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CONie is not COBie: information exchange differences between network and building handover to asset management

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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 utilisation 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.

1. Introduction

As part of the drive for governmental efficiency, the use of building information modelling (BIM) has been mandated for public works, for example, Singapore, Japan, UK and Malaysia [1, 2, 3]. This is because the concept of Integrated Project Management suggests value-added is gained by sharing and exchanging information utilising a BIM environment [4].

Integrated Project Management could be applied to the obvious bottleneck in the construction process, handover. Currently building owners globally continue to allocate resources to both finding and converting construction information at handover [5]. Their major problem is the need to reduce the project information for useful input into their facilities management systems. COBie (Constructions to Operations Building information exchange) was developed to simplify this process [6]. COBie, as the name suggests, was specifically designed to focus on the asset management for buildings.

COBie has been successfully used in vertical construction since 2007. The specification was developed in the USA as a part of their contribution of the expansion of the global effort to find an international standard for Integrated Project Delivery (IPD) [7].

One of the reasons that COBie has been successful is because during development, facilities managers (the expected end-users) were asked what information they needed [6]. The end-user information supplied the constraints for the specification, which in turn led to functionality in BIM enabling systems [2].

Obviously, a handover specification that was developed specifically for road asset management could provide horizontal infrastructure the same value-add as COBie does for vertical infrastructure. Thus, the industry need to conceptualise a handover specification is the aim of a government funded research project with road authorities in Australia and New Zealand [8, 9].

This paper outlines the fundamental differences between construction information required at handover for COBie and a proposed CONie. The structure of this paper begins with details of the research method 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. 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 the development of COBie and the rationale for the proposed CONie. Thus, a three stage method was used [10].

2.1. Stage one

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

The first search terms were: COBie and BIM. The search was initially based on two timeframes 1990-1998 and 1999-2007 because of the large number of digitalised documents that became available early in this century.

The development of the BIM technology 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 and those that feature COBie were considered relevant. Although COBie claims to be integrated into 170 software programs, little academic literature was found [11, 12]. However, industry research reports and guidelines on BIM implementation often includes COBie usage and/or recommended modifications [1, 2, 13].

2.2. Stage two

The search was extended to include 2008-2018 in order to find additional documents for COBie. This also included a new search terms COBie for All and CONie. However, only a small subset of items were found.

2.3. Stage three

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

For example, topics such as: COBie as part of the Industry Foundation Classes (IFC), the importance of appropriate definitions of location in the different types of models, and difference in the needs of asset management for vertical and horizontal infrastructure.

Little was found about CONie. This is explained because this information exchange open specifications is still in the early stages of development, and should be considered a ‘concept’ rather than a specification.

3. COBie: handover for vertical infrastructure

SMART international has developed definitions for BIM based on object libraries and IFC standards [14]. The international standard, ISO16739, specifies a conceptual data schema and an exchange file

format for BIM data [15]. Increasingly, BIM environments are being used to design 3D models for construction projects. IFC was initially developed specifically for the vertical infrastructure.

Traditionally, the facility management information was created after construction. On completion of the project all project materials (drawings, manuals, schedules, etc.) were delivered to the facility owner/operator [5]. However, with the increase in the use of digital modelling, devising a new method was obviously necessary and resulted in the development of COBie [16].

COBie *(*Constructions to Operations Building information exchange*)* is a subset of IFC2. COBie defines a precise set of information needed to solve a specific problem at a specific point in the construction life cycle: handover [17].The required information for building facilities management is small subset of all construction information. It is needed to support the operational requirements and locate assets in a building. COBie information exchange format has been achieved by extracting the required information from the BIM file or an IFC schema and transporting it into a standard COBie schema, ready to import into a facility management system.

4. COBie-for-All: handover for buildings and roads

In May 2011, the UK government published the *Government Construction Strategy* paper, announcing the intention of requiring Level 2 BIM by 2016 (collaborative 3D BIM with all project and asset information, documentation, and data being electronic) for all government infrastructure projects.

