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Centres of Excellence and Roadmaps for Digital Transition: Lessons for Ireland's Construction Industry

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Abstract– Like most sectors in today's working world, construction businesses are challenged to work in an increasingly digitised world with sophisticated demands from intelligent clients. So much has been written about the inefficiencies of the construction industry, its fragmentation, lack of collaboration, low margins, adversarial pricing, poor productivity, financial fragility, lack of research and development, poor industry image and relatively weak use of digital solutions. The Irish government recognises the importance of digital innovation to address many of the challenges the construction industry faces. With recent high profile reports of escalating spend on signature public sector projects and weak productivity performance in the sector, the Irish government is seeking out new strategies that will help create improved value for money for publically funded projects including stimulating economic growth and competitiveness in the sector. One such approach is the creation of a new Centre of Excellence for digital construction to help encourage both the government and industry to work together to create a more agile and innovation-rich sector, create jobs and improve project outcomes for public sector projects. In this paper, the authors will examine the current context surrounding this recommendation, in particular the vision of Ireland's National BIM Council to instigate the formation of a national central resource to support the rollout of digital tools and processes in Ireland. This paper serves mainly as a relatively high-level early desktop study that will document the missions and activities of particular international exemplars of such centres. The paper also seeks to potentially influence representative groupings in Ireland that have been charged with the responsibility of recommending to the Irish government the likely implementation model and funding mechanism that will help drive a sustained transformational programme for the Irish construction industry. The authors did not seek to consult with these stakeholders directly in preparation of this paper given the ongoing consultations at governmental level taking place in mid-2019.

Keywords – Digital, Excellence, Transformation, Ireland, BIM

I INTRODUCTION

In 2017 the Irish government launched their strategy to increase the use of digital technology in key public works projects with Building Information Modelling (BIM) to be mandated in the design, construction and operation of public buildings and infrastructure over the next 4 years [1]. 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. The industry reacted to this call for digital workflows and proposed, through a publication of the National BIM Council (NBC) of Ireland, a roadmap to digital transition for Ireland's construction industry from 2018 – 2021 [2]. This industry roadmap is an initiative that advocates more productive ways of working that improves

competitiveness at home and overseas. This roadmap not only seeks to increase efficiency and productivity in the industry but also aims to support an SME community that makes up almost 95% of the sector both in Ireland and across the broader European Union. The roadmap was divided into four key pillars; leadership, standards, education and training and procurement. 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. Such a resource can support the roll-out of digital tools and processes in Ireland while in the short term provides a platform for the digital transformation programme envisaged by the NBC in 2017.

A proposed centre has long been voiced in Ireland with Hore et al. outlining, as far back as 2011, their vision for a dedicated competence centre to facilitate the Irish construction industry [3].

The construction industry has responded to the requirement to keep pace with other sectors by its proposal for its own Digital Centre of Excellence. While the roadmap has been in circulation since late 2017, there has been no official announcement of its funding and formal implementation. To assist with the establishment of an Irish Digital Centre of Excellence, this paper will explore existing centres globally, to establish a possible framework that the Irish AEC Sector can follow once adequate funding becomes available.

The purpose of this paper is to undertake a scoping desktop exercise to be used in influencing any future proposal for a proposed Irish centre. The authors intend to extend this research at an appropriate time once the framework for such a centre has been established when those stakeholders charged with this responsibility have concluded their work. The authors contend that any proposed Irish entity will initially focus on BIM implementation support and the role out of the NBC roadmap. The centre, once established, should expand to focus on a broader spectrum of digital innovations.

It will be seen in the conclusion of this paper that the delivery of the NBC roadmap and any proposal for a newly established Centre of Excellence for Irish construction are extrinsically linked and connected projects.

II METHODOLOGY

The methodology involved an initial high-level desktop based research exploring existing international exemplars of such centres by primarily reviewing website content. Particular international centres were

selected based on previous research by McAuley et al., (2018) and Hore et al., (2017a and 2017b) which recommended that Construction Scotland Innovation Centre and the Centre for Digital Built Britain be reviewed as potential best-case exemplars of such centres[4] [5] [6].

