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Diffusion of innovations approach to explore sustainable development in the UAE built environmet

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Abstract

Sustainable development is important for the UAE, not just to follow global ongoing efforts to reduce consumption of and preserve resources, but also because of the breath-taking development for the UAE economy since its formation in 1971, which is coupled with fast development in buildings and real estate sectors. This research directly addresses the UAE government policy for innovation and sustainable development by providing better understanding of the processes for innovative sustainable development of buildings. Environmental assessment methods such as Estidama and its related Pearl Building Rating System (PBRS) has the potential to play the role of market changers for the spread of sustainable development practices in the built environment, however, most of the existing research in assessment methods is focused on either comparing different methods, or adapting existing and developing new methods for specific contexts. And while a lot of research is focused on the outcomes of the assessment, very little is concerned with the assessment process itself and its effect on design and construction processes and practices. A scoping study is developed, which adopts diffusion of innovations theory as the analytical tool, and interpretive content analysis of key policy documents and guidance as the research method to explore the diffusion of sustainable development of the built environment in the UAE. Early findings indicate the role of Pearl rating system as the foundation for sustainable development in Abu Dhabi built environment, and reveal multiple two-way communication channels for diffusing sustainable development policy and practices. Next steps for the research to further explore these findings through in-depth case studies of the adoption of PBRS in projects in UAE are presented.

Keywords

Adoption, building assessment, design management, innovation, sustainability

1. Introduction

Reducing energy consumption and conserving natural resources is an important topic, which is currently receiving universal interest. Governments across the globe have been developing strategies and policies to address issues such as: climate change, carbon emission, and the use of more sustainable sources for energy (United Nations 1992). In the UAE, the government vision is to be at the forefront of innovative sustainable development by 2021. The UAE national innovation strategy, which was published in 2015 places great attention on building an innovation friendly ecosystem, and creating a culture of innovation among individuals, firms and the public sector to aid sustainable development of the country to reflect its economical growth, which is happening in a breath-taking rate since its independence in 1971 (Ministry of Cabinet Affairs 2015).

The UAE investment in innovation is estimated to be between AED 10 and 14 billion yearly, AED 7 billion of which is in R&D (Ministry of Cabinet Affairs 2015). However, emerging research in the transition of

the UAE from oil-based towards knowledge-based and innovation-driven economy has found that despite extensive spend on research and development (R&D), the UAE still requires more work to catch countries such as Brazil, Russia, India and China (Gackstatter, Kotzemir and Meissner 2014). This calls for more government-academia collaboration, and more research to investigate the intersection between government policy and sustainable development as it unfolds in practice, or in other words how government policy in innovative sustainable development is actually realised? Thus, this research seeks to address the UAE governmental efforts towards more innovative and sustainable development by focusing on the building and construction sectors which are directly related to the seven main sectors identified by the UAE national innovation strategy to lead innovation at the national level, these are: renewable and clean energy, transportation, technology, education, health, water and space (Ministry of Cabinet Affairs 2015).

The UAE construction and real estate sectors are ones of the fast growing globally, they account for around 20% of the UAE total GDP (2014). The growth in both sectors is coupled with major consumption of resources, which highlights the UAE building industry as a fertile environment to explore the provision of sustainable development. Hence, the focus of this research on sustainable development of the UAE built environment, through the investigation of the adoption of environmental assessment methods for sustainable buildings and infrastructure in the UAE.

In the following sections, literature in environmental assessment tools and methods is reviewed, diffusion of innovations theory is introduced as the conceptual lens for answering the research question, and then early findings of this scoping study are discussed. The paper finally concludes with final discussion and future steps for this research.

Background to environmental assessment tools and methods

In response to government policy in sustainable development, buildings, infrastructure and urban developments are required to meet certain performance criteria in relation to different design, construction, and operation aspects as it intersects with its surrounding natural environment. This has resulted in the adoption of different processes, tools, and methods by design and construction professionals in their efforts to demonstrate sustainable development of the built environment. These tools and methods often referred to as building environmental assessment tools and methods, which provide objective evaluation and assessment of the performance of the developed facility in relation to its environmental impact (Cole 2005).

The growing literature, which focuses on building environmental assessment tools and methods has found that these tools and methods vary on focus and scope based on: types of buildings, users of the tools, the phases within the lifecycle of the assessed building, databases of the tools, and the form of the results of the use of the tools (Haapio and Viitaniemi 2008). Environmental assessment tools and methods are mostly developed by research institutes and adopted by local authorities and municipalities as guiding frameworks for sustainable design and construction. Despite majority of the tools and methods favoring the environmental aspect over the social and economic aspects of sustainability, but building environmental assessment tools and methods are still seen as *market changers* for more sustainable built environment (Cole 2005).

Scholars often differentiate between assessment tools and assessment methods. In one hand, there are assessment tools in the form of software tools and plug-ins, which provide architects and engineers with interactive opportunities to explore different options and scenarios in relation to environmental performance of different building components, materials, or elements. In the other hand, there are methods for assessment of buildings or facilities as a whole, following the assignment of scores or points to different performance criteria. Building Research Establishment Environmental Assessment Method (BREEAM)

was the first assessment method of this type, it was introduced in the UK in 1990, then followed by a wide range of similar methods such as Leadership in Energy and Environmental Design (LEED), which was introduced by the US Green Building Council in 2000.

Cole (2005) has defined assessment tools as *the techniques that predicts, calculates or estimates one or more environmental performance characteristics of a product or building*; and assessment methods as *the frameworks that organize or classify environmental performance criteria in a structured manner with assigned points of weightings* (Cole 2005:456). This research adopts Cole's definition, and focuses on Estidama framework for sustainable development and its associated Pearl Building Rating System (PBRS), which is currently used to assess buildings in the emirate of Abu Dhabi in the UAE.

Most of current literature on assessment methods is focused on two aspects: First, there are studies that focus on comparing the different available methods (Happio and Viitanieme 2008) and their applications on different contexts (Cole and Valdebenito 2013). Research addressed Estidama and PBRS follows this stream, as it often tends to compare it with international assessment tools such as BREEAM and