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BIM Research in Irish Academic Institutions 2015-19

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ABSTRACT: The use of BIM in the Irish construction industry has become pervasive in the last decade and it is an essential element in improving productivity in the market. The developments in BIM education and training in supporting the increase in Ireland’s BIM maturity has been well documented in recent years, principally through the proceedings of the BIM Gatherings and the BIM in Ireland 2017 and 2019 reviews. Similarly, the public and private sectors have been surveyed to establish their readiness for digital transformation on their BIM journey. However, BIM research undertaken by Irish academics, while individually strong, has not been strategic at national level nor has it yet met all the needs of industry. This paper will review the learned publications of all research-active academics on this island in the various aspects of the field of BIM-related research in the last 5 years. It will categorise and analyse their achievements, acting as a national reference source for all parties in this industry. It will also suggest areas where further research opportunities exist in support of the continuing fast-paced evolution of this digital technology in the construction industry, nationally and internationally.

KEYWORDS: BIM Gathering, BIM research, Academic institutions.

1 INTRODUCTION

The use of Building Information Modelling (BIM) as a collaborative tool between all the parties in the construction industry has arguably been the single most significant technological change in the last decade [1]. The extent of the diffusion of this technology into the industry has been clearly evaluated in a BIM in Ireland 2017 report [2] under the BIM Innovation Capability Programme (BICP) funded by Enterprise Ireland, supplemented by an update in 2019 [3]. In these publications, a review was presented which mostly focussed on the penetration of BIM into industry and education. However, there was not a strong focus on research, the backbone of any technological development, but research (and industry) has been very well served by a series of BIM Gathering conferences organised every two years since 2013 by the Construction IT Alliance (CitA) [4-7]. This has become a platform for industry, education and research communities to showcase their BIM activities through a published set of proceedings. The best papers from this conference series were published in the International Journal of 3-D Information Modelling. However, no concise and collected list of research publications in BIM-related research, as pertaining to the 3rd level institution activities, has been compiled until now and this paper sets out to rectify that absence.

2 METHODOLOGY

A method for research publication gathering has been successfully employed in another sector of the construction industry, namely that of concrete technology. Through investigation of all conference and journal papers published by academic authors from all third level institutes on the island of Ireland, a comprehensive list of over 650 concrete-related papers were categorised and analysed in 2015 [8], with a further 150 papers reviewed in 2018 [9] and these have become a national reference source for the concrete community since then. Indeed, advice has been offered [10] on how to conduct a BIM research survey.

For this paper, with the advantage of the knowledge of the active members of the Irish BIM Academic Special Interest Group, a contact point in each of the academic communities in the Universities and Institutes on this island, as listed in Table 1, was requested to furnish the authors with a list of their colleagues’ peer-reviewed publications in the five year period from 2015 to 2019 inclusive, excluding theses and business reports. Note only BIM papers from disciplines in construction, not computer science, were sought. From these, a database of publications has been created in a series of categories so that a narrative can be generated to reflect the wide extent of BIM-related research on this island.

Table 1. Key contact list in the third level institutions.

<table>
<thead>
<tr>
<th>Institution</th>
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<tr>
<td>Athlone IT</td>
<td>Pinola Deavey</td>
<td>Sligo IT</td>
<td>Daniel Clarke-Hagan</td>
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<td>Carlow IT</td>
<td>Eon Homan</td>
<td>Technological University of Dublin</td>
<td>Barry McAuley</td>
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<td>Cork IT</td>
<td>Ted McKenna</td>
<td>Trinity College Dublin</td>
<td>Roger P. West</td>
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<td>Dundalk IT</td>
<td>Eamon Cusinhan</td>
<td>University College Cork University</td>
<td>Denis Kelliher</td>
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<td>Galway-Mayo IT</td>
<td>Mark Kelly</td>
<td>University of Limerick</td>
<td>James O’Donnell</td>
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<td>Letterkenny IT</td>
<td>Anne Bonner</td>
<td>University of Ulster</td>
<td>Javier Buran</td>
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<td>Limerick IT</td>
<td>Paul Vesey</td>
<td>Waterford IT</td>
<td>David Comiskey</td>
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<td>Queens University Belfast</td>
<td>Tara Brook</td>
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<td>Gordon Chisholm</td>
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An analysis shows that there are 124 learned publications reviewed in this paper, of which just over 80% have been conference publications. Interestingly, 57% of those were published in the BIM Gathering conference series, indicating the important role of this initiative by CitA as an avenue for research expression in Ireland. Furthermore, about 25% of all journal papers were published in the International Journal of 3D Information Modelling, as a consequence of being selected as the best papers at the BIM Gathering series.