The authors do not intend to focus on the formal meaning of a Centre of Excellence but to locate international exemplars of communities of practices that focused primarily on the digitisation of construction. While it is expected that any future established entity will eventually focus on a more comprehensive range of digital construction innovations, the author's key focus was placed on supporting the roll-out of Ireland's BIM mandate, and, therefore, it is logical to limit the selection, at present, to those which are primarily focused within this area.

On that basis, the following centres were selected:

1. Centre for Digital Built Britain
2. Construction Scotland Innovation Centre
3. Global BIM Centre of Excellence China
4. NUS Centre of Excellence in BIM Integration Singapore
5. Australasian Joint Research Centre for BIM
6. The Digital Innovation Lab Georgia
7. Centre for Integrated Facilities at Stanford University

The authors focused on their mission/vision, governance, services offered, funding and a sample of their contributions.

III CONTEXT

Project Ireland 2040 is the Government's long-term overarching strategy for Ireland (Government of Ireland, 2018a), which was further supported by a National Development Plan 2018-2027 (Government of Ireland, 2018b). The plan outlines how investment is made in public infrastructure in Ireland, moving away from the approach of the past, which saw public investment spread too thinly and investment decisions that did not align with a well-thought-out and defined strategy. Alongside the development of physical infrastructure, Project Ireland 2040 vision is to support businesses and communities across all of Ireland in realising their potential [7] [8].

As part of this initiative, a Construction Sector Group (CSG) was formed to ensure 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 successfully deliver on the commitments in Project Ireland 2040. The CSG is made up of representatives of key industry bodies, as well as senior representatives of relevant government departments and agencies with responsibilities for

policy and the delivery of infrastructure. Chaired by the Secretary General of the Department of Public Expenditure and Reform (DPER), the group reports to the Minister of the DPER [9].

The Project Ireland 2040 National Development Plan 2018-2027 outlined the key role of CSG Part of the group's remit will be to consider matters such as:

- the data/trends relating to the construction sector in Ireland;
- the supply of necessary skills and enhancing capacity;
- the role of Building Information Modelling and adopting other technologies and innovative
- practices in driving improved productivity and efficiencies;
- the use of sub-contracting and the level of self-employment and
- the productivity of the construction sector.

At the time of writing this paper, DPER, in collaboration with the CSG, has commissioned a study of the root causes of the poor productivity prevalent in the Irish construction industry together with potential Government policies and industry actions to tackle the root causes of this poor productivity (Government of Ireland, 2019) [10]. The Construction Industry Federation (CIF) recently published an important contextual report on the productivity of the Irish construction industry (CIF, 2019) which provided recommendations that were complementary to these tactics [11].

IV DIGITAL CENTRE OF EXCELLENCE FRAMEWORK

This section will explore the seven selected international entities in more detail.

a) Mission

Dermol and Breznik (2012) describe a mission statement as an organisation's "credo," "philosophy," "core value," "reason for being," "image creator," or "a distinctive factor" as frequently used concepts that describe the importance and the value of an organisation [12]. The majority of entities selected had multiple strategic goals.

The Centre for Digital Built Britain's mission is to "*develop and demonstrate policy and practical insights that will enable the exploitation of new and emerging technologies, data and analytics to enhance the natural and built environment, thereby driving up commercial competitiveness and productivity, as well as citizen quality of life and well-being*". This is expanded to "*act as the custodian of the integrity of the*

UK BIM, and Digital Built Britain Programmes across all the levels and to be recognised both nationally and internationally as that institution". This is further advanced to include commitments to technical standards and protocols, acting as an academic bridgehead, tracking digital capabilities, inspiring the industrial community, adopting and implementing new digital approaches and ensuring that the findings and insights from the centre inform future policy, industrial practice, standards and research initiatives.

The Construction Scotland Innovation Centre vision "*is to uncover and develop with industry the value that lies in innovating and drive future demand for the innovation support available from Scotland's leading universities*." They also aim to empower industry, align academic expertise and public sector support, match industry needs to appropriate innovation support packages and deliver support from inception to commercialisation.

Other mission statements, such as that of the Global BIM Centre of Excellence, are not so task orientated and simply state that they aim to "*gather top BIM experts and excellent BIM enterprises both at home and abroad*."

