Towards a Hybrid Approach to BIM implementation – A Critical Discourse

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Abstract
BIM adoption in many countries involves different approaches including the use of government mandates. The UK's 2016 BIM mandate for public projects to be delivered at BIM Level 2 maturity, is an example. However, BIM mandates do not apply to private sector projects which leave questions about the inclusivity of its adoption and the susceptibility of SMEs to being digitally disenfranchised. Developing countries yet to adopt BIM are at the risk of out-rightly imitating the mandate-driven policies of countries like the UK, without considering alternative options that might better suit their socio-economic realities. This research investigates the use of alternative strategies (nudge theory) for promoting BIM adoption for inclusivity of smaller organisations, the private sector or developing countries. By drawing on two interrelated yet independent theories of loss aversion theory and nudge theory, this study examines the current mandate-driven policies and provides a critical discourse around ways that these two theories can be combined to form a new kind of construct on the way BIM implementation is (or can be) understood. The result from the critical analysis suggests that a hybrid of mandate and nudge can be effective in promoting BIM and none of these approaches is self-sustaining given their challenges. This finding opens a new vista for applying behavioural policies based on nudge theory and its potentials for promoting BIM implementation in the construction sector.

Keywords
BIM implementation, BIM mandate, BIM policies, Loss Aversion theory, Nudge theory.

1 Introduction

The promotion of Building Information Modelling (BIM) in the Architectural, Engineering and Construction (AEC) industries of many countries have been driven by different kinds of strategies, among which government BIM mandates are popular (Smith 2014). This is despite conflicting opinions about the effectiveness of mandating BIM. Some studies (McAuley *et al.* 2012, Porwal and Hewage 2013, Smith 2014) looked into how realistic a BIM mandate is with respect to two contrasting groups: small and medium scale enterprises (SMEs) and large organisations - with arguments that mandates favour the latter group (Dainty *et al.* 2015). Whilst leaving the SMEs which account for majority of the firms in the AEC industries on the disadvantaged side of the BIM divide. Both SMEs and large organisations vary in size, capability, resources, cash-flow, expertise, etc. (Sexton *et al.* 2006). Hence, BIM implementation may be relatively easier for some while posing a challenge for others and often alluding to liability of smallness (Aldrich & Auster 1986). Governments have intervened on the issue of BIM adoption primarily for its political expedience and for socio-economic reasons (Dainty *et al.* 2015), particularly on the back of decades of documented

inefficiencies, waste and slow pace of (or resistance to) change in the construction industry (Latham 1994, Egan 1998). Resistance to change is common in organisations that thrive within cultural practices and habits (Bresnen & Marshall, 2000; Ford, Ford, & McNamara, 2002; Khosrowshahi & Arayici, 2012; Thomas & Davies, 2002). Therefore, in the absence of an external push such as a government-imposed BIM 'mandate', some AEC organisations will resist change (Arayici *et al.* 2011, Kassem *et al.* 2012, Vass and Gustavsson 2017) and continue to use outdated processes and technologies. In countries like the UK, public sector projects account for 40% of the construction industry's workload and the central government is considered the industry's biggest customer (Cabinet Office 2011), as such BIM could be a procurement policy issue. However, the private sector can neither be mandated nor ignored in the ongoing BIM revolution or evolution.

In recent years, governments have used more subtle approaches for implementing beneficial policies through strategies such as Nudge theory (Thaler and Sunstein 2008). The 2017 Nobel Prize in economics awarded to Professor Thaler for his contribution to this theory and its applications in contemporary policies underscores its widespread acceptability and success. The non-forced compliance approach of nudge could usher wider acceptability of BIM as well as answers to reasoned criticisms by researchers, e.g. Dainty et al. (2015) who argued that government involvement (e.g. by imposing mandates) and the 'hyping' of BIM is beclouding its true value and potential, if not somewhat misleading about its expected benefits. However, the nudge theory and concept have not found its way into the lexicon of BIM research. It is in view of these intertwined issues that this study was undertaken with the following objectives: (i) taking a detached, critical and in-depth look into the realities of BIM adoption from the perspectives of developed and developing countries; (ii) questioning the effectiveness or otherwise of using a government-driven mandate - a reference position for this study; and (iii) exploring alternative or complementary adoption strategies that could be better suited to the nuances inherent in AEC organisations or countries.

