Developing a Handover Information Exchange Specification between Construction and Asset Management for Road Networks

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Abstract

This desktop review of road asset management information requirements at the handover phase of construction studies the different needs of vertical and horizontal infrastructure. The paper considers three specifications for construction information at handover to asset management. COBie (Construction to Operations for Building information exchange), and the proposed CONie (Construction to Operations for Network information exchange). COBie has been successfully used for vertical construction since 2007, but the specification was not intended for use in road construction. However, the UK drive to introduce digital information exchange for all new government projects resulted in in an attempt to development a hybrid COBie-for-All specification to include both vertical and horizontal infrastructure. However, differences in definitions and utilization of data linked to specific attributes, such as location, cannot be force fitted into a dual-use information exchange specification. Thus, the development of a single-use specification intended for horizontal network assets is deemed the only logical option. That is the purpose of the CONie research project into the development of a handover specification to meet the needs of asset management of a number of road authorities from Australia and New Zealand.

Keywords: Handover, COBie, CONie, road networks, road assets

1. Introduction

As part of the drive for governmental efficiency, in some countries, the use of building information modelling (BIM) has been mandated for public works, for example, Britain, Singapore, Japan, and Malaysia (UK NBR, 2019; Kaneta et al., 2016; Latiffi et al., 2013). This is because the concept of Integrated Project Management (IPM) suggests a value-add is gained by sharing and exchanging information utilising a Building Information Modelling (BIM) environment (Kent & Becerik, 2010).

It has also been suggested that IPM (Rowlinson, 2017) is the obvious solution for one of the handover bottlenecks in the construction process. However, advent of digital technology has not diminished the massive amounts of project information. This is especially true for the data that is useful input into facilities management systems. COBie (*Constructions to Operations Building information exchange*) was developed to rectify the problem by simplifying the process (East, 2007). COBie, as the name suggests, was specifically designed to focus on the asset management for buildings.

The COBie specification was developed in the USA as a part of their contribution in the global standardization effort for Integrated Project Delivery for vertical infrastructure (Rowlinson, 2017; Cerovsek, 2011). During the development of COBie, facilities managers (the expected end-users),

explained to the specification developers the types of information they need to manage their assets (East, 2007). This bottom-up approach to research (Tan et al., 2018) meant that parameters for the facilities management specification led to functionality in BIM enabling systems for vertical infrastructure (UK NBR, 2019).
However, what was missing from that research into the needs of asset end-users, was input from network asset managers. Obviously, a handover specification developed for horizontal infrastructure assets, such as roads or utilities, could provide the same value-add as COBie does for vertical infrastructure.

It makes sense to learn from the COBie specification development project. For example, in the design of a *construction to operations for network information exchange* (CONie) it is important to ask end-users what handover information will enable effective network asset management. In addition, modelling a new information exchange on contract conditions as set out in COBie, can establish constraints. These fundamentals are, therefore, built into the design a network handover specification that is being developed in an Australian government funded research project with road authorities in Australia and New Zealand (Kenley & Harfield 2018; Kenley & Harfield 2016).
This paper outlines the fundamental differences between construction information required at handover for COBie and for the proposed CONie. The structure of this paper begins with details of the research design in section two. Section three explains some COBie specification attributes for buildings. Section four focuses on the lack of development of a proposed COBie-for-All that was expected to also be useful for road network assets. Section five discusses the need for an information exchange for horizontal infrastructure. CONie, a proposed information exchange for road networks, is outline in Section six, followed by the Conclusion.

2. Research Design

The purpose of this historical desktop research is to explore both the development of COBie (vertical infrastructure) and the rationale for the proposed CONie (horizontal infrastructure). The development of the BIM concepts, standards and specifications is the topic of a large range of documents from a variety of points of view. For this project, a limited number of seminal references plus those that feature COBie were considered relevant.

Thus, a three stage analytical document content review method was used (Fielding, 2008).

2.1 Stage one

Online (open access) and university library (limited access) resources were employed as possible datasets. Documents found included: academic journal articles, academic conference papers, government reports, international standards, and industry research publications. Presentations or talks were excluded because of the access limitations.

The first search terms were: COBie and BIM. The search was initially incorporated to publications between 1990 and 2007. IPD was suggested in 1990 and 2007 was the year COBie specification was accepted (East, 2019).

2.2 Stage two

The search was extended to include 2008-2019 in order to find additional documents about COBie. Although developers of BIM environments claim COBie is integrated into 170 software programs, little academic literature was found (Zhao, 2017; Kaneta et al., 2016; Becerik-Gerber et al., 2011). However, industry research reports and guidelines for BIM implementation for these later dates, often includes COBie usage and/or recommended modifications (ABAB, 2018; Hampson et al., 2018).The stage two search also included new search terms COBie-for-All and CONie (*Construction to Operations for Networks information exchange*). However, only a small subset of items were found (Kenley & Harfield, 2016; Scarponcini et al., 2013).

