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# Why are Residential Property Developers in Ireland not using BIM?

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**Abstract**–The aim of this paper is to establish the level of BIM adoption by larger-scale residential property developers in Ireland and investigate the benefits and challenges of implementing BIM for residential housing. While BIM is a relatively new concept in Ireland for housing, developers and investors in larger scale developments are beginning to recognize areas where BIM can add value to their projects. The research also indicates that while there is evidence of successful BIM implementation for housing resulting in savings in cost and time, widespread adoption is hindered by a lack of knowledge and skills, costs of implementation, lack of client demand and difficulties with downstream adoption by sub-contractors and the building products supply chain. The research highlights how this has the potential to create a two-tier system, with more large-scale adoption by small and medium sized developers less likely, unless action is taken to increase the level of BIM maturity in the construction industry. It also proposes supports be provided for smaller developers who currently are unwilling to risk the financial exposure in adopting new technologies and additional expenses of training and changing work processes to cope with new technology, and with little or no client demand. However, with Government being the largest client for housing in Ireland, Government need to take the lead in driving innovation by mandating BIM for housing.

*Keywords*–BIM, Residential Housing, Property Developer, Barriers & Benefits

## I. INTRODUCTION

The potential benefits from the adoption of Building (BIM) Information Modelling in the construction industry have now been voiced by a significant number of practitioners and academics [1]. BIM's information delivery abilities are acknowledged by the building and construction industry worldwide. Many countries have already mandated its use on Government construction projects as a result of BIM facilitating a more integrated design and construction process that results in better quality buildings at lower cost and reduced project duration [2]. In recent years, researchers have investigated in depth the use of BIM in managing many different aspects of the delivery of projects in different sectors [3], however there has been very little research into the residential housebuilding sector [4], and even less into the use of BIM by Property Developers in that sector [5].

## II. LITERATURE REVIEW

A literature review was followed in four steps to ensure the research findings remain as unbiased as possible [6]. First, the objective was to frame the research question, i.e., to explore the benefits,

challenges and risks to the adoption of BIM by Property Developers in Ireland. Second, the study identified relevant resources, seminal peer-reviewed papers and reports in academic and industry databases published that were reviewed, including government reports and statistics. The main key search words were 'BIM', 'Residential Housing', 'Property Developers', 'Barriers' and 'Benefits'. This included identifying important publications that did not show up in keyword searches but were found through recurring citations in relevant sources. The third step involved analysis of the quality of the existing studies focusing on the benefits and barriers for residential property developers using BIM, BIM in Ireland, BIM in residential property development and Housebuilding in Ireland. Then examining them for connections, before interpreting the literature review findings by understanding the level of readiness of BIM adoption and maturity in Ireland before focusing more specifically on Property Developers in the housebuilding sector in Ireland. The fourth step was to interpret the literature review findings by understanding the level of readiness of BIM adoption and maturity in the Irish construction industry, before focusing on primary research.

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## a) Property Development

The words Property Developer and Builder are often interchangeable, however it is important to state that for this research, the term Property Developer is understood as an individual and/or company that buys land or property for development and develops it either through building themselves or employing builders to build for them. Whereas the word 'Builder' or 'Contractor' is understood as solely engaged in the building of a project [7]. Both Builders and Property Developers are engaged in the residential housing sector.

The Irish economy suffered a major recession in the period 2008 to 2010, which had severe impacts on the construction industry, resulting in many Property Developers leaving the Irish market. Since 2013, with improvements in the economy, developers have re-entered the market and construction in residential housing is growing year on year [8]. With government actively promoting innovation to support the rapid delivery of housing [9] to relieve the level of homelessness, this research is timely in understanding the role of BIM adoption by Property Developers in Ireland in the residential sector.

## b) Housing in Ireland

After the collapse of the construction industry in Ireland in 2008, many builders and developers ceased trading, which resulted in a huge downturn in the economy. The housing market and housing construction had contributed enormously to the growth in the Irish economy over the previous decade [10].

In 2013, as a response to the financial crisis, Government amended the Finance Act, to entice international investors into Ireland, to stimulate the economy, which included lucrative tax incentives for Real Estate Investment Trusts [11]. These REITs bought up much of the NAMA properties at reduced cost.

The Construction 2020 Report noted a significant rise in land purchased by investment companies [12] and while REITs are engaged in the development of projects for long term rental, which contribute to the overall supply of housing, concerns were expressed that institutional investors may be buying up property that would otherwise be available to individual home buyers [13].

REITs have now become the largest investors in residential housing in Ireland, including Irish Residential Properties Real Estate Investment Trust who are the largest residential landlord in Dublin owning more than 3,000 homes [14].

Insufficient supply of housing particularly in the larger cities is a primary driver of price pressure in the housing market. Government published The

Rebuilding Ireland Action Plan for Housing [15] to address housing supply. It aimed to accelerate the construction of more social and private housing to meet demand at affordable prices, while fulfilling the Energy Performance of Buildings Directive requiring all new domestic buildings to be Nearly Zero Energy Buildings (NZEB) from 31<sup>st</sup> December 2020 [16].

