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BIM in Ireland 2019: a Study of BIM Maturity and Diffusion in Ireland

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BIM in Ireland 2019: A Study of BIM Maturity and Diffusion in Ireland

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Abstract−In 2017, the BIM Innovation Capability Programme team applied five macro BIM maturity conceptual models to capture the capability of the Irish construction industry and assess its BIM maturity. The results found that while Ireland is mature for modelling processes, it is less developed with regards to collaboration processes and policies. Ireland also ranked poorly when it came to regulatory frameworks, measurements and benchmarks compared to a number of countries which also applied the same conceptual models. At the time, the findings highlighted that Ireland's diffusion dynamic was middle out, meaning that larger organisations or industry associations were pushing the BIM agenda and not the government, which had primarily chosen a passive approach with little or no assertive activities. The results also showed that the educational institutes had a much higher BIM diffusion compared to policymakers. Since the initial findings of the macro BIM maturity study, the Irish government has endorsed many initiatives, such as the announcement of a strategy to increase the use of digital technology in crucial public works projects, as well as contributing to the Digital Construction Transition Roadmap 2018-2021. As a result of Ireland's growing market for BIM and the recent public sector requirements, it was decided to reapply the five macro BIM maturity conceptual models to investigate if this has impacted on Ireland's BIM diffusion dynamic and levels. The results will be complemented through a selection of research initiatives which the researchers have undertaken to further establish Ireland's BIM maturity in 2019. It is hoped that the results from this exercise will inform the Irish government and AEC sector of the key requirements to ensure wider adoption of BIM in Ireland.

Keywords−Building Information Modelling, Ireland, Maturity, Leadership, Education, Standards,

I INTRODUCTION

The 2017 Macro BIM Adoption in Ireland Study [1, 2] at the time provided crucial information in highlighting areas that were required to be addressed if Ireland was to continue the momentum in promoting BIM within the industry. The BIM macro maturity models developed by Succar and Kassem [3] are part of the BIMe Initiative Macro Adoption Project. This framework consists of five conceptual models that have been utilised to measure macro BIM adoption across the world (Figure 1). The research conducted in 2017 strongly indicated that clients were struggling to understand the actual benefits of BIM. At the time there was a strong requirement for the development and dissemination of national guidelines to create and implement a collaborative environment that would foster BIM use for particular professions [1 - 4]. The macro BIM adoption study results were used in the Roadmap to Digital Transition for Ireland's Construction Industry 2018 – 2021 to help guide the industry [5].

Figure 1: Macro BIM adoption models [3]

Since the publication of the roadmap in 2017, 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 [6]. 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 radically improve project outcomes and asset operations [6]. These initiatives have been encouraged by the ongoing revival of the construction industry with the sector expected to grow by 20% in 2019, totalling €24 billion [7].

Given that the roadmap and government's strategy to increase digital technology had been in effect for two years, along with a continued surge in construction sector output, it was decided by the authors to reapply the macro BIM maturity conceptual models to investigate if Ireland's BIM diffusion dynamic and levels have been impacted. Also, as the roadmap is industry-led and the government's digital strategy for the construction sector had not provided any clear guidance to-date, it was agreed that the macro BIM maturity model would assist in understanding any limitations that a lack of funding has had on the adoption of BIM.

II METHODOLOGY

The BIM Innovation Capability Programme (BICP) between 2016 – 2017 captured the Irish construction industry's and the Higher Education Institutes' (HEI's) response to the increased requirement for BIM on Irish construction and engineering projects [8].

At the beginning of 2019, the Construction IT Alliance (CitA), in consultation with academics from the Technological University Dublin (TU Dublin) and Trinity College Dublin (TCD), commissioned an exploration of a selection of BICP initiatives that could be used to provide further guidance for the Irish AEC Sector. The overall goal of this initiative is to publish a BIM in Ireland 2019 report, similar to that produced in 2017 [9].

This paper will explore an extension to the macro BIM maturity study, which was a BICP initiative in 2017. This framework consisted of five conceptual models that have been utilised to measure macro BIM adoption across the world. These models can be used for:

- Assessing a country's current BIM adoption policy.
- Comparing the BIM maturity of different countries.
- Applying models in developing a national BIM roadmap.

Data for the Irish macro maturity study was collated through a survey tool developed by members of the BIMe Initiative and hosted on BIMexcellence.org [10]. The maturity study in this research, as similar to 2017, focused on "markets" and not projects, teams, organisations or individuals. Specifically, the study undertook to investigate the levels of "adoption and diffusion" of BIM in Ireland. A selection of complementary research initiatives was used to triangulate the data.