The Centre of Excellence in BIM Integration in Singapore mission is "*to transform the way people design, deliver and manage the built environment through BIM innovation and practice*." This is expanded to include how this will be achieved, through high-impact research, broad-based education and collaboration with industry.

The Australasian Joint Research Centre for BIM focuses on developing leading research that integrates BIM with other advanced concepts and technologies to improve the performance and productivity of building projects in the energy, mineral and construction industries worldwide.

The Centre for Integrated Facilities' vision is to apply "*VDC principles and methods to help projects deliver exceptional value and help member organizations achieve breakthrough objectives in support of their exceptionally reliable design, engineering construction, and management to develop and operate sustainable facilities*."

The Digital Innovation Lab in Georgia aims to "*connect industry to research, creating innovative ways to design, build, and operate buildings, cities, and infrastructure*."

Whilst not a mission per se, the NBC Roadmap envisaged that any new central resource established would "*support the rollout of digital tools and processes in Ireland. It will be a resource with both public and private commitment, which will leverage from existing digital interest communities*" (NBC Roadmap

2017, pp. 10).

b) Services Offered

The services offered by any organisation is ultimately the critical area of interest concerning the users. For the purposes of this paper, the authors focus primarily on BIM support services. The authors acknowledge that many of the centres selected have a remit beyond BIM and are now looking at a much broader ecosystem of digitalisation taking into account the impact of digital technologies, modern methods and broader innovative practices in construction.

The Centre for Digital Built Britain envisions a broad scope of commitments to support the adoption of BIM as business as usual and the evolution of the UK BIM Programme. They articulate the creation of a digital framework for infrastructure data through applied research including standards guidance, delivering pilots and outlining how the industry needs to change to establish how information-rich assets in the built environment can be planned and used to perform their functional service. They also generate informative publications, case studies, videos and blogs.

The Construction Scotland Innovation Centre offers skills programmes designed to support industry, educators, and learners. They also offer seminars, workshops, and conferences, providing a range of information suitable for all levels of BIM understanding. Also, they provide access to resources and industry experts.

The Global BIM Centre of Excellence aims to support BIM development by providing the latest BIM information, promoting industry communication, providing professional assessment, stimulating BIM application, accelerating BIM innovation and creation, and ultimately making contributions to BIM through sharing members' knowledge, techniques, experience, and opinions. The NUS Centre of Excellence in BIM Integration has two units. Their research unit focuses on developing leading research that improves building construction and performance through the integration of BIM with other advanced concepts and technologies. Their innovation and education unit focuses on developing guidelines, best practices, journals, etc. along with designing short term courses in BIM for the industry workforce.

The Australasian Joint Research Centre for BIM, through a series of pilot projects, aims to create and share knowledge to enhance policy development and enable key industry stakeholders to improve informed decision-making throughout a project's life cycle. The Digital Innovation Lab in Georgia provides a link that connects technology and professional members with real-world problems, while researchers try to provide emerging technology innovation and

solutions to these problems. They have an annual symposium, member workshops, professional courses and a living laboratory that maintains a physical testbed for digitally integrated design, construction and operations projects. The Center for Integrated Facilities broadly covers a range of research areas. It is a mature research entity of international reputation working with industry to develop and test innovative ways to model and increase awareness of and competence in the use of the methods and to understand the value and costs of Virtual Design and Construction (VDC).

All of these entities have a central message that the construction industry is ripe for digital transformation and use a variety of tactics to drive this agenda within their network.

On further analysis of the services provided by these entities, there were three recurring pillars of activities, namely:

1. Research – systematic inquiry of particular studies or a particular problem of concern to industry. Many entities investigated included a resource of funded full-time and part-time investigators.
2. Education – provision of industry-led training, workshops, seminars, conferences, published papers, videos, webinars and case studies.
3. Guidance - publication of guidance material to assist industry in transitioning to BIM and other digital innovations.

c) Governance Models

The entities investigated had varying governance models. Table 1 provides a summary of the key stakeholders involved in each entity. A key feature was the hosting of such centres in Higher Education Institutes (HEIs).