Recognizing the value of BIM as a strategic enabler for cost, quality and policy goals, the Irish Government published numerous papers recommending supports be put in place to increase the level of residential housing including:

Project Ireland 2040 advised progressing to digital and embracing BIM to deliver value for public money through the structured introduction of BIM across the sector, with projected Project investment by housing increasing from 26% in 2019 to 45% in 2023, with social housing delivery having the highest funding allocation of €5.35 billion [17].

The State of Ireland 2019 Report, suggested "*growing the volume of off-site manufactured homes to significant levels*", including establishing a Construction Innovation centre of Excellence to support the adoption of Modern Methods of Construction (MMC), seeing the National BIM Council Roadmap implementation as an important step in growing MMCs in Ireland [18].

The growth in social housing developments has increased since the Government's Action Plan for Jobs 2017 was published, which called for the Office of Government Procurement to prepare a strategy for the adoption of BIM across the public sector [19]. It recommends developing proposals to offer competitive financing on a commercial basis to developers to meet on-site and other infrastructure requirements on large development sites [18].

Following on from this, in February 2018, the Ireland Strategic Investment Fund provided loan finance to residential developers and builders working on smaller-scale projects in large urban areas and in December 2018, it provided investment in build to rent residential platform to partner with builders, developers and housing associations to deliver new rental housing projects, and in August 2019, it provided an equity fund for capital to small and mid-scale developers to build residential units in Ireland [20].

However, investment funding is only one of the issues facing developers, other key barriers to BIM implementation by housebuilders include: cultural change, lack of awareness of BIM and how it can benefit this sector, lack of knowledge and skills, lack of BIM objects for residential and the cost of investment of time and resources [21].

While the housing sector is a key driver of the overall economy, it faces numerous challenges relating to competitiveness, including labour shortage, resource efficiency and productivity. The Government recognise the value of BIM and its

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importance for the construction sector to stimulate new growth in the economy [21].

As the volume of output grows in housing, the need to improve productivity is more crucial, with labour and skills shortages and rising costs, 'the sector must embrace new delivery mechanisms and overhaul its approach to the adoption of technology and next generation building techniques' [17].

Adoption of BIM assures construction quality, safety and environmental friendliness [22].

### c) BIM in Ireland

BIM in Ireland was first mentioned in a Forfás report in 2013 as an advanced technology that will ensure increased competitiveness and innovation in the construction sector [23]. It recommended actions for Enterprise Ireland, Industry Representative Bodies, Higher Education Institutes, and Skillnet Ireland to work together to promote the use of BIM and for Irish construction firms to develop the appropriate technical skills to compete in markets where BIM was required [24].

In 2014, the Construction 2020 Report outlined two specific actions to support companies advancing to level 2 BIM capability, which led to the development of the BIM Enable and BIM Implement programmes for Enterprise Ireland clients [24]. The UK mandate encouraged many Irish companies working in the UK to adopt BIM, with Enterprise Ireland being central in promoting innovation in Irish construction, funding the BIM Enable and BIM Implement Programmes [25].

The Action Plan for Jobs in 2017, contained a requirement for the Office of Government Procurement and Enterprise Ireland to prepare a strategy for the adoption of BIM across the public capital programme and to mandate how it is to be adopted across the public sector [18].

Subsequently, the Government Construction Contracts Committee (GCCC) prepared a position paper titled *A Public Sector BIM Adoption Strategy* inviting responses from industry. The paper outlined the context and rationale for the adoption of BIM on Irish public works projects and suggesting a proposed timeline for adoption ranging from 12-48 months depending on project complexity [24]. Band 1 was low density housing projects, Band 5 were complex projects such as acute hospitals [26].

In December that same year, Ireland's National BIM Council published the Roadmap to Digital Transition for Ireland's Construction Industry 2018-2021, identifying Leadership, Standards, Education and Procurement as the four main areas to drive the construction sector to digitization in Ireland [27].

Construction IT Alliance (CitA) has primarily been responsible for providing research, training and events to support this drive to digitization [28]. In

2016, CitA received funding for the BIM Innovation Capability Programme for Ireland (BICP), to carry out research globally to assist in Ireland's adoption of BIM. BICP was established to support the development of digital competency across the construction sector, running events, training and publishing research including Case Studies which focus on best practice effecting of BIM on Irish Projects [25].

Since the publication of this Roadmap, and the recognition of the government to the importance of BIM as a 'strategic enabler for improving decision making and delivery for both buildings and public infrastructure assets across the whole lifecycle', support structures are being put in place to assist both the public and private sector with building digital capability [27].

Local Authorities including Dublin County Councils (DCCs) are implementing their BIM plans over a three-year period in a similar fashion to the 'NBC Roadmap to Digital Transformation' and this is broken down into targets, goals and timeframes of short, medium and long-term [29].

A report in 2018 into BIM in Ireland found that *Ireland's BIM journey was well underway and in many respects we are as mature as any country in the developed world when it comes to BIM proficiency and diffusion*. However, the BICP highlight areas that will need to be addressed if Ireland is to continue its momentum [30].

