

# Northumbria Research Link

Citation: Hore, Alan, McAuley, Barry, West, Roger, Kassem, Mohamad and Kuang, Shiyao (2017) Ireland's BIM Macro Adoption Study: Establishing Ireland's BIM Maturity. In: CitA BIM Gathering Conference 2017. The Construction IT Alliance, pp. 32-40. ISBN 397809573957-2-6

Published by: The Construction IT Alliance

URL:

This version was downloaded from Northumbria Research Link:  
<http://nrl.northumbria.ac.uk/32714/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

[www.northumbria.ac.uk/nrl](http://www.northumbria.ac.uk/nrl)



# Ireland's BIM Macro Adoption Study: Establishing Ireland's BIM Maturity

<sup>1</sup> Dr. Alan Hore, <sup>2</sup> Dr. Barry McAuley, <sup>3</sup> Prof. Roger P. West, <sup>4</sup> Dr. Mohmad Kassem  
and <sup>5</sup> Shiyao Kuang

<sup>1,2&5</sup> *School of Surveying and Construction Management, Dublin Institute of Technology,  
Bolton Street, Dublin 1, Ireland*

<sup>3</sup> *Department of Civil, Structural and Environmental Engineering, Trinity College, College  
Green, Dublin 2, Ireland*

<sup>4</sup> *Energy and Environment, Northumbria University; United Kingdom*

E-mail: [1alan.hore@dit.ie](mailto:alan.hore@dit.ie) [2bmcauley@cita.ie](mailto:bmcauley@cita.ie) [3rwest@tcd.ie](mailto:rwest@tcd.ie) [4m.kassem@tees.ac.uk](mailto:m.kassem@tees.ac.uk)  
[5shiyao.kuang@mydit.ie](mailto:shiyao.kuang@mydit.ie)

---

**Abstract**—Since 2016 the BIM Innovation Capability Programme (BICP) has captured the capability of the Irish Construction Industry's and the Higher Education Institutes' (HEIs) response to the increased requirement for BIM on Irish construction and engineering projects. One of the primary responsibilities of the BICP research team is to collate data to assist the National BIM Council of Ireland in the formulation of a National BIM Roadmap. To assist the Council with this task the BICP research team applied five macro BIM maturity conceptual models to assess Ireland's BIM maturity. The results from the models were further utilised to develop a national BIM adoption policy. The application of the five models helped identify the key policies' deliverables and the macro maturity components that must be addressed within the initiation and consultation phase of proposing the Irish roadmap. The results also demonstrated the benefits of continuing the BICP initiative into the execution phase of the roadmap, so as to ensure successful integration of its findings within the sector.

*Keywords*—Building Information Modelling, BICP, Public Works, Ireland, BIM Macro Adoption

## I INTRODUCTION

The BIM Innovation Capability Programme (BICP) is a direct response from Enterprise Ireland to recent initiatives in the European Parliament who voted to amend European public procurement rules by recommending the use of electronic tools, such as BIM, for public works contracts and design contests [1]. Further to this, the global adoption of BIM, with particular focus on the mandating of Level 2 BIM by the UK, who are Ireland's largest trading partners, has resulted in the requirement for a fast response to prevent loss of international contracts, exports and Irish-based employment. To this effect, since 2016 the BICP research team has worked to capture the capability of the Irish Construction Industry's and the Higher Education Institutes' (HEIs) response to the increased requirement for BIM on Irish construction

and engineering projects. This has been primarily achieved through a combination of desk-top based research and industry consultation with both public and private sector bodies. The importance of this research has been reinforced through recent Irish publications, which have prompted BIM as fundamental in enhancing the industry's competitiveness [2, 3&4]. The recent BIM in Ireland 2017 report documents an array of BIM initiatives, activities by BIM champions, promotion of BIM within HEIs, BIM adoption by industry and government leaders [5]. All these initiatives have played an important role in the movement of the Irish AEC sector towards digitisation and innovative practices [6].

The BIM in Ireland 2017 report also presented the results of the Macro Maturity Component models

that were utilised to measure macro BIM adoption across the world.

The Macro BIM Adoption in Ireland 2017 Study is part of the BIME Initiative Macro Adoption Project and is based on the published research by Dr Bilal Succar and Dr Mohamad Kassem. This was a landmark study for BIM in Ireland and represented a collaborative knowledge-sharing agreement signed between the BIME Initiative, CitA and Dublin Institute of Technology.

This paper will provide a more focused review of this study and will provide a further analysis of the data collected.

