Collective Dynamics

The Birth of a New BIM Standard: From PED 2018 to 2023, New Parameters and Workflows "Going Live" for Everyone

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Abstract Building Information Modelling (BIM) has become the de facto standard for the digital representation of buildings. However, from the pedestrian dynamics perspective, BIM Industry Foundation Classes (IFC) schema specification do not fully support data properties required for two-way data sharing with pedestrian modelling tools. An international team of academic and industry researchers, supported by buildingSMART International (bSI), is developing an Occupant Movement Analysis (OMA) standard. The project is focused on expanding the IFC schema specification to support workflows for pedestrian simulation tools and is close to completion. So far, multiple process maps and a list of data properties synchronised with several representative pedestrian modelling tools have been produced. This list of data properties was then converted into bSI's recommended flexible and machine interpretable Information Delivery Specification (IDS) format for specifying data exchange requirements and to add clarity. Currently, this is undergoing testing and review by the project team. Once completed, it will be submitted to bSI's committees for review. Also, to support this work, a prototype open-source Add-in has been developed to demonstrate a two-way integrated data sharing between BIM authoring tools and pedestrian simulation tools. This standard will enhance data sharing

between BIM authoring and pedestrian modelling tools by facilitating the capturing of the required data and addressing friction in multiple design iterations and reassessment.

Keywords Building Information Modelling · Pedestrian dynamics · Industry Foundation Classes · Pedestrian Modelling tools · Information Delivery Specification

1 Introduction

Building Information Modelling (BIM) has become the de facto standard for the parametrically rich digital representation of a building. It was introduced to overcome the problems of the traditional Computer Aided Design (CAD) based approach, such as loss of information due to inefficient and error-prone data sharing. The Grenfell Tower Fire [1] and New Berlin Airport [2] are some of the examples that have highlighted the importance of information management and its implications on human life and cost. Hackitt Report [3] identified the need for a 'golden thread of information' and recommended the use of BIM. Progress has been made to try and address some of the issues in the Hackitt report. For instance, Fire Safety (England) Regulations 2022 [4] and work on BS 8644-1:2022 [5]. However, as far as the use of BIM for pedestrian dynamics is concerned, currently, there are several limitations (e.g. no specific data exchange for the consumption of pedestrian modelling tools, and only a small number of pedestrian modelling tools have support for BIM that is mostly limited to geometry extraction) that have to be resolved to fully realise the true potential of BIM [6].

To overcome the current BIM issues from the pedestrian dynamics perspective, this paper highlights the work of an international team of practitioners from academia and industry that has been working under the administration of buildingSMART International (bSI) on the Occupant Movement Analysis (OMA) project [7]. The key purpose of this project is to enhance support for OMA in the Industry Foundation Classes (IFC) schema specification which is an International Organization for Standardization (ISO) standard schema for BIM based data and is maintained by bSI [8]. In addition to schema specification, IFC is also a standard file format for sharing BIM data. The project team initially set out to develop a Model View Definition (MVD) i.e. a subset of the overall IFC schema [9] for OMA specific data exchange but later switched to Information Delivery Specification (IDS) which has now become bSI's recommended approach due to its flexibility and machine interpretable aspects [10].

The above mentioned work is near completion and the team has already produced multiple process maps and a list of data properties, informed by several representative pedestrian modelling tools. The data properties were then converted into an IDS file. Currently, this is undergoing testing and review by the project team. Once completed, it will be submitted to bSI's committees for review. Furthermore, a prototype open-source Revit Add-in has been developed to demonstrate a two-way integrated data sharing between BIM authoring tools and pedestrian simulation tools [11]. This standard will enhance data sharing between BIM authoring and pedestrian modelling tools by facilitating the capturing of the required data and addressing friction in multiple design iterations and reassessment.

2 BIM for OMA - current situation and challenges

A key concept of BIM was to address the limitations of the traditional Computer Aided Design (CAD) based approach. For instance, the loss of information due to inefficient and error-prone data sharing [6]. However, for OMA, the current BIM-based approach which is summarised in Fig. 1, also has limitations.

