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Accelerating BIM Adoption in Ireland: A ten-year review of CitA BIM Gathering Proceedings

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Digital construction interfaces have been studied extensively over the last few decades, with an ever-growing catalogue of publications. The CitA BIM Gathering conferences have played a key role in bringing together the research and industry communities in a collaborative setting over the past decade in Ireland. In this paper the authors systematically review 10 years of papers published in the BIM Gathering proceedings since the inaugural conference in 2013. A total of 175 papers involving over 200 authors have been reviewed and classified under the 2018 World Economic Forum (WEF) recommendations in respect to accelerating BIM adoption. The primary contribution of the review is to present the broad landscape of digital construction research. There is clear evidence at a high-level that the BIM Gathering proceedings collectively address many of the WEF recommendations. Nonetheless, an uncoordinated approach remains in implementing and monitoring BIM adoption in Ireland. The most influential studies related to articulating BIM benefits, data sharing, openBIM standards, and BIM skills. Fewer studies were evident on early collaboration, procurement requirements, behavioural change and long-term commitment to support small to medium enterprises. While there are encouraging signs due to the Irish government introducing a requirement for BIM on public sector projects in the near future and funding vital centres of excellence, there remains still a fragmented and uncoordinated approach to BIM adoption in Ireland.

Keywords – Motivation, Collaboration, Enablement, BIM Gathering proceedings

I. INTRODUCTION

Since its formation over 20 years ago the Construction IT Alliance (CitA) has played an important role in Ireland in promoting the benefits of digitisation in the Irish construction industry. A cornerstone of this discourse is the CitA BIM Gathering biennial conference and published proceedings serving as an important repository of knowledge in respect to BIM adoption in Ireland [1-6].

At the inaugural BIM Gathering conference in 2013 the construction industry was characterised as the last bastion of the analogue world and delegates were reminded of the beneficial use of BIM by clients [7]. The conference called for the abandonment of paper-based analogue systems and the identified urgent need to improve the performance of the sector, through the effective and efficient creation, management, and exchange of building information [8].

Comprehensive detail was provided on BIM adoption and maturity in Ireland in 2017 and 2019 [9,10]. Since the 2019 report, anecdotal evidence would suggest that there is a relatively low level of BIM adoption in Ireland among SMEs.

A review of digital construction and BIM research in Ireland 2016-2020 was carried out in 2021 [11]. The 2021 conference coincided with the opening up of the construction industry post-pandemic and a renewed focus on the importance of digitalisation for the sector. The post pandemic era brought with it new and significant challenges, not least rising inflation, Brexit, the impact of the war in Ukraine, the housing crisis and the very significant climate change challenge.

The focus of this year's conference was inspired by the World Economic Forum (WEF) "An Action Plan to Accelerate Building Information Modeling (BIM) Adoption" published in 2018 [12]. In 2019 the authors of this report recommended the deployment of the WEF framework in Ireland in order to stimulate BIM adoption [13].

The WEF action plan is founded on three parallel interventions.

a) Motivation - set the right motivation for increased BIM adoption and effective monitoring of BIM capability.

b) Collaboration – work in a culture of collaboration, supported by standard information flows allowing for improved use of BIM to support better projects.

c) *Enablement* – enable all stakeholders to acquire the skills, knowledge and support to drive the cultural change required to realise digital transformation.

It is acknowledged that important interventions have been introduced nationally in recent years with the funding of the Build Digital Project. There is however a distinct absence of a coordinated effort to increase BIM adoption and effectively monitor BIM capability in Ireland currently.

II. MOTIVATION

A motivational strategy is key for the wider adoption of BIM. The WEF suggested three core actions to stimulate motivation.

1. Articulate the BIM's benefits across the entire lifecycle.
2. Think of BIM as a value creator, not as a cost factor.
3. Approach BIM as the essential first step to digital transformation.

a) *BIM's benefits*

There was a multitude of papers focused on the benefits of BIM across a project lifecycle. A sample of benefits articulated included:

1. Improved design [14-19];
2. Improved information flow [20-22];
3. Project planning, model checking and clash detection [23-26];
4. Accuracy of quantity take-off [27];
5. Technology assisted inspection [28-31];
6. Supporting knowledge management [32].

A key feature was the presentation of case studies and the articulation of the benefits in using BIM by client organisations. This included the benefits during the construction phase in respect to project planning, model checking and clash detection.

There is a misconception that BIM is mostly used on larger sized projects with a number of publications articulating the relevance of BIM on smaller sized organisations and projects [33-37]. BIM Gathering proceedings have consistently articulated that BIM is a powerful communication tool for SMEs [34].

