An investigation into Ireland's BIM Skills Gap

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The adoption of digital skills within the Irish AEC Sector has the potential to enhance efficiency and competitiveness among its stakeholders. Despite this opportunity, there is still a high demand for skilled BIM professionals, which cannot be currently met. To meet this skills demand and directly target future skills gaps within Ireland, several challenges must be addressed to facilitate broader BIM adoption. This paper focuses on addressing this gap by identifying steps to be followed to develop skilled professionals within BIM. This has been achieved by investigating the extent to which construction stakeholders in Ireland comprehend BIM and, examining the training and educational initiatives implemented locally and internationally to facilitate the digital transition. The research also provides insights into the ramifications of the absence of a mandate for BIM implementation in the country concerning skills maturity. The findings highlight that insufficient BIM knowledge and resistance to change are the major challenges of digitalisation and how educational initiatives can play a major role in addressing these issues. A set of recommendations are put forward to increase the involvement of key stakeholders and younger generations in addressing Ireland's BIM skills gap.

Keywords ─ Building Information Modelling, BIM Awareness, BIM Mandate, Education & Training.

I INTRODUCTION

The adoption of digital skills has the potential to enhance efficiency and competitiveness among industry stakeholders [1]. Due to this, there is a high demand for skilled BIM professionals, which cannot be currently met [2]. Therefore, an organisation with inadequate or limited resources might have insufficient access to the custom knowledge required to transition into BIM, affecting its performance [3]. There is a shortage of professionals with a deep understanding of BIM and data management in Ireland, which is one common barrier that firms encounter when transitioning into BIM [3] [4].

Despite the potential benefits of BIM, several challenges need to be addressed to facilitate its adoption in Ireland. Client reluctance to embrace BIM processes and the lack of software programming expertise remain the main obstacles for organisations [5][6]. It appears that these same challenges have persisted for over a decade, with the primary issues centering on the initial costs involved in adopting BIM software, investment in computer upgrades, employee training, and technical support [7][8][9]. Effective strategies for BIM adoption acknowledge the importance of allowing for a period of adjustment as BIM requirements increase gradually [9].

Even though the country lacks a formal BIM mandate, the progress of Ireland's transition to BIM is noteworthy. However, the absence of such a requirement may pose a challenge to achieving a seamless and efficient implementation of BIM [10]. On the one hand, organisations are responding to the industry's shift towards digitalisation by implementing structural and operational alterations to their business frameworks and strategies. In the absence of a specific directive, they are adopting various measures such as establishing an implementation team, designing training programmes, and restructuring their organisational framework to accommodate new responsibilities and roles to reduce resistance [11]. On the other hand, the absence of a mandate affects the clients' tendency to request the adoption of BIM in their projects, which can also be attributed to their limited understanding of BIM and their obligations [5]. Considering this, introducing a BIM roadmap that aligns change management techniques with a BIM implementation plan can help bridge the gap between stakeholders and ensure the successful incorporation of BIM within an organisation [11].

The purpose of this research is to identify why the demand for BIM specialists is not satisfied in the Irish AEC industry and which steps should be followed to develop skilled professionals within this area. Moreover, the paper aims to investigate and

analyse the extent to which construction stakeholders in Ireland comprehend BIM and examine the training and educational initiatives implemented locally and internationally to facilitate the digital transition.

II LITERATURE REVIEW

a) BIM Skills and their Importance

BIM is the process that generates and assembles all the building's data and enables its management during the entire project [12], representing a sustainable design decision-making tool that allows the planning of a building to achieve the best favourable outcome possible [13]. As a result, there is a gradual upward trend in the number of companies within the AEC sector that are embracing BIM methodologies. This would imply that the number of competent BIM professionals in the country should be increasing accordingly. However, the demand for highly skilled specialists is expected to outstrip supply over the next 20 years [14].

According to the World Economic Forum (WEF), the shortage of employees possessing adequate BIM skills within the AEC industry and among its clients is slowing down the global adoption of BIM [7]. Considering the significant ongoing transformation towards digitisation in the built environment, it is highly likely that the workflows within the construction sector will undergo a fundamental transformation, as supported by previous research [4][6][7]. However, it appears that the advancement of technology is outpacing the development of workforce skills and competencies [2].

