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BIM e INITIATIVE

Digital Transformation through BIM:

Insights for a collective national and trans-European approach

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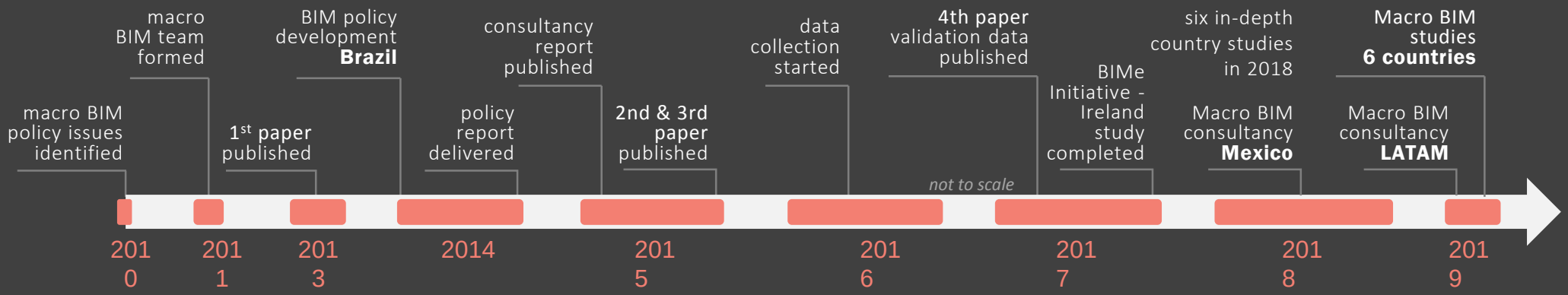
- Is BIM a ‘manifestation’ of digital transformation in construction?
- How are policy makers responding to opportunities brought by BIM?
- What are the key ingredients required in a market to achieve a BIM-enabled digital transformation?
- How does BIM diffusion unfold across a market?
- What are the approaches/actions available to policy makers to stimulate BIM adoption?
- Who to involve and how to share the BIM adoption effort across a market?
- Insights for a national and trans-European approach



A Proposed Approach To Comparing the BIM Maturity of Countries

A PROPOSED APPROACH TO COMPARING THE BIM MATURITY OF COUNTRIES

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ABSTRACT

BIM concepts and tools have now proliferated across the construction industry. This is evidenced by the comparative results of BIM adoption rates reported through a number of industry surveys. However these surveys typically cover a small number of industry stakeholders, are intended to establish adoption rates by organizations rather than markets; and are unsupported by theoretical frameworks to guide data collection and analysis. Based on a published theoretical framework, this paper proposes three metrics to augment survey data and help establish the overall BIM maturity of countries. These metrics apply to noteworthy BIM publications (NBPs) and assess their BIM knowledge content (BKC). NBPs are publically-available industry *documents* intended to facilitate BIM adoption; while BKCs are specialized *labels* (e.g. report, manual, and contract) used to describe NBP contents. The three metrics – *NBP availability, NBP content distribution,* and *NBP relevance* - are applied in assessing the knowledge deliverables of three countries – United States, United Kingdom and Australia - chosen for their similar construction culture and active BIM scene. The paper then discusses how these complementary metrics can inform policy development and identify market-wide knowledge gaps.

Keywords: Building Information Modeling (BIM), Country-scale BIM maturity, Noteworthy BIM Publications, BIM Knowledge Content taxonomy.

1. INTRODUCTION

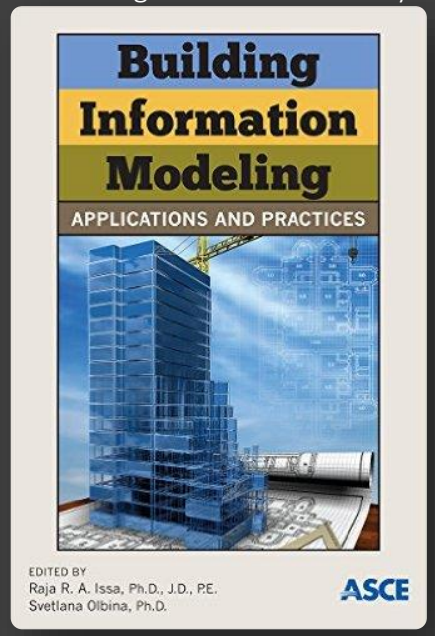
This paper adopts a wide-angle approach to BIM maturity as applicable to countries rather than organizations. Assessing maturity at this large scale is conceptually supported by a published framework used as a basis for proposing new qualitative metrics to complement quantitative surveys conducted in three countries. For the purposes of simplification and targeted exploration, we propose three - out of many possible - qualitative metrics; focus on three countries with similar construction cultures; and steer away from differentiating between BIM readiness, adoption, diffusion, infusion and maturity. These self-imposed limitations are intended to facilitate this exploration of country-wide BIM maturity and will be removed in future more detailed studies.

1.1 COUNTRY-SCALE BIM MATURITY

BIM maturity refers to the quality, repeatability and degrees of excellence in delivering a BIM-enabled service or product (Succar, 2010). There are an increasing number of BIM-specific maturity frameworks (Giel and Issa, 2012) (Chen, Dib and Cox, 2012) (Mom and Bloch, 2012). Many of these frameworks are intended to measure the performance of organizations and teams but are not applicable across all *organizational scales* (Succar, 2010). For example, there are several maturity models available for assessing *organizational BIM capability/maturity* (CNO, 2010) (CIST, 2007) (BIMe, 2013) (Succar, 2010), *BIM project performance* (IU, 2009) (Suermann, Issa and McCuen, 2008) (BIMScore, 2013) (BIMe, 2013), and *individual BIM competency* (Succar 2013) (BIMe,

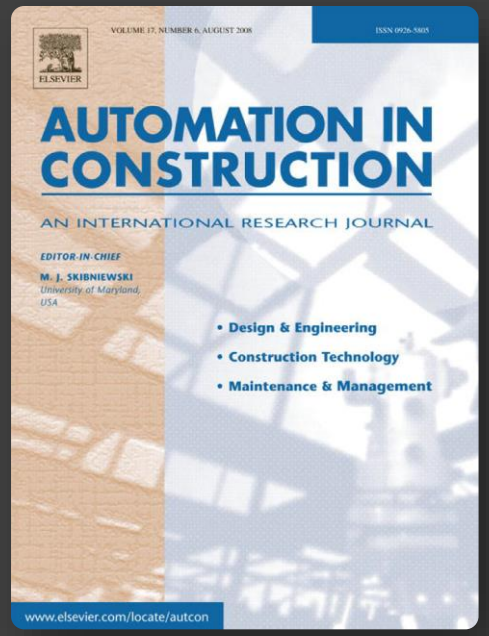
2013

Analyzing Noteworthy Publications of Eight Countries Using a Knowledge Content Taxonomy



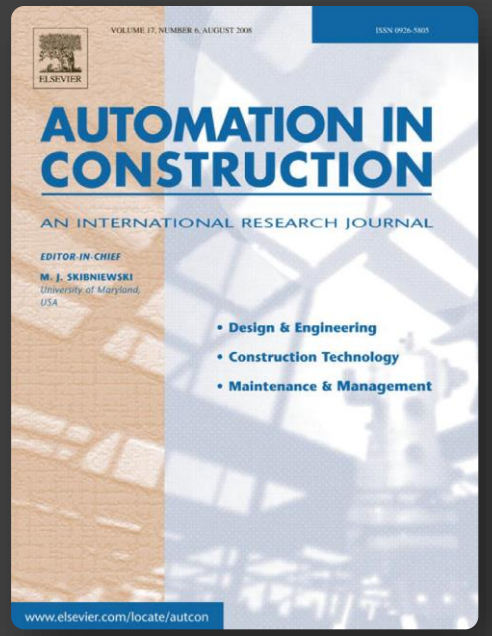
2015

Macro BIM Adoption: Conceptual Structures



2015

Macro BIM adoption: Comparative Market Analysis



2017

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26 countries so far including input from +350 experts

Initial Benchmarking Data – collected in 2015 -2019

Australia	New Zealand	Netherlands	Switzerland	Russia	Canada
China	Brazil (thrice)	Portugal	UAE	Peru	Guatemala
Finland	Ireland (twice)	Qatar	United Kingdom	Argentina	
Hong Kong (twice)	Italy	Russia	USA	Uruguay	
Malaysia	Mexico (twice)	Spain (twice)	South Korea	Chile	

FIESP, Sau Paolo 2014 | Brazil

EU BIM Summit, 2015 & 2016 | Spain

Future BIM Implementation , 2015 | Qatar

GEOBIM, 2014 | Netherlands

Geospatial World Forum, 2015 | Portugal

BIM Leadership Forum, 2015 | Brazil

2015 – 2019

Barcelona, Milan, Sao Paolo, Hannover, Cairo, Dublin, Montreal, Hong Kong, …

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Is BIM a 'manifestation' of digital transformation in construction?

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Cloud-based collaborative working

Industrialised construction

Smart buildings and cities

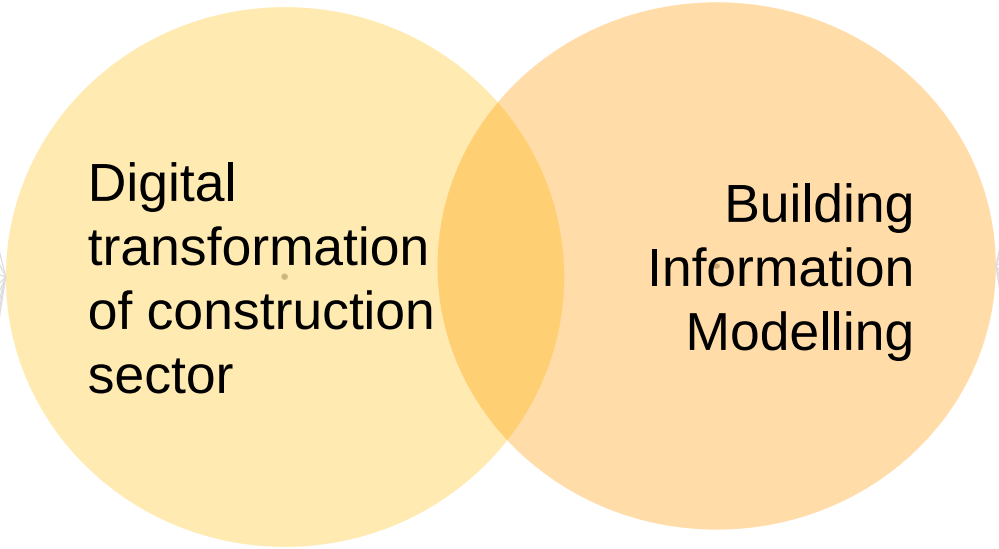
Automation, robot, & drones

Digital Twin

VR & AR

Sensing and IoT

DLT and smart contract



Facilitate collaborative working

Enable offsite manufacturing and industrialised construction

Better asset management and maintenance

Automate repetitive tasks and reduces effort and costs

Better visualisation and coordination

Test designs options, test performances and value engineering

Improved scope, cost & time predictability

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BIM is the current expression of digital innovation within the construction industry

Adoption = (Implementation + Diffusion) x activities

Within projects, organisations, and by individuals

Macro Adoption = market/country level

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How policy makers are responding to opportunities brought by BIM?

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Mandates + Standards + Incentives

UK's BIM Level 2

France's BIM Plan 2022

Quebec's Construction 4.0 Initiative

Construction Industry Council's Initiative (Hong Kong)

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Public vs private sector

Capacity building

Engagement reach

Lack of guidance

Untested case studies

Reality vs. hype

Gaps/ redundancy in policy

Metho-dological approach

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- Strong evidence for **collective approach** to accelerate adoption, reduce costs, and increase collective benefits
- Key attributes of **BIM Adoption Policies**
  - Provides a clear and purposeful vision
  - Demonstrates strong leadership
  - Engages with all relevant stakeholders and interest groups
  - Provides incentives
  - Prioritise learning, education and capacity building
  - Commit for a long term journey (maintenance, succession, or termination)

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What are the key ingredients required in a market to achieve a BIM-enabled digital transformation?