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 recommending essentials be included in COBie for use in Civil and Infrastructure projects. 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. Currently, this document does not appear to be available from an open access repository online.

Clearly the 60-page manual of ‘problems’ and ‘solutions’ aims to stretch the initial COBie specification for buildings to include roads. Three of the 12 problems are directly related to issues of location for road asset management.

The BIM Task Force that developed strategies to continue British development of the COBie-for-All information exchange has since been disbanded [13]. In addition, personal communication in 2018 with British contractors tendering for government infrastructure, indicate they have not been required to use COBie-for-All. Therefore, it is assumed that the development of a vertical/horizontal infrastructure information exchange specification is no longer being developed.

However, the global drive to increase the implementation of BIM platforms continues, thus, the need for a horizontal infrastructure specific digital information exchange specification.

5. Why we need a network not a building information exchange

A digital information exchange specification for roads requires a horizontal infrastructure perspective. One example of this type of perspective is the different ways that location is defined in models of building or roads. Therefore, in the development of an information exchange specification for horizontal infrastructure, the specification elements for location must be based on appropriate definitions of location [9].

5.1. Location information in buildings

The IFC schema defines a set of consistent data representations of building information exchange between the various software applications. The IFC vertical infrastructure model includes location information as an essential part of the definition. An object-view of assets requires precise geometrical

information about the spaces and equipment required in the detailed design stage that are essential for construction.

Continuous Objects: Building (Floors and Spaces) components tend to be discrete entities. In COBie there is an assumption that all components are discreet elements because discrete elements can be identified by their physical location limits.

Geospatial Location: Containment is achieved by the assignment of a component to a space where spaces or rooms are contained on the floors without defining their precise geometry [13]. Therefore, building location is only an area, not a line or a point.

5.2. Location for networks

Networks of pipes, culverts or roads have a linear aspect that requires location to be very specific over a long distance. Therefore, mechanisms for network location integration into BIM models remains problematic.

Continuous Objects: In continuous linear entities, such as roads, the variation of horizontal infrastructure elements of the continuous assets needs to be segmented with defined limits [18].

Geospatial Location: Obviously, road projects have larger spatial extents than any individual building. Therefore, Geographical Information Systems (GIS) play a more significant role in defining asset management needs. However, it is important not to confuse the concept of 'spaces' with the concept of 'location'. It is therefore, important to understand the network information context with the multiple location definitions of points, lines or areas and how they can be combined into identified segments [8].

6. Proposed CONie: handover for horizontal infrastructure

Currently there is no handover information exchange specification that can be used in road asset management systems. However, it is obvious that the same problem for vertical infrastructure of too much information, in too many formats, is the same for horizontal infrastructure. Thus, the development of an information exchange specification that can limit the amount of information required, must begin with identifying what varieties of information road asset managers currently access.

6.1. Requirements for a network information exchange model

Road asset management includes several different types of systems. These systems are used for different types of ongoing projects that impact on specific parts of the road network. 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.

This complexity must be captured in the development of an information exchange specification. Therefore, a model of construction to network information exchange 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 and 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 because they are based on standards-of-practice.
- Resources: A set of tools, materials, labour, 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.

6.2. What do asset managers need at handover?

Handover is considered to be the set of all documents that must be provided by the contractor [16]. However, 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.

For example, pavement information will be accurate to the sub-metre. Other structures such as bridges and tunnels will be accurate to the millimetre. This is usually much more data than is necessary for asset management functions.

Therefore, the information that is exchanged should be based on current and foreseeable future data requirements for performance-based asset management and operations of the road network [17]. This will ensure that handover is implemented in a reasonable amount of time, and with the least amount of disruption to network Maintenance and Asset Management information and systems.

7. Conclusion and future research

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 value-added is gained by sharing and exchanging information utilising a BIM environment. This would be a means to eliminate the information exchange bottleneck in the construction process, 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*).

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, appears to have been abandoned.

Proactive road authorities in Australia and New Zealand are currently working on a solution through the development of a specification intended for use in road asset management systems.

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