2.3 Stage three

Stage three was a systematic review of a documents containing text related to COBie, COBie-for-All, and CONie. The review was only to verify that the documents actually discussed, in some detail, these three types of digital information exchange.

Themes were then created from substantive texts. Three common themes found are: the development of COBie as part of the Industry Foundation Classes, the continuing problems of information exchange interoperability for BIM environments, and the differences between vertical and horizontal infrastructure asset data needs.

3. COBie: Asset Handover Specification for Vertical Infrastructure

3.1 Analytical document content review

The historical desktop review was not able to find a significant number of research reports on the use of COBie. The academic and industry journals seem to be limited to a small number of articles by the specification developers. Internet webpages also provide commentary and access to the open source standards and specifications. Government reports and working papers related to BIM are mostly aspirational rather than substantive. The monitoring reports for BIM implementation in the UK (UK NBR, 2017) provides an example:

> *"The vision of the UK being the world leader in BIM has yet to be realised, according to the design community. Only 19% agree that we are the world leader. Perhaps the Government set the bar a little high?"*

More importantly, for this study, the annual survey does ask questions about the use of COBie. Although the reports does not provide extensive data about respondents, in the 2018 report, 41% of the 808 respondents used COBie to provide an 'output' for asset management. (UK NBR, 2018).

At the same time, although the COBie specification was completed in 2007, research using the specification was only found in two industry reports. Examples of substantive text from these research reports were not based on simulations. Akhurst (2017) used Australian data from the Queensland Department of Works public housing database:

> *"An important principle in the use of COBie is to maintain the structure of the COBie asset data tables so that the methodology can be applied repeatedly across many and varied projects and assets. The case study found that the housing asset information did not readily align with the generic COBie workbook tables. The housing asset information has evolved over many years and is structured in a manner that on occasions combines type, component, space, facility and other information in a manner that must be deconstructed to achieve alignment with the COBie tables."*

In a second report Hampson et al. (2018) reported on a multi-residential housing project in Toowoomba, Australia. They conclude:

> *"The feasibility of bringing the model directly into an asset management system was tested using the COBie export utility for the Autodesk Revit software. The original naming conventions and attribute policies within the BIM model did not conform to the COBie standard. However, minor editing of the relevant families (object definitions) within Revit led to successful export of valid COBie files. These could then be imported directly into a COBie-conformant asset management system."*

3.2 Development of a speciation

buildingSMART international (Jackson, 2018) has developed definitions for Building Information Modelling based on object libraries and International Foundation Classes standards (Eastman et al., 2008). The international standard, ISO16739, specifies a conceptual data schema and an exchange file format for BIM data (ISO16739, 2013). IFC2 was initially developed for vertical infrastructure in which COBie is a subset. COBie specification defines a precise set of information needed to solve a specific problem at a specific point in the construction life cycle: handover (East et al., 2015).

Traditionally, the facility management information has been created after construction is completed. All project paper materials (drawings, manuals, schedules, etc.) were delivered to the facility owner/operator (East et al., 2015). However, ominously large amounts of these types of information were not necessary for building asset management operations.

The problem is the same with the increasing use of digital modelling, devising a method for managing the large amounts of digital materials at the handover phase (East, 2019). Thus, the solution of a COBie information exchange format. COBie extracts the required asset information from an IFC schema by transporting it into a standard COBie schema, making it ready to import into a digital facility management system.

4. COBie-for-All: Handover for Buildings and Roads

4.1 Analytical document content review

COBie for All: Required Information for Facility Ownership Buildings & Civil/Infrastructure, Understanding How COBie Works in the UK Infrastructure Market (Scarponcini et al., 2013). This report outlines problems that arise when the requirements of a handover specification designed for vertical infrastructure and conflated with the needs of horizontal infrastructure asset management

4.2 Development of a speciation

In May 2011, the UK government published the *Government Construction Strategy* paper (UK Cabinet Office, 2011), announcing the intention of requiring Level 2 Building Information Modelling by 2016 for all government infrastructure projects. This meant use of digital collaborative 3D BIM for all project and asset information and documentation.

Both the UK drive to introduce digital information exchange for all new government projects and the lack of interoperability between object-based design (vertical infrastructure) and string-based design (horizontal infrastructure) was the business case for the development of a new COBie-for-All specification. Based on the initial studies conducted between 2011 and 2013, a draft report was released for public comment on 15 October 2013 (Scarponcini et al., 2013).

The title of the document provides a simple explanation of the contents:

> *"COBie for All: Required Information for Facility Ownership Buildings & Civil/Infrastructure, Understanding How COBie Works in the UK Infrastructure Market."*

Clearly this 60-page manual of 'problems' and 'solutions' aims to stretch the initial COBie specification for buildings to include network assets such as roads.