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There are

8 Components

that every market needs to develop to enable both holistic and systematic BIM Adoption

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Macro Maturity Components Model

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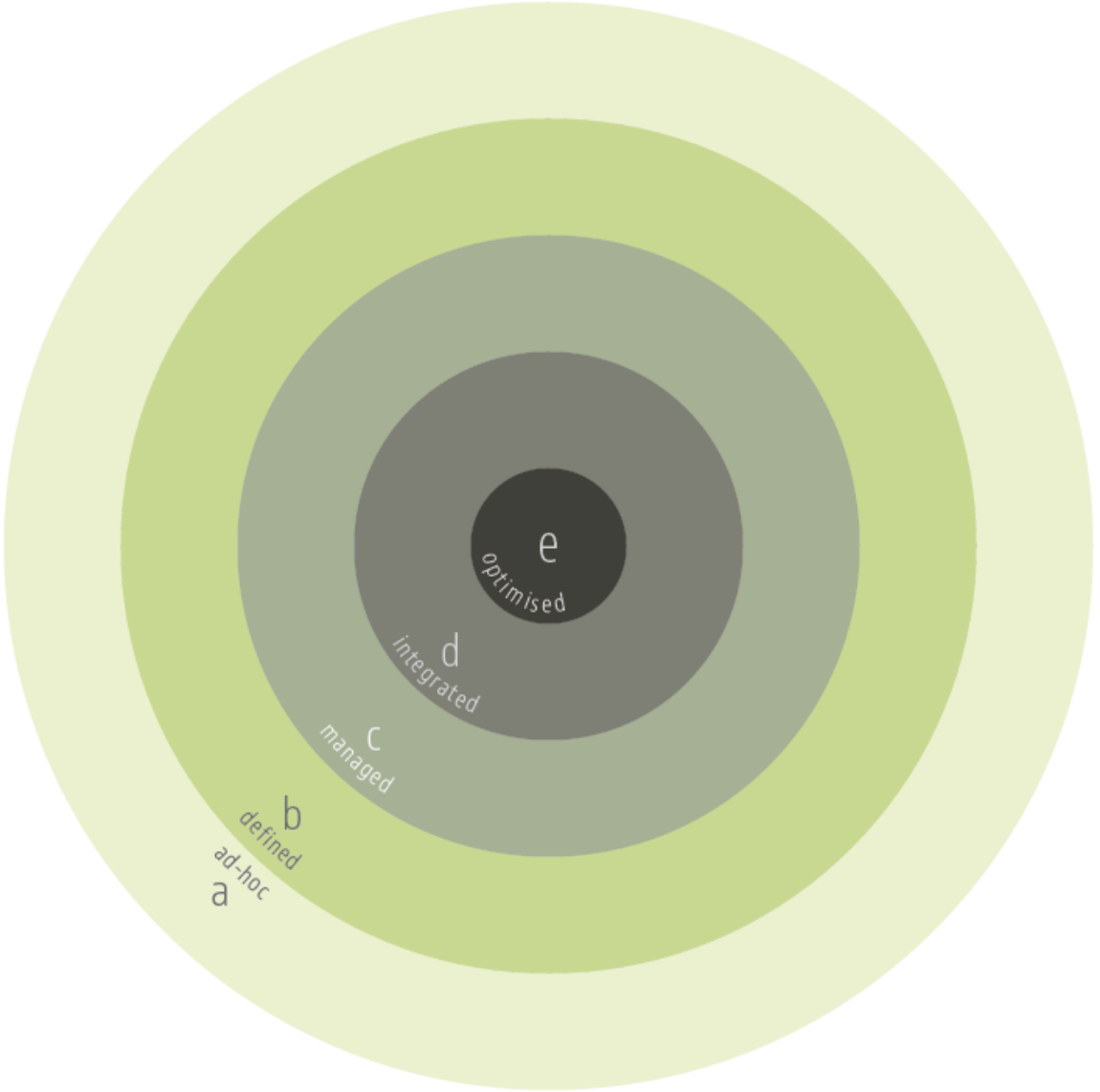
Macro Maturity Components Model



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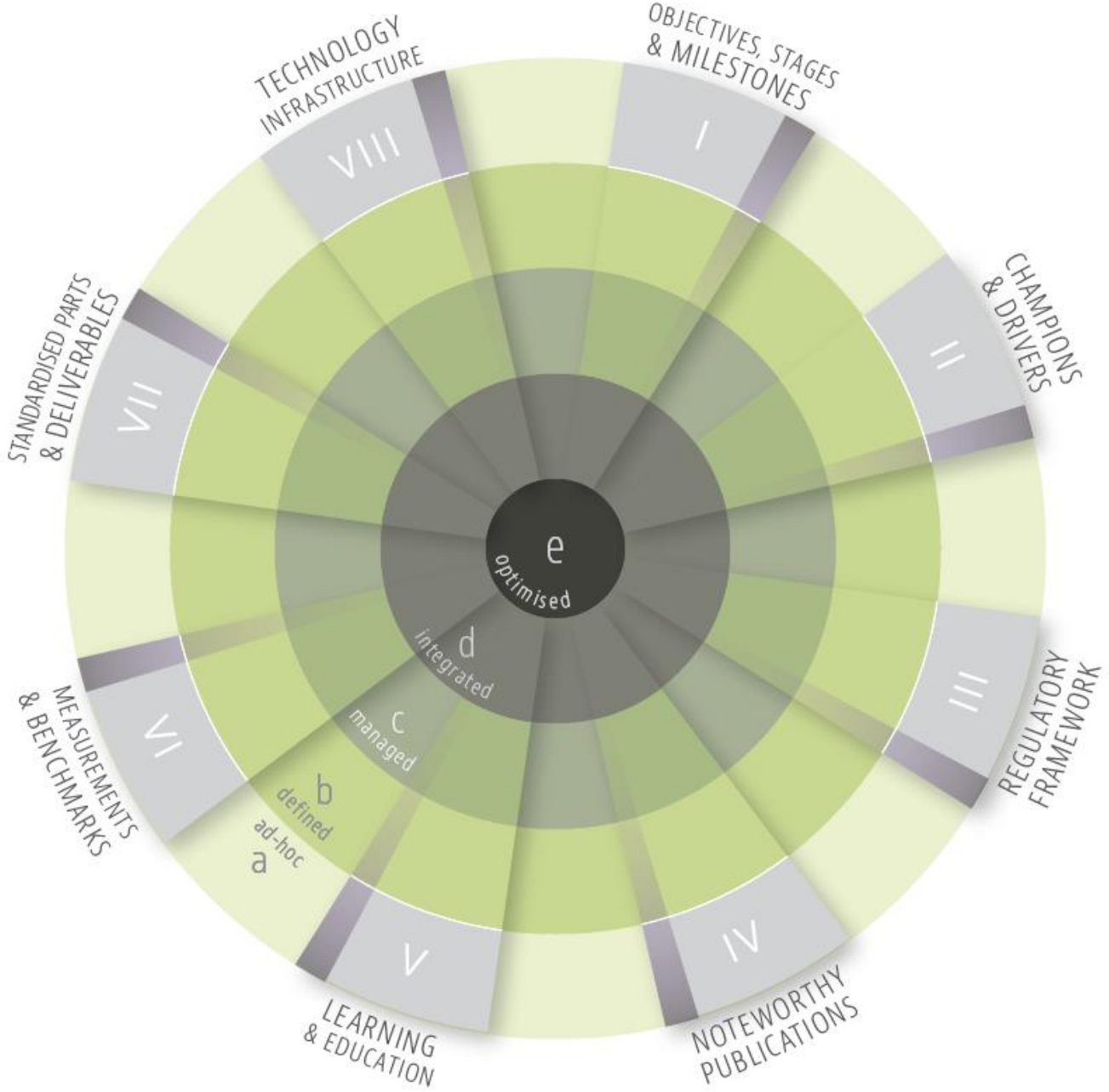
Macro Maturity Components Model



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Component I

Objectives, stages and milestones

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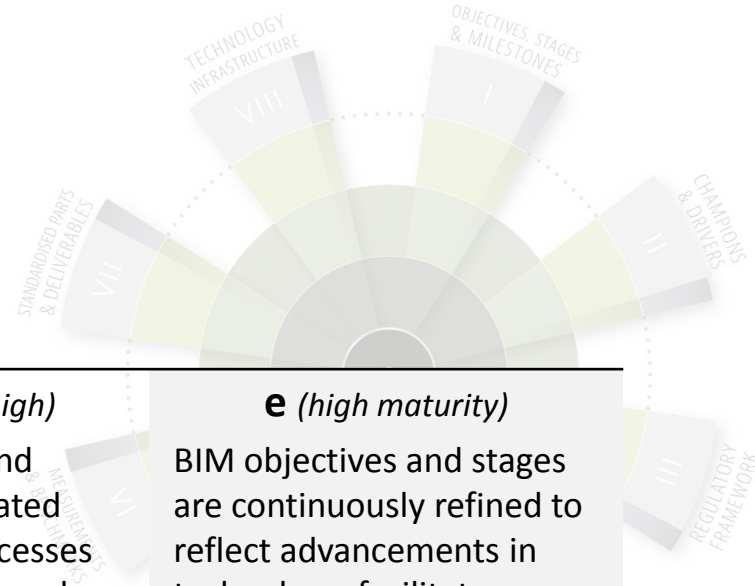

a *(low maturity)*	**b** *(medium-low)*	**c** *(medium maturity)*	**d** *(medium-high)*	**e** *(high maturity)*
There are no market-scale BIM objectives or well-defined BIM implementation stages or milestones	There are well-defined macro BIM objectives, implementation milestones and capability stages	BIM objectives, stages and milestones are centrally managed and formally monitored	BIM objectives and stages are integrated into policies, processes and technologies and manifest themselves within all other macro maturity components	BIM objectives and stages are continuously refined to reflect advancements in technology, facilitate process innovation, and benefit from international best practices

Other component-specific metrics include: *The Availability of Long-term Objectives to Guide Market Adoption; Availability of Capability Stages to Guide Market Adoption; The Availability of Maturity Milestones to Guide Market Adoption; …*

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Component V

Learning and education

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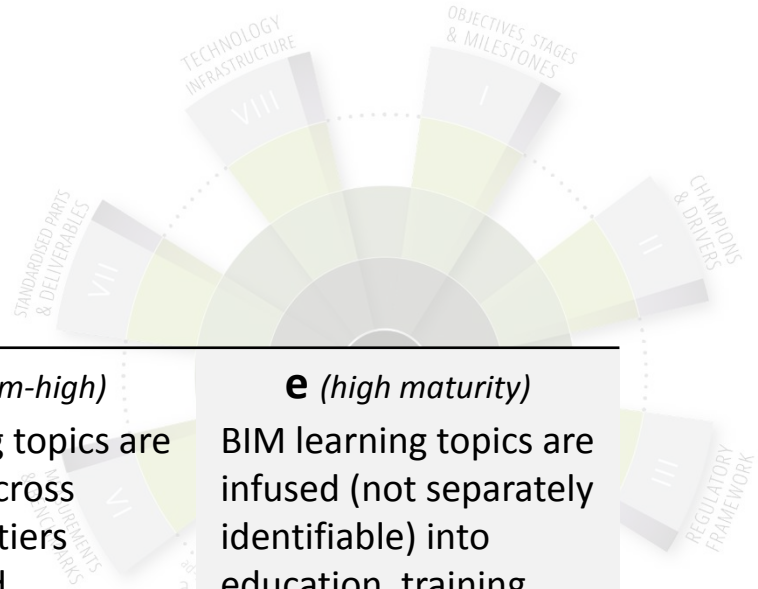

a *(low maturity)*	**b** *(medium-low)*	**c** *(medium maturity)*	**d** *(medium-high)*	**e** *(high maturity)*
BIM learning topics are neither identified nor included within legacy education/training programs; learning providers lack the ability to deliver BIM-infused education	BIM learning topics are identified and introduced into education/training programs; BIM learning providers are available across a number of disciplines and specialties	BIM learning topics are mapped to current and emergent roles; BIM learning providers deliver accredited programs across disciplines and specialties	BIM learning topics are integrated across educational tiers (tertiary, and vocational) and address the learning requirements of all industry stakeholders	BIM learning topics are infused (not separately identifiable) into education, training and professional development programs

Other component-specific metrics include: *BIM Infusion into Tertiary Curricula; Multi-disciplinary Integration of Curricula; Use of Simulated Design, Construction and Operation Environments; Expertise of Learning Providers; …*