## II BACKGROUND TO THE STUDY

As part of the BICP study it was agreed that the research team would establish the maturity of the Irish AEC sector. To achieve this, a number of maturity models were explored which included Barlish and Sullivan who conducted a review of over 600 sources of information to analyse the current information available with regards to benefits derived from BIM utilisation [7]. The National BIM Standard (NBIMS) Capability Maturity Model is a tool to plot one's current location and plan ahead for one's goals for future aspirations. It addresses software issues and maturity levels [8]. Another maturity model discussed was the Indiana University's BIM Proficiency Matrix. This is an evaluation tool used to assess the proficiency of a respondent's skill at working in a BIM environment [9]. The Virtual Design and Construction (VDC) Scorecard developed by Stanford University's Center for Integrated Facility Engineering (CIFE) was discussed as a possible tool to use. This Scorecard assesses the maturity of the VDC implementation of a project across 4 areas, 10 divisions, and 56 measures, and deploys a Confidence Level measured by 7 factors to indicate the accuracy of scores [10]. Despite the benefits of these models within their respective environments, they do not provide an understanding of BIM diffusion or macro BIM adoption. As this research was to be used to assist the National BIM Council (NBC) of Ireland in the development of a BIM Roadmap it was important that the collated data could help in assessing current or developing new market-specific BIM diffusion policies.

The Macro BIM Adoption in Ireland 2017 Study is part of the BIME Initiative Macro Adoption Project includes 3 Project Phases:

Phase 1 [Data Collection] will be conducted using a survey tool developed by members of the BIME Initiative and hosted on BIMexcellence.org.

To this effect the BIM macro maturity models developed by Succar and Kassem was adopted by the BICP team [11]. This framework consists of five conceptual models that have been utilised to measure macro BIM adoption across the world (figure 1). These models can be used for:

- Assessing a country's current BIM adoption policy
- Comparing the BIM maturity of different countries
- Application of the models in developing a national BIM adoption policy [11].

The macro maturity models is one of most cited maturity models in use today and had already been applied in Ireland [12&13]. This previous application of the model ensured that the selected framework was suitable for the BICP research team's objectives.

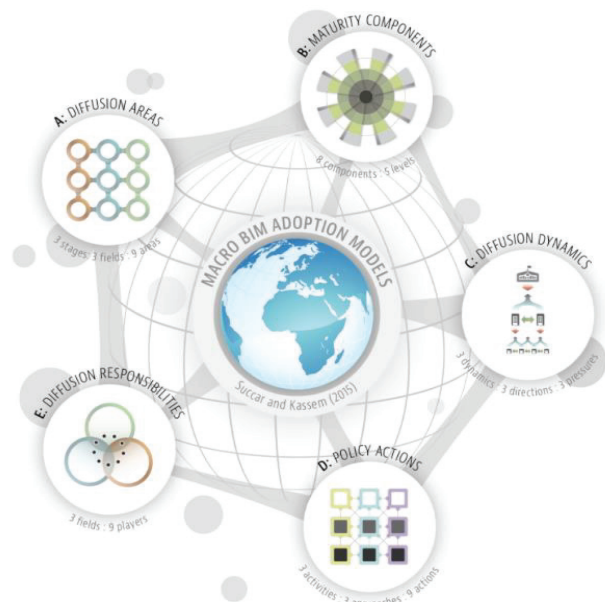


Figure 1: Macro BIM adoption models (Source Succar and Kassem, 2015)

## III IRELAND MACRO MATURITY MODEL

A total of 19 persons (see Table 1) were targeted in Ireland to complete the Macro BIM Adoption Study. The maturity study in this research 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. For the sake of clarity “implementation” represents the successful adoption of a system/process by a single organization, while diffusion represents the spread of the system/process within a population of

adopters [11]. Data Collection [12] was conducted using a survey tool developed by members of the BIME Initiative and hosted on BIMexcellence.org.

Name	Company
Ralph Montague	Arcdox
Michael Murphy	BAM Ireland
Paul Brennan	BAM Ireland
Adrian Small,	BRFS Ltd
Barry McAuley	CitA / DIT
Calogero Marino	C + W O'Brien Architects
Joe Mady,	Designer Group
Alan Hore	DIT
Antoinette Rourke	DKIT
John Hunt	Enterprise Ireland
Claire Crowley,	Facebook
Rob Moore	GGDA
Ger Casey	GGDA
William Power,	Reddy Architecture
Aonghus O'Keeffe	Roughan & O'Donovan
Barry Kirwan	Ryan & Lamb Architects
Paul Sexton	SCEG Ltd
Michael Earley	Scott Tallon Walker
Roger West,	Trinity College Dublin

Table 1: Participants

*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 BIM diffusion planning. The results reveal an uneven distribution of the distribution rates, as illustrated in the figure 2. Ireland is quite mature with regards to applying technology for modelling and collaboration purposes, as well as the integration of network-based disparate systems.