However, the UK BIM Task Force that developed strategies to continue British development of the COBie-for-All information exchange has since been disbanded. All online searches for BIM Task Force documents is now referred to the UK government funded Centre for Digital Built Britain at the University of Cambridge (CDBB, 2018).

In the first CDBB major review of information exchange structures COBie and IFC are considered, but not COBie-for-All. Currently, the COBie-for All (Scarponcini et al., 2013) is not available from an online open access repository.

However, personal communication in 2018 with British contractors tendering for government road infrastructure, indicates they have not been required to use COBie-for-All. Therefore, it must be assumed that the development of a vertical/horizontal infrastructure information exchange specification is no longer being developed. Clearly, one shop does not suit every type of construction project (Pärn et al., 2017).

Yet, the global drive to increase the implementation of BIM platforms continues. Thus, the continuing need for a horizontal infrastructure specific digital information exchange specification (Kenley & Harfield, 2016).

5. Why We Need a Network Information Exchange

5.1 Analytical document content review

Little was found about CONie (*Construction to Operations for Network information exchange*). Currently it remains a 'concept' because this proposed information exchange open specification is still in the early stages of development.

5.2 Development of a speciation

Handover is the set of all documents that must be provided by the contractor (East, 2019). However, horizontal infrastructure projects have the same problem as vertical infrastructure projects. Even with IPD, by the end of construction many types of documents will have accumulated, and not all of them will have information useful to road asset managers. COBie is the handover solution for vertical infrastructure.

But, currently there is no handover information exchange specification that can be used effectively by road asset management systems. For example, The software AutoCAD Civil 3D from the company Autodesk ('http://www.autodesk.com') is a tool to design road networks with the support of BIM. The IFC 4 and IFC 4x1 support has been implemented in Civil 3D with the update 2018.1. The update adds the functionality to import/export alignments and profiles (Autodesk, 2017). However, the IFC Alignment solution only supports the design phase not the handover phase. Therefore, it is important to develop a *Construction to Operations for Networks information exchange* (CONie) handover specification to assist asset managers for the horizontal infrastructure. The desired outcome is to transform the data sets more easily from one program into another without information loss so that the existing databases can be both supplemented or adapted.

Road asset management includes several different types of systems. For example, Their road project data are usually produced with software such as 12d, AutoCAD or Bentley, and lacks an export functionality to asset management systems. To ensure best practice and code compliance, road authorities have access to extensive technical libraries of standards and references for regional or national standards. This means that road asset systems utilise several different types of management resources.

To capture this complexity the development of an information exchange specification, needs to consider five types of information:

- Systems: An interconnected network of road resources of specific types, typically defined by number of lanes and median type, and managing jurisdiction.
- Projects: A set of work with a defined start and end. Projects require engineering plans and specifications that are executed by either road authorities or contractors.
- Jobs: A recurring set of projects needed to keep the network operating at appropriate levels of performance. Jobs typically do not require engineering plans and specifications that are based on standards-of-practice.
- Resources: A set of tools, materials, labor, and training needed to perform jobs that can be internal or external to a road authority thus, requiring knowledge of how to transfer the information that might be useful for asset management functionality.

- Standards: A set of templates for roadway profiles (and associated assets) and jobs, as well as engineering details necessary to insure consistency of projects within the network. Specific departments within a road authority usually can develop standards for processes, products and information. In addition, national or international standards can in applied as they are developed or revised.

Thus, the data format must have generally applicable business rules, and sample data in a format that respects those rules. To be successful in developing CONie it is necessary to apply the lessons learned from the development of COBie (East et al., 2015).

6. Conclusions

The use of building information modelling (BIM) has been mandated for public works as part of the drive for governmental efficiency. The concept of Integrated Project Management suggests sharing and exchanging information utilizing a BIM environment adds value. Thus, BIM is expected to eliminate the information exchange bottleneck, construction handover to asset management.

Therefore, this desktop review has provided a comparison of three related information exchange specifications for construction information at handover to asset management. COBie (*Construction to Operations for Building information exchange*), COBie-for-All and the proposed CONie (*Construction to Operations for Network information exchange*).

Although COBie has been available since 2007 to be used as part of the IFC structure for integrated project delivery, little published research is available. Of the many governments mandating the use of BIM, only the UK has attempted to modify the original use of COBie to include both vertical and horizontal infrastructure. However, development of this hybrid, COBie-for-All specification, has been abandoned.

The only proactive account of designing a specific handover specification for horizontal rather than vertical infrastructure is from road authorities in Australia and New Zealand. They are currently working on a CONie that takes into account the network requirements for asset management. Their solution is expected to be the development of a handover specification intended for use in road asset management systems.

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