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Component VII

Standardised parts and deliverables

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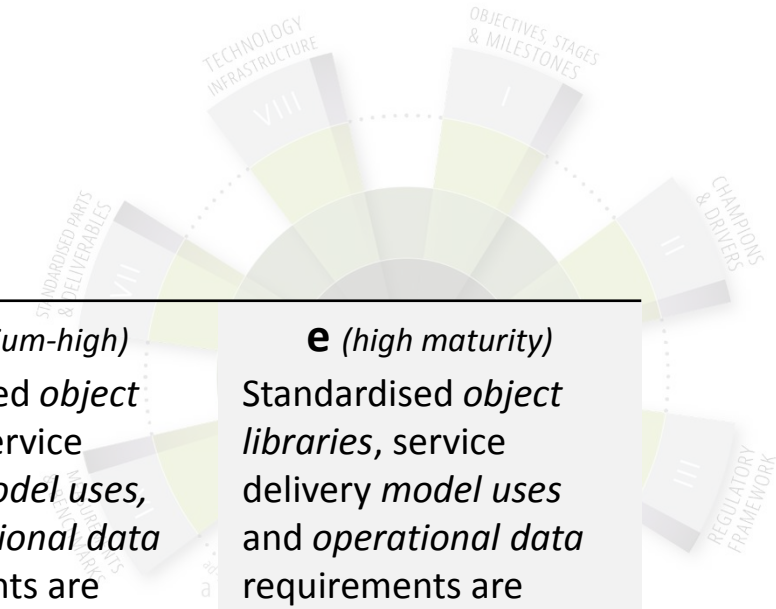

a *(low maturity)*	**b** *(medium-low)*	**c** *(medium maturity)*	**d** *(medium-high)*	**e** *(high maturity)*
There no market-specific *object libraries* (e.g. doors and windows); service delivery *model uses* (e.g. clash detection) and *operational data* requirements (e.g. COBie)	*Object libraries* are available yet follow varied modelling and classification norms; service delivery *model uses* and *operational data* requirements are informally defined and partially used	Standardised *object libraries* are available and used; service delivery *model uses* and *operational data* requirements are formally defined and used across all project lifecycle phases	Standardised *object libraries*, service delivery *model uses,* and *operational data* requirements are integrated into, procurement mechanisms, project workflows and lifecycle facility operations	Standardised *object libraries*, service delivery *model uses* and *operational data* requirements are continuously optimised and realigned to improve usage, accessibility, interoperability and connectivity

Other component-specific metrics include: *Availability of an Elemental Classification System; Availability of National Object Libraries; Availability of Standardised Model Uses; …*

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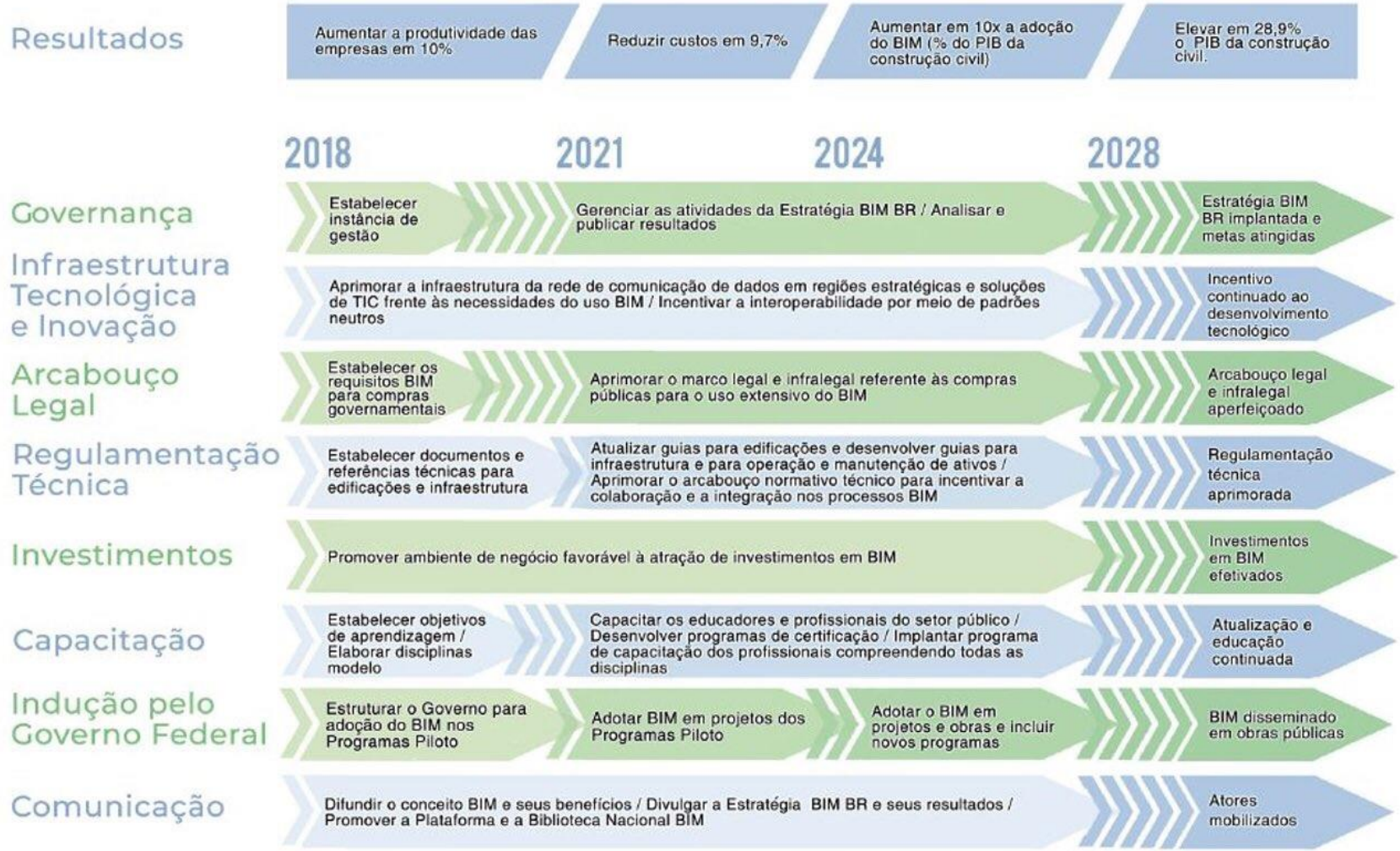
	Objectives, Stages & Milestones	Establish basic strategic objectives	Define min capability requirements for projects of Type X	Define minimum capability requirements and project deliverables for all other types and sizes of projects
	Champions & Drivers	Establish a high-level task group to develop a national strategy	Establish mid-level, regional or specialised satellite task groups to implement the national strategy and develop detailed protocols	Dissolve all regional satellite groups and encourage the formation of specialised Communities of Practice (CoP)s
	Regulatory Framework	Develop a framework that encourages process innovation, early involvement of contractors and integrated project delivery	Conduct pilot projects using the new framework. Refine the framework and establish a strategy for its market-wide adoption	Mandate the use of the new regulatory framework
	Noteworthy Publications	Establish a list of noteworthy publications to be developed	Develop the development of the first set of guides, protocols and mandates that facilitate BIM adoption across the market	Develop or coordinate the development of a set of standards that regulate the quality of project deliverables across the supply chain
	Learning & Education	Develop a competency inventory, educational framework, and learning modules. Conduct awareness sessions across the supply chain	Develop learning modules for tertiary, vocational, and professional settings. Encourage the development of e-learning material covering all disciplines and roles. Educate the educators.	
	Measurements & Benchmarks	Develop metrics for assessing and prequalifying the capability of organizations and the competency of individuals	Develop a market-wide benchmark for project performance. Develop a performance pre-qualification framework	Establish a market pre-qualification register
	Standardised Parts & Deliverables	Develop a protocol for standardized components	Generate standardized components for most-used architectural, structural and mechanical elements.	
	Technology Infrastructure	Develop a protocol for min hardware specifications	Develop a protocol for common data environments (for exchanging files and data)	Develop a protocol for a whole life-cycle, *integrated-data environment* (covering all documents, models and data)

BIM Roadmap: Brazil



Source: http://www.dnit.gov.br/planejamento-e-pesquisa/bim-no-dnit/bim-no-dnit-1/estrategia-bim-br

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How does BIM diffusion unfold across a market?

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There are

3 market dynamics

that affect how BIM adoption is triggered and diffused

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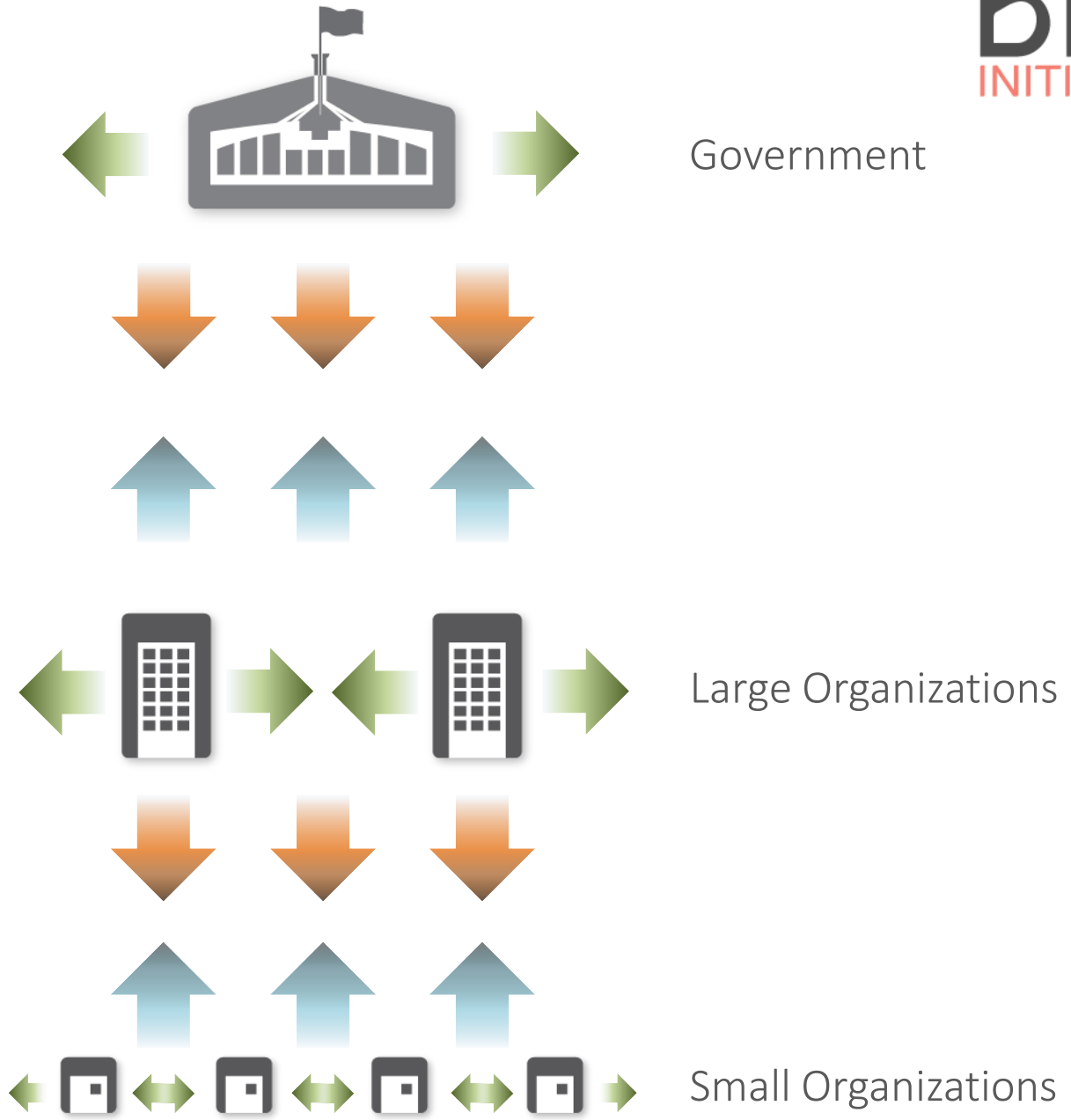
Diffusion Dynamics