### d) Benefits for Housing using BIM

When considering the benefits of BIM for residential housebuilding, it is important to understand the three key components required for successful BIM implementation [31]. Firstly, a system to organise and label data in the model to ensure documents can be tracked and found when required. Secondly, a method for handling and making use of this data, and finally a method for exchanging the data with other stakeholders [32].

All of these processes already operate on projects, however, the BIM model can bring together all the information about the building, in one place, to be accessed by any stakeholder, and capable of detecting conflicts and errors at all stages of the project [3]. This BIM process together with the software model offers the potential for increased efficiencies and reduced errors and costs [33] for housebuilders.

Together with the efficiencies the BIM process can offer housebuilders, BIM software tools can be used to perform various analyses that add further value to the project. Some of the tools particularly useful to housebuilders will be explored further in the section on how BIM can add value to housebuilding.

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### e) BIM for Residential Housing

Research carried out by the National House Building Council Foundation [21] in 2018, a UK organisation established to carry out research in the house-building sector, found that the uptake of BIM was low amongst housebuilders, however it is clear BIM is gaining momentum in the house building sector with examples of housing developments using BIM increasing in Ireland and abroad.

In the UK, examples of successful BIM adoption on residential buildings include Nottingham City Homes (NCH), where two similar social housing schemes were built simultaneously, one using BIM processes (The Meadows) and one using traditional build (Cranwell Road) to compare directly with each other [34]. Despite the barrier of cultural change, as this was NCH's first project using BIM, and the challenge of down-stream adoption by sub-contractors, they still achieved a reduction of 5% on a per-unit basis for The Meadows compared to Cranwell Road [34].

Discovering how BIM can add value to a project is key for developers adopting BIM. For example, the Haggerston Phase 2 residential building project in the UK, where BIM was used for early massing models by the environmental team for daylighting and solar analysis. BIM facilitated the creation of accommodation scheduling and the exploration for façade material options with quantity and cost take-offs [32].

Since introducing BIM in Dublin County Council in 2017, more examples are emerging where many more local authorities are engaged in providing new social housing projects using BIM including: Projects built by Fingal County Council such as the Lusk scheme, where BIM was used for siteworks and landscaping [35] and a small six house development in Ballyboughal used BIM modelling to provide information on data, specifications, aesthetics, thermal and acoustic properties, to improve quality control and on-site documentation [36]. Another social housing development constructed 37 new residential units and refurbished 63 units at Dolphins Barn [37], using BIM processes to assist in site development, where laser scanning can be particularly useful for built up areas with poor access [38].

BIM adoption is also evident among the Build-to-Rent sector. These build-to-rent developers are using BIM for both their residential and commercial developments and are particularly interested in the life cycle maintenance cost benefits that BIM offers, including the use of COBie data in the model which can produce considerable savings for procurement and future facilities management operations [39], increasing the value of their asset [40].

Hines is a REIT developer, who is developing Cherrywood Town Centre, which was used as a case study by The BIM Innovation Capability Programme for Ireland [41]. This large scale project which includes residential units, used in-house BIM technologies mainly in the form of 3D design tool Autodesk Revit from early stages of planning, which enabled a greater understanding of the design due to extensive analysis performed at early stages, compared to traditional methods [41]. With a project of this scale, including roads, parkland and a luas stop, BIM's 3D visualization capability was used to provide a 360 degree, 3D experience of the proposed development to respond to complex constructability issues, and permitted an understanding of the design that could not have been realized through the application of existing 2D processes.

The key to the adoption of BIM for the house building sector is to understand how it fits in with what the industry currently does, and to identify areas where it may be able to add benefit in terms of increased efficiency and reduced costs and/or time [32]. However Hore believes that BIM needs to be recognized as a value creator rather than seeing it solely in terms of a cost factor (McAuley, Hore, and West 2019).

### f) How BIM can add Value for Housebuilding

Although BIM effectiveness in residential developments is still in a transitional period, and challenges, such as higher CAPEX in software and training and lack of expertise need to be addressed, there is evidence of developers beginning to identify areas where BIM processes and software can save time and money, while adding value.

Approved Housing Bodies and Real Estate Investment Trusts who have an interest in lifecycle costs, benefit most from BIM [43]. Many private property developers engaged in residential housebuilding are in the build-to-sell market, efficiencies in lifecycle costs is not relevant at present for this sector. Implementing BIM needs to benefit them in other ways, gaining efficiencies in the design and build, and sale of their development.

Barrett Homes, a traditional builder of block and brick homes in the UK, wishing to increase the volume of homes produced to meet market demand, while maintaining quality, embarked on a project to investigate alternative methods of construction. They found that off-site timber frame increased their output which achieved a quicker return on capital and utilising BIM added further value to their business [44]. Engineers Ireland, in the State of Ireland Report 2019, shares this view, recognises how the adoption of Modern Methods of Construction (MCC) could contribute to increased output of housing in the future [45], with prefabrication of elements a good route for

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transferring the intelligence of the data rich BIM model to the actual physical construction site [46].