2 Review of BIM implementation strategies

This research builds on two interrelated yet independent theories: loss aversion theory and nudge theory that together, can combine to form a new kind of construct on the way BIM adoption is (or can be) understood. These theories can also serve as a basis for evaluating the effects of the types of BIM implementation strategies adopted by change agents.

2.1 Digitizing the AEC industry for BIM: A mandate-driven approach

As the construction industry rapidly enters the BIM era, there have been uptake and support by different governments to help promote its adoption. The various kinds of initiatives on BIM adoption by the public sector have been summarised into six main categories by Cheng and Lu (2015) which include: initiators and drivers; regulators; educators; funding agencies; demonstrators; and researchers. Each category has examples of aspects that relate to it (Fig. 1) which help in clarifying how the public sector has engaged in developing different strategies for implementing BIM. BIM mandate by governments is popular in developed countries like UK, Hong Kong, Finland and Denmark (Wong *et al.* 2011, Tahrani *et al.* 2015), where legislations have been enacted on the use of BIM for public sector projects. The rationale has been that BIM will lead to better project outcomes in terms of project cost, quality and time. Other studies show benefits of BIM in areas such as supply chain management (Le *et al.* 2018), claim management (Shahhosseini and Hajarolasvadi 2018), prefabrication (Mostafa *et al.* 2020) and model authoring processes (Singh *et al.* 2017). In some developing countries, there have also been calls for mandates (Saka and Chan 2019). However, there are opportunities, risks and issues of priorities associated with mandates in both types of countries.

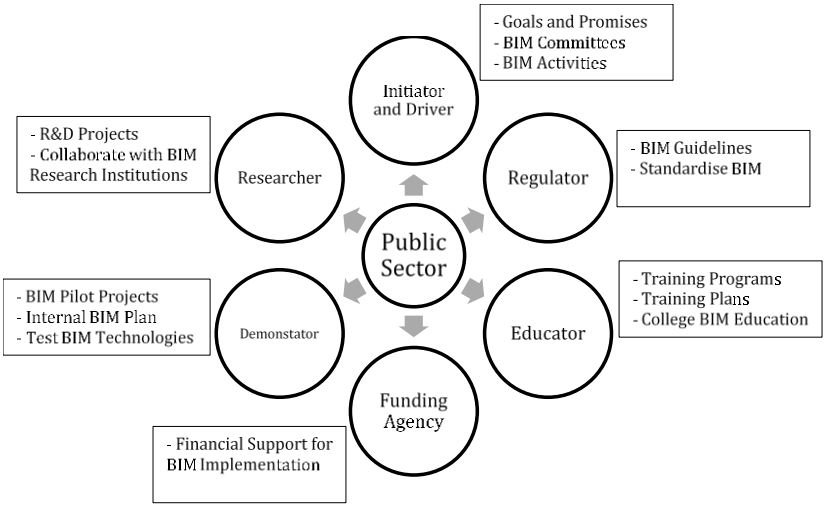

Figure 1: Roles of the public sector in BIM adoption (Source: Cheng and Lu, 2015)

2.1.1 Mandating BIM in developed countries: Opportunities and risks

Government mandate on BIM aims to promote (or speed up) its adoption (Eadie *et al.* 2013, Smith 2014) in developed countries, but different opinions have emerged. BIM adoption in European countries varies from 23% and 25% in Poland and Czech Republic respectively to 74% and 78% in United Kingdom and Denmark respectively (Ullah *et al.* 2019). Some researchers on this subject (Smith 2014; Porwal and Hewage 2013; McAuley *et al.* 2012) believe mandating BIM is the best way to facilitate and increase its adoption and to motivate the industry to embrace newer processes and technologies. Others (e.g. Dainty *et al.* 2015, 2017) have questioned the wider impact of mandate on the industry, including the politicisation (and hyping) of BIM, which feeds into the 'technocratic optimism' that pervades in the higher tiers of the industry (Fox 2014). There is also the erroneous presumption that once technology was in place, all AEC firms would be BIM compliant (Dainty *et al.* 2017) which ignores the skill and usage access of BIM. A government BIM mandate could increase its 'awareness' (McAuley *et al.* 2012) and help stimulate stakeholders towards responding to client and industry needs. Smith's (2014) study of criteria necessary for successful BIM implementation in developed countries found 'government and industry leadership as a critical success factor. However, a downside of mandating BIM (Ayinla and Adamu 2018; Dainty *et al.* 2015) is that in an already fragmented industry, there is a risk of a digital divide emerging between small and large organisations i.e. between those who can comply with the new policy and those who cannot. Specifically, the SMEs are at the risk of being digitally 'disenfranchised' by a BIM mandate due to their incapacity to rapidly mobilize requisite resources to operate at the required BIM maturity level, and thus struggling to win public projects (Ganah and John 2013, Lam *et al.* 2015). In the UK, this would mean SMEs delivering projects at BIM Level 2, which has robust technical requirements found in the standards and guidelines such as BS1192, PAS1192 and ISO 19650 (British Standards Institution 2015; ISO 2017).