Model

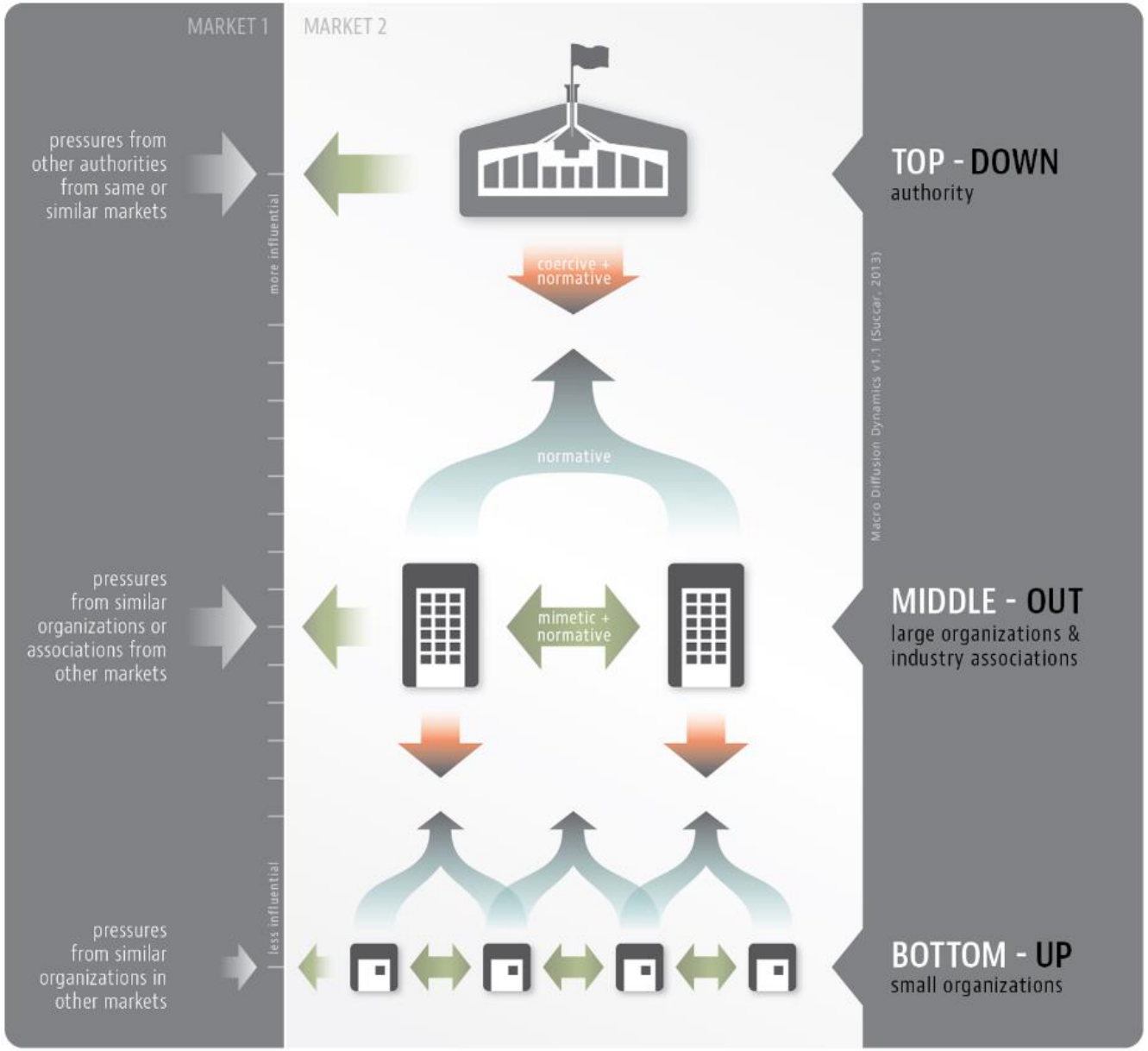


Diffusion Dynamics Model

3 Diffusion Dynamics:
Top-Down, Middle-Out & Bottom-Up.

3 Pressure Mechanisms:
Downwards, Upwards & Horizontal; and

3 Pressure Types:
Coercive, Normative, & Mimetic



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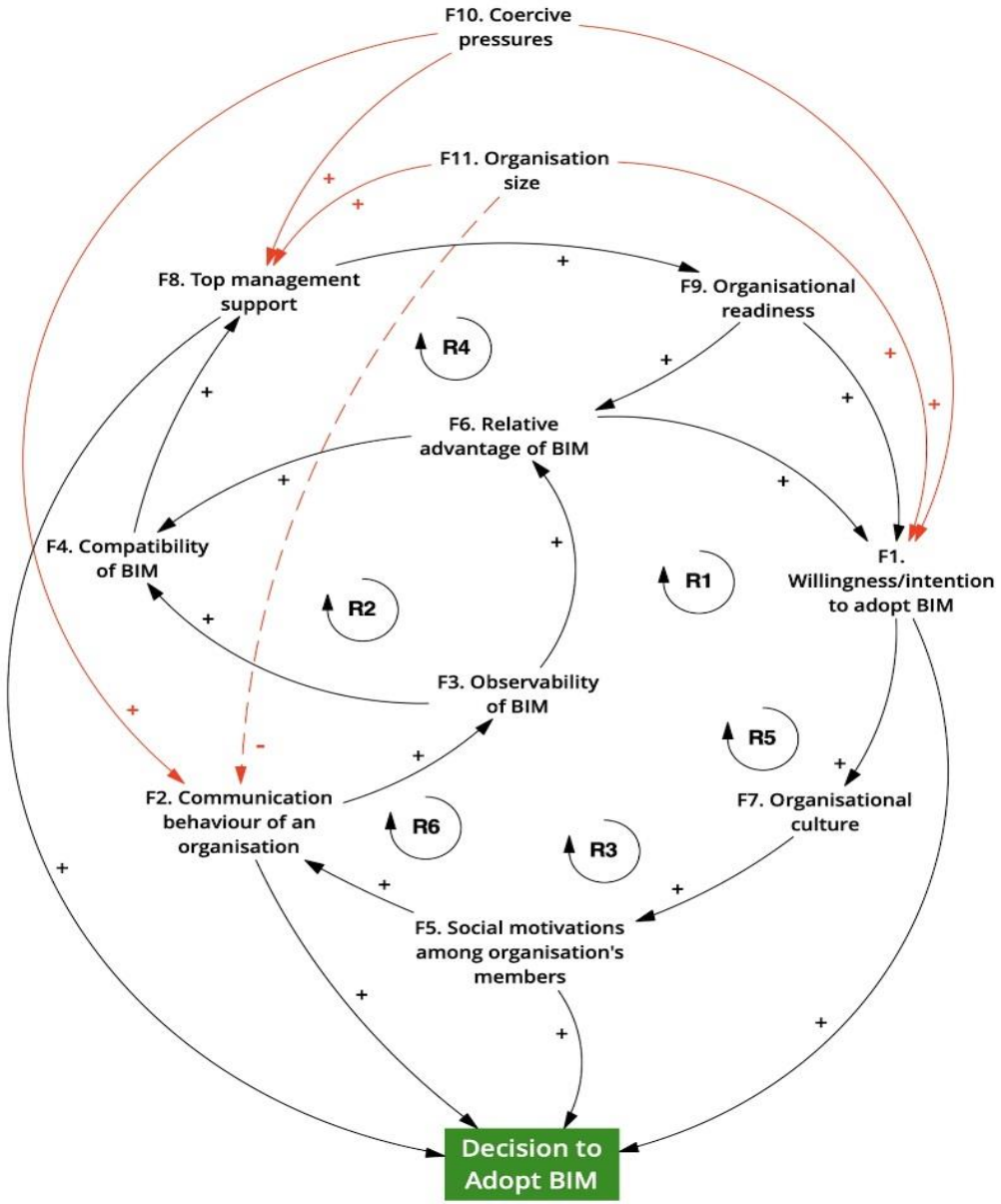
At organisation level

Many dynamics

affect how BIM adoption occur and top one can be identified



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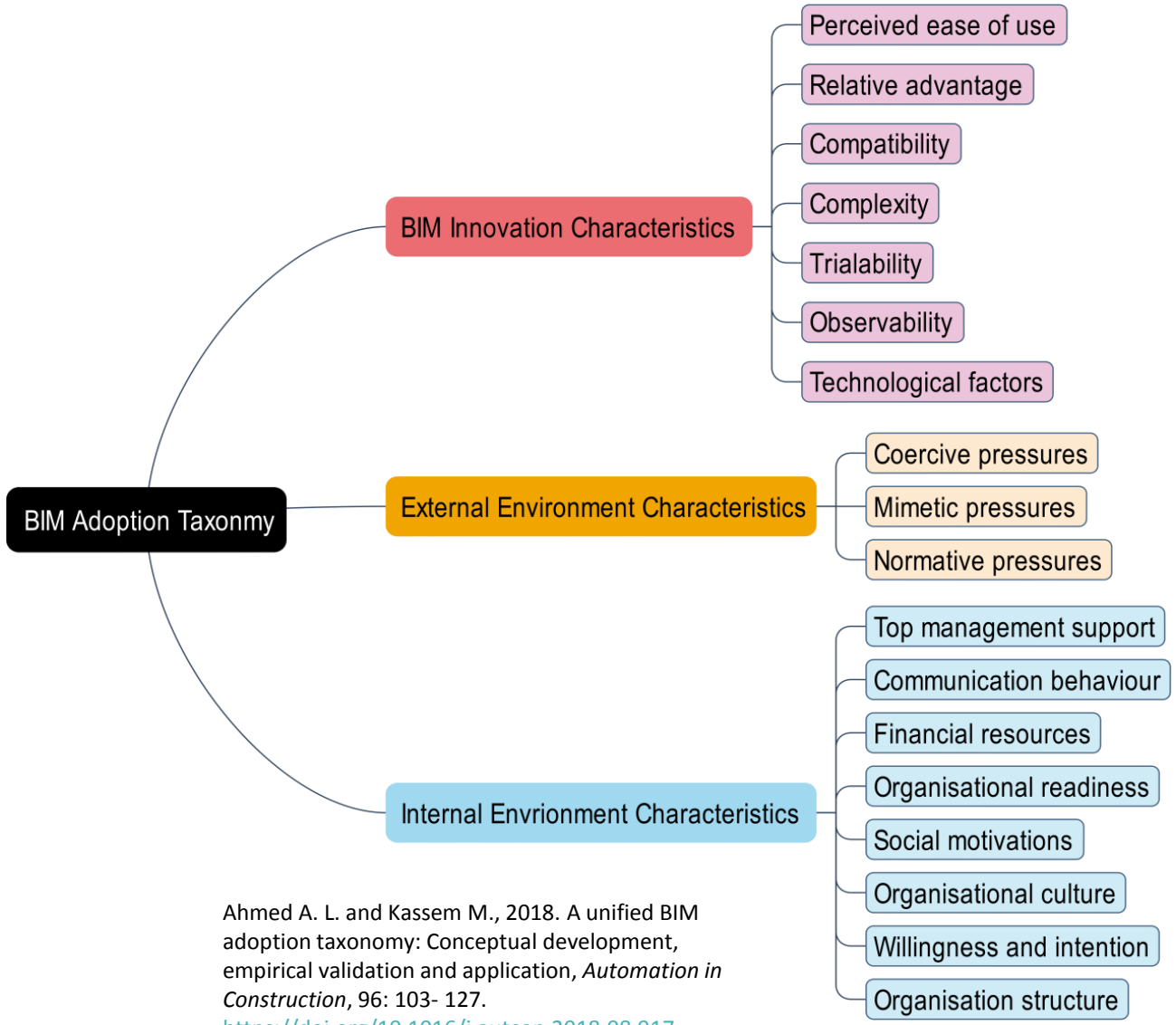

Ahmed A. L. and Kassem M., 2018. A unified BIM adoption taxonomy: Conceptual development, empirical validation and application, *Automation in Construction*, 96: 103- 127. https://doi.org/10.1016/j.autcon.2018.08.017

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Loop	Loop name	Interdependent factors	Indication
R1	Benefits of BIM innovation	Relative advantage of BIM (F6) ⟶ Willingness/ intention to adopt BIM (F1) ⟶ Organisational culture (F7) ⟶ Social motivations among organisation's members (F5) ⟶ Communication behaviour of an organisation (F2) ⟶ Observability of BIM benefits (F3) ⟶ Compatibility of BIM (F4) ⟶ Top management support (F8) ⟶ Organisational readiness (F9) ⟶ Relative advantage of BIM (F6).	BIM benefits can lead through its influence on a number of organisational characteristics (willingness to adopt BIM, organisational culture, social motivation, and communication behaviour) to an appreciation of the benefits of BIM and its compatibility, hence, inviting top management support which improve the organisation readiness and lead to the decision to adopt BIM.