Curtin also found off-site manufactured homes can be built to higher sustainability standards, with the advantages of speed of delivery, build quality, energy in use, carbon usage and reduced labour requirement in factory environments, [47] which aligned with new government regulations for all new homes being nearly zero energy rated buildings (NZEB), by 31<sup>st</sup> December 2020 [16].

It also has many benefits in reducing construction waste and the environmental impacts of construction, which aligns with Ireland's National Low Carbon Transition and Mitigation Plan to address climate change [48].

A report by Lloyds Bank also found a sizeable increase in building firms investing in new building techniques, led by modular housing [49]. They also found housebuilders using modern methods of construction reported 'faster build programme, fast watertight envelope, improved build quality, reduced costs and improved profitability, improved site efficiency, improved health and safety, reduced site wastage, tackles skills shortages, helps meet sustainability targets, increases number of units built and addresses materials shortage' [49].

Other areas that BIM can assist Developers, is dependent on the type of procurement route the developers are using, and if they are building the project themselves, or appointing a main contractor to design and build the project. However, a Design and Build procurement route in which the main contractor is appointed to design and build the project for an agreed price, would benefit most from the investment, 3D visualization, O&M facility and the sales and marketing aspects of BIM. Whereas BIM can offer a developer-contractor additional benefits across the lifecycle of the project including:

#### a) *Investment*

Securing finance for projects is the biggest challenge faced by developers [50]. Investors require information regarding profitability of the planned investment, therefore using BIM to assess project feasibility and verify the investment profitability is useful [51].

#### b) *Feasibility/Design Stage*

In the early stages of project design, BIM can be used to determine whether a development is feasible, and if it is capable of being delivered within a given cost and time budget. Using a macro-building model linked to a cost database can be incredibly valuable in assisting the developer to establish the viability of a project before construction [52]. The model can also be used to 'trial' potentially difficult construction

projects, resolving issues in the virtual environment, preventing costly re-working on-site [21].

Clash detection is one of the most promising aspects of BIM, offering savings of up to 10% of contract value and up to 7% savings on change orders. The cost to developers on variations is a substantial cost factor in time and money, using clash detection can improve accuracy and timeline of the project, including reducing Requests for Information (RFI), as issues are resolved in the model before commencement on-site [52].

#### c) *Site Development*

Underground Utility Surveys which can provide an overall view of the entire site's underground structures and cable and pipe networks, and can assist in the design and planning, minimising utility damage and project delays [53]. Cost of site development is a major expense for developers especially sites with gradient issues. Laser Scanning for site development can be used to create more detailed and accurate BIM models, and is particularly useful on challenging sites and built up areas with poor access [38].

Infraworks can be used by developers to demonstrate the house model on site using actual geographic data obtained through 'Bing maps' which facilitates external context setting such as surrounding buildings, services and infrastructure [54].

#### d) *Construction*

Many developer contractors employ cost managers /quantity surveyors to oversee their developments. Using 5D BIM tools to produce accurate quantities from the building model for all materials and objects in the design, including duration of each task and resources required, increases cost certainty, generating digital workflows and automatically updating quantities if/when changes occur. This can save money and time on costly rework and delays [55], including reducing Requests for Information (RFIs), ensuring the project comes in on time and budget.

With accidents on construction sites rising [56], on-site safety and planning are crucial for efficient project delivery. 4D scheduling software can be used by project managers to plan and schedule in a visual environment, and to work more safely, efficiently and collaboratively on site, while reflecting all changes to the schedule or sequence in real-time [57].

#### e) *Sales and Marketing*

Developers can also use the BIM model to create marketing materials to assist in off-plan sales [58] reducing more costly alternatives.

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Autodesk Revit can provide VR walkthroughs for clients in architecture Google Cardboard or with VR Headsets, providing the ability to virtually walk through the show homes irrespective of location. This can reduce initial capital outlay for developers on showhouses. In the Nottingham Development, BIM provided clients with the facility to have virtual walk throughs, which improved the uptake of customers [59].

#### g) Summary

The literature review confirms that although the NBC have prepared a roadmap for the adoption of BIM across the construction industry in Ireland, the lack of funding to implement this roadmap, impacts on the level of BIM maturity in Ireland. It also establishes that the early adopters of BIM in Ireland are mainly larger contractors, who have developed their BIM capability, either abroad or in other sectors of the industry. Although the Irish Government have called for the adoption of BIM across public works contracts, and have set ambitious targets to double the annual level of residential construction of social housing, there is limited evidence of BIM being implemented by Irish developers providing social housing in Ireland. The research also indicates that while there is evidence of successful BIM implementation for housing resulting in savings in cost and time, widespread adoption is being hindered mainly by lack of knowledge and skills, costs of implementation, lack of client demand and difficulties with downstream adoption by sub-contractors and the building products supply chain.

### III. RESEARCH METHODOLOGY

The purpose of this research was to examine the relationship between BIM and property developers in the housing sector in Ireland. It consisted of a desk study, a questionnaire survey and complementary semi-structured interviews that explored the attitudes, views and opinions of those involved in this sector. The author chose a mixed methods research approach [62]. In the first phase, quantitative hypotheses addressed the level of uptake and use of BIM by Property Developers working in the residential housing sector in Ireland. In the second phase, the results from phase one and the Literature Review assisted in developing the qualitative semi-structured interviews, which used maximal variation sampling, interviewing individuals with different roles within the sector.