III IRELAND'S MACRO MATURITY MODEL 2019

The same 19 persons from 2017 were targeted to complete the macro adoption study, along with 7 new respondents who are actively involved in BIM. A total of 13 persons completed the study. While responses were lower than 2019, they were still well above the threshold required to produce functional data for interrogation from the macro adoption models. This section will explore the results and compare them with the findings from 2017.

Model A: BIM diffusion areas

The macro-adoption model clarifies how BIM field types (technology, process, and policy) interact with BIM capability stages (modelling, collaboration, and integration) to generate nine areas for targeted BIM diffusion analysis and planning. The 2017 results showed that Ireland was mature for modelling processes and model workflows, but it was weak in regard to collaboration processes and policies. Table 1 details the results from 2019 in comparison to 2017.

The BIM diffusion model for 2019 (Figure 2) determines that Ireland has experienced a steady increase in both collaboration and integration for process and policies. The improvement in policy and processes in regard to the BIM collaboration fields can be partially attributed to the roadmap and government's digital strategy.

However, a more significant initiative which has helped in this context is the introduction of ISO 19650. The ISO 19650 documents provide a standardised approach to using BIM for the delivery phase of assets [11]. The Irish BIM community previously reported that it was comfortable working with the requirements of BS 1192 and the PAS 1192 suite of standards [1].

As these documents have influenced the new suite of ISO 19650 standards, it has resulted in a smooth transition for the Irish BIM community, which has contributed to the increase of this diffusion model.

This maturity model should exhibit further growth in the coming years as the National Standards Authority of Ireland (NSAI) now offers third-party certification to IS EN ISO 19650 part 2. The certification scheme caters for three main categories of organisations - employers, designers and contractors. Other certification bodies, such as BRE, have developed a certification pathway scheme that offers BIM certification and is now focusing on the Irish market due to the uptake of BIM within the sector.

	Techno -logy (%)		**Process (%)**		**Policy (%)**	
	17	**19**	**17**	**19**	**17**	**19**
Integration	42	58	21	37	13	25
Collaboration	58	65	35	44	23	27
Modelling	76	77	45	46	27	35

Table 1: BIM diffusion 2017 vs. 2019

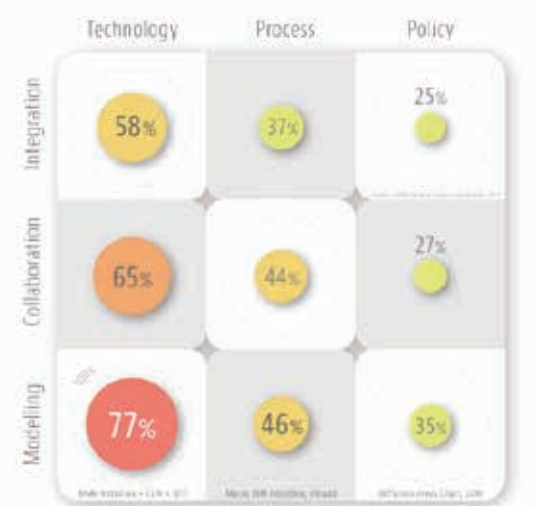

Figure 2: BIM diffusion areas model for Ireland 2019

Model B: Macro Maturity Components model

The macro maturity components model identifies eight complementary components for establishing and measuring the BIM maturity of countries and other macro organisational scales. The components are: Objectives, stages, and milestones; Champions and drivers; Regulatory framework; Noteworthy publications; Learning and education; Measurements and benchmarks; Standardised parts and deliverables; and Technology infrastructure. Table 2 details the results from 2017 in comparison to 2019. Figure 3 illustrates Ireland's current maturity within each area.

Figure 3. Model B macro maturity components model for Ireland

Compared to 2017, Ireland has seen moderate growth in the majority of components. The largest growth has come within the objectives and milestones, regulatory framework and noteworthy publications. In 2017 concerns were raised that unless a regulatory requirement for BIM is promoted from within the government, then these critical areas would stagnate or regress. The roadmap, government's digital

strategy and ISO publications have all played a part in elevating these figures.