Ahmed A. L. and Kassem M., 2019. Micro BIM Adoption: Identifying the Profiling Patterns of adoption using a Systems Thinking Approach, *proceedings of 2019 CIB78, 18-20 Sep, Newcastle, UK.*

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What are the approaches/actions available to policy makers to stimulate BIM adoption?

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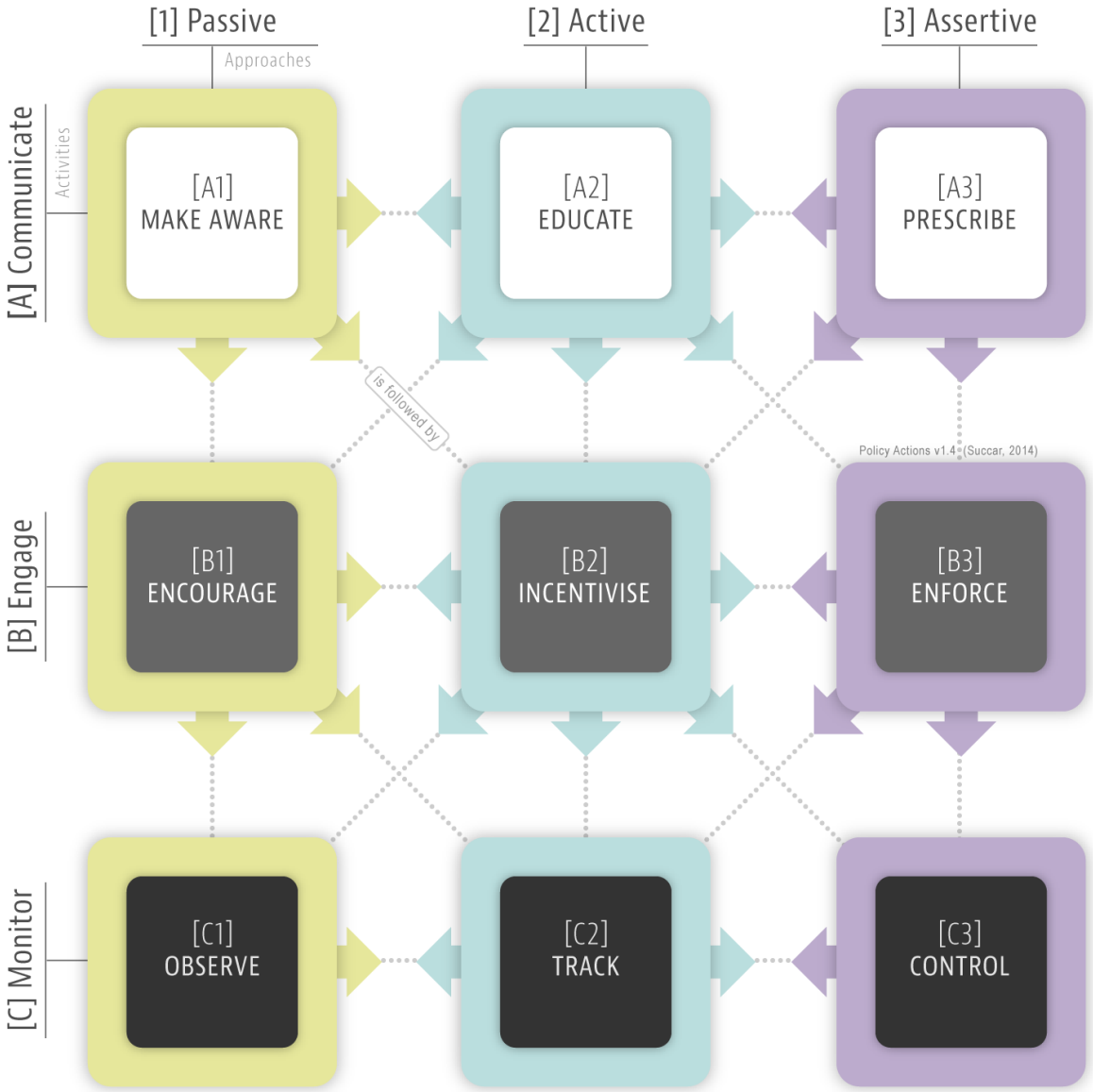
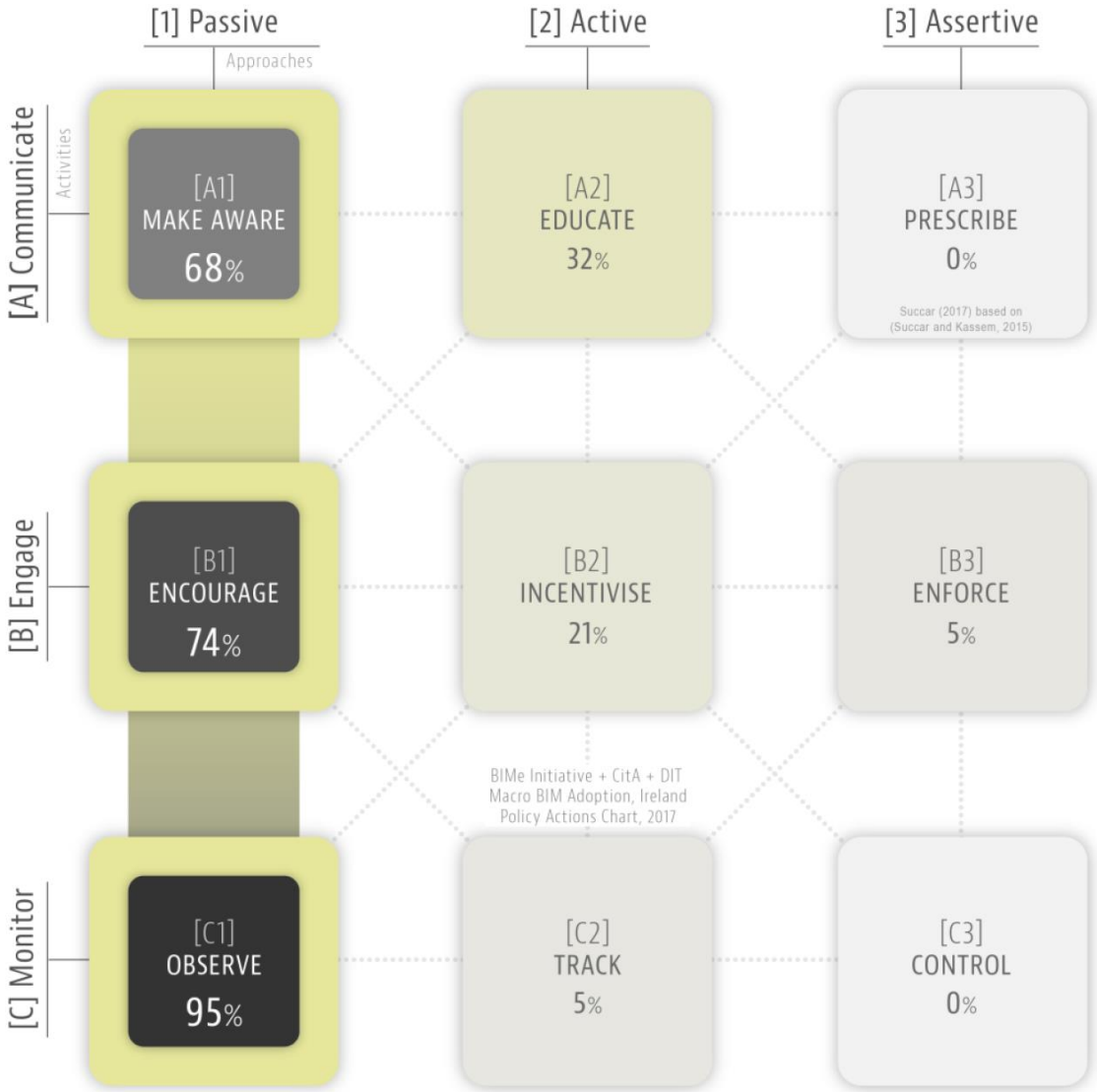
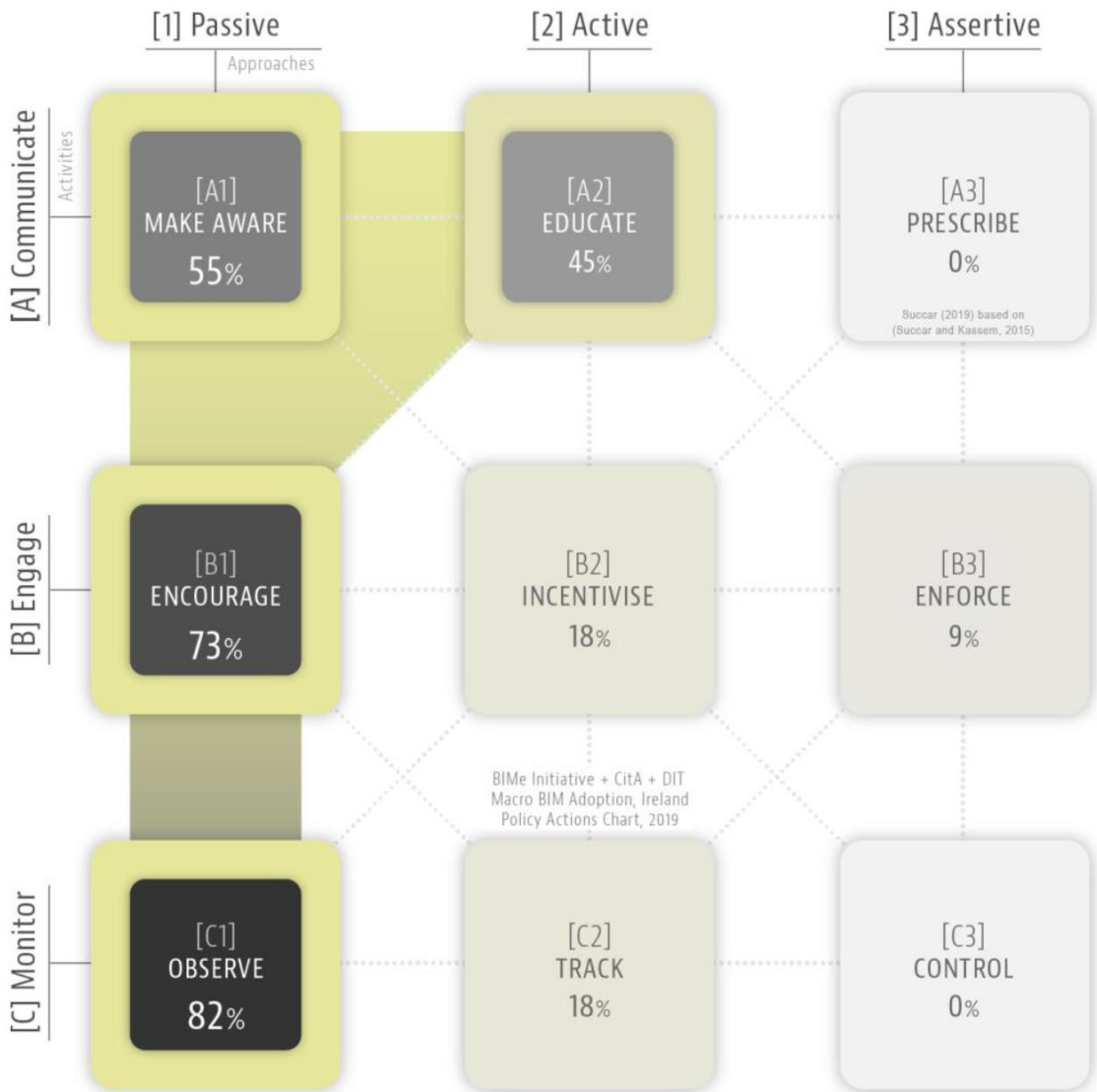
Policy Actions

Model





Ireland 2017



Ireland 2019

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Who to involve and how to share/plan the BIM adoption effort across a market?