#### a) Survey

The findings from the literature review indicated the possibility that larger private build to rent developers with experience in commercial development and/or

interests in other countries were more likely to be the early adopters of BIM in housebuilding in Ireland. The survey was designed to establish the accuracy of this assertion and to establish the current level of awareness and use of BIM by Property Developers with developments of 50+ residential units. A basic questionnaire was created. To find the sample the author used the Department of Housing, Planning and Local Government website to access planning permissions, using a filtered database to include 50 units or more and planning permissions granted since January 2016 to January 2020. This was then downloaded as an Excel spreadsheet which contained 232 applications. In the spreadsheet, there were HTML links that connected to all local authority planning applications. From reviewing these applications, 97 applications were removed due to duplication, where some applications came from the same property developer. The remaining 128 applications were reviewed using the credit safe website, which was used to find correct contact details for each application which was then analysed. 86 additional planning applications were removed as no contact details were found, leaving 51 remaining. This was the number surveyed.

#### b) Interviews

This two-phase explanatory mixed methods study obtained statistical quantitative results from a sample and then followed up with in-depth semi-structured interviews with six individuals engaged in the Residential Housebuilding sector which included:

**Participant 1.** Private Developer who is engaged in build-to-sell private housing development and social housing units not using BIM.

**Participant 2.** Private Developer of build-to-sell and build-to-rent housing developments using BIM.

**Participant 3.** Project Manager for Private Developer of build-to-sell housing in Ireland and UK using BIM.

**Participant 4.** Project Manager for both commercial and residential largescale projects in Ireland using BIM.

**Participant 5.** Contractor using BIM for residential units for Public Works Contracts and REIT clients.

**Participant 6.** BIM Consultant who advises developers on a strategy for adopting BIM and provides training for staff.

All the participants are working in the residential housing sector and play significant – but - different roles in project process, to probe or explain those

results in more depth. Two of the interviewees worked together on same projects but in different roles and were specifically chosen to reflect different perspectives of BIM on the same project. In this way a ‘more rounded’ investigation of the barriers, gaps and issues were explored. All interviewees were anonymised in order to protect both their identity and confidentiality. Each interviewee was presented with the same questions relating to the objectives of the research, and some additional questions tailored specifically to each interviewee. Following the interviews with the five developers, the BIM Consultant, was interviewed to discuss the research findings and to offer his expertise and insight into current commercial practice.

#### IV. DATA ANALYSIS & FINDINGS

##### a) Survey

The survey was conducted for Large Property Developers with planning permission for 50+ residential units. There were no Real Estate Investment Trusts (REITs) surveyed.

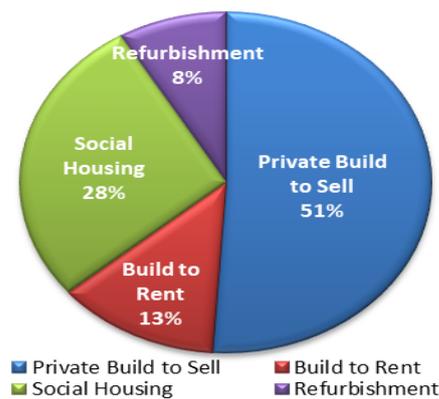


Fig. 1: The Section of the Residential Sector Supplied by the Developers Surveyed

There was a 57% response rate to the survey. Of these respondents 83% were engaged solely in Private Property Development. 31% were engaged in Private and Social Housing and 10% were also engaged in Commercial development. The key findings included:

- 21% of Property Developers are using BIM on Residential developments and these Developers that are implementing BIM on residential projects, 80% of them are also engaged in commercial development.
- Of the 79% of Developers not using BIM for Residential Housing, 69% of these had an

awareness of BIM and 38% had used BIM previously on projects other than residential.

- Developers using BIM for residential housing were using it for Pre-Design, document management, planning permission, site-development, on-site construction, on-site planning and scheduling, off-site construction, sales and marketing, energy analysis, tendering, and O&M.
- Developers with more than 21 years in business were more likely to be using BIM.
- Developers engaged in the Build-to-Rent sector were more likely to be using BIM. This confirms findings from the literature review that this sector used BIM for the O&M of their units and were the early adopters of BIM.
- 45% of those surveyed intend to implement BIM for residential within 1-2 years.

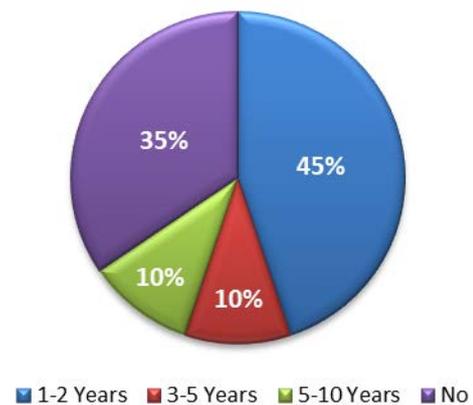


Fig. 2: Anticipated Future Level of BIM Adoption by Property Developers for Residential Housing in Ireland

- Developers using BIM for residential housing were more likely to employ contractors to build their projects. This result indicates that contractors with BIM capability are now moving into residential housing in Ireland for Private Developers.
- A significant 31% of these Large Property Developers did not know what BIM is.