SMEs in developed countries dominate their construction industries making up over 70% of the AEC industry's workforce (Dainty et al., 2015; Lam, et al, 2015). They exhibit diverse specialties and capabilities ranging from design, manufacturing and as well as hands-on tradespersons (Rezgui *et al.* 2009). Therefore, imposing a BIM mandate on them could be problematic (e.g. suppliers or sub-contractors) and inadvertently, some risks to the smooth functioning of the industry could be inadvertently introduced. For policymaking, the impact of BIM mandate on SMEs needs thorough consideration from a digital divide perspective. There is little evidence in literature that such impact

studies have been carried out since available studies on the drivers of BIM (e.g. Lin *et al.* 2006, Gu and London 2010, Khosrowshahi and Arayici 2012b, Smith 2014) have not studied the consequences of 'digital marginalisation' of SMEs. Nevertheless, while the role of government and national standards for compliance and mass adoption of BIM in several countries cannot be underestimated (Edirisinghe and London 2015), mandating of BIM has been limited to public sector projects and other countries could learn from this.

2.1.2 Mandating BIM in developing countries: A question of priorities

The construction industry in developing countries is also dominated by SMEs (Eyiah and Cook 2003, Kheni *et al.* 2008) meaning they face similar (possibly greater) challenges when it comes to BIM (i.e. lack of client demand, lack of BIM expertise, cost of implementation, etc.) (Saka and Chan 2020). Studies on BIM adoption in these countries are increasing (Khanzadi *et al.* 2018) with the indication that adopting BIM would be more complicated than in developed countries. The level of BIM adoption in Asia was found to be low (Ismail *et al.* 2017) and in Malaysia, Zakaria *et al.* (2013) found that BIM adoption was difficult due to firms not knowing where, when and how to start and the absence of national standards/guidelines. Ahuja *et al.* (2018) found BIM adoption at an early stage in India, while Dim, et al. (2015) revealed that in Nigeria some clients, designers and contractors were not familiar with BIM or what it was all about. Abubakar, et al. (2013) recommended that governments and industry stakeholders should jointly address the identified barriers to BIM adoption. Given the challenges of mandating BIM in developed countries, it is surprising that some researchers focusing on developing countries (Dim *et al.* 2015, Hosseini *et al.* 2015, Musa *et al.* 2015, Ugochukwu *et al.* 2015) have recommended BIM mandates to the government in such countries. Some have argued that lack of government involvement 'worsens the current situation' (Zakaria *et al.* 2013). Besides, even with minimal government involvement, AEC firms in Malaysia seemed prepared to adopt BIM for competitive advantage and due to market demands (Rogers, et al. 2015). Mandating BIM in the near future is, therefore, unlikely to solve the many challenges faced by the AEC industry in countries like Malaysia, India or Nigeria where resistance to change and lack of awareness has been identified as key barriers (Zakaria *et al.* 2013, Dim *et al.* 2015, Ahuja *et al.* 2018).

Moreover, for developing countries, the technology infrastructure (hardware, software and network systems) needs to be available, accessible and affordable because connectivity is a prerequisite for hosting information models (Succar and Kassem 2015). Furthermore, there is widespread utilisation of unlicensed or pirated software in such countries (Bui *et al.* 2016). Instead of forced compliance, gradual adoption in such countries could bring benefits in terms of the learning process, which may be lost when it is mandated for government projects (Ismail *et al.* 2017). Lastly, using coercion for BIM adoption would adversely affect the SMEs which are mostly indigenous firms and would lead to job loss.