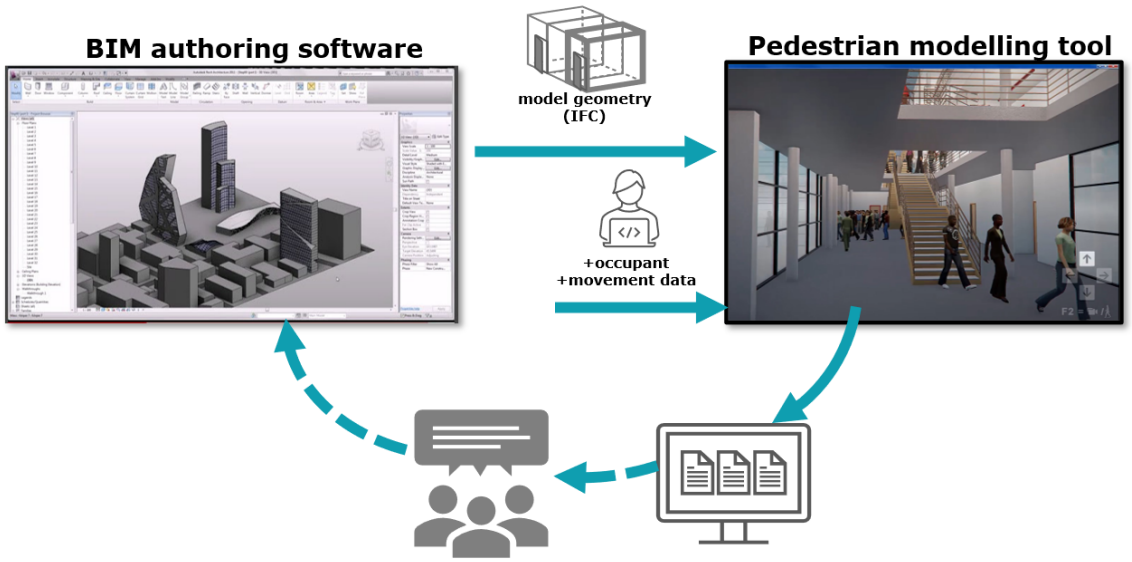

Figure 1 Current BIM data loop, with manual data and review

Currently, there is no specific data exchange for pedestrian modelling tools and no explicit support in the IFC schema specification to capture modelling based results. This means each time a design is updated by the architect or design team, the geometry and basic parameters will be updated and potentially exported, to the pedestrian simulation tool. Any additional explicit parameters required for modelling will need to be redefined each time, such as intended door and staircase flow rates, planned travel directions, gate dynamics, detailed signage and assembly or queuing zones.

This lack of a specific data exchange for pedestrian modelling tools means that only a limited number of pedestrian modelling tools have support for BIM [6]. Also, this support is limited to extracting just basic geometry information from the IFC file. Therefore, to fully realise the potential benefits offered by BIM, these issues must be resolved.

3 The OMA project

3.1 Project background

To address the issues identified in Section 2, enhancing support for OMA in the IFC schema specification was identified as essential [6]. To achieve this, an international team of practitioners from academia and industry formed an initial working group which then approached bSI. A bSI administered project was then initiated back in 2021.

3.2 Project methodology

The project team initially set out to develop an MVD to specify data exchange requirements for OMA but later switched to IDS considering it became bSI's recommended approach due to its flexibility and machine interpretable aspects. The OMA project was divided into two phases. The first phase was focused on producing process maps, while the second phase was focused on producing a list of data properties suitable for the consumption of pedestrian modelling tools and then converting that into the required IDS format. This methodology has been used by similar types of bSI administered projects and therefore it was a logical option for the OMA project as well.

3.3 Project deliverables and the current status

The project team has produced three process maps (Evacuation Analysis – RIBA stages, Evacuation Analysis – International, and Circulation Analysis – International) [7]. In addition to these process maps, the team has created an Excel spreadsheet that lists the required data properties, including both existing properties in the IFC schema and proposed new ones. From this spreadsheet, an initial version of the proposed IDS file has been generated. Currently, the team is testing and further evaluating this IDS file for consistency and suitability for OMA.