	2017	2019
Objectives, Stages, and Milestones	0.8	1.4
Champions and Drivers	1.5	1.5
Regulatory Framework	0.5	1
Noteworthy Publications	1.4	1.7
Learning and Education	1.6	1.7
Measurements and Benchmarks	0.8	0.8
Standardised Parts and Deliverables	1.2	1.2
Technology and Infrastructure	2.1	2.1

Table 2: BIM diffusion 2017 vs. 2019

While other figures have not significantly grown, they remain stable. Ireland's technology and infrastructure continues to attract foreign investment with Project Ireland 2040 firmly placed to support businesses and communities across all of Ireland in realising their potential [12]. Learning and education remain strong with ongoing commitments to digital construction evident within leading third level educational bodies. This commitment is fundamental as the Irish construction industry now faces an unprecedented skills shortage that could potentially impact on the proposed Project Ireland 2040 targets, with 86% of contractors identifying staff shortages as a major concern [13, 14].

Model C: Macro Diffusion Dynamics Model

This model assesses and compares the directional pressures and mechanisms affecting how diffusion unfolds within a population. The model includes three diffusion dynamics: top-down; middle-out, and bottom-up. The model is also augmented by three pressure mechanisms: downwards, upwards and horizontal. Results are similar to those of 2017, which suggest again that that Ireland's diffusion dynamic is still middle-out, meaning that larger organisations or industry associations are pushing the BIM agenda within the industry and not the government.

As the government has not provided strategic funding to-date or guidance documents to assist with BIM implementation, this has resulted in this model remaining static. This is concerning considering that unless adequate funding is provided to support the government's digital strategy, it may risk further alienating SMEs within an already demanding and extremely competitive sector [15].

Model D: Policy Actions Model

This model identifies, assesses and compares the actions which policymakers take (or can take) to facilitate market-wide adoption. The model includes three policy approaches, namely: passive; active and assertive. These approaches are, in turn, mapped against three policy activities: make aware, encourage, and observe. Table 3 details the results from 2019 in comparison to 2017. Figure 4 illustrates Ireland's current maturity within each area.

	Passive (%)		Active (%)		Asserti -ve (%)	
	17	**19**	**17**	**19**	**17**	**19**
Communicate	68	55	32	45	0	0
Engage	74	73	21	18	5	9
Monitor	95	82	5	18	0	0

Table 3: BIM policy actions 2017 vs. 2019

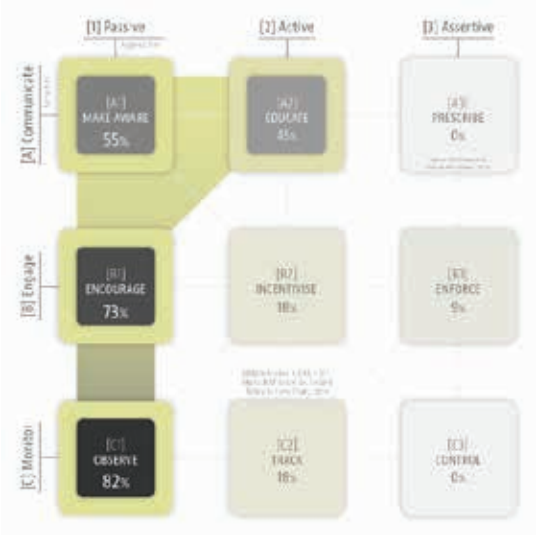

Figure 4: Macro diffusion dynamics model

In 2017 the policymakers in Ireland were mostly passive, with some evidence of active approaches and with little or no assertive activities. While results are similar in 2019, it is encouraging to observe that the Irish government is now seen as taking a more active approach when it comes to communication. This is evident by recent initiatives, such as the establishment of the Construction Sector Group (CSG), which ensures that regular and open dialogue between government and industry takes place on how best to achieve and maintain a sustainable and innovative construction sector positioned to deliver on the commitments in Project Ireland 2040. A part of the CSG's remit is to advise on BIM and other digital innovations and processes. The CSG reports to the

Minister of the Department of Public Expenditure and Reform (DPER) [16]. The Public BIM Sector Group has also played a valuable role in educating members of the public sector through workshops and Hackathons.

While results have improved in comparison to 2017, there is a slight reduction in incentivisation despite an increase in training. These figures would be predicted to decrease or stagnate if the government fails to provide the industry with more encouragement and support to adopt BIM.