2.2 Adopting BIM to win jobs – Loss Aversion

The success of mandating BIM in developed countries like the UK could be linked by the theory of Loss Aversion (Tversky and Kahneman 1991, Gächter *et al.* 2010) which states that people are more sensitive to a decrease in their wealth than an increase in the same. This results in the consequences of losses being weighed twice as much as corresponding gains (Thaler *et al.* 1997). It is plausible to argue that given the well-documented barriers to BIM adoption, it is sometimes implemented by some AEC organisations (e.g. SMEs) because they are loss averse. This means some organisations would adopt BIM even when its benefits to their business, society or the environment are not clear to them but simply because they want patronage on government projects. It is conceivable to expect that such companies will only implement the basic requirement for BIM as required by a mandate

without any effort to exploit the well-documented benefits that it offers. This leads to questions about whether a government mandate is actually just an 'enforcer' and not necessarily a 'motivator' for BIM adoption as suggested by some studies (McAuley et al., 2012; Porwal & Hewage, 2013; Smith, 2014). Besides, there are doubts about the effectiveness of the threat of sanctions by defaulters of mandated policies (e.g. regulations and taxes) and whether such sanctions enable policymakers to achieve desired outcomes (Wells 2010) including long-term behavioural change (Hansen and Jespersen, 2013), which for BIM is thought to be more important than technological change (Mc Auley *et al.* 2013). Mandating BIM might hence lead to compliance due to business considerations and not necessarily stimulate long-term change in attitude or behaviour towards the intrinsic value of BIM. Evidence from the UK also suggests professional opinion is split about mandating BIM and its long-term future. Just before the 2016 mandate kicked in, the NBS (2015) survey of professionals showed a slight majority (54%) believed the government was on the 'right track' by placing a mandate on using BIM. Three years after the 2016 mandate, the BIM survey (NBS 2019) revealed that: only 48% of respondents thought the mandate was successful overall; only 32% agreed the mandate was able to sustain the momentum since 2016; and just 22% thought the industry was delivering on the mandate.

In summary, whereas BIM mandates can help increase BIM awareness and promote its adoption and implementation across the AEC industry in various developed countries, there are disadvantages associated with mandates as suggested in literature, including (a) being applicable to only public sector projects meaning the private sector is not directly benefiting since such clients cannot be compelled to use BIM; (b) mandates disenfranchise SMEs due to the existence of the digital divide; (c) mandate may not work for all countries especially those who are developing and are unable to cope with the governance and standards aspects of BIM implementation; and (d) BIM mandates particularly when enforced on SMEs might be attaining compliance due to loss aversion, i.e. adoption is based on fear of losing work while the value of BIM itself is lost; (e) mandating BIM in developing countries should not be a priority until the basic awareness, training and IT infrastructure have been put in place. In light of these points, a rethink is required on the effectiveness of a mandate-driven approach for achieving a holistic adoption of BIM in the entire industry inclusive of SMEs and private sectors. This argument necessitates the exploration of either an alternative strategy or perhaps complementary approaches to be used concurrently with mandates for macro-scale BIM adoption across the AEC industry.

2.3 Digitizing the AEC industry for BIM: The 'nudge' alternative

Governments can bring about social change via a 'motivational' approach or through imperceptible techniques to arrive at desirable policy outcomes. An example of a non-forced compliance concept is 'nudge theory' defined by Thaler and Sunstein (2008) as *"*any aspect of choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives*"*. Crucially, the intervention must be easy and cheap to opt-out from and should be designed to produce beneficial outcomes that individuals or organisations cannot produce on their own (Thaler and Sunstein, 2008). Many countries have embraced the nudge concept in different aspects of policymaking, with examples seen in Sweden, Netherland, France, Denmark, UK and US (John *et al.* 2009, Oliver 2013). A good nudge leads people towards making positive choices e.g. automatically enrolling people on a pension scheme unless they willingly opt-out (John *et al.* 2009). In this regard, although the importance of pension to the individual and the society is well established, many workers are negligent in setting up their pensions. Therefore, a default automatic pension enrolment for everyone (with opting out made possible) improves the number of enrolled pensioners thereby 'nudging' people to save for retirement. This clearly has benefits for the entire society as it reduces future financial burden on taxpayers due to lack of enrolment by negligent