Ireland has become one of the global technology hubs of choice when it comes to attracting the strategic business activities of ICT companies, with 4 out of the top 5 IT services companies and 9 of the top 10 global software companies in the world all based in Ireland [14]. Despite this the construction industry is struggling to adopt the required ICT skills needed to fully drive the digital agenda [3].

While results show, Ireland is mature for modelling processes i.e. intra-organisational BIM roles and model workflows, it is less mature with regards to collaboration processes and policies. Despite recent governmental publications, there is still no agreed policy or mandate for BIM. However, some Governmental departments, such as the National Development Finance agency (NDFA), have successfully mandated the application of BIM

technologies across a selection of PPP programme projects. If Ireland is to advance in these areas, strong leadership must be shown from the Government. Such leadership will have an impact on improving the low process figures.

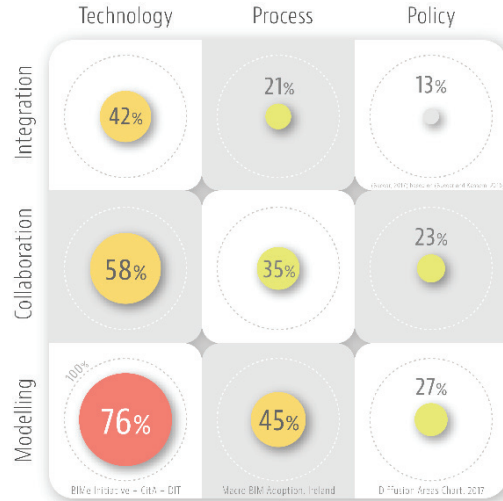


Figure 2: BIM diffusion areas model for Ireland

*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.

Figure 3 illustrates Ireland's current maturity within each area. Ireland ranked highly when it came to Technology Infrastructure and Learning and Education. The results for Technology Infrastructure further demonstrate that Ireland has one of the most advanced and competitive telecommunications infrastructures in Europe, as a result of large investments in recent years [15]. One of the reasons for the continued growth of BIM is through the commitment shown from HEIs to the delivery of BIM programmes which represents a direct response to an industry which is struggling to meet its ICT needs [5].

However, Ireland ranked poorly when it came to regulatory frameworks; measurement and benchmark. These three maturity components are linked and will not advance unless a regulatory requirement for BIM is promoted from within the Government. The GCCC paper published in 2016

has put tentative actions in place that could potentially increase the maturity in these areas [4].

Table 2 illustrates Ireland’s maturity ranking, based on a study performed in 2015 with twenty-one countries, where the same model was applied [13]. One can see from this table that the UK, which has a roadmap in place since 2011, is considerably more advanced than Ireland in regulatory frameworks, measurement and benchmark.

	Ireland (%)	Top Rank (%)
<b>Objectives, Stages and Milestones</b>	20	65 UK
<b>Champions and Drivers</b>	38	63UK
<b>Regulatory Framework</b>	13	58 UK
<b>Noteworthy Publications</b>	35	58 UK
<b>Learning and Education</b>	40	45 UK
<b>Measurements and Benchmarks</b>	20	43 China
<b>Standardised Parts and Deliverables</b>	30	58 China
<b>Technology and Infrastructure</b>	53	75 Switzerland

Table 2: Ireland’s maturity comparison

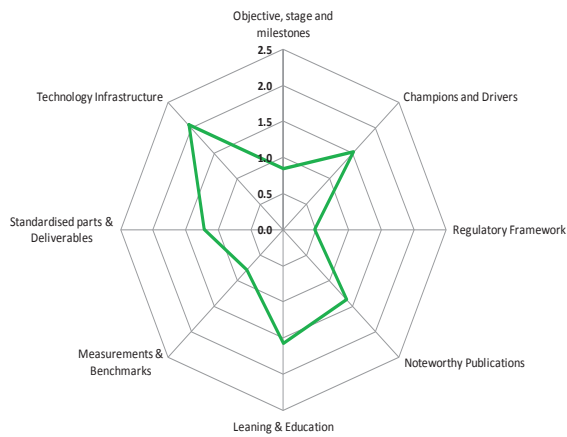


Figure 3: Macro Maturity Components model

*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 (Figure 4). The model in addition is augmented by three pressure mechanisms: downwards, upwards and horizontal. Results suggest that Ireland’s diffusion dynamic is middle out

meaning that larger organisations or industry associations are pushing the BIM agenda within the industry and not government.