The construction industry has experienced a notable deficiency in labour productivity, which has been alleviated by introducing advanced technologies and innovative construction strategies [15][16]. Considering this, the WEF issued an action plan to accelerate BIM adoption in collaboration with 35 delegates from prominent global companies. The key findings of this report highlight the importance of upgrading the education curricula in third-level institutions by integrating practical BIM modules that are directly applicable to real-world scenarios. In addition, it was mentioned that it is crucial for organisations to offer internal upskilling training programmes to equip current professionals with the necessary BIM competencies, along with the interdisciplinary skills required for effective BIM collaboration. The government also plays an important role, as its involvement in integrating BIM skills training into public projects can help facilitate a smooth transition towards digitalisation [7]. Considering this, it is worth noting that the success of these initiatives depends on the commitment and collaboration of the industry stakeholders in working together towards a common goal [10][17].

b) BIM Skills Challenges within Ireland

The implementation of BIM has gained significant traction within the Irish construction industry, as it is recognized as the best-practice approach to successfully manage information throughout the asset life cycle [18]. The reality in Ireland is that the economic recession of 2009 negatively affected the construction sector's performance. During the economic recovery, numerous professions encountered a shortage of skilled personnel [19]. A study by Friel identified that it was only in 2018 that most companies could recover from the economic downturn and saw a return to profitability. Findings indicate that the most affected areas in the country have been "skills" and "education" since many skilled construction workers changed professions and/or emigrated during the recession. Furthermore, third-level education institutions were challenged in attracting new individuals into surveying and engineering courses, ultimately resulting in a strain on the budgeted funds [20].

Research demonstrates that to alter the way the Irish industry operates, it is essential to have an overall goal to transition into BIM. Moreover, organisations need to improve their change management strategies to reduce employee resistance [10][11]. Change management denotes a resilient approach aiming to develop an organisation's structure and capabilities to satisfy customer needs [21]. As described in the McKinsey 7S Model, "Staff" represents human resources that must be nourished and protected. In addition, the top managers are responsible for promoting a good work environment to attract new talents, which will contribute significantly to the company's performance [22]. Therefore, implementing new processes and technologies usually occurs when employees manifest their desire for continuous improvement to their employer. However, in order to upgrade an organisation's workflow, a top-down approach from management would be essential [11][23].

Over the years, the Construction IT Alliance (CitA) and Enterprise Ireland have conducted several surveys to estimate the level of BIM awareness in Ireland. The 2017 survey revealed that 76% of the respondents recognized the importance of BIM processes and their technologies. The 2019 NBS National BIM Report confirmed the top barriers to transitioning to BIM in Ireland, which included the absence of in-house expertise, lack of client demand, and training, but also the lack of a mandate which would be essential for introducing a BIM framework to the construction industry [11][15].

Further analysis was conducted in 2020 regarding the productivity in the Irish construction sector. This report evidenced that even though there is a willingness to embrace new technologies, there has not been enough funding or training resources, which would facilitate the development of not only the field professionals but also the country itself [24]. Moreover, the NBS Digital Construction Survey conducted in 2021 revealed that, even though most of the participants were going through a BIM adoption process, there seem to be different stages of implementation between clients, contractors, and manufacturers. This implies that until there is a consistent demand for BIM data, the full adoption of BIM as the default will not occur [6].

Research supports that governments can expedite BIM adoption by making it a mandatory requirement in projects, engaging other stakeholders in pilot initiatives, advocating for education and training opportunities, and implementing diverse financial/non-financial incentives [7]. Moreover, government policies and public procurement methods are recommended as effective strategies to facilitate a drastic transformation in the sector. Without a top-down approach, the industry will most likely have limited and inconsistent data, thus significantly restricting its capacity to enhance productivity and cost-effectiveness [9]. To avoid this, establishing a BIM mandate will provide a standardisation across the Irish construction sector, ensuring the key requirement for innovation [23]. As seen in the USA and UK industries, mandating BIM speeds up its adoption and diminishes education and training challenges [25]. According to an investigation into Irish clients' understanding of the capabilities of BIM and their role within a construction project conducted in 2019, several potential issues have been identified towards mandating BIM in the Irish AEC sector, including leadership, standards, training/education, and procurement [5].