Model E: Macro-diffusion responsibilities

This macro adoption model analyses BIM diffusion through the roles played by industry stakeholders as a network of actors. It first identifies nine BIM player groups (stakeholders) distributed across three BIM fields (technology, process, and policy) as defined within the BIM framework. The nine-player groups are policy makers, educational institutions, construction organisations, individual practitioners, technology developers, technology service providers, industry associations, communities of practice, and technology advocates. Table 4 details the results from 2019 in comparison to 2017.

	2017	2019
Policy Makers	1.2	0.5
Educational Institutions	2.7	2.7
Construction Organisations	2.4	2.4
Technology Developers	2.9	3.1
Technology Service Providers	2.6	3.2
Industry Associations	2.2	2.1
Communities of Practice	2.4	2.1
Technology Advocates	2.7	3.2

Table 4: BIM diffusion 2017 vs. 2019

In 2017 the technology developers were seen as the most influential technology players. However, the developers, service providers and advocates are now seen as co-leaders in this space (within the accuracy of the data). For the policymakers, the educational institutes continue to have much higher BIM diffusion compared to policy makers. On a concerning note, the survey shows a significant drop for policy makers within this area which indicates that, despite an increase in objectives and milestones, regulatory frameworks and a move toward an active communication strategy, industry in overall are not satisfied with the government's leadership and support. Educational institutes have responded in kind to this, as seen through the growing number of undergraduate and postgraduate BIM courses, such as the 2019 Irish Construction Excellence Postgraduate winning Masters in Applied BIM and Management at TU Dublin. There has also been a marked improvement in BIM-related research projects, such as the Horizon 2020 BIMcert project, Limerick Institute of Technologies BIMeED project, Galway Mayo Institute of Technology BIM Futures project, TU Dublin/TCD BIM Frameworks, etc. [17 – 19].

The construction organisations are seen as the key process players. However, industry associations and communities of practice are also ranked highly. The BIM in Ireland Umbrella Forum, co-ordinated by CitA, was launched in January 2019 and provided an additional neutral and holistic environment for the sharing of information for review or comment between the different professional institutes digital construction / BIM subcommittees. The Forum has provided updates to the Irish AEC industry on work being performed by the individual professional institutes with regards to digital construction [20]. Some key milestone within 2019 includes the launch of the Construction Industry Federation's BIM Starter Pack, NSAI's ongoing work on a National Annex for ISO 19650 and the CitA BIM Regions continued dissemination and educational workshops on digital construction. Perhaps the most significant development has been the launching of the Royal Institute of Architects (RIAI) BIM Guidance Pack which has provided industry-ready templates, such as, Employer Information Requirements, BIM Execution Plan, etc. Other forum members included BIM subgroups from the Society of Chartered Surveyors (SCSI), Association of Consulting Engineers (ACEI), Women in BIM (WIB), Irish Public Sector BIM Group, Institute of Engineering Surveyors and Transport Infrastructure Ireland (TII), who all continue to do crucial work in promoting BIM within their respective organisations, as well as communicating amongst each other to ensure ongoing conversations are happening.

IV Digital Transition for Ireland's Construction Industry 2018 – 2021

The National BIM Council (NBC) of Ireland roadmap to digital transition for Ireland's construction industry 2018 – 2021 advocates more productive ways of working that improve competitiveness at home and overseas. The roadmap was divided into four key pillars; leadership, standards, education and training, and procurement. This section will explore how the results from the macro maturity models have provided an insight into the current state of the roadmap.

a) Leadership

The leadership section of the roadmap requests that strong, consistent leadership is at the very centre and that it is essential that a platform is created and supported with the resources to sustain the change process. While government has not provided the leadership required, as of yet, there is still evidence that the industry continues to mature.

In the recent NBS CitA survey it was reported that 76% of respondents had adopted BIM. According to the macro maturity models, leadership is presented by construction organisations, professional institutes, and the 3rd level educational sector. Despite no strategic funding being provided to-date from the government, some public sector organisations, such as, the Grangegorman Development Agency, Dublin City Council, Transport Infrastructure Ireland, Office Public Works, Office of Government Procurement, National Development Finance Agency, amongst others, all continue to push BIM. The NBS CitA survey also reports that BIM is being used more often on public sector projects, such as health projects [20].