Entity	Key Stakeholders
Centre for Digital Built Britain	Department of Business, Energy & Industrial Strategy University of Cambridge (host)
Construction Scotland Innovation Centre	Scottish Funding Council Scottish Enterprise, Highlands & Islands Enterprise 14 Scottish university partners
Global BIM Centre of Excellence	University of Nottingham Ningbo Chartered Institution of Civil Engineering Surveyors China Member firms

NUS Centre of Excellence in BIM Integration	NUS Department of Architecture and the NUS Department Building (host) Real Estate Developers' Association of Singapore Member firms
Australasian Joint Research Centre for BIM	Curtin University (host) and Huazhong University of Science and Technology in Wuhan, China
The Digital Innovation Lab	Georgia Tech includes inter-department collaboration (host)
Centre for Integrated Facilities at Stanford University	Stanford University (Host) Member firms

Table 1: Stakeholders involved in selected entities

All of the entities investigated appear to have strategic alliances with industry and parent governmental departments, which is a crucial element to any proposed strategic offering in Ireland.

A case in point is the Centre for Digital Built Britain in the UK where there is a strategic partnership between the UK government and the University of Cambridge. The Construction Scotland Innovation Centre differs in that it was an independent centre formed with links to government and multiple HEIs. The Scottish centre was only one of nine such centres in Scotland focusing on alternative industries.

The following alternative governance models were evident from this study of the seven entities selected.

- Model 1: Entity established in a single HEI with links to industry and government. These models tend to have a predominant research focus.
- Model 2: Entity establishes in two or more universities with links to industry and government. These models tend to have a predominant research focus with inter-institutional collaboration in specialist research areas.
- Model 3: Entity founded on a strategic partnership between government and academia with links to industry. These models tend to have a programme of activities that shape the strategic focus of the entity that includes the establishment of interest groupings, commissioning research, a dissemination programme that include hosting seminars, conferences, etc.
- Model 4: Entity established in an independent organisation with links to academia, industry, and government. These entities tend to be non-profit organisations.

d) *Funding*

Acknowledging the limitations of the desktop exercise, it is possible to deduce the funding mechanisms evident for each of the entities investigated

1. Funding Model 1: This model is focused on attracting research as part of a university's strategic research programme plan. The universities, in this case, compete for available funding to conduct high-impact research through research and development funding by a dedicated research resource of principal investigators and research students.
2. Funding Model 2: Funding, in this case, is provided by government and then acquired by a university that will work in partnership to deliver the requested R&D. The university is responsible for delivering the government's required BIM programme. An example of this is the Centre for Digital Built Britain who are funded, as part of the recommendations of the HM Government in the 2017 Autumn Budget, up to £5.4 million. This enables it to launch initiatives such as "Delivering a Digital Built Britain" which is a request for feasibility studies, research projects or experimental development projects ranging in value from £50,000 to £250,000.
3. Funding Model 3: Funding for this model is sought by an independent body outside of academia who receive funding by way of government or through industry. An example of this is the Construction Scotland Innovation Centre, which received almost £11 million of core funding to support the sector to innovate, modernise and grow from government funding. This funding can be then dispersed to universities or research bodies to do part of the required research, such as through Innovation Vouchers and collaborative innovation projects in which a percentage of overall project costs are provided from this source.

The above funding models offer alternative approaches and it seems likely that in an Irish centre would need significant state funding initially before it could become *more reliant on alternative funding streams*.

e) *Sample Contributions*

The paper thus far has investigated mission statements, services offered and funding models. While Section 4.2 investigated general services, this part of the paper will examine particular projects or contributions within each of the centres investigated. This will help to provide an understanding of the expected scope and type of projects envisaged for any new centre to be instigated for Ireland.

The Centre for Digital Built Britain has launched a “Research Bridgehead” which aims to build effective relationships with the research community to harness value, enabling results of innovative academic research to inform the development of Digital Built Britain. The bridgehead developed a network model that will bring together academic researchers, industry and stakeholder organisations to drive the creation of a digitally enabled landscape.

The centre is also establishing the “Digital Twin Hub,” a collaborative web-enabled community for those who own, or who are developing, digital twins within the built environment. They have published the first output of its “Digital Framework Task Group”, The Gemini Principles. The paper sets out proposed principles to guide the national digital twin repository and the information management framework that will enable it. They have also published the “Roadmap to the Information Management Framework for the Built Environment”.