Another factor to be considered is the impact of COVID-19 on the construction sector. The pandemic forced the industry to re-evaluate lifestyles and work practices [6]. It not only heightened the importance of digital technologies, but also prompted several organisations that previously underutilized BIM to recognize its significance as a vital component to be incorporated into their business models [10].

In light of the above, it becomes apparent that Ireland is still at an earlier point of its BIM transition, as not many projects have achieved BIM stage 2. Still, also, a substantial discrepancy in expertise among industry stakeholders seems to exist. Despite this, there is evidence to suggest that over the next five years, BIM will be positioned as the leading construction strategy in the industry, as it possesses the greatest potential to transform the built environment positively. Consequently, clients and contractors are expected to increasingly mandate the adoption of BIM, which is anticipated to result in elevated levels of BIM implementation in the forthcoming years [6][26]. Nevertheless, for this to be successful, all stakeholders involved in the construction sector must adopt and cooperate with these new practices [17].

In recent years a number of government and industry strategies, training methods, and education initiatives have been launched in the country, with the purpose of assessing whether further progress in this domain is imperative for effectively undergoing the digital transition. These include:

- National BIM Council (NBC) unveiling of its 2018-2021 Roadmap for Digital Transition, representing the country's first-ever digital construction strategy. The strategy contained a training pillar to deliver a broad awareness and upskilling learning framework for educators and the industry. The roadmap was influenced by findings from the Irish BIM Innovation Capability Framework (BICP) [27][28].

- *Digital Technology in Public Works Projects Strategy* - The Irish government announced its strategy to increase the use of digital technology in particular categories of public works projects over a 4-year timeframe ending in 2021. This statement of intent from the Irish government demonstrated an acute awareness of the importance of BIM and how it brings together technology, process improvements, and digital information to improve project outcomes and asset operations [29] radically.

- *Project Ireland 2040* - This strategy established a €500m Disruptive Technologies Innovation Fund (DTIF) to facilitate research and innovation growth, higher education, and further education and training (FET) development. The fund aims to enhance awareness of the significance of digital transformation in the Irish AEC sector (Enterprise Ireland, 2022) while fostering collaboration between the industry and the nation's research base [30].

- *Build Digital Project* - This project was created to encourage higher levels of innovation and continuous improvement approaches within the construction sector in Ireland. One of its main priorities is to enhance the skills and capabilities of the AEC workforce to mitigate the skills gap throughout all levels and areas of specialisation [31].

a) *Interventions at Secondary & Third Level Education*

Globally, there is a growing trend towards implementing interventions at the secondary level of education to address the shortage of skilled personnel. Multiple construction firms in Ireland collaborate with educational institutions to align with the syllabi. The aim is to offer BIM awareness at schools and BIM-related training programmes at universities that emphasise the growth of future skills and the development of young engineers/architects [32]. It is important to consider that current student generations have most likely grown up in a technologically advanced world, and, as a result, they tend to prefer learning through active participation rather than passive observation or reading [33]. Using innovative approaches in schools to introduce BIM to students at an early stage will help them understand the significance of the AEC sector.

Additionally, providing education on BIM to individuals in Higher Education Institutions (HEIs) holds the potential to positively transform the future of the construction sector [32]. If we look at the UK's introduction of its work experience schemes, promotion of AEC degrees, and talent retention strategies have helped increase the engagement of younger generations in the construction industry and facilitated the upskilling/reskilling of the existing workforce [19]. Evidence suggests that adopting these types of strategies could be key in engaging young individuals and encouraging them to join the construction industry, thereby mitigating skill shortages [34]. In Australia for example, a non-profit organisation, NATSPEC, facilitated the promotion of quality and productivity in the built environment by providing tailored guidance packages for all building structures and diverse professionals in the field [35]. An initiative called "Collaborative Design Education-CODE BIM," supported by the Australian government's Learning and Teaching Department, was established to address the challenges of poor implementation of BIM education, which were associated with the relevance of the syllabus content and cultural resistance to change [25].