The results are aligned with recent findings from the BICP Industry Consultation Workshops. One of the workshops was held in Dublin and the other in a regional location, so as to collect opinions from a diverse range of professionals who are operating throughout the country. One of the key findings from the cross-referencing of answers from both workshops was that the larger contractors both centrally and regionally have shown strong BIM maturity but prevalent concerns are still in place for Small to Medium Enterprises (SMEs). While SMEs generally have shown a reluctance towards engaging with BIM it would seem that this is more evident regionally [1]. With no policy in place and a reluctance from SMEs to embrace BIM, the diffusion dynamic of middle out will continue.

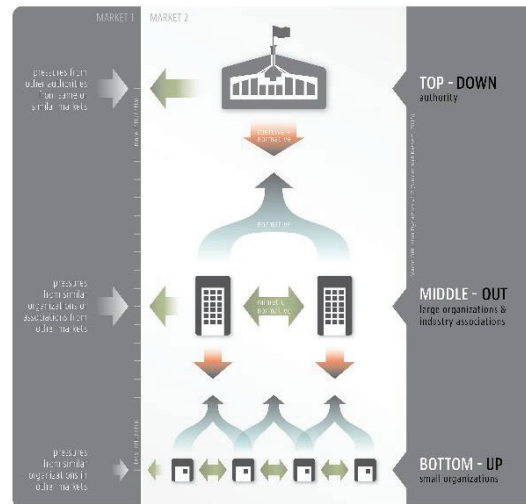


Figure 4: Macro Diffusion Dynamics Model (Source Succar and Kassem, 2015)

*Model D - Policy Actions Model*

This model identifies, assesses and compares the actions policy makers 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. It can be seen that policy makers in Ireland are largely passive, with some evidence of active approaches and with little or no assertive activities (Figure 5).

The results from this model are aligned with the other maturity models and further reflect the current governmental passive approach.

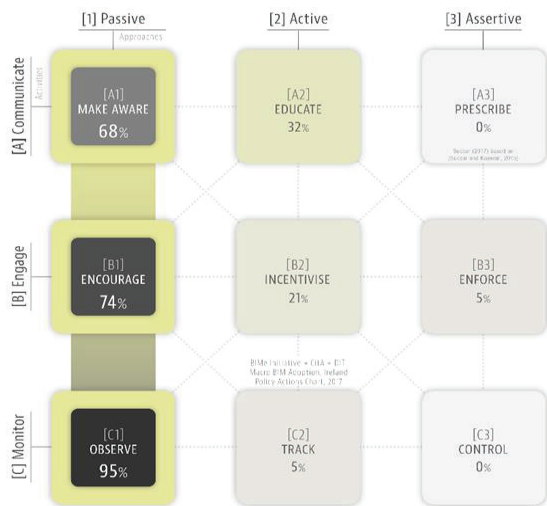


Figure 5: Macro Diffusion Dynamics Model

*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 (Figure 6).

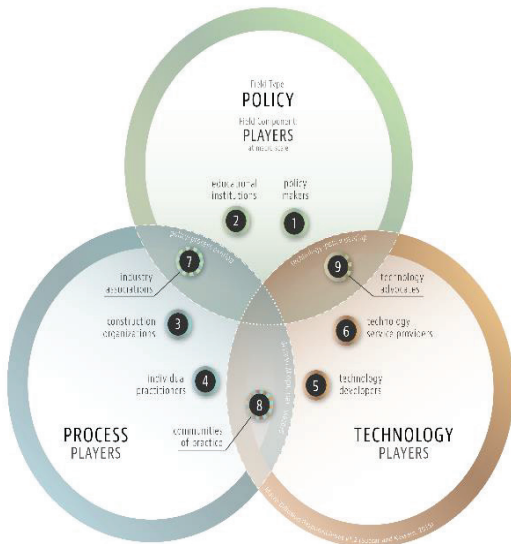


Figure 6: Macro Diffusion Dynamics Model (Source Succar and Kassem, 2015)

The results show that at present the Technology Drivers are the most influential technology players. For the policy makers, the educational institutes had a much higher BIM diffusion compared to them. The HEIs, as discussed, have responded rapidly to a demand by industry for BIM related education and training programmes despite the absence of a national BIM mandate. Both construction organisations and communities of practice were identified as the key process players. Figure 7 illustrates the results of the model.