These findings largely correspond with the results from the Literature Review including developers engaged in other sectors e.g. commercial sector, to be much more likely to use BIM for residential. It was also interesting to discover that almost half of those surveyed intend to adopt BIM over the next two years.

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The filters used to create the database for the survey precluded Property Developers of smaller developments, consequently, the author decided to include an interview with a developer engaged in smaller projects to counterbalance the argument and understand the position of smaller developers, who make up a large percentage of the residential house building sector in Ireland.

## b) Semi-Structured Interviews

The findings from the survey indicated that only a small percentage of Large Residential Property Developers were using BIM. However, the author decided to interview four individuals working in residential house building who were using BIM for some aspects of their project and one developer engaged in smaller developments, who was not using BIM. Two participants had experience over numerous projects using BIM including commercial projects, and two were using BIM on their first project. The interviews included organisations engaged in the build-to rent sector, the build-to-sell sector and social housing, to establish any nuances relevant to each sector. The author was interested in establishing what the ‘real’ benefits and challenges were for organisations adopting BIM for housebuilding and to explore more deeply some of the findings from the research in other countries. The interview with the developer not using BIM was conducted in order to establish what are the main issues arising for SME developers using traditional methods of construction and this helped to ensure the answers were not biased towards larger organisations. The key areas of interest were:

### a) Length of Time Using BIM and Reasons for Adopting it

In order to leverage the potential of BIM for developers, it is important to understand what their key motivations for implementing BIM are. The survey indicated that 45% of the respondents intended to implement BIM within the next 2 years, and two of the interviewees using BIM, were using BIM on their first project. This corresponds with earlier research in Ireland in 2018 indicating housebuilders were not using BIM [47] and suggests developers engaged in residential housing are now beginning to recognise the value of BIM adoption for housing. The primary motivation to implement BIM was economic, but the main contractor also stated environmental pressure following downturn from competitors adopting BIM and client demand with BIM mandate in UK. Cost and lack of knowledge were the primary motivating factors for not implementing it also:

- *“Having come from a background in main contracting over 13 years, where I was introduced to BIM.” Implementing BIM in the design stage and using clash detection “to tease out a lot of the things that can go wrong on site that cost contractors money.... they would pay a lower premium on the buy-out of the contract with the main contractor”.*
- *“In their build-to-rent fund where they are holding onto these assets for up to 15 years, the BIM 360 Field technology could be used by the end user to report snags and problems and all done in the cloud through downloading the app BIM 360, which would be far more cost effective than a more manual manner such as ringing a help desk”.*
- *“The chief reason for deciding to begin implementing it, was the cost of consultants for providing all the various reports needed for some of their developments in Dublin, when applying for planning permission, including Daylight and Sunlight Reports, Shadow Analysis, Wind Analysis Reports, CGIs and Photomontages. By designing the building in Revit from the start, it is easy to generate these reports and images from the model. So economically it made sense”.*
- *“Lack of knowledge and cost would stop me considering BIM”*
- *“Decided to adopt it after the downturn, recognising that investing in technology and innovation would help them become more competitive particularly in the UK with the BIM mandate and many of their competitors had already adopted BIM, and they did not want to be left behind”.*

### b) Modern Methods of Construction

It was interesting to discover that all of the developers interviewed were using MMCs for some of their developments, but none were using a BIM model for fabrication purposes for houses, however, two were using it for apartments. One was using it for modular bathroom pods for apartments. The majority of research believes that MMC offers the greatest potential to developers to leverage the greatest efficiencies for housebuilding. The small developer not using BIM was more aware of the benefits in time and quality through using off-site construction than developers using BIM.

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### c) Challenges Adopting BIM

Although BIM is one of the most promising innovations to address performance problems that have long plagued the construction industry, most organisations still lack knowledge on how to adjust traditional design and construction processes to meet the requirements of BIM implementation. Even with BIM capability it may take time to fully realise the value of BIM due to interoperability problems and non-collaboration of other project participants. Many of the participants answers were comparable to research carried out by the National House Building Council Foundation in the UK including:

- Cultural change – “getting employers to buy into it, getting design team to buy into it, getting their supply chain and subcontractors to buy into it”.
- Lack of cooperation between parties in construction – “getting design team to agree who is modelling what”.
- Lack of knowledge and skills – “found the coordination challenging and the extra time required for modelling at the start and transferring from 2D to 3D has a definite time impact”.
- Lack of client demand – “Architects are not going to invest in new hardware and software when no-one is asking for it”.
- Change in mindset – “Working in Revit is completely different than CAD. BIM allows you to build the building digitally first working out issues before you build on site”.

One participant found “Revit’s lack of flexibility with making changes” a challenge, compared to larger industrial projects.