The Construction Scotland Innovation Centre offers skills programmes designed to support industry, educators, and learners. The renewed “BIM in Practice” programme provides a unique opportunity to learn, collaborate and implement all things BIM. Working with the Scottish Funding Council, the centre part-funds the course fees of the students, who will also benefit from working closely with industry, contributing to industry research and helping participating businesses achieve higher levels of innovation and productivity. They also have a 3,500m² facility designed to support construction-related enterprises to collaborate and innovate.

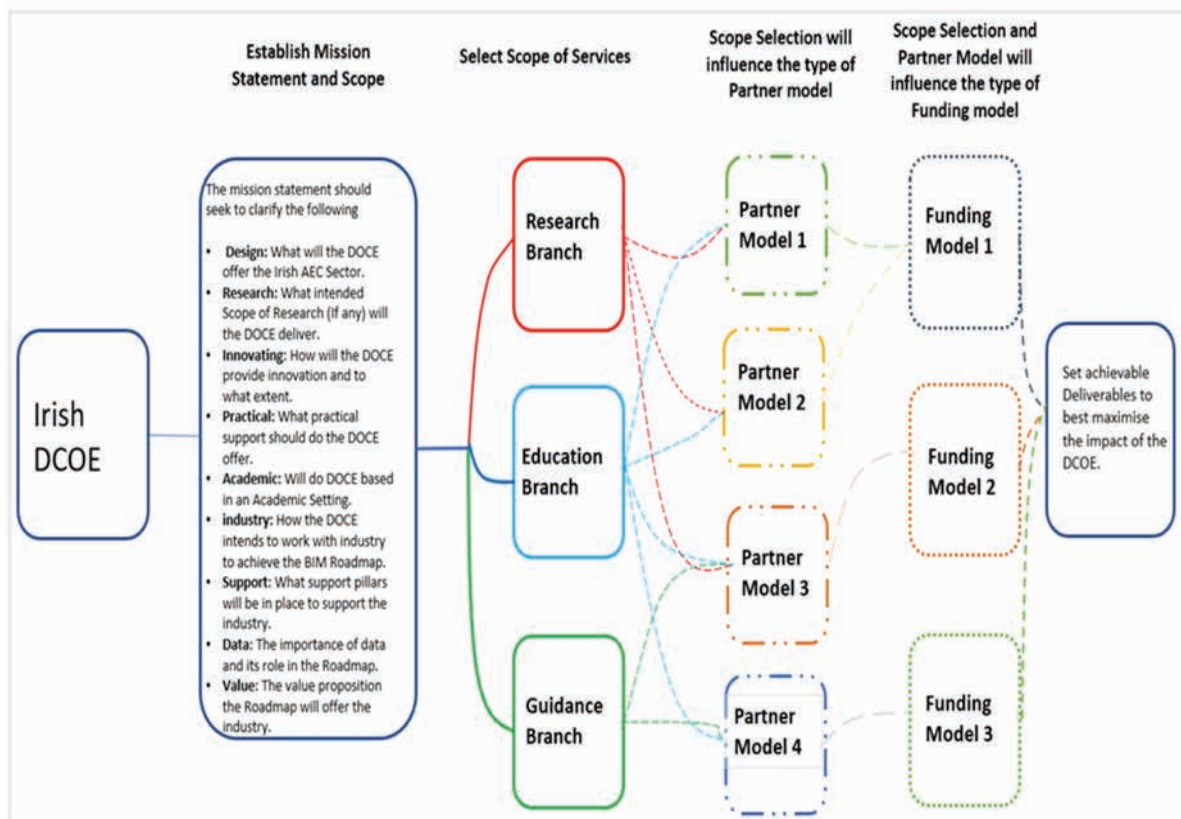
Some of the research outputs from the NUS Centre of Excellence in BIM Integration include establishing an electronic Quick Bills of Quantities, safety risk drivers to assist with risk management and a BIM-based integrated workflow for the design of sustainable tall buildings. The Australasian Joint Research Centre for BIM has published more than 200 technical journal articles over the past five years and has presented innovative solutions to the oil and gas, mining and infrastructure sectors. Both the Digital Innovation Lab and Center for Integrated Facilities are renowned for their prodigious outputs and have been responsible for transformational changes, such as the National BIM Standard for Reinforced Concrete and pioneering research in the area of 4D BIM, respectively.