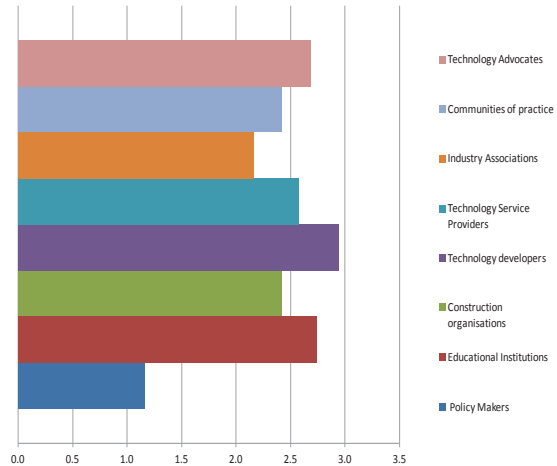


Figure 7: Irish Macro Diffusion Dynamics Model

#### IV USING THE MODELS TO DEVELOP BIM POLICY PLANS AND TEMPLATES

The models have enabled a deeper understanding of Ireland’s current BIM maturity and have assisted in highlighting areas of prevalent concern. Succar and Kassem have expanded their research to demonstrate how the models can provide the foundations for a Policy Development Plan / BIM roadmap.

The proposed Policy Development Plan has three key phases which are the Initiation Phase, Consultation Phase and the Execution Phase. The next section will suggest how the findings from the model in partnership with the BICP can assist in informing an Irish BIM roadmap [11].

*Initiation Phase*

The initiation phase seeks to establish both the Task Group and the seed BIM Framework that will guide the national Framework. The application of models B, C and D are respectively used to assess worldwide efforts, identify the market specific diffusion dynamic, and establish a policy approach.

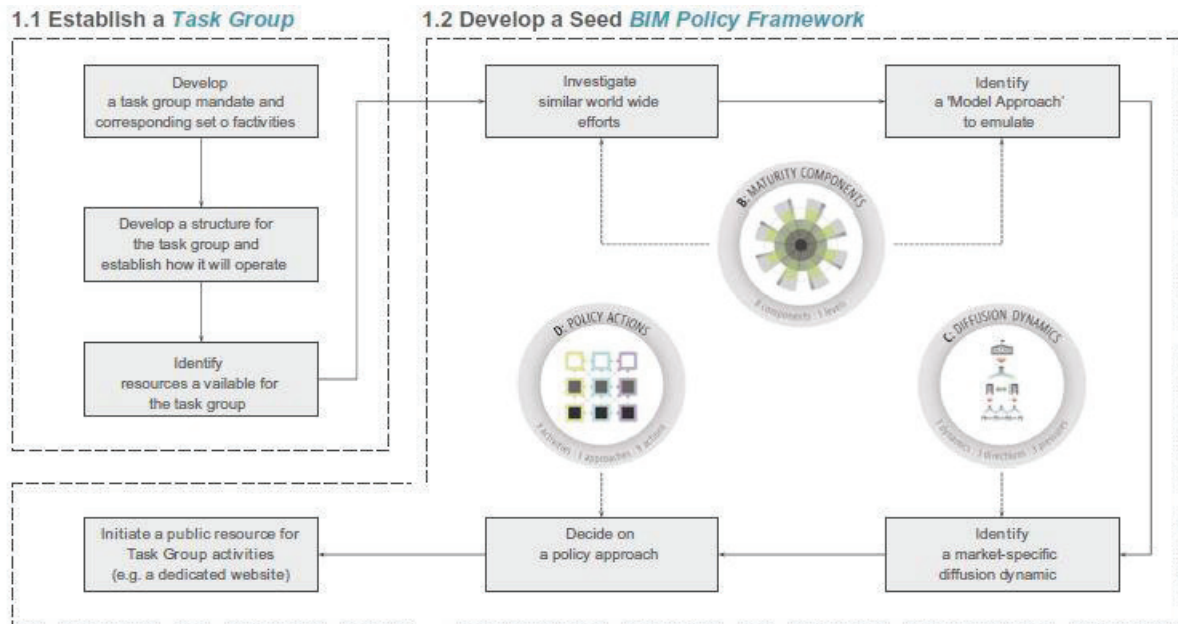


Figure 8: The Initiation Phase of the Policy Development Plan (Source Succar and Kassem, 2017).