The developer not using BIM felt his lack of knowledge and cost of implementing BIM were the main barriers to considering it, however the BIM Consultant and the contractor believed that “the technology does not have to be expensive, it can be as practical and reasonable as you would like, costing as little as €15 to €20 per day”. No matter what size the project is, “the cost is less doing it in BIM than not doing it in BIM but only if BIM is used properly. Multiple studies have proven this” [60].

### d) Advantages for Property Developers for BIM Adoption

Many of the earlier stated motivations for implementing BIM by developers were mainly

economic, however other advantages were realised through the adoption process including:

- “the level of comfort modelling in Revit from the start can be a major plus for projects”
- “when dealing with an existing landscape, such as trees or a water body, or challenging underground servicing”
- Document Management
- Clash Detection.
- All the developers use the model as a marketing tool.
- Coordination of bathroom pods
- BIM had added value to their developments including savings from generating reports from the model, design team had not charged more for BIM modelling.
- Using BIM to generate a fully federated BIM model which can be used for OPEX is a huge benefit and improves the value of the asset.
- Improved site safety.
- Improved project delivery time.
- Reduced arguments and disputes.
- Improved collaboration between all stakeholders.
- Model provided 3D visualization which permitted greater understanding of the project for all.
- Project Cost – using BIM reduces waste and overall cost of project significantly

All interviewees using BIM agreed that BIM is a mindset and because BIM is still a new concept for developers, it is viewed by most as “more trouble than it’s worth” and “a time consuming, laborious negative thing”. However, even though two have not yet completed a project using BIM, all of them are “very much for it”, seeing it as a powerful tool for change in their companies.

### e) Education and Training

Research from the literature review from main contractors who have successfully implemented BIM over the past few years advocate strongly the

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importance of developing a plan and not underestimating the importance of training and change management within the company. Considering this advice, it was remarkable that none of the developers interviewed had any training in BIM, two were relying on external consultants and one was considering employing a BIM Manager in the future. The main contractor had much more understanding of BIM “in action”, and the need to upskill all their staff, including their suppliers and subcontractors which improved their productivity on site. He also had a good understanding of the standards and regulations regarding BIM and the importance of establishing a CDE for data management and site management and issues of interoperability. Two of the developers had experienced interoperability issues with software used by their external consultants producing CGIs.

#### f) *General Comments on Using BIM*

Two of the participants did not believe using BIM on traditional or timber frame housing is necessary or adds value as “*it is pretty standard and you can decide in 2D pretty quickly and so it is a waste getting into the cost of using BIM*”, however both agree “*that BIM is far more useful and cost efficient for apartments, as they would see the coordination of services from plant rooms and basements and all that kind of stuff, much more fundamental and tricky than in a housing development*”. However, the Developer/Contractor found the opposite and saw BIM as “*even more useful for their houses than apartment blocks. Many developers have scrapped it. We stuck with it but at times it was tough not to go back to 2D. But it has paid off. You either do it right or not at all*”.

The findings from this research broadly confirm the results from the literature review, recognising areas that BIM adoption can add value to residential projects. However, there are also new findings that add to this research area including:

- The importance of *doing BIM right* when adopting it.

The BIM consultant was keen to stress the importance of not doing ‘sudo’ BIM, which if you don’t have enough knowledge to have a decent conversation with your architect or engineer – then the whole process will be dictated to you by others who don’t know what they are doing, and where, you do BIM incorrectly – and a lot of people do, then it does take more time and money. All of the BIM users interviewed agreed with this account but interestingly the only one that got advice and training has been the main contractor. However, each of them agreed that they could be making better use of BIM if they understood it better, believing that because they were

not directly engaged with using the model themselves, they had less need to understand it, which legitimizes the BIM Consultant’s point.

#### g) Summary

The literature review points to more main contractors using BIM than developers, and all four participants using BIM believe that contractors were way ahead of “the game” when it came to BIM adoption, agreeing that contractors are better educated in “using BIM to get ahead of the issues”. The BIM Consultant believes the main reason for this is the potential benefit BIM offers to the contractor in reducing the risks through coordinating the model, when “it is really cheap and you can work out all the issues and test it thoroughly, its performance, its quality, its cost everything, reducing the risks before starting on site”. This indicates that the potential benefits for using BIM in housebuilding may realize greater returns for developers who are also engaged in building their own projects. One of the most unexpected findings in the primary research was the lack of use of the model for fabrication of their timber frame housing by developers even though they were all using MMCs for housebuilding, although one was using BIM for “the modular construction of bathroom pods, where they found BIM as fundamental to the coordination of the shafts and risers that feed and drain those pods”. The research confirmed the fragmented work practices on traditional sites, and highlighted the cost efficiencies, of using off-site construction, on a traditional site, in time, quality and cost, particularly in improving the Building Energy Rating (BER) of the houses which increased the price offered by the local Authority for the final build. The study also confirms that despite challenges implementing BIM, the benefits of implementing it were worth it.