It is imperative for the rest of the construction and education entities to collaborate with the industry by introducing educational programmes, participating in skills development, and implementing continuous improvement approaches. The major challenges for a country to successfully embrace BIM are related to people, particularly their insufficient knowledge and resistance to change. As demonstrated by the research above, implementing preventive measures, particularly educational initiatives, plays a major role when addressing these issues [36].

III RESEARCH METHODOLOGY

The aim of this paper is to formulate a question relevant to the programme's subject matter and learning objectives, followed by providing a comprehensive answer to the question posed. In this case, the inquiry pertains to whether implementing a digital construction mandate could potentially mitigate the BIM skills gap in Ireland. Consideration was given to the fact that research methodologies can generally be categorized into two distinct groups: quantitative and qualitative; both offer a valuable opportunity to analyse the problem statement at hand critically. Quantitative methods are concerned with measuring observable aspects of phenomena to generate knowledge. In contrast, qualitative methods aim to increase understanding of the social world by exploring the underlying reasons for human behaviour and attitudes [37]. The research methodology employed in this paper can be identified as a pragmatic mixed methodology approach [38], given that qualitative data was scrutinized through concept analysis. In contrast, quantitative data was evaluated by reviewing surveys and official statistics. The research methods adopted within this assignment were: Literature reviews and Semi-structured interviews.

The semi-structured interviews were conducted with Irish public and private construction sector representatives, including 3 participants from SMEs, 2 participants from large private organisations and 1 participant from a large public organisation. Organisations where selected based on their impact within their relevant sector. All of the participants selected have a responsibility for BIM within their organisation. It is important to note that the findings discussed below are relative of this small sample size and in some case may not accurately reflect the industry.

IV FINDINGS

The semi-structured interviews were divided into three phases to cover the following themes:

- BIM Awareness
- BIM Training/Education Initiatives
- BIM Mandate

a) BIM Awareness

The interviewees were asked a series of questions to determine the level of BIM awareness in their organisations. Concerning each organisation's level of BIM adoption, it appears that SMEs and large private businesses have been gradually implementing BIM; however, full implementation is yet to be achieved. On the other hand, the public body realises it is still in the early stages of its BIM adoption process. Results from the interview revealed that the implementation of BIM had had a positive impact on the workflow of the organisations under study. The benefits observed were consistent across all cases,

including improved information management and its delivery and enhanced communication facilitated by a collaborative approach among employees. It became apparent that engagement between organisations from diverse industry sectors and with different levels of BIM adoption can strengthen the development of companies with lower BIM readiness. Additionally, it appears to be a growing trend among organisations, irrespective of their type, to incorporate BIM-related methodologies and technologies into their daily workflow to standardise processes and boost productivity. These approaches include periodical coordination meetings, implementing lessons learned, and utilising cloud-based platforms.

Interviewees were also questioned regarding potential resistance to BIM in their organisation. 83% indicated there is currently no resistance, despite some initial opposition during the early stages of implementation or amongst other companies working on the same project. Only one participant responded that resistance towards BIM still exists. Although some respondents suggested that older generations may be more resistant to change, most interviewees agreed that resistance towards BIM is not solely determined by age but rather by the individual's mindset.

In light of the impact that Covid-19 had on the construction industry, the findings from the interviews suggest that the pandemic positively influenced BIM adoption as digital technologies have been adopted in greater scale throughout this period. Moreover, organisations recognise that the pandemic acted as a catalyst for adopting flexible workflows and implementing various coordination approaches.

Five of the six interviewees were asked if their clients had knowledge of BIM and if there was a difference between the level of BIM engagement among national and international clients. While most respondents indicated that the difference in BIM knowledge between the company and the clients is no longer significant, some participants suggested that clients from smaller towns in Ireland may have more limitations than their international counterparts. Moreover, some international clients were also observed to have a lower level of BIM adoption, which could be attributed to the level of BIM implementation in their respective countries.