One of the key recommendations within the leadership pillar in the roadmap was the establishment of a National BIM Centre of Excellence with a focus on driving the digital transformation of the sector. A collective consortium of industry bodies has presented their findings to the CSG on a roadmap for what services the Centre of Excellence should offer and how it should be funded. The paper by Hore et al. [21] also provides supportive information on a proposed framework for a BIM Centre of Excellence and how it could be managed. This funded Digital Centre of Excellence could support the roll-out of digital tools and processes in Ireland while in the short term it could provide a platform for the digital transformation programme envisaged by the NBC in 2017 [22].

b) Standards

One of the key recommendations within the standards pillar was to specify training, educational and certification support initiatives to develop the core BIM capabilities of the industry. The roadmap suggested that government, NSAI and other recognised institutes, develop industry training and certification programs on current best practice standards. In response, as suggested within the roadmap, NSAI has now developed a BIM certification program. This is aligned with the publication of IS EN ISO 19650 part 2, which provides an internationally recognised standard for BIM. Along with the development of the National Annex and the ongoing release of templates and guidance documents, such as the RIAI BIM Pack, continued progress is expected in this area.

Other targets within the standards pillar include support for Ireland's involvement in international and European standards development and aligning planning, building control and public asset information with standards. These aims are both being managed, with three Irish BIM experts attending CEN meetings and, for example, funding being made available for a Postdoctoral Scholar at Dublin City University to investigate how Industry Foundation Classes can be used for digital planning and building regulation control submissions. The development of online tools and supports to help implement "National Tools" has yet to be progressed.

c) Education and Training

The third level education sector continues to be seen as the primary entity for upskilling. Professional institutes also continue to upskill internally by offering workshops and documentation regarding BIM. Organisations, such as CitA, continue to provide guidance to both large enterprises and SMEs within the sector through workshops, discounted training, conferences, research publications, etc.

The roadmap outlines a series of recommendations to deliver a broad awareness and upskilling learning framework for both educators and industry through a National BIM Education Taskforce within the educational and training pillar. A necessary action for the taskforce is the inclusion of digital design and construction in second-level curricula. To target the skills shortage at its core, it is recommended by the authors to explore exemplary international initiatives, such as Class of Your Own and BeIMCraft [23-24]. A condensed focus on pupils before they finish secondary school can assist in presenting them with a broad and diverse range of career choice opportunities within the construction sector. The platform of BIM and other digital technologies can be used to demonstrate the attractiveness of the industry in meeting the aspirations of future generations. At present, the National BIM Education Taskforce has not been established.

To-date, the development of an online BIM self-assessment tool for companies and a base level of learning outcomes targeted at alternative National Framework of Qualifications (NFQ) levels have not been progressed.

c) Procurement

The procurement process of a phased BIM mandate for public works projects is on schedule to commence in Q2 2019. However, as of yet, there are no online supports or reviews of the suitability or provisions made for developing government construction contracts. Concerning the maturity, despite rising in this area, benchmarks and processes may stagnate unless clear direction is provided. The absence of

significant developments in these latter areas since 2017 is a cause of concern and addressing these deficiencies should be the focus of the various stakeholders in the next two years.

V Conclusions

Ireland has shown a steady increase in some aspects of its BIM maturity since 2017. The Irish AEC Sector has, by default, led in the execution of parts of the roadmap and, in doing so, achieved a number of significant targets. However, as evident from the findings from the maturity models, there are still many vital objectives outstanding that will need funding if the key aims of the roadmap are to be achieved. Importantly, these include the establishment of a Digital Centre of Excellence, online tools and support and a BIM self-assessment tool. The AEC sector now finds itself at a crossroads with a push from government required to advance the BIM maturity within the industry. Without this incentive, the industry's digital transition may stagnate, as evident from the comparison of the 2017 and 2019 macro maturity models presented here, where a number of vital outcomes remained the same. The industry cannot afford to stay static and must advance in line with other global jurisdictions to maintain its competitiveness.

References

[1] McAuley, B., Hore, A. and West, R. (2018) BIM Macro Adoption Study: Establishing Ireland's BIM Maturity and Managing Complex Change, International Journal of 3-D, Information Modeling, Iss 7, Volume 1, pp 1-11

[2] Hore, A., McAuley, B., West, R., Kassem, M. and Kuang, S. (2017) Ireland's BIM Macro Adoption Study: Establishing Irelands BIM Maturity, Proceedings of the 3rd CitA BIM Gathering, Dublin, 23rd - 24th November, 2017, pp 32-40

[3] Succar, B., and Kassem, M. (2015). Macro-BIM adoption: Conceptual structures. Automation in Construction, 57, 64–79. doi:10.1016/j.autcon.2015.04.018