It should be noted that the list of data properties was produced after reviewing the properties supported in selected representative pedestrian modelling tools (buildingEXODUS [12], Pathfinder [13], Crowd:it [14], STEPS [15], LEGION [16], SimCrowds [17], Evacuationz [18] and ASERI [19]). This includes both input and output (summary of key simulation results) related properties. An example of some selected properties of a door in MS Excel and their representation in IDS (XML format) is shown in Fig. 2:

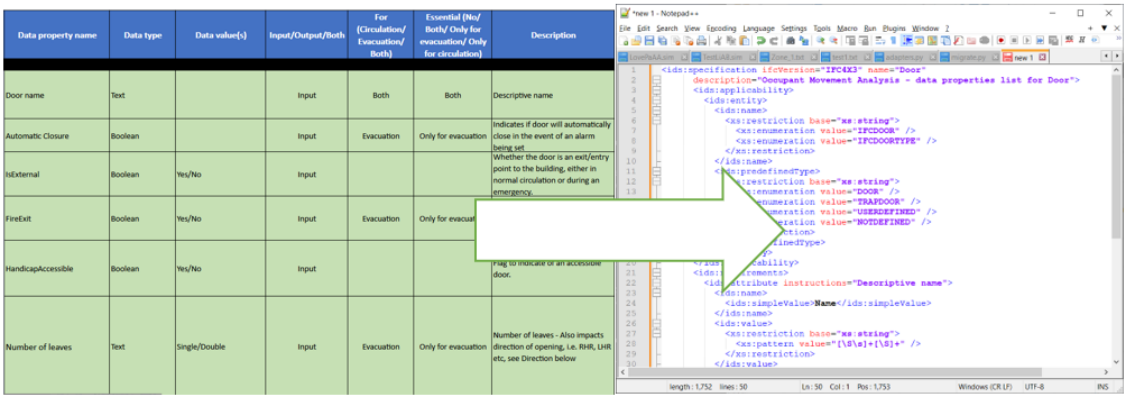

Figure 2 Some selected properties of 'Door' relevant for OMA in MS Excel converted to IDS XML format

The OMA project is now close to completion. After the project submission, it will be reviewed by multiple bSI committees, and will then go through further external review. This process will take time but once approved, the updated IFC schema specification with

enhanced support for OMA will be published by bSI. Implementation support for the updated version of the IFC schema specification will then be provided by vendors.

4 Prototype Revit Add-in

To demonstrate the potential benefits of integrated BIM based data sharing for OMA, a prototype Revit Add-in called Evac4BIM was developed at Lund University as part of an MSc project [11]. Evac4BIM was developed when the work on identifying data properties was still underway, therefore, only a relatively small number of potentially relevant additional data properties were created which will be updated after the completion of the OMA project.

The Evac4BIM Revit Add-in allows users to set flow rates, occupancies, and other parameters, and export enhanced IFC files with new parameters. It also supports a full data round-trip, importing simulation results back into the BIM model. Additionally, the Add-in can be used to remove unwanted detail, and display flow rate charts and other data directly in the Revit based BIM model.

Evac4BIM Add-in will be updated in future based on the final list of data properties for OMA. Also, it will be further developed to potentially include more detailed data specifications for even more parameters associated with different forms and phases of circulation and demographics.

5 Discussions and Conclusion

This paper has highlighted the work undertaken by international collaborators to support the development of a BIM-based standard for OMA. The work is close to completion and so far it has produced process maps, identified a suitable list of data properties, and created an IDS file for these properties. After testing and review of the IDS file by the project team, the work will be submitted to bSI for further review.

In addition to the work on developing a standard, an open-source Add-in prototype to demonstrate the benefits of this approach has been developed. This work will pave the way for two-way data sharing between BIM authoring tools and pedestrian modelling tools through an OMA-specific data exchange and enhanced support for OMA-required data properties in the IFC schema. The essential data will not only be captured but also shared more efficiently. Additionally, when BIM models are shared, the occupant movement data will be synchronised because it is now in a single “source of truth”. This allows reviewing bodies, such as building regulation bodies, to reproduce simulations without the need for additional sharing of bespoke data files.

This work will be augmented by another bSI project about the development of an IDS for Fire Safety Engineering, which is expected to commence in 2024. The project will focus on producing data exchange requirements for the consumption of fire modelling tools.

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