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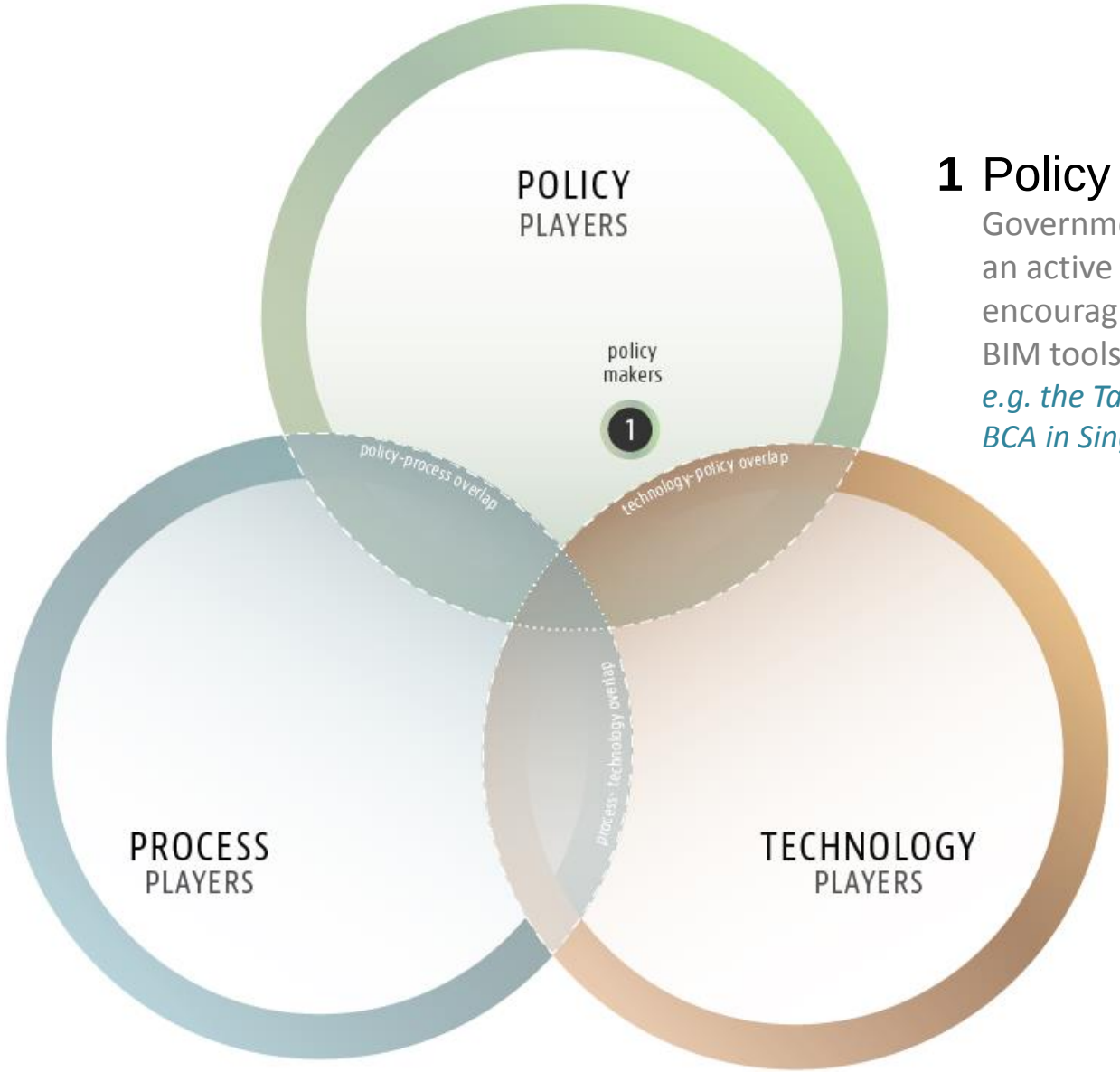

1 Policy Makers

Governmental players playing an active role in mandating or encouraging the adoption of BIM tools and workflows

e.g. the Task Group in the UK and BCA in Singapore

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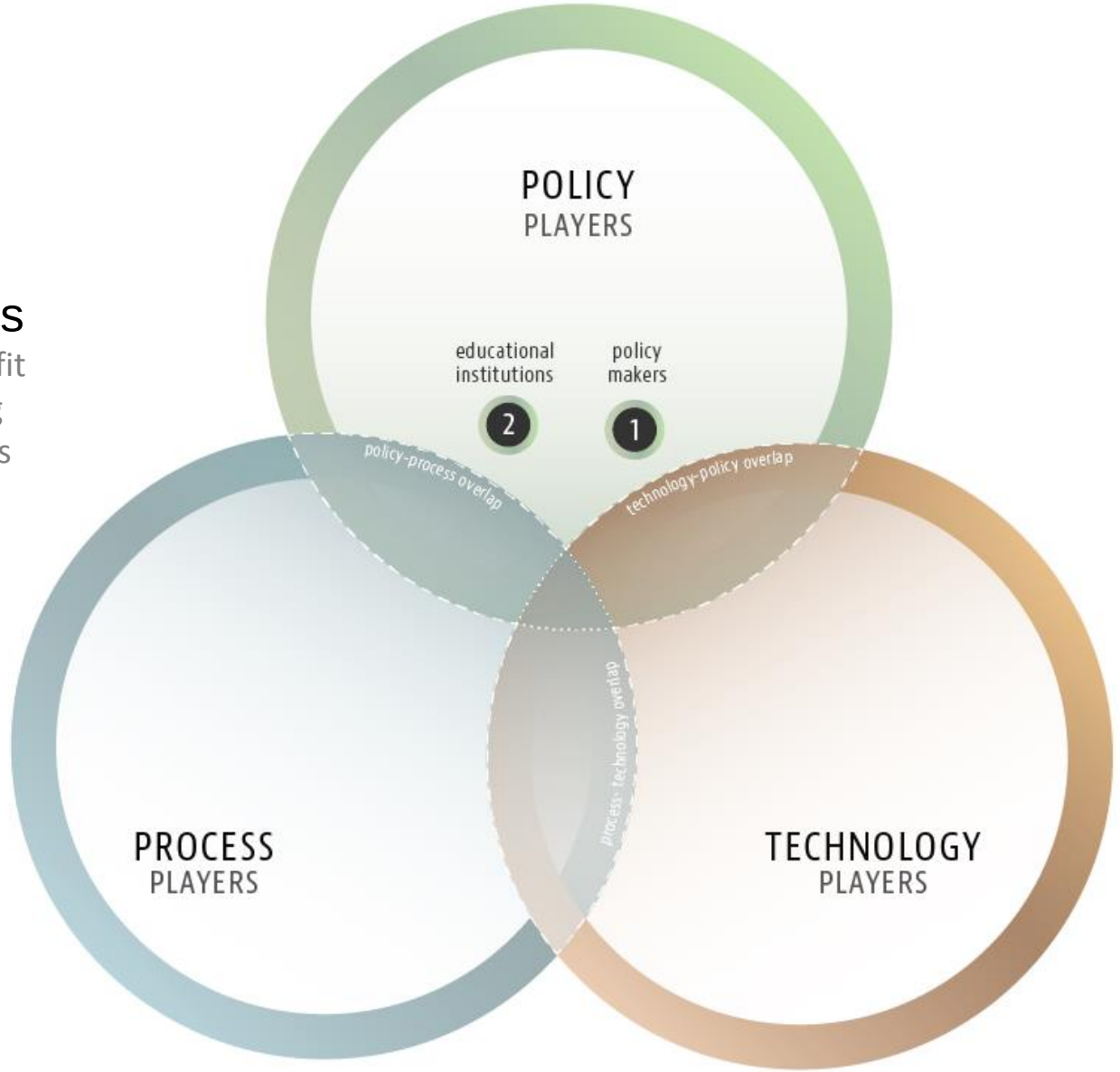
2 Educational Institutions

The universities and not-for-profit technical institutions developing and delivering learning programs and materials



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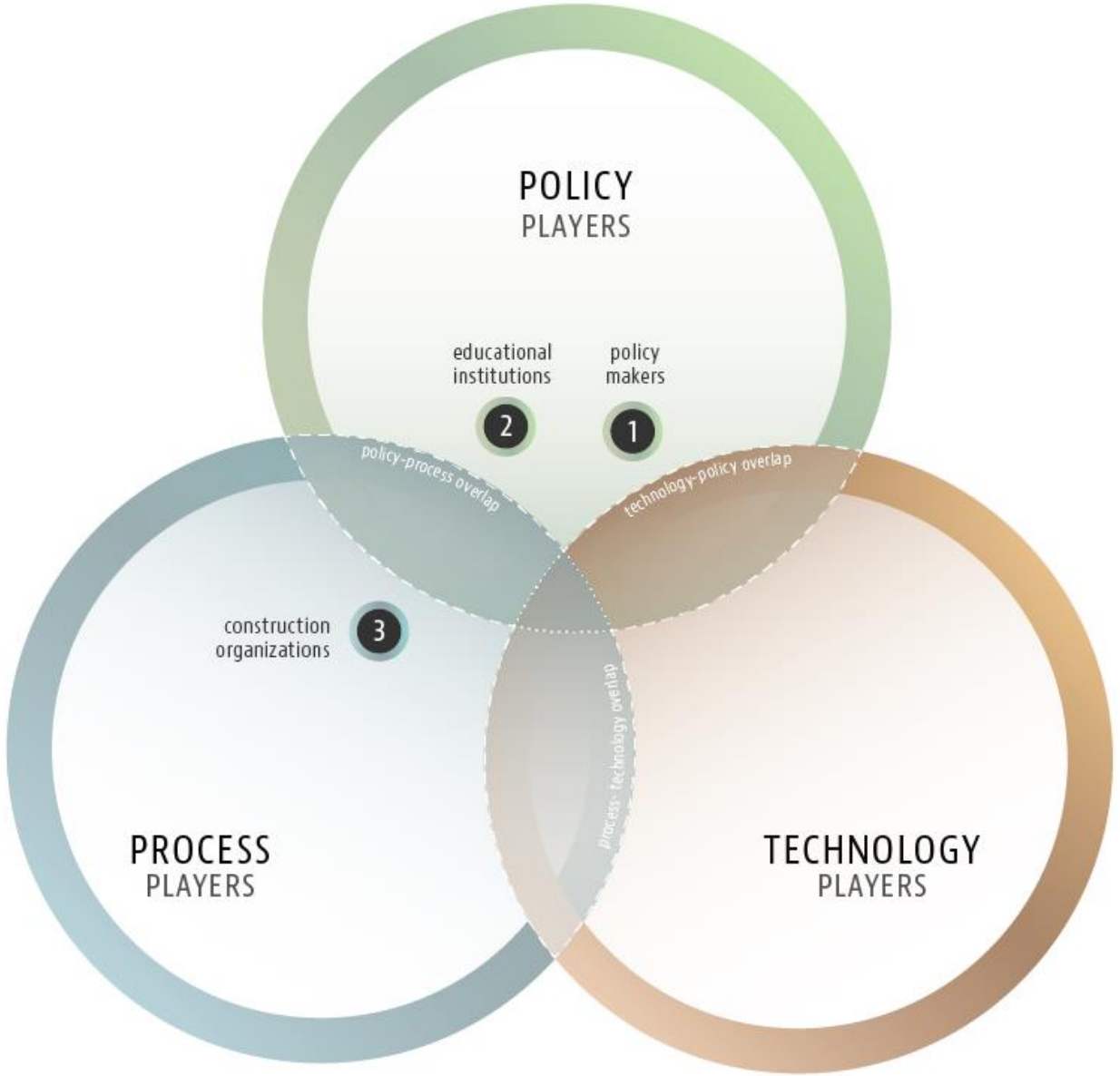
3 Construction Organizations

Designers, contractors, owners, operators and other organizational players involved in deploying BIM tools and workflows, training their staff and delivering BIM-enabled outcomes