workers (Wells 2010). In the context of this study on BIM adoption, therefore, nudging organisations towards relevant and beneficial design and construction processes by making digital technology and training easily available (e.g. subsidised BIM software/hardware, wireless networks and the requisite up-skilling and training) could encourage people and organisations to adopt BIM. This 'subsidy' approach has been used in Singapore, now regarded as a leading country in BIM adoption (Tahrani *et al.* 2015) and proven to be effective per (Yuan and Yang 2020). This is quite different from a forced compliance method that, for instance, bans them from using pens, rulers and drawing boards. The subsidy aspect of nudge could be useful to SMEs in the AEC industry as implied by Ganah & John (2013) who found that 'added cost' reduces their profit margins, but government-driven incentives (e.g. tax rebate/relief) are indeed a prerequisite for them to embrace the BIM agenda. Even with the opt-out option of nudge, it is unlikely that SMEs would abandon BIM if or when they recognise they have been 'nudged'. The nudging concept would likely counteract a one-sided 'mathew effect' of rich getting richer and results in all nudged firms willing to implement higher BIM level.

3 Findings and Discussion

An array of different BIM adoption strategies as implemented by several countries (Table 1) are based on six categories suggested by Cheng and Lu (2015). The categories have been modified in this study to recognise government mandate in the "Initiator and Driver" category which is an enforced driver for BIM adoption in public sector projects because stakeholders have no choice (Porwal and Hewage 2013, Smith 2014).

Table 1: Role/Initiative of Government/Public Sectors in Promoting BIM Adoption (adapted from Wong *et al.* 2011, Cheng and Lu 2015, Tahrani *et al.* 2015)

Country	Organisation/ Committee	Role/Initiative	Public sector roles (category)
United States (US)	GSA	Collaborated with software developers to produce a BIM guide.	Regulators
		Launched numerous pilot projects to study BIM implementation for various uses.	Demonstrators
		Mandated IFC-based BIM for various building analysis and design.	Initiator - Mandate
		International collaboration with real estate partners (e.g. Finland's Senate Properties) to support the creation of open standards for BIM so that interoperability and seamless exchange of digital data can be supported.	Regulators
	National Institute of Building Science (NIBS)	Carry out research on BIM and oversee the development of open data exchange standards such as IFC and COBie as well as the National BIM Standards.	Researcher
	National Institute of Standards and Technology (NIST), Fiatech and the Construction Industry Institute (CII).	These organizations are governmental agencies that carries out research on BIM	Researcher
United Kingdom (UK)	BIM Task Group	Mandated the use of BIM for public sector projects starting for 2016	Initiator - Mandate
		Development of open standards to facilitate interoperability and data exchange to reduce barriers in this exchange.	Regulator

		Development of COBie drops to allow public owners to validate the information received from their project team in a structured manner.	Regulator
		Reporting and promoting BIM by developing and monitoring activities such as forums, presentations, training, and workshops.	Demonstrator
	BSI, CIC, AEC-UK	Provision and development of BS series, AEC-UK-BIM Standard and AEC (UK) BIM Protocol.	Regulator
Finland	Tekes	Organised a public and private sector funding Pre-program at RYM for research and development of up to € 21.7 million for a period of 4 years between 2010 and 2014.	Funding agencies - Support
	Senate Properties	Require the use of IFC/BIM for its projects and provision of BIM standards and guidelines (e.g. COBIM).	Initiator - Mandate
Hong Kong	The Development bureau (DevB)	It has ordered the CSWP working group to monitor the development of BIM solution, and evaluate a time table for BIM to be incorporated into the current CSWP existing CAD standard.	Initiator - Mandate
		Encouraged a continuous monitoring and evaluation effort within the CWSP groups to determine a strategic plan to go in line with the emerging trends for BIM within the industry.	Regulator
	Housing Authority	Included BIM into its programme of activities for development and have been conducting investigation on some pilot project on how BIM can be used for improving design, operational efficiency and effectiveness.	Initiator - Mandate
	The HKIBIM	It established various committees for promoting and BIM implementation and providing a platform to aid the communication of different stake holders of BIM	Initiator – BIM activities and committees
Singapore	Building Construction Authority (BCA)	Public sector funding BIM fund to cover up to 50% of costs associated to BIM adoption within firms (12 million SGD)	Funding agencies - Support
		Provision of BIM standards	Regulator
		Reporting and promoting BIM by developing and monitoring activities such as forums, presentations, training, workshops	Demonstrator
Australia	BEIIC, AMCA, NATSPEC	Require 3D BIM for Gov. projects by 2016. BEIIC implemented BIM plan and pilot projects also, AMCA BIM initiative includes BIM forums and training plans NATSPEC have been working on the provision of National BIM Guide (e.g. ANZRS)	Initiator – Mandate
Denmark	*Det Digitale Byggeri*	The *Det Digitale Byggeri* is a public-private initiative by the Danish government; they have been providing series of requirements governing the use of BIM and ICT for consultant and contractors.	Regulator
	DECA	International collaboration with the GSA (USA) and Statsbygg (Norway) in 2008 to support open BIM based on IFC for BIM so that interoperability and seamless exchange of digital data can be achieved.	Regulator
	Palaces & Properties Agency	Require BIM on projects, organised BIM pilot projects and provision of BIM standards and guidelines e.g. 3D CAD Manual 2006	Initiator - Mandate
Norway	Statsbygg	Public and private sector funding for research and development (R & D) of up to € 21.7 million for a period of 4 years between 2010 and 2014.	Funding agencies - Support
		International collaboration with the GSA (USA) and DECA (Denmark) in 2008 to support open BIM based on IFC for BIM so that interoperability and seamless exchange of digital data can be achieved.	Regulator