The papers were gathered and categorised and the outcome is a short statement on the key publications identified in this survey. The survey may not be exhaustive because the completeness of the reference lists depended on the responsiveness of the individual academics themselves, but all 16 academic institutions contacted (Table 1) made a return.

3 NATIONAL MATTERS
3.1 Public Sector and Government
It can reasonably be argued that the practical use of BIM has been industry-led [7], but it is vital that the government in Ireland adopts BIM for its public contracts as soon as practicable. To this end, some observations on the adoption strategy [11], framework [12] and policy objectives [13] needed to achieve this have been made. The collaborative nature [14] and procurement strategies [15] to be adopted in the public sector have also attracted attention.

3.2 Standards
Putting in place standards to regulate the industry is no less important for BIM than it is in other aspects of the construction industry and some useful work has been done in this regard [16, 17], considering international best practice. With the introduction of the new ISO 19650 standards, this aspect of BIM’s introduction will have to be complied with, so industry will have to adapt quickly using these standards directly, given the sparsity of academic research and guidelines in this area.

3.3 Readiness
A key question in imposing a national BIM mandate for public projects is how prepared and capable is the Irish construction industry for BIM level 2 implementation, recognising the high percentage of SMEs which exist in the industry. The BIM Innovation Capability Programme (BICP) established in 2017, the state of readiness of the Irish construction industry, where it was established that there were weaknesses, especially in policy, procedure and training [18]. By studying the international trends in BIM adoption [19, 20], lessons could be learnt from other jurisdictions while simultaneously establishing Ireland’s BIM maturity and diffusion [21, 22], thus formulating a roadmap for managing the complex change which adopting BIM will inevitably entail [23].

3.4 Roadmap
This research on maturity and readiness was fed into the National BIM Council (NBC) who developed a national roadmap for BIM adoption and digital transition [24]. Concerns have been raised about maintaining the momentum in executing the roadmap [25], especially the funding and development of a Centre of Excellence on which future BIM research will depend so much [26]. Without such an initiative by the government, future BIM research will be more likely to be ad hoc and uncoordinated, as at present.

4 INDUSTRY SECTORS
Academics generally do research in areas of their own expertise by seeking out funding for postgraduate students to assist with their work. Therefore, much of the BIM research has been in quite specific areas, not necessarily aligned to a national strategy but grounded in applied problems related to various technologies available or emerging within industry. This section of the paper largely reflects this diversity of approach.

4.1 Design
Defining what a design model is in the new BIM context is a good place to start [27], recognising the key role of BIM collaboration in relation to practice [28]. In particular, at early stages in design, the establishment of the design intent [29] and, later, the employer’s information requirements (EIR) are both evolving services designers provide in developing an IT model for the design, construction and operation/maintenance of buildings. The concept of intelligence-assisted building design and management [30, 31] is interlinked with developing a virtual BIM model of the project.

4.2 Quantity Surveying and 5-D BIM
As have other parties in construction, the quantity surveying profession has had to take the ubiquity of IT in construction on board extensively in their daily practices [32]. For example, the role of digitisation in the strategic planning process has been investigated [33], as has the client-driven life cycle costing of projects in the so-called 5-D BIM [34, 35]. In particular, the use of 5-D BIM as a collaborative tool with better interoperability leading to improved efficiencies for Quantity Surveyors has been noted [36, 37].

4.3 Facilities Management (FM)
Inevitably, life-cycle analysis is not only the bailiwick of the quantity surveyor – the “life-cycle engineer” is more under the auspices of a facilities manager [38, 39], where future operational efficiencies have taken on a new and deserved importance. The early involvement of the Facilities Manager in the design process is a notion that several researchers have investigated, identifying what value can be added and what key tasks can be usefully employed in design development [40 – 44]. Through the use of BIM specific FM software [45], big data can thus be used to develop more efficient, smarter buildings [46, 47].