Interviewees were asked to rank the following items in order of importance: 'Technology,' 'People,' and 'Process'. 67% of respondents affirm that 'People' is the most important of the three. The remaining results highlight the importance of having appropriate technology at the outset to implement BIM methodologies successfully. This is followed by a fixed period of time dedicated to employee training and process development to ensure the effective adoption and integration of BIM into the daily workflow.

b) BIM Training/Education Initiatives

Participants were questioned to determine if their respective organisations acknowledge the importance of BIM training/education initiatives. It was asked if their company implemented any BIM awareness or upskilling initiatives for employees. In this regard, large private organisations have multiple benefits for pursuing continuing professional development (CPD), including educational funding for third-level education courses, flexible working hours, study leave, and training throughout the company's online platform. On the other hand, the situation with SMEs varies. Results indicate that, despite some upskilling initiatives and flexible work/study schedules that may be available, they are not as extensive as those offered by large private organisations.

In some instances, BIM promotion is completely absent, and only a basic introduction to the company's software is offered. In the case of the large public organisation that was interviewed, there are indications of efforts to promote BIM awareness; however, there are currently no upskilling courses available. It was mentioned that the organisation does not have a broad enough programme to provide training for all its employees. Nonetheless, if someone identifies a course that would benefit the organisation's BIM adoption vision, they are willing to support it.

Considering that there have been initiatives in HEIs to add new BIM-focused courses, participants were asked if this was reflected within the existing employees or new hires. Findings indicate that most employees acquire BIM knowledge through on-the-job experience rather than formal courses. This could potentially lead to bad practice if individuals are not fully aware of the extent of BIM methodologies.

According to the results, 83% of the participants have completed or are currently undertaking a BIM-focused course. It was highlighted that all these courses were delivered online and included practical exercises that applied BIM principles to real-life scenarios, facilitating a quicker understanding of the concepts. Moreover, some interviewees highlighted that having diverse specialists involved in course instruction proved beneficial, allowing for teaching content based on various experiences and perspectives.

Lastly, participants were asked about their organisation's motivation for encouraging their employees to enroll in BIM-related courses. The majority of respondents acknowledged that by doing so, the company would acquire significant returns in the future, including a boost in productivity and streamlined progress to keep pace with the industry.

c) BIM Mandate

The third part of the interview focused on organisations' perceptions of the government's approach toward BIM implementation and which measures would facilitate BIM development in the industry.

When discussing whether BIM has become the norm in Ireland, the interviewees' responses were equally split, with 50% stating that BIM has become the norm, while the other 50% disagreed. From the perspective of SMEs, BIM is considered to be the norm based on their experience working in the country. Conversely, large organisations tended to agree that while BIM is gaining popularity, it is not yet widespread enough to be considered the norm in Ireland. This can be attributed to the varying levels of BIM adoption within national projects and the lack of awareness and understanding of BIM within the industry.

When considering whether the government is leading the industry in digital construction, some interviewees stated that the government should be more proactive in leading the industry, particularly given the competition and leadership shown by the UK. Others felt that the industry is the primary driver of BIM adoption and that the government needs to be more involved in the implementation process, as previous upskilling initiatives have not been sufficient to facilitate a smooth BIM transition.

Participants were also asked if introducing a BIM mandate would lead to greater awareness and adoption within the private and public sectors, and 83% agreed that mandating BIM would provide the necessary push for the industry to continue developing further. It was mentioned that a mandate would likely lead to BIM becoming the norm within 5 to 10 years of its implementation, as every transition requires a progressive period for adaptation. On the contrary, if a BIM mandate is not introduced, results stated that resistance towards BIM would likely persist, as many organisations may not see the need to adopt BIM unless required. Nevertheless, results noted that adopting BIM in the public sector is expected to drive adoption in the private sector, as design teams and contractors who work in the private sector often also work on public sector projects.