[4] Succar, B., and Kassem, M. (2017). Macro BIM adoption: Comparative market analysis. Automation in Construction, 81, 286–299. doi:10.1016/j.autcon.2017.04.005

[5] National BIM Council, (2017), Roadmap to Digital Transition for Ireland's Construction Industry, December 2017

[6] Office Government Procurement. (2017). A Public Sector BIM Adoption Strategy: A GCCC positional paper. Government Construction Contracts Committee

[7] AECOM (2018) Taking The Long View: Ireland Annual Review 2019, Aecom

[8] BIM Innovation Capability Programme (2017) Research Objectives, available from www.bicp.ie

[9] Hore, A., McAuley, B. and West, R. (2017) BIM in Ireland 2017, CitA Ltd.

[10] BIMe Initiative (2019) BIMe Initiative, Retrieved from Welcome to the BIMe Initiative: https://bimexcellence.org/

[11] International Standards Organisation (2018) ISO/DIS 19650-2 Part 1: Organization of information about construction works Information management using Building Information Modelling Concepts and principles, ISO

[12] Government of Ireland, (2019), Project Ireland 2040, Build Construction Sector Performance and Prospects 2019.

[13] Fitzgerald, K. (2019) Irish Examiner, Retrieved from Construction skills shortage is the new elephant in the room: https://www.irishexaminer.com/breakingnews/business/columnists/construction-skills-shortage-is-the-new-elephant-in-the-room-898880.html>

[14] McCrave, C. (2019) The Journal, Retrieved from Construction costs to rise further as Dublin one of most expensive cities to build in the world: https://www.thejournal.ie/dublin-construction-cost-to-rise-4585421-Apr2019

[15] Carroll, P. and McAuley, B. (2017) Establishing the key pillars of innovation required to execute a successful BIM strategy within a Construction SME in Ireland, Proceedings of the 3rd CitA BIM Gathering, Dublin, 23rd - 24th November, 2017, pp 84-91

[16] Construction Industry Federation (2019), An Examination of Productivity in the Irish Construction Industry, CIF Economic & Policy Research 2019

[17] McAuley, B., Behan, A., McCormack, P., Hamilton, A., Rebelo, E., Neilson, B., Beckett, G., Costa, A.A., Carreira, P., Likar, D., Taneva-Veshoska,A., Lynch, S., Hynes, W. and Borkovic, T. (2019) Delivering Energy Savings for the Supply Chain Through Building Information Modelling as a Result of the Horizon2020 Energy BIMcert Project, Proceedings of the 5th International SEEDS Conference 2019: Growing Sustainability - Natural Capital and Society in the Built Environment, Leeds, 11-12th September, pp 1-11

[18] McAuley, B., Behan, A., McCormack, P., Hamilton, A., Rebelo, E., Neilson, B., Beckett, G., Costa, A.A., Carreira, P., Likar, D., Taneva-Veshoska, A., Lynch, S., Hynes, W. and Borkovic, T. (2019) Improving the Sustainability of the Built Environment by Training its Workforce in More Efficient and Greener Ways of Designing and Constructing Through the Horizon2020 Energy BIMcert Project, Proceedings of the CitA BIM Gathering, Galway 26th -27th September, pp 1-8

[19] Hore, A., Kuang, S., McAuley, B. and West, R.P., 2019), Development of a Framework to Support the Effective Adoption of BIM in the Public Sector: Lessons for Ireland, *CIB World Building Congress 2019*, Hong Kong, pp 1-10

[20] BIMIreland.ie (2019) BIMIreland.ie, Retrieved from BIM in Ireland Umbrella Forum launched http://www.bimireland.ie/2019/02/07/bim-in-ireland-umbrella-forum-launched/

[21] Hore, A., McAuley, B. and West, R. (2019) Centres of Excellence and Roadmaps for Digital Transition: Lessons for Ireland's Construction Industry, Proceedings of the 36th CIB W78 2019 Conference ICT in Design, Construction and Management in Architecture, Engineering, Construction and Operations, Northumbria University at Newcastle, United Kingdom, 18-20 September 2019, pp 1-11

[22] NBS (2019) National BIM Report 2019: The definitive industry update, RIBA Enterprises Ltd

[23] Beimcraft (2019) BeimCraft, Retrieved from BeIMCraft Overview: www.beimcraft.com

[24] Class of Your Own (2019) Design Engineer Construct, Retrieved from What is Dec: https://designengineerconstruct.com