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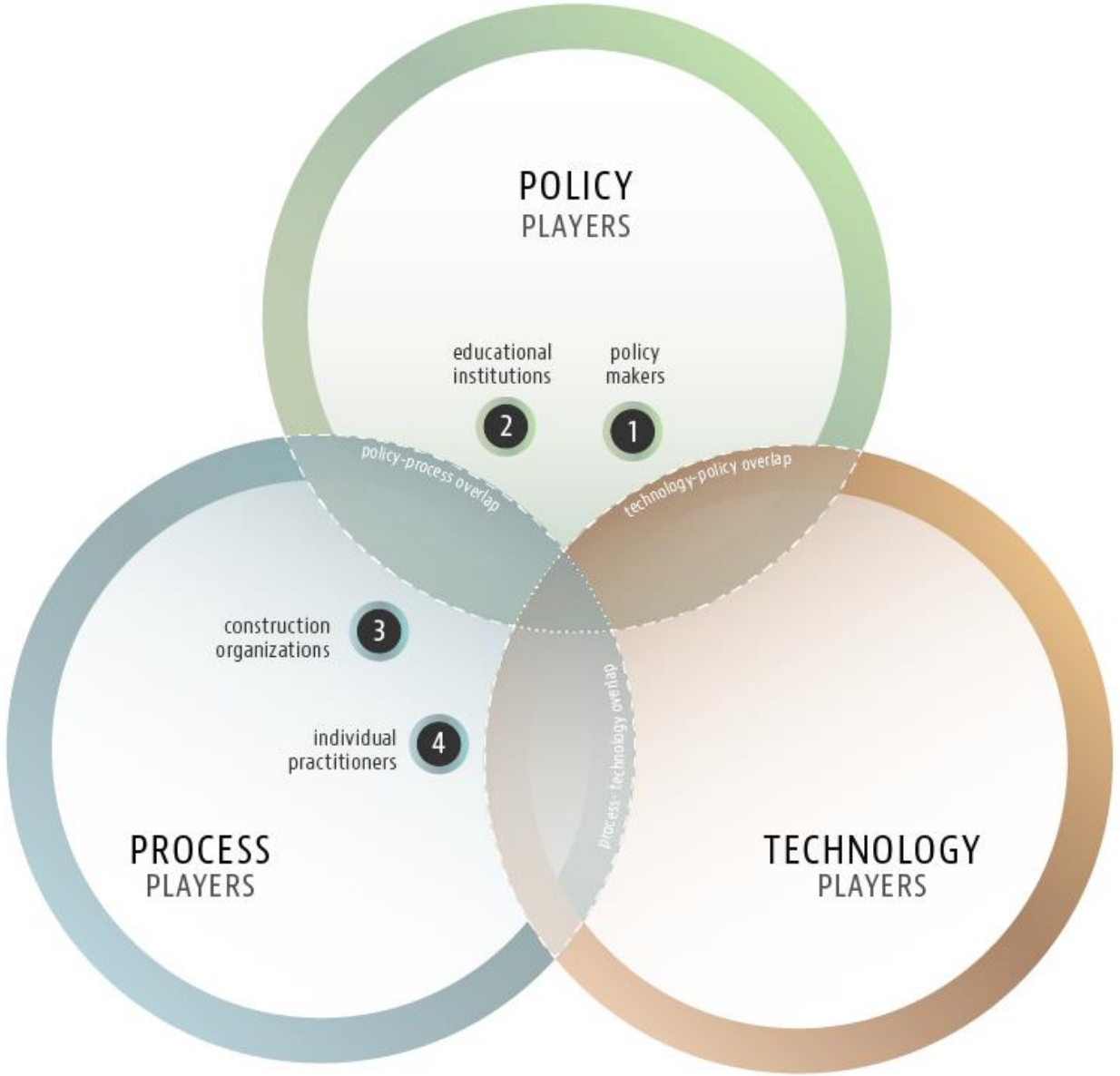
4 Individuals

The individual practitioner, researcher, lecturer and student involved in learning, or actively implementing BIM tools and workflows



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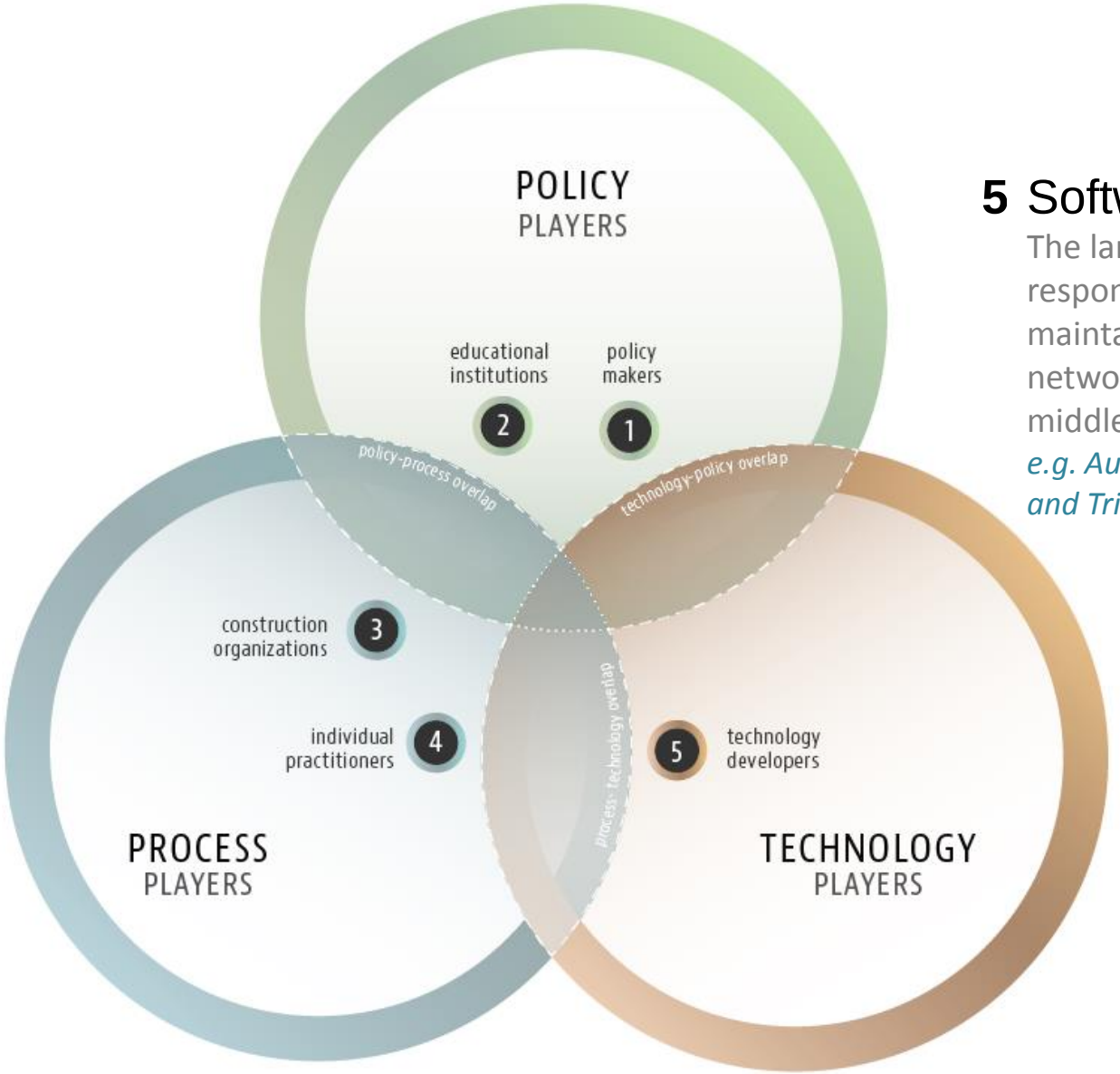

5 Software Developers

The large software houses responsible for developing and maintaining BIM software tools, network solutions and middleware

e.g. Autodesk, Nemetschek and Trimble

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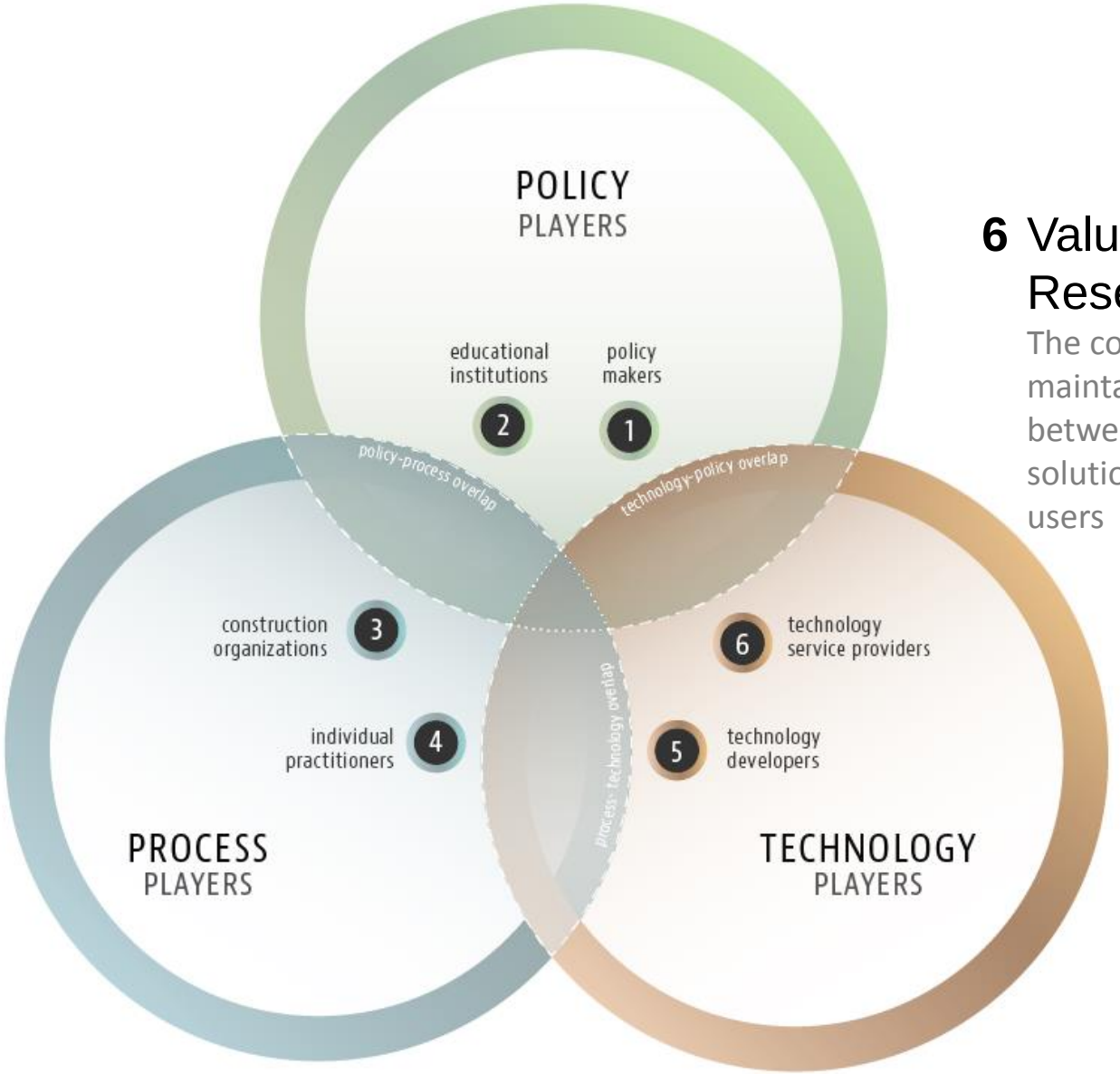

6 Value-adding Resellers

The companies bridging and maintaining the relationship between software/network solution developers and end users