### V. RECOMMENDATIONS

This study evaluated the level of BIM adoption by larger residential property developers in Ireland and the benefits and challenges of implementing it for residential housing. Although BIM is a relatively new concept in Ireland for housebuilders, developers are beginning to implement BIM, recognizing areas where BIM would add value for them. However, challenges exist including lack of knowledge and skills, lack of client demand, cost of implementation and lack of BIM objects for domestic building materials and products. The research also found that small developers were mainly deterred by cost and lack of knowledge and highlights how this has the potential to create a two-tier system. The lack of progress in implementing the NBC Roadmap impacts on the level of maturity of BIM across the industry. Government, as the largest client of housing has most to gain from lower housing costs. Despite

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Government recognizing the potential of BIM to radically transform how housing is delivered, and the predicted efficiencies in its Project 2040 Plan, no action has been taken to deliver on large scale social housing. The lack of supply is driving high rents and investor appetite in the Irish market. Government need to take the lead in providing better quality, more affordable housing quicker. From the results of this study the following recommendations are proposed to support BIM implementation by Developers in the residential sector:

#### a) *Education*

- In order to drive innovation, public and private providers need to be educated firstly on the proven benefits of BIM for residential housing, as there is a lack of knowledge on the subject, providing information and workshops.
- Provide incentives for staff training and BIM implementation i.e. implement a Research & Development (R&D) tax credit to companies in construction for BIM adoption and use of innovative construction materials that achieve better performance or have a smaller negative impact on the environment or that use recycled ingredients in their manufacturing [61].

#### b) *Client Demand*

- Increase client demand to see significant improvements in cost, value and carbon performance, by making BIM a requirement on residential housing, which will require industry to respond accordingly.
- Regulate for a digital asset to be provided as part of all newly built housing, which provides a digital set of information on the O&M of every new home.
- Create client demand for BIM in this sector by mandating BIM for social housing, including private developers with social housing obligations as part of their planning permission. This will encourage downstream adoption by manufacturers, suppliers and subcontractors to adopt BIM.

#### c) *Government*

- Government need to provide funding for the NBC Roadmap for Digital Transition for the Construction Sector 2018-2021 to grow the level of maturity across the industry.

- The government need to take a long-term view on the provision of social housing and increase its direct involvement in building houses.
- By funding a BIM library of objects that are needed for housing – a generic set of objects and make those objects available to the whole market, every architect, every developer, every builder. This would provide specific support to everyone engaged in housebuilding in BIM.
- Provide the same set of objects to every manufacturer in Ireland who produce building materials or products for housing and encourage them to use these sets of generic products and adapt them to their own products, putting in more detail, more information about their objects. In this way they are promoting Irish manufactured goods through educating them in what is required for their goods to have the standard of information required. Then these can be included in a central server and available to everyone.

#### d) *Industry*

- BIM models to become a requirement for planning permission applications for developments of fifty houses or more and to be introduced over a phased basis across Local Authorities countrywide.
- Industry leaders provide pilot projects to demonstrate benefits of BIM for housebuilding to drive innovation across the design and construction of housing that can be used to encourage more widespread adoption.

#### e) *Promote the adoption of MMCs*

- Provide education within the industry and to the public on Modern Methods of Construction to increase demand.
- Government have promoted MMCs in numerous reports on housing, but they also need to encourage housebuilders to embrace offsite construction to meet new energy targets which can be achieved more easily under factory conditions than building on-site. This could be done in the form of a Research & Development tax credit [61]. This would encourage house builders to move to more off-site manufacture.
- A Construction Innovation Centre of Excellence needs to be established to support the adoption of MMCs with focus on SMEs and public sector clients.

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## VI CONCLUSION

Developers and Investors in larger scale developments are beginning to recognize areas where BIM can add value to their projects. However more large-scale adoption by small and medium sized developers is less likely unless supports are put in place to promote more widespread adoption across residential housebuilding. Government need to show greater ambition and recognise the initial investment in BIM supports as the route to delivering houses quicker, cheaper with better quality, as has happened in other countries. Otherwise house prices will continue to increase.

With government support to drive its implementation, BIM can facilitate greater industrialized house building, using prefabrication and off-site construction and standardized objects to increase output. With low density housing projects being the least complex for BIM adoption, which would suggest housing would be ideal for first time early adoption projects.

However, the adoption of BIM for smaller developers is currently less probable, as the financial risk is too great in adopting new technologies and additional expenses of training staff and changing work processes to cope with new technology, and with little or no client demand. Larger developers are better able to absorb any potential costs incurred by the transition to BIM. This has the potential to create a two-tier system. If a BIM mandate comes in, Government should consider either a tax credit or other tax incentives to encourage BIM implementation across the industry.

## VII LIMITATIONS AND FUTURE RESEARCH

The scope of this research is limited by the lack of previous research studies into property developers adopting BIM. Other limitations included the difficulty in sending the questionnaire out to participants created by the national lockdown for Covid 19 Pandemic, with many companies closed, and the difficulty accessing contact details on planning applications. Areas for future research include:

- The role of Government implementing BIM for housing in Ireland.
- How BIM adoption for housing is supported in other countries
- What supports need to be put in place by Government to support more widespread adoption of MMCs for housebuilding.
- What supports need to be put in place to promote more widespread adoption of BIM across the housebuilding sector by SME developers.

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