While some of the centres selected are more academically focused, this may not necessarily be the core focus of an Irish centre which could seek a more “applied” and pragmatic construction innovation programme where practical guidance and training is part of its core service model.

f) Proposed DCoE Framework

Based on the findings from this desktop-based research, the following framework is proposed to assist Ireland in the establishment of their Digital Centre of Excellence. The framework, illustrated in Figure 1, outlines the essential items that will need to be addressed, thus:

1. The mission statement should state the key areas outlined in Figure 1 and establish an initial scope of work.
2. The scope of work should be refined such that it dictates what area of expertise is required, such as, will the DCOE offer a research branch with innovation funding, etc., an education branch offering courses and workshops and a guidance branch offering consultancy through access to BIM experts?
3. The next stage involves the selection of a partner model that best represents the most advantageous way of achieving the agreed scope of services. While all partner models can be adapted to meet the range of services, some work better than others, for example, a DCOE established within a university would not be required to offer a guidance branch because it would not be expected that industry experts would be freely available to assist with BIM implementation.



Once an adequate mission statement, scope of services, areas of expertise and suitable partner model have been established, then one can identify what type of funding is required, whether governmental, industrial or a combination of both.

Finally, once funding has been secured, an achievable set of deliverables should be set, to maximise the impact.

V GOVERNANCE OF DCOE

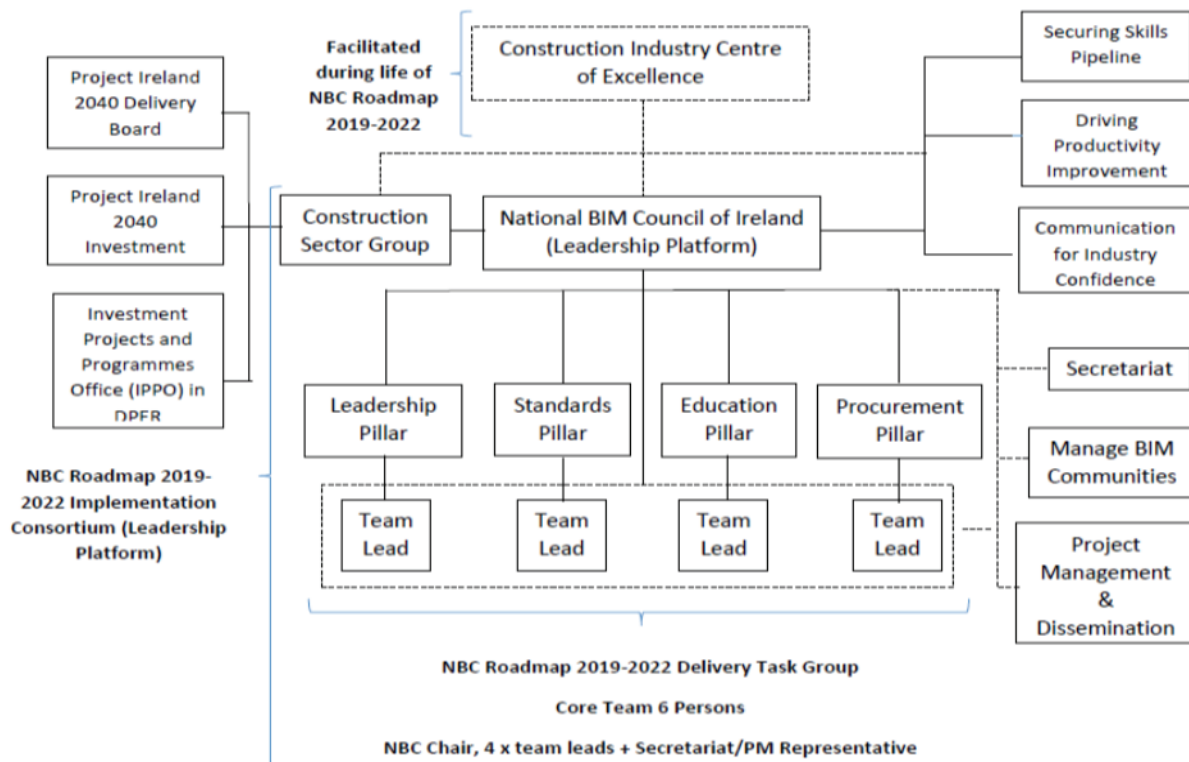
While the paper has established a proposed generic framework with different pathways, this section will explore how such an Irish focused Digital Centre of Excellence will potentially be managed. Figure 2 illustrates how the authors envisage the governance framework for the newly proposed centre. At the core of the framework is the re-establishment of the NBC (Leadership Platform). It is recommended that a platform of the most knowledgeable persons represented by relevant stakeholders sits on this council and that a chairperson with appropriate credentials is appointed to lead this council.