The first part of this phase is to establish a task group. This involves developing a task group mandate and corresponding set of objectives. The NBC in partnership with the BICP research team have operated within a similar remit in Ireland.

The BICP research team have worked to establish the maturity of BIM within the Irish public, private and HEI sector over the last 18 months. This has been achieved through direct consultations with the industry and professional bodies. The team have worked within the best interest of the AEC sector and has retained a neutral and focused stance with regards to establishing BIM diffusion.

The goal of the task group is to develop a seed BIM policy framework (figure 8). The first stage of developing this framework involves a) investigating similar worldwide efforts and b) identifying a model approach to emulate. The macro maturity components model, which was applied to 21 different countries, suggests that the UK is one of the strongest frameworks.

The BICP team, through the Engaging with the BIM Community Survey, engaged with persons who have a responsibility for BIM in Irish architecture, engineering, construction, facility management businesses. The community of BIM practitioners reported they were comfortable working with the requirements of BS 1192 and the PAS 1192 suite of standards. The AEC UK BIM protocol was also used as a source of guidance by many of the respondent companies. The majority of the respondents were in agreement that the UK model, given its proximity,

should be adopted. The findings from the BICP Global BIM Study also strongly endorses the Canadian roadmap as another potential exemplar of best practice [16]. Whatever BIM framework is chosen it must ensure legitimacy to the country's context and ecosystem.

The third stage involves the application of the diffusion dynamics model to identify a market specific diffusion dynamic. This, as seen from the results, is predominately middle out. This in turn will influence stage four which is the policy approach. The policy approach, as seen from model D, is largely passive which will put further pressure on the proposed BIM framework to be led by the larger contractors.

While no government mandate / roadmap is in place there still has been significant momentum from governmental bodies as demonstrated by the research of the BICP. The Office of Public Works (OPW) has representatives who are actively involved in the EU BIM Task Group. The awareness in the Department of Education and Skills is strong and movement has been made to understand the BIM process. Transport Infrastructure Ireland is exploring the possibility of using BIM for the Metro North. Irish Water has also signalled its intention to use the BIM processes on the Ringsend project. The Dublin Airport Authority is using BIM processes to carry out works on an upgrade of the baggage handling system. Awareness is growing within the County Councils with interest registered from Dublin City Architects, Fingal County Council, South Dublin County Council, and Dun Laoghaire