There was a call in 2013 for thinking beyond project and organisation level and focusing more on a higher level of national adoption [38, 39]. This strategic focus on BIM was later articulated in 2015 as extending to build informed environments that drive incredible value for the individual building and smart cities agenda. A link was also made to the power of BIM solutions in predication and monitoring of climate change challenges [40].

A number of authors spoke of the barriers that existed to increased BIM adoption, such as a lack of understanding of the BIM process, issues pertaining to

intellectual property and liability issues with sharing information, investment and training costs, as well as the long-term cultural changes required to commit to a new way of working.

The drivers predominately articulated the need for strong client leadership mandating the use of BIM, process change, uptake of information management standards and upskilling across the sector. Professions are largely waiting for client demand and leadership before embracing BIM implementation. Furthermore, AEC businesses require a complete understanding of the key benefits and risks derived through BIM adoption and fundamental business process restructuring [41].

b) *BIM as a value creator*

BIM has been described as providing considerable value for the building industry and the wider smart cities agenda [42].

The viability and application of BIM can also be extended across lean and green agendas [43-46].

There was much debate over the past decade on the added value that BIM can bring in bridging the disconnect between construction and operation phases. This disconnect has been comprehensively dealt with by many authors who articulated the need for BIM for whole lifecycle analysis, in particular extending the beneficial use BIM into digital twin operational solutions. This added value was also evident in the papers that focused on the contribution that BIM can provide in the optimisation of building performance and consideration of energy efficient strategies for building performance enhancement, energy certification and passive house compliance [47-67].

Demand for BIM by clients however is the key to unlocking the wider adoption on BIM in the construction industry. The true value of BIM lies in the whole lifecycle and facility management phase. In more recent years the debate surrounding BIM for the operations and maintenance phase has extended into the concept of digital twins.

c) *First step to digital transformation*

According to the WEF if the industry is slow to adopt BIM, it will likely impede adoption of other digital technologies. There has been significant advancement in the use of BIM dependent technologies for improving productivity in the construction industry.

Advanced scanning technologies featured extensively in the period of BIM Gatherings under review [68-76].

Drones have proven to be a powerful tool that can assist in creating 3D lifelike models via photogrammetry software [77], for example in the measurement of cut and fill to accommodate level foundations.

In more recent years there has been a debate about the application of blockchain technology and its integration with BIM, in particular how blockchain data can work alongside BIM data to create digital twin solutions connected to live data analytics [78-80].

Coupled with these advancements is the potential for BIM tools to work in tandem with product identification standards and reality-capture technologies [81, 82].

III. COLLABORATION

Successful BIM adoption requires a high level of collaboration among stakeholders. The WEF suggested three core actions to stimulate the collaborative use of BIM in construction.

1. Use of integrated contracts, redefine risk-reward mechanisms and BIM procurement requirements.
2. Set up early collaboration and communication among stakeholders.
3. Adopt data-sharing and open BIM standards.

a) Procurement Requirements

The linkage between BIM and procurement featured extensively in the proceedings. BIM and Integrated Project Delivery (IPD) are two innovations that must be deployed effectively in the construction industry to compete in the emerging knowledge economy [83].

IPD processes improve efficiencies and allow for the reduction of costs by resolving issues during the early stages of the project [84].

The use of BIM was considered in Irish standard forms of construction contracts as requiring only minor amendments to the public works contracts by adopting a contract protocol similar to that proposed by the Construction Industry Council in the UK [85].

The Irish government is planning to introduce a BIM mandate on larger scale public works projects from early 2024. Further work is required to develop the legal status of BIM in Public Works Contracts and to determine contract implications and obligations for public sector clients [86].

The collaborative role that BIM can play in infrastructure development was evident in a number of publications. For example, the use BIM application and the spectra of more efficient asset management of existing infrastructure [87]. BIM offers the methodologies and technologies to develop the required digital asset database to best inform lifecycle decisions associated with conception, design, construction and operation of physical infrastructure assets [88] and the challenges and opportunities for the use of BIM on larger infrastructure projects [89].

Additional contributions included a number of case studies that articulated the beneficial use of BIM on infrastructure projects. For example, Penn State University [90]; recreation of heritage buildings in Waterford city [91]; educational projects [92-94] and large-scale civil infrastructure projects [95].

In more recent years the increasing importance of Modern Methods of Construction (MMC) featured in proceedings [96-98]. The intersection of BIM and MMC is also gaining significant traction in 2023 [99].