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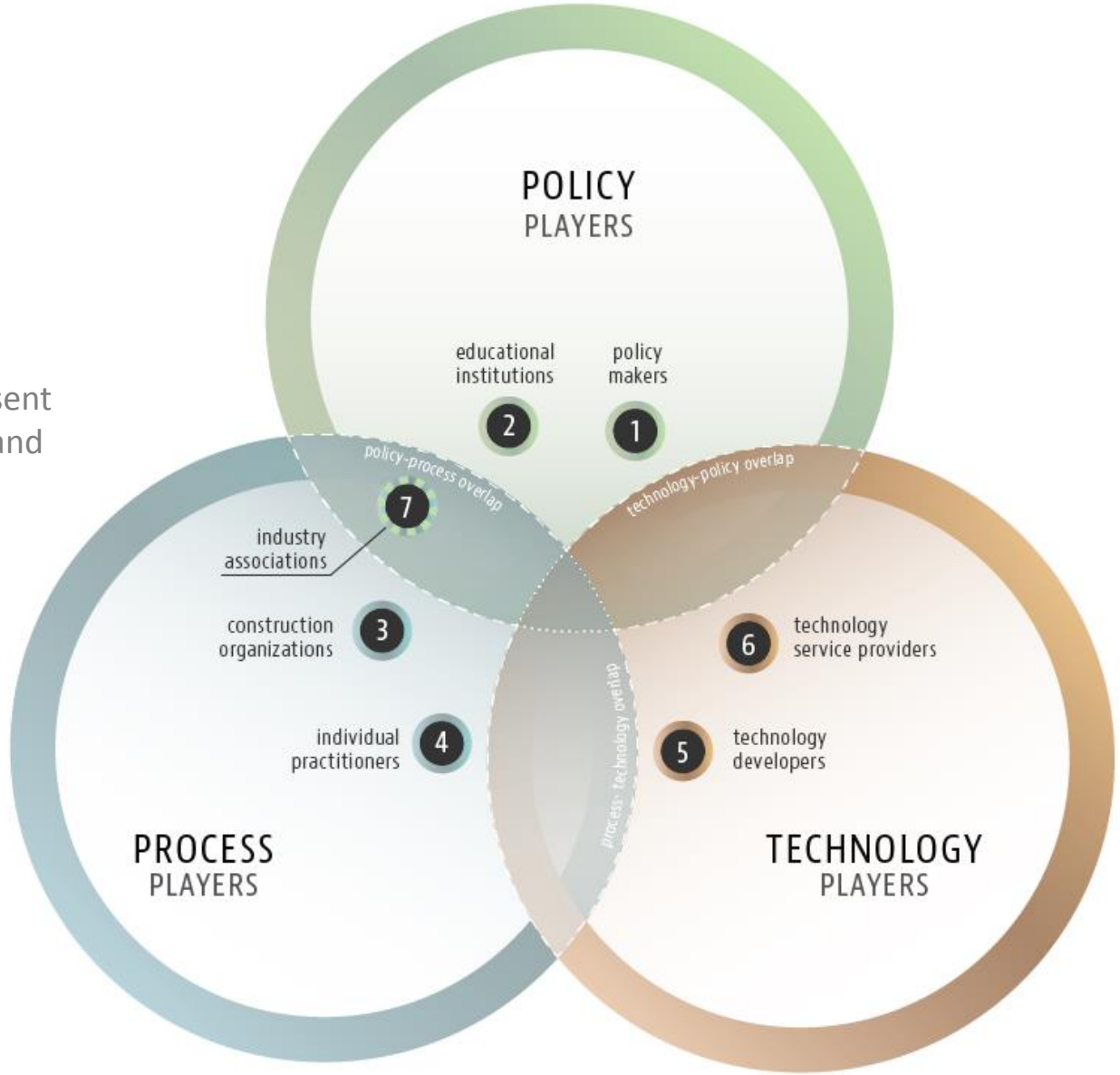
7 Industry Associations

Associations dedicated to represent the interests of their individual and organizational members

e.g. AMCA in Australia



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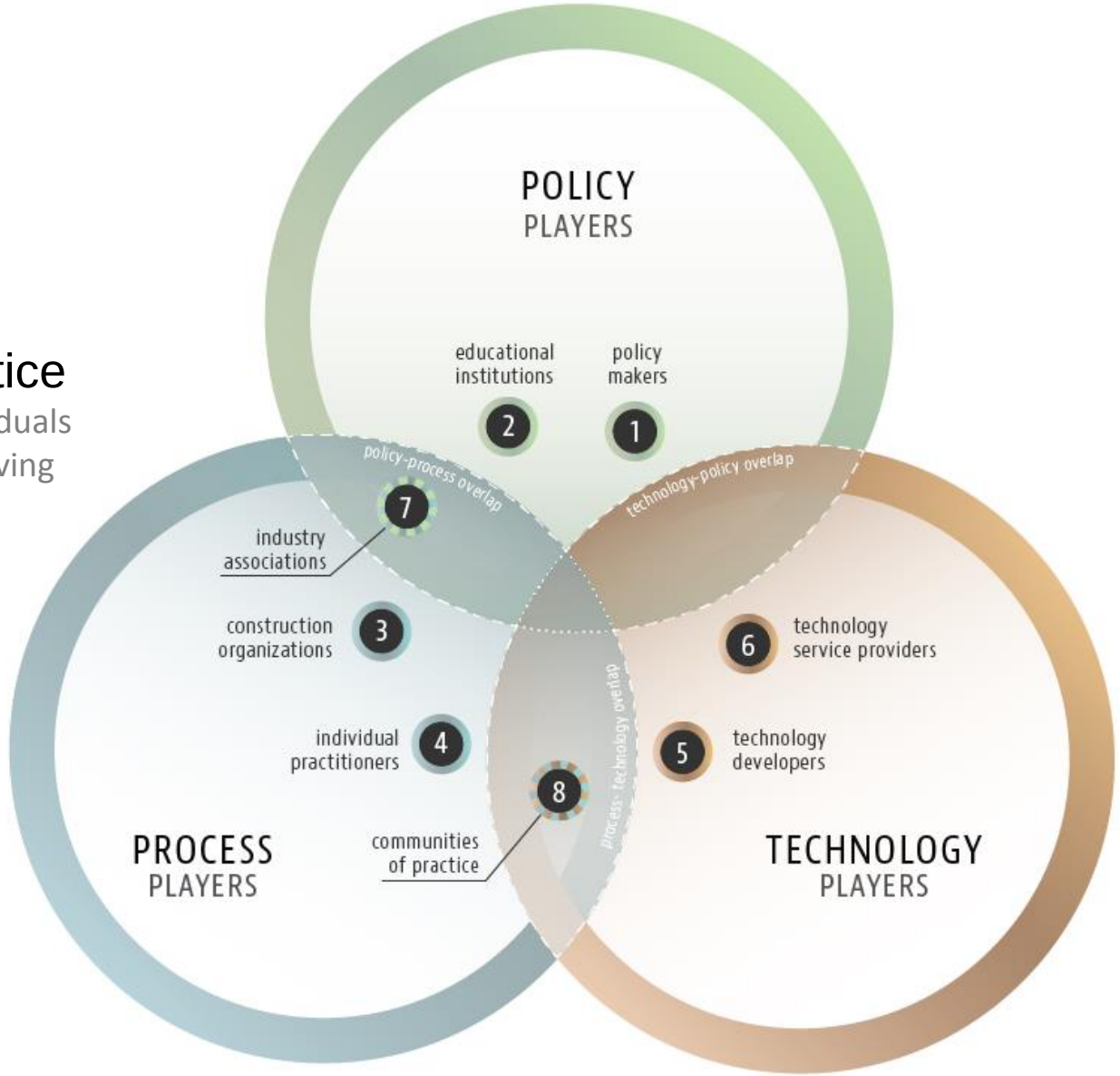
8 Communities of Practice

The informal grouping of individuals with a shared interest in improving their own BIM performance

e.g. Revit user groups



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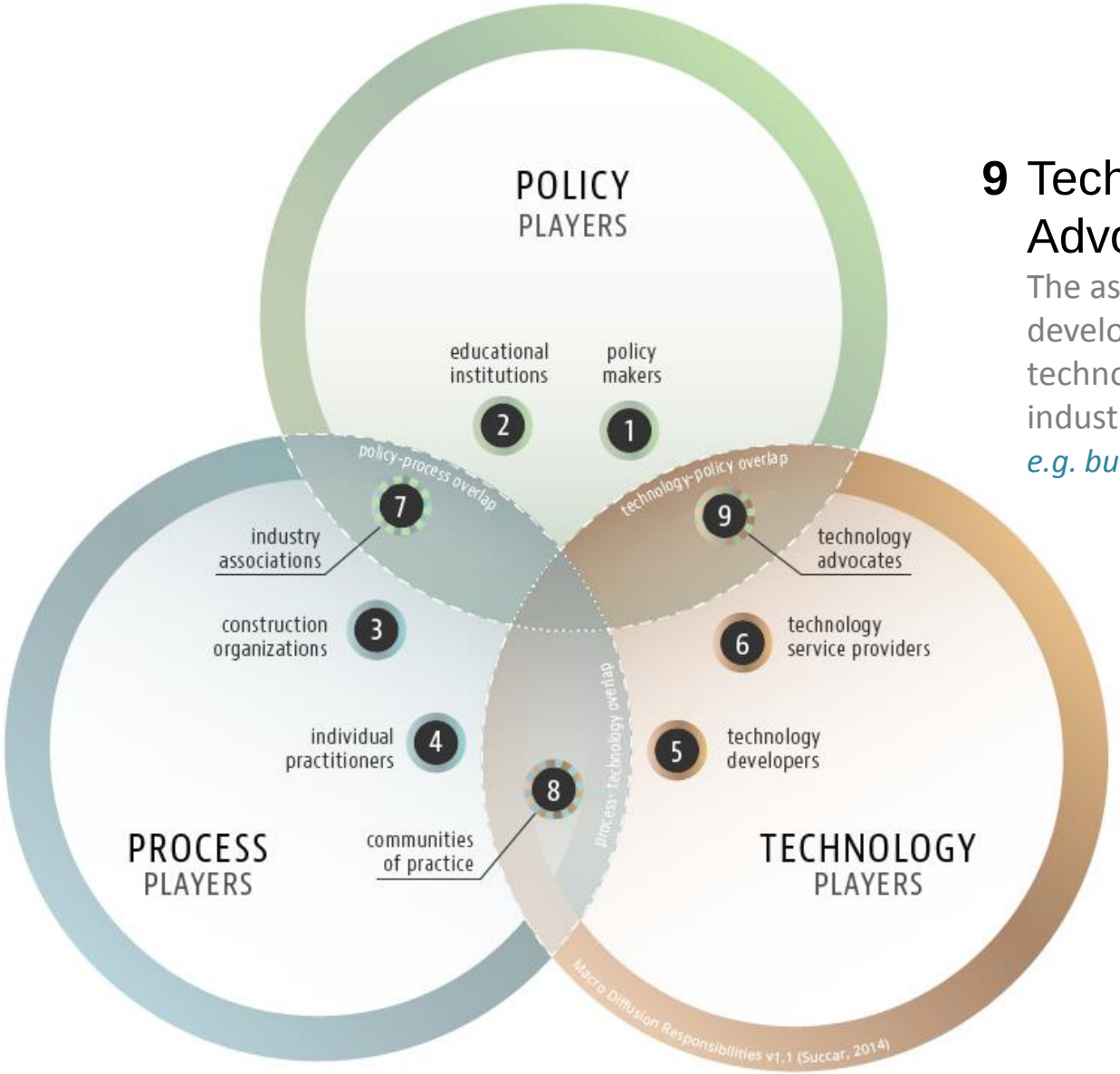

9 Technology Advocates

The associations involved in developing and promoting technology-centric solutions for industry problems

e.g. buildingSMART

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Macro Maturity Components

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

Macro Player Groups	Objectives , Stages and...	Champions & Drivers	Regulatory Framework	Noteworthy Publications	Learning & Education	Measurements & Benchmarks	Standardised Parts and...	Technology Infrastructure
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

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Insights for a national and trans-European approach?

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Lessons Learned

- Mandate vs. no mandate?
- Mimic macro BIM adoption of other countries?
- Digital transformation like ‘network/coalition’ ecosystem
- Policy makers needs to lead by example, engage and incentivise industry stakeholders
- It takes a long time to achieve BIM adoption across a market. Commit for a long journey.

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Trans-European Opportunities

- A **Collaboration Network** between policy makers to align strategies and roadmaps
- A **Coordinated BIM Education Framework** for all types of educational institutions
- A **Knowledge Hub** for sharing use cases, learning, materials, guides, and protocols
- An open **BIM Object Library** for products across the EU?

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There is so much benefit from

Coordinated efforts

across the EU (EU BIM Task Group)

Unified efforts

across government departments

Collective efforts

by industry stakeholders

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Change takes time

effort, perseverance, and patience

Keep up the momentum!

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A call for collaboration

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THANK YOU

https://BIMexcellence.org