It is recommended that the NBC will in turn report to

the Project Ireland 2040 programme. It was stated earlier that the initial focus of the NBC would be the implementation of the NBC Roadmap for Digital Transition of Ireland's Construction industry. The NBC roadmap will need to be adapted to cater for the period 2019-2022. In the author's opinion, the original remit and vision of the roadmap should be largely retained with the exception of the output from the recently commissioned construction productivity study by DPER, which should be included in an updated Roadmap.

It is recommended further that the Council include team leads for each of the four pillars outlined in the NBC Roadmap (leadership, standards, education and procurement). The authors believe it would be appropriate that the four-team leads are joined by a secretariat representative and programme manager to make up the newly formed NBC Roadmap 2019-2022 Delivery Task Group who will be tasked with the delivery and roll out of the roadmap to support the Irish governments phased introduction of the public sector BIM mandate.

The core vision of the NBC will seek to support the CSG remit of 1) securing the skills pipeline 2) driving productivity improvement in the Irish construction industry and 3) communication for



VI RECOMMENDATIONS

The paper has proposed two different frameworks; 1) a generic DCoE framework, and 2) Irish Digital Centre of Excellence Governance framework that will need to be considered in partnership. On this basis, the authors have made a series of recommendations that will require the two frameworks to be considered in unison, that is, a management framework will need to be agreed before a pathway can be established within the generic DCoE framework. Taking this into consideration, the authors recommend the following

- The first step should be the re-establishment of the NBC as a platform of leadership comprising of the most knowledgeable persons represented by relevant stakeholders and that a chairperson with appropriate credentials is appointed.
- The NBC roadmap should be updated to reflect the recommendations from aspects of the DPER commissioned report on construction productivity believed to be completed in Q4 2019.
- The NBC roadmap should be funded in advance of any decision to set up a new DCoE and that an NBC Roadmap 2019-2022 Delivery Task Group be appointed to support the rollout of the Irish government's public sector BIM mandate.

4. The leadership platform formed by the NBC should be the seed for the formation of a new CoE for Irish construction. It is essential that this platform consists of a strategic alliance between a parent government department and industry with academic input. A further more detailed study will be required prior to a preferred partnership model being suggested, before any final decision is made on the design and location of any new centre.
5. The Centre will need significant state funding initially before it could become more reliant on external alternative funding streams. Consideration should be given to the funding models in Figure 1 with a preference established once an agreed governance model is known.
6. Any new Centre envisaged should leverage the achievements of existing established communities focused on digital construction, for example, the Construction IT Alliance (CitA), and the CIF Construction 4.0 committee.

VII CONCLUSION

The Irish construction sector has experienced a return to productivity since the lows of the recession. To meet the requirements of an overworked and under skilled sector, as well as compensating for years of underfunding for infrastructure, the construction

sector has embraced digital technologies, primarily BIM. This has resulted in the launch of a digital roadmap with a specific recommendation for a Digital Centre of Excellence. While funding has not yet been secured for such a centre, it was the purpose of the authors to investigate a potential framework that can be used to inform its design and implementation. An initial desktop-based research project exploring existing centres globally has determined that any future Irish Centre will need to follow international best practice. In the author's opinion, the original remit and vision of the roadmap should be primarily retained and implemented as soon as possible. This work will provide an essential backdrop for facilitating the formation of any newly proposed Centre of Excellence for Irish construction.

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