The interrelationship between BIM and dispute avoidance or management also features in proceedings. Research into the use of BIM in the US Government Services Agency suggests that 3D BIM technology has positively avoided certain types of disputes. However, there are further contractual risks that may be associated with BIM and that may require additional skill and knowledge for construction contract procurement specialists and construction contract practitioners to effectively manage them in the future [100].

A more recent publication presented a framework for the implementation of a BIM based data analytics approach for construction adjudication, concluding that a digital approach can offer a promising solution to these challenges by providing a more objective, data-driven construction adjudication [101].

b) Early Collaboration

Collaboration featured as a key theme in the BIM Gathering proceedings. If the Irish Industry is to take advantage of BIM it must embrace both the technology and new ways of working [102]. An example of successful collaboration featured papers looking at Bridge Information Modelling (BrIM) from conceptual design through to operations [103, 104].

Many contributions looked at the improvements in communications on case study projects. For example, the Corrib Onshore Gas Pipeline [105]; MEP coordination on a Slovenian University project [106]; collaborative lessons learned on the first case study project on TU Dublin's Grangegorman campus [107]; and Newcastle's Quayside Project [108].

The broader contribution of BIM in facilitating virtual unified communication platforms in lieu of synchronous face-to-face design coordination communications was also found to be beneficial [109].

The question was raised about the suitability of the traditional procurement model to deliver early collaboration. An investigation into current procurement strategies that promote collaboration through early contractor involvement found that this best works when BIM, lean and IPD procurement strategies are working in unison [110].

The implementation of BIM by large public sector clients can be very challenging and will require a significant investment [111].

The concept of BIM can facilitate knowledge management by enabling project parties (appointing and appointed) to share and access knowledge and information in a coordinated collaborative manner [112].

c) Data-sharing and openBIM standards

The broader theme of adopting information management standards featured extensively in the conference proceedings. In order to transform the industry must adopt standards that allow information

to flow across the entire project life cycle and into the operations phase [113].

The case has been made for the industry to move away from in-house CAD standards and onto international information management exchange standards [114, 115].

openBIM is a collaborative process promoting interoperability of data to benefit projects and assets throughout their lifecycle. Collaboration itself should never be the goal, the goal is the creation and efficient exchange of good data across the lifecycle. It is based on open standards and workflows that allow different stakeholders to share their data with any BIM compatible software [116].

Examples of innovative openBIM data sharing contributions included:

- Exchanging partial set of BIM information on a cloud-based service [117];
- Model View Definitions for environmental assessment [118, 119];
- Interoperability of BIM objects [120];
- Telecommunications life-cycle information exchange (TLie) Data model [121].

BIM has the capability to leverage Whole Life Cycle Cost (WLCC) data requirements to perform WLCC calculations and produce WLCC estimates [122, 123].

While much of the focus on data exchange is on the design information, there needs to be improved standards in the structuring of cost data and life-cycle costing and the quantity surveyor in particular needs to increase their uptake of BIM and leverage its greater potential to create more accurate financial assessments [123].

Recent developments in data sharing include the Build Digital Project focus on information standards; launch of the BIM mandate on Public Works Projects; the introduction of Agreed Rules of Measurement fifth edition (ARM5) and the introduction of the International Construction Measurement Standards (ICMS) in Ireland. These innovations will all collectively help provide a renewed focus on improving standardised data exchange in the industry going forward [124].

While there remain some complexities in regard to the proliferation of BIM guidance and standards internationally, it is incumbent that the appropriate authorities in Ireland develop BIM guidance for industry and that this is compatible with internationally recognised ISO information management standards [125-126].

IV. ENABLEMENT

Accelerated BIM adoption can only be achieved if we enable it to happen. The WEF identified three core actions to support this enablement.

1. Establish BIM skills along the value chain.

2. Change behaviours and processes, not just technology.
3. Make a long-term commitment and support construction SMEs.

a) BIM Skills

The experiences of international and Irish Higher Education Institutes (HEIs) introducing collaborative multi-disciplinary BIM programmes featured extensively in proceedings, in particular the call for a paradigm shift in collaborative education [127]. In recent years all of Ireland's HEI's have developing BIM education programmes by availing of national development and stimulus funding from Skillnet Ireland and/or the Higher Education Authority.

In addition, there was experience of HEI's working collaboratively with industry in developing BIM programmes [128]. A particular challenge remains in developing multi-disciplinary programmes across faculties and embedding BIM across multiple programmes [129- 132]. There was a particular focus on skills for structural engineering [133-134]; quantity surveying [135-139]; architecture [140-142] and geospatial surveying [143].