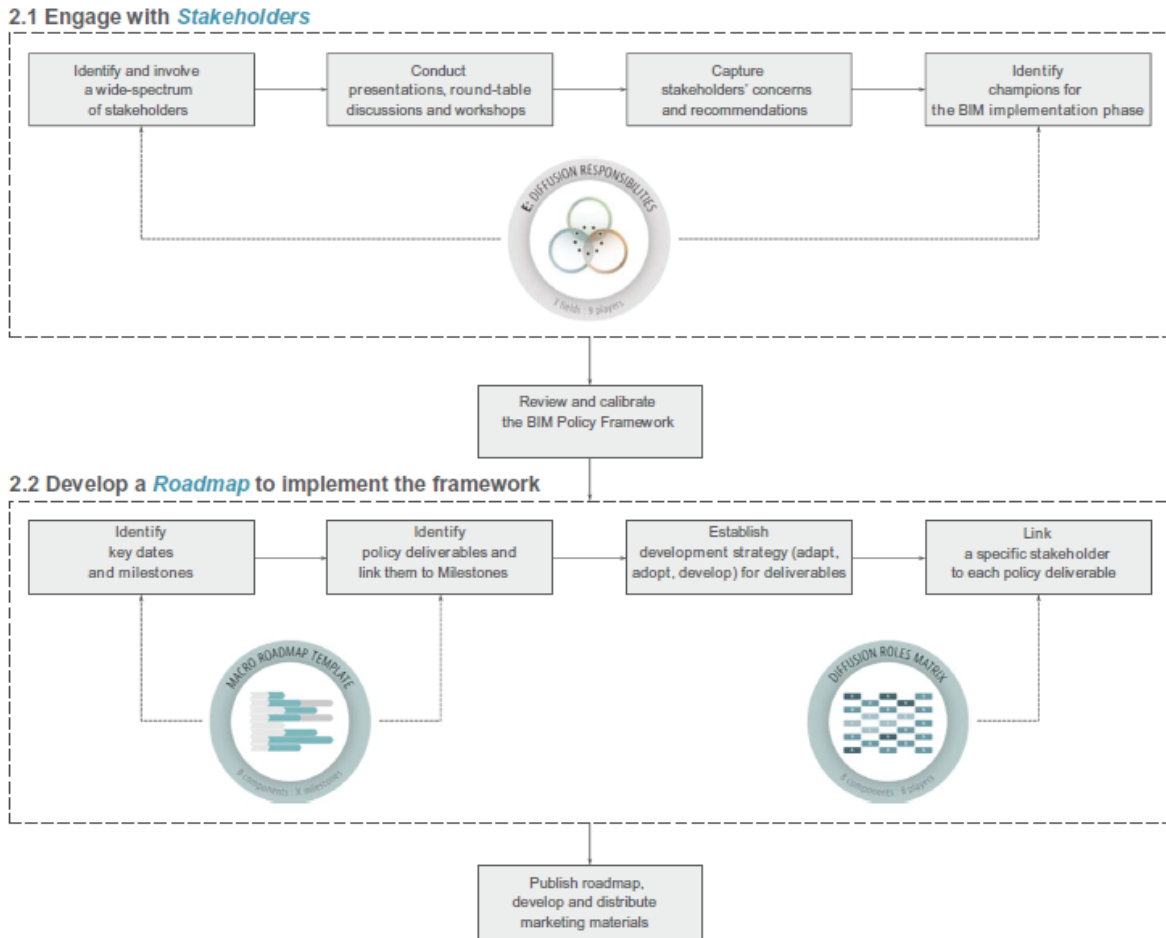


Figure 9: The Initiation Phase of the Policy Development Plan (Source Succar and Kassem, 2017).

and Rathdown County Council. The National Development Finance agency (NDFA) have successfully mandated the application of BIM on a number of projects [5]. All of these public sector bodies represent individual approaches to adopting BIM and require deep consultations with the proposed designers / contractors to ensure they are adequately executed. This is currently why the middle-out diffusion dynamic is prevalent within the industry.

The final stage in the initiation phase is to have a public resource for task group activities. At present a number of portals exist which provide valuable information for the Irish AEC Sector. The BICP website could serve as the primary portal for the task group with an additional partnering website such as NBCIreland.ie, CitA.ie, BIMIreland.ie and BIMregions and all offering valuable resources.

*Consultation Phase*

Succar and Kassem explain that at this stage the seed BIM framework is refined and converted into a

roadmap and the responsibilities for each of the roadmap items are assigned to selected stakeholders (Figure 9). Model E is applied at this stage with adequate milestones and timeframes provided. The first stage involves identifying and engaging with a wide-spectrum of stakeholders and conducting presentations, round-table discussions and workshops. This will result in the capturing of stakeholders' concerns and recommendations and identifying champions for the BIM implementation phase. The diffusion responsibility model has enabled one to identify the areas where Ireland is weak and may require extended consultations to ensure adequate resources are provided for the identified nine BIM players. In effect, the NBC and BICP have worked in tandem to achieve this through an 18-month period of engagement with industry.

Once the engagement with stakeholders period is complete, a roadmap to implement the framework can be designed with key dates and milestones designated and linked to policy deliverables through a Macro Roadmap Template. This template consists of the nine BIM policy areas from Model E aligned



Macro Maturity Components Diffusion-Role Matrix v1.0 *sample shown at GLevel 1 (Succar, 2015)*

	Objectives , Stages and...	Champions & Drivers	Regulatory Framework	Noteworthy Publications	Learning & Education	Measurements & Benchmarks	Standardised Parts and...	Technology Infrastructure	
Macro Player Groups	Policy Makers	A	A	A	B	B	A	B	C
	Educational Institutions	B	B	A	A	A	B	C	C
	Construction Organizations	B	A	B	B	B	A	A	B
	Individual Practitioners	C	C	C	C	A	C	C	C
	Technology Developers	C	C	C	C	B	C	B	A
	Technology Service Providers	C	C	C	B	A	C	B	A
	Industry Associations	B	B	A	A	B	A	C	C
	Communities of Practice	C	B	C	B	B	C	A	C
	Technology Advocates	A	A	B	A	B	B	A	B

[A] Leading, [B] Supporting, & [C] Participating roles

Table 3. A template for assessment and planning of diffusion roles (Source Succar and Kassem, 2017).

to deliverables and timeframes within each area. By working within this template, adequate timeframes and realistic targets can be provided for the areas that demonstrated the weaker results.