From the examples (Table 1), it is clear that not all initiatives rely on forced compliance. Tahrani *et al.* (2015) showed that a 'BIM fund' was introduced by the Singapore government to support training, consultancy services, as well as the purchase of hardware and software. This is in addition to 'Demonstrator' projects that have also been used in USA and UK and the use "Funding agencies –

Support" in Finland and Norway. Other categories of public sector roles that might qualify under non-forced compliance initiatives are 'Researcher' and 'Regulator' (Tahrani *et al.* 2015; Wong *et al.* 2011). However, the nudge concept of policy implementation is not free from criticism as highlighted by Wells (2010) who argued that architecting choices may lead to unintended consequences since individuals tend to react unsympathetically to having their decisions being 'manipulated'. This is regardless of the benevolent principles behind whatever they are being nudged towards. Therefore, techniques of nudge tend to work best when users are 'unaware' that their behaviour is being influenced by choice architects because the desired outcome of nudging could disappear if nudging is recognized (Hansen and Jespersen, 2013; Selinger and Whyte, 2012). The temptation might be to 'disguise' a nudge but Thaler and Sunstein (2008) advocated for transparency in the process through the 'publicity principle' (Hansen and Jespersen 2013). This principle emphasises the *benevolent standpoint* that forbids governments from considering a policy they would not be able/willing to defend publicly to its own citizens. Hence, a government wanting to successfully nudge the industry towards BIM should be legally and ethically prepared to defend its discreet approach if or when stakeholders discover the strategy. Other critics of nudge theory (Selinger and Whyte, 2012) claimed that it does not always yield promising results as 'hyped' by the proponents because they could go wrong or may be ineffective. Consequently, Rayner and Lang (2011) have maintained that since more regulation (e.g. mandate) will not be any better either, improved information and effective communication can help nudge-driven policies achieve desirable outcomes.

This review conducted suggests that neither of the two strategies (i.e. mandate and nudge) would be ideal or self-sufficient on their own and further reflection is required regarding the possibility of merging them. This study thus takes the position that although contemporary BIM adoption strategy in countries like the UK is mandate-driven, the longer-term view for other countries could be to combine mandate and nudge.

4 Conclusions and Further Research

This study was aimed at understanding how competing BIM adoption strategies could lead to the achievement of a macro-scale adoption in the AEC industry. The study's focus is to critically examine the predominant BIM implementation strategy from the perspective of macro scale adoption in the AEC industry. The study argues that the predominant strategy used in developed countries (i.e. BIM mandates) is effective to an extent, but does not address all the challenges/problems of BIM technology diffusion in the AEC industry. Therefore, other strategies like nudge should be considered to complement mandates to realise the desired outcome of a holistic acceptance of BIM by all AEC organisations irrespective of sub-sector, size and geographic location. Nudging through subsidies and incentives was shown to be a suitable compliment to mandates and should be combined and used concurrently. Both strategies have their strengths and weaknesses and combining them will enable them to complement each other, possibly minimising their identified individual weaknesses. Hence, change agents should consider implementing such combined strategies to speed up the rate of adoption and for the process to be all-inclusive and sustained in the long term, especially for developing countries looking into a macro-scale BIM adoption.

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