The sustainability and green skills also emerged as a key theme in recent years [144-149].

Micro credentials more recently have come to the fore and advancements in BIM research skills [150].

The pedagogical experiences of HEIs in transitioning to BIM education, research and compatible teaching BIM methodologies featured over a number of BIM Gathering conferences demonstrating a maturity of approach to BIM education [151-158].

There was a call in 2023 for a more consistent education experience for graduates across the Irish HEIs by developing core BIM competencies across multiple programmes [159].

b) Behavioural change

This is perhaps the single most important action to be addressed in the construction industry and in any national roadmap for increasing BIM adoption. Much work was carried out by the National BIM Council and the BIM Innovation Capability Programme managed by CitA between 2015-2017 in focusing on the cultural challenges evident in the industry in respect to BIM.

Many in the industry see it as an unnecessary disruption to traditional ways of working at a time when the industry is short of people and where the skills are not evident in the sector in respect to its use, particularly by non-design professionals. This is particularly evident with the quantity surveying profession [160].

The question of BIM ownership was a significant challenge that needs to be addressed, particularly from a trust perspective [161].

It is widely accepted that the adoption of digital tools, automation, information sharing and communication technology has been envisaged as the main concept of the fourth Industrial Revolution, due mainly to demand in industry for increased efficiency. This requires strong leadership both from industry and in the state government [162-164].

Trust was further explored in the critical relationship between the client and the design consultant [165, 166].

Authors have consistently called for an implementation roadmap to accelerate BIM adoption in Ireland [167].

c) Long term commitment and support SMEs

Alongside the cultural change imperative tackling procurement is a huge challenge necessitating leadership from government to bring about change. Many governments across the globe have introduced BIM requirements into procurement models, some creating national laws or mandates effectively forcing the industry to use BIM processes. Others have not and have left the supply chain to work it out for themselves.

It was previously stated that the Irish government has been very proactive, particularly in recent years in subsidising BIM training through their various national upskilling initiatives and driving forward their Project Ireland 2040 vision. The formation of the Construction Sector Group and its participating stakeholders have driven a construction innovation and digital adoption agenda with the formation of Build Digital and Construct Innovate Ireland's National Research Centre for Construction Technology and Innovation.

The drive for change in Ireland is more of a "top-down" approach rather than a "bottom-up" approach [168, 169].

In more recent proceedings there was a recurring theme to overcome resistance to BIM including calling for a roadmap and a national BIM mandate to begin embedding BIM in the public sector projects [170-174]. There was an urgent call for decisive support for SMEs to drive digital transition of the industry in Ireland as was called for in 2017 by the National BIM Council [175].

V. CONCLUSIONS

It is clear from the review that there is ample evidence that all of the 9 actions identified by the WEF have been collectively articulated by the BIM Gathering publications over past 10 years.

The most influential user studies related to articulating BIM benefits, data sharing, openBIM standards and BIM skills. Fewer studies were evident in early collaboration, procurement requirements,

behavioral change and long-term commitment to support BIM adoption by SMEs.

The absence a BIM mandate was seen as stifling the development of BIM in Ireland. It is encouraging that this mandate is planned to be introduced in 2024.

Over the past decade there is increasing evidence of maturity in BIM adoption by principal industry stakeholders in Ireland and an increasing offering of BIM education across Irish HEIs.

It is acknowledged that the Irish government have made significant strides to drive the adoption of digital in the Irish construction industry through the work of the construction sector group construction innovation and digital adoption working group. This initiative has seen the funding of national programmes such as the Build Digital Project and the establishment of the Construct Innovate centre of excellence.

There remains however a relatively low level of uptake from public sector stakeholders which is likely reflective of the absence of a national roadmap and government requirement for BIM adoption on public sector projects.

In order to support BIM adoption in Ireland, it is clear that there is an urgent need for a coordinated programme to support the imminent public sector BIM mandate and encourage the wider adoption of BIM in the private sector, particularly among SMEs.

The WEF recommended that companies must take a strategic approach to digitalisation starting with implementing BIM as the baseline application to support a green, lean and digitised future. While BIM adoption was the main focus of the BIM Gathering conferences, it was recognised that BIM remains only part of the wider technological adoption that is required to tackle the productivity, sustainability and communication challenges in construction. The published proceedings reviewed in this paper collectively provide a compelling case for BIM as a necessary disrupter to unlock the unproductive and inefficient work practices so prevalent in the Irish construction industry today.

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