4.4 Construction Management
Multiple authors have published on the implementation of a wide range of construction site related BIM research [48]. Papers in areas as diverse as fire safety compliance [49], record keeping [50], information transfer [51], knowledge management [52] and on-site performance [53] have been published. Infrastructure delivery has also received attention [54], including the application of BIM to road construction [55]. An approach to developing a managerial system to implement BIM has also been proposed [56].
5.3 Blockchain

One of the principal opportunities afforded by introducing BIM and Blockchain teams to trust each other in procurement processes is to use Blockchain for its transparent and immutable nature, which can help reduce corruption in the construction industry. This is particularly important in third-level institutes where contracts are often large and complex.

5.2 Energy

Energy provides the first real evidence of a BIM research cluster, with 17 papers published in this category. Building information models can be used to improve sustainability by delivering energy savings using LEAN construction, which is an emerging technique. LEAN construction covers an extensive range of topics and is a useful resource for those commencing their BIM adoption journey. Some authors have used case studies such as the National Children's Hospital or the Grangegorman development [114, 115] to model buildings such as the Heritage Centre or the observatory [95, 96].

5.5 Digital Twin

The emergence of a digital twin in architecture, engineering, and construction (AEC) has been driven by the need to preserve the national building heritage. The Netherlands' Digital Twin for the Operational Maintenance of Buildings (DTOM) project is a prime example of how digital twins can be used to optimize building performance virtually. The Digital Twin can be used to simulate various scenarios, predict problems, and optimize building performance. The DTOM project has shown that a Digital Twin can provide valuable insights into building performance and help reduce energy consumption and maintenance costs.

5.4 Historic BIM (HBM)

Historic BIM (HBM) is another growing area where BIM is used for historic buildings with a strong international dimension. HBM projects, such as the National Children's Hospital, Grangegorman development [114, 115], the National Children's Hospital, and the observatory [95, 96] can be used as a starting point for developing Digital Twins for historic buildings. There are several examples of BIM projects in Ireland that have been successful in preserving the architectural heritage, and many more can be expected in the future.
developed collaborative partnerships with industry [119-122]. Others still, more specifically, have established collaborative data sharing platforms and multidisciplinary frameworks [123-124]. Participants on these programmes will probably be better prepared for the multidisciplinary collaborative environments which BIM engenders in practice.

6.3 Education by Discipline

In Civil and Structural Engineering, it was interesting to know of the successful introduction of BIM into undergraduate curricula [125, 126]. Similarly, in Quantity Surveying and Facilities Management [127, 128], the benefits of incorporating BIM into modules of such courses, including students working with live estates management projects on campus [129], is a notion that could be expanded to other institutes, though the evidence is that they are well-provided for in this regard [3].

7 MISCELLANEOUS

The cultural shift required for industry to adopt BIM is not without its challenges. Several papers have highlighted relevant factors; client-consultant trust [130], management aspects [131] and lessons learnt from perceived changes in the UK [132].

There are persistent and new legal issues arising from introducing BIM, which has not received enough research attention [133].

IT-based BIM-supported knowledge management is also a matter deserving of more research [134, 135], as is e-procurement [136] and compliance checking [137], all rich avenues for further investigation.

8 CONCLUSIONS

A snapshot of the extent of BIM research on the island of Ireland has been provided in this paper. It is noteworthy that almost 60% and 25% of all conference and journal papers respectively have been sourced from initiatives undertaken by CitA. There are two key observations to be drawn from this; Namely that continued funding for CitA is vital for Irish research at a time when the financial impacts of Brexit and the Covid-19 virus are going to be harshly felt by the industry; Secondly, it is important that Irish academics are also encouraged to travel to international BIM events to share and gain knowledge – such a heavy reliance on domestic conferences is not necessarily healthy. A further observation can be made in the disparity of topics in BIM research and this largely emanates from not one institute or College having the critical mass to be a strong, internationally competing BIM research centre – indeed the strongest BIM research category in this review is related to teaching and learning which imposes limitations in respect of leading industry to the next stage of BIM’s evolution. The continued absence of a national Centre of Excellence does not help in this regard.

Nonetheless, for a country of our population, there exists an active BIM research community in which continued initiatives and efforts reflect very well on the island’s BIM academic capability, as evidenced by the volume of research undertaken during 2015-19, in an environment of parsimonious funding.

Finally, hopefully this paper will be a useful reference source for students, academics and industry alike over the next 5 years or so.

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