Furthermore, the interviewees were asked about potential barriers that could hinder the implementation of a BIM mandate in Ireland. The findings revealed three main challenges that could impede its successful adoption from the outset. Firstly, the lack of skilled professionals could potentially lead to bad practices. This could be attributed to a lack of awareness within the field, leading to a disregard for established standards.

Secondly, the combative nature of the construction industry. As organisations prioritize profits, they may prioritize financial gains over the collaborative approach that BIM requires, which could lead to a focus on monetary gains rather than proper project execution. Lastly, the strict adherence to a predetermined set of requirements could potentially limit the Irish industry from exploring and implementing more efficient workflows or better solutions that may not align with the prescribed mandates.

The interview's final question asked what training would be necessary if a BIM mandate was introduced. The findings indicate that it would be beneficial to implement BIM-focused modules into the syllabi of third-level institutions using interactive learning methods that can be applied to real-life scenarios. Additionally, presenting new BIM courses within multiple national frameworks of qualification levels could facilitate the upskilling of professionals with diverse levels of expertise. Furthermore, introducing BIM in schools could boost the interest of younger generations in the construction sector, which could eventually diminish the current skills gap.

V DISCUSSION

Based on the research findings it has been found that the government's digitalisation efforts need to be accelerated. Therefore, it is recommended over the short term (next three years) that the government revise the Digital Technology in Public Works Projects Strategy. This revision should focus on providing public entities with adequate information to comply with requirements related to information management and collaboration approaches. Secondly, it is recommended that the government should review the mandate strategies employed by other countries as a reference for developing an Irish mandate. Mandating BIM will encourage its adoption among industry stakeholders, as observed in the countries examined in the literature review [9][25]. Thirdly, the government should promote BIM awareness and upskilling initiatives for the construction sector, such as the ones highlighted by the Expert Group on Future Skills Needs [19]. Lastly, the government should establish educational support schemes to encourage young professionals to pursue careers in the construction industry and attract them to BIM. By implementing these initiatives, the Irish government can develop a more strategic approach to overcome the challenges and risks associated with BIM implementation and efficiently manage scarce human resources [11]

Additionally, based on interview results, it is recommended that the construction sector should consider implementing BIM-focused CPD programmes and providing training to establish a BIM department within the organisation. This will

help promote BIM awareness and develop guidelines and standard operational procedures based on BIM approaches.

Regarding HEIs, to positively transform the industry's future, it is recommended to research the accuracy of current syllabi within construction degrees and the availability and range of BIM-related courses in the country to develop a wider variety of modules for different expertise levels [32]. This can be argued is already taken place with studies as far back as 2019 highlighting that learning and education remain strong with ongoing commitments to digital construction evident within leading third level educational bodies [30]

It is recommended that HEIs develop updated curricula incorporating multi-disciplinary, team-based modules focused on real-world BIM challenges in architectural/engineering degrees. Some International Universities have seen how the use of Integrated Construction Studio as a BIM teaching methodology which can promote collaborative construction skills through BIM-integrated learning environments focused on software skill training and applying teamwork within a real-world scenario in a BIM interdisciplinary project. Collaborative BIM-based projects have been seen to share a common trait in that communication and collaboration are enabled by BIM-based communication environments. BIM as a learning environment represents a new educational paradigm in which integration, multidisciplinary collaboration, simulation, real-life scenarios, and application of learning concepts are at the heart of the learning process [40-41]. This approach in Ireland has provided excellent document and collaboration tracking, with full activity analytics that could inform further research on the learning experience [42]. Additionally, these courses should be presented in Secondary Education Institutions to attract younger generations into construction.

VI CONCLUSION

The main concern is that as long as there is a reluctance to embrace BIM, the nation's progress will be hindered. In addition, the lack of a mandate for the construction sector could impact Ireland's effectiveness in satisfying society's needs and the market's competitive nature. As a result, an action plan needs to be established to prevent the loss of international contracts, exports, and Irish-based employment. It is important to highlight that evidence suggests that the Irish construction industry could address skill shortages by making BIM more appealing to young professionals.

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