The next stage of the roadmap involves the development of a strategy for deliverables. This is linked through assigning a specific stakeholder to each policy deliverable as a result of the diffusion roles matrix (Table 3).

This involves matching the macro maturity components to the nine BIM players through assigning them to:

- A. A leading role played by those responsible for initiating, developing and maintaining a structured diffusion effort
- B. A supporting role played by those assisting the leading role to communicate and engage with other players, and in delivering diffusion components; and
- C. A participating role played by early adopters of innovative systems/processes.

*Execution Phase*

The execution phase involves the initiation of a Pilot Programme which will require the development of Employer Information Requirements, a training programme for public procurers and support system for industry groups around the BIM policy framework. This will assist in the development of supporting documents such as BIM guides, protocols, a model-use inventory and development of a BIM competency framework and inventory. This can eventually lead to a BIM certification and accreditation programme.

While potential roadmaps are being discussed for both the private and public sectors, there is still a gap in the execution and monitoring of these roadmaps. The BICP research team, which has been fundamental in providing research for the Irish AEC sector, could potentially assist with facilitating the key deliverables of the execution phase. If the correct resources are not provided at this stage then the roadmap could falter and be met with strong objections from the industry.

The BICP research team could work in tandem with the NBC and the GCCC to provide the important research resources required for the roadmaps.

V CONCLUSIONS

The results from the macro adoption study has provided crucial information in highlighting areas that will need to be addressed if Ireland is to continue momentum in promoting BIM within the industry. This paper has demonstrated how this information can be used to assist in the development of a roadmap. The BICP has provided an effective resource in addressing the key stages in both the initiation and consultation phase of the roadmap. A proposed roadmap from the NBC will reflect these findings through a series of recommendations based on BICP findings. However, the execution phase remains uncertain and will require significant resources to ensure its success. With the BICP’s contribution to date, it could be a seamless integration for the programme to become the monitoring body for the execution phase. This could provide a valuable link between the lifecycle of the roadmap and further improve its potential for successful integration within the sector.

## REFERENCES

- [1] BIM Innovation Capability Programme (2017) Research Objectives, available from [www.bicp.ie](http://www.bicp.ie)
- [2] Irish Government (2014) Construction 2020: A Strategy for a Renewed Construction Sector, The Stationery Office
- [3] Department of Jobs, Enterprise and Innovation (2017) Action Plan for Jobs 2017, Irish Government
- [4] Office Government Procurement (2017) A Public Sector BIM Adoption Strategy: A GCCC positional paper, Government Construction Contracts Committee
- [5] Hore, A., McAuley, B. and West, R. (2017) BIM in Ireland 2017, CitA Ltd.
- [6] Hore, A., McAuley, B. & West, R. (2017). "BIM Innovation Capability Programme of Ireland". In: LC3 2017: Volume I – Proceedings of the Joint Conference on Computing in Construction (JC3), July 4-7, 2017, Heraklion, Greece, pp. 761-768
- [7] Barlish, B. and Sullivan, K. (2011) How to measure the benefits of BIM — A case study approach, Automation in Construction, Vol, 24, pp 149–159
- [8] National Institute of Building Sciences (2007) National BIM Standard: Version 1 Part 1: Overview, principles and methodologies, BuildingSMART Alliance
- [9] Indiana University Architects Office (2009) BIM Guidelines & Standards for Architects, Engineers, and Contractors, Indiana University
- [10] CIFE (2017) VDC and BIM Scorecard, Stanford University, available at <https://vdcscorecard.stanford.edu/members>
- [11] B. Succar and M. Kassem (2015) macro-BIM adoption: conceptual structures, Automation in Construction, 57 (2015), pp 64–79
- [12] Yilmaz, G., Akcamete-Gungor, A. and Demirors, O. (2017). "A review on capability and maturity models of building information modelling." In: LC3 2017: Volume I – Proceedings of the Joint Conference on Computing in Construction (JC3), July 4-7, 2017, Heraklion, Greece, pp. 629-638
- [13] Succar, B and Kassem, M (2017) Macro BIM adoption: Comparative market analysis, Automation in Construction, 81, pp 286-299
- [14] IDA Ireland (2017) Business in Ireland, available at <http://www.idaireland.com/business-in-ireland/industry-sectors/ict/>
- [15] IDA Ireland (2017) Invest in Ireland, available at <http://www.idaireland.com/invest-in-ireland/ireland-infrastructure/>
- [16] Hore, A., McAuley, B. and West, R. (2017) BICP Global BIM Study, CitA Ltd.