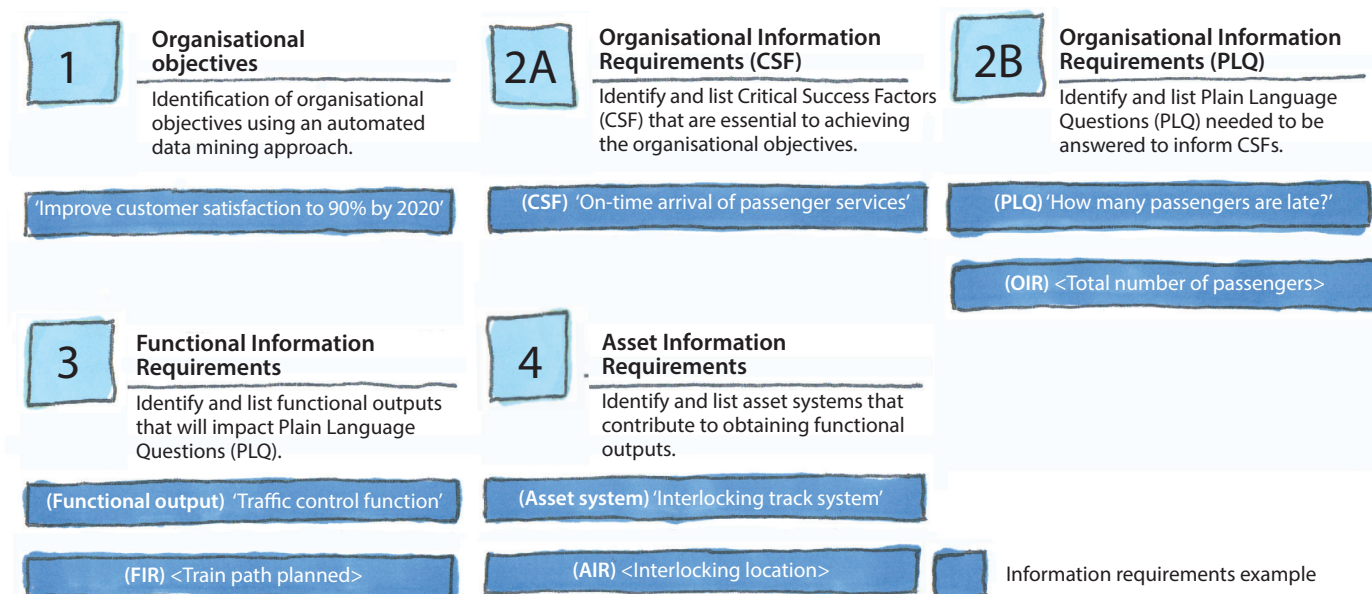


Figure 6: Summary of Network Rail case study results (Modified from www.icevirtuallibrary.com/doi/full/10.1680/jsmic.20.00017)

Summary and next steps

The Line of Sight Methodology has been developed to address the current challenge that exists in developing Asset Information Requirements that support, and are informed by, organisational objectives. It achieves this through development of a framework and set of tools to extract Organisational Information Requirements and link these to Functional Information Requirements, which are then used to inform the Asset Information Requirements. This development of FIR bridges the gap in existing methodologies, and ensures that data gathered by organisations truly supports achievement of the organisational objectives.

The methodology has been successfully trialled with sets of Organisational, Functional and Asset Information Requirements (OIR, FIR and AIR) being developed within Network Rail as described in the case study. Furthermore, development of Asset Information Model (AIM) databases enabled the use of the captured information within multiple asset management processes, including resource management, financial reporting and operational optimisation.

Feedback on the methodology noted that its structured approach enabled efficient development of information requirements aligned to identified asset management objectives. However, it was also noted that the methodology's level of maturity at the time of testing made it resource intensive, possibly limiting its wider industry adoption.

To address this challenge, a project based at the Centre for Smart Infrastructure and Construction (CSIC) at the University of Cambridge, and funded by CSIC, Costain, and the Construction Innovation Hub, is continuing the development of the Line of Sight Methodology. This next iteration will provide tools and guidance to support the wider adoption of the methodology within industry. The main outcomes of the project include:

- Detailed guidance on how to use the methodology
- Development of a web application for using the methodology
- A set of new tools to enable the development of information requirements while reducing resource requirements
- A common set of information requirements
- A common set of Critical Success Factors (CSF) and Plain Language Questions (PLQ)
- An open-source BIM extraction application, with source code provided in the GitHub code hosting platform.

The importance of achieving a clear line of sight between organisational objectives and asset requirements cannot be understated. Especially so given the extent of our existing asset infrastructure; in the UK we add just 0.5 per cent to its capital value every year⁵. Hence our asset infrastructure will be with us for some time to come and a direct line of sight, a 'golden thread' between information on those assets and organisational objectives is absolutely crucial – doubly so as organisational objectives change with the impact of climate change, global pandemics, environmental targets and more.

How to engage with us

The Line of Sight Methodology provides an information management approach that enables data to be effectively aligned to decision-making in support of organisational objectives. It also provides an important underpinning for the realisation of digital twins. However, this would be ineffective without the engagement of industry professionals and associates. This is where you come in.

There are two ways we would invite you to be involved with the methodology:

1. Engage with the on-going work to develop an industry-friendly, less resource-intensive set of tools and guidance on adoption of the Line of Sight Methodology. We are planning several industry trials in summer 2021 to provide feedback to the research team and will also provide expert input to participating organisations on the application of this methodology.
2. Engage with existing industry standards and start using the Line of Sight Methodology to frame information requirement discussions in your organisation and inform the development of AIMS.

For more information in either instance please email James Heaton: jrh212@cam.ac.uk or csic-admin@eng.cam.ac.uk

⁵Smart Infrastructure: Getting more from strategic assets, CSIC and industry partners, June 2017

List of relevant standards

BS EN ISO 19650-1:2019 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling.

BS EN ISO 19650-2:2019 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling.

BS EN ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling.

BS EN ISO 19650-5:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling. Security-minded approach to information management.

BS EN ISO 9001:2015 Quality management systems. Requirements.

BS 8536-1:2015 Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure).

BS 8536-2:2016 Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure).

BS EN ISO 41001:2018 Facility management. Management systems. Requirements with guidance for use.

BS EN ISO 41011:2018 Facility management. Vocabulary.

BS EN ISO 55000:2014 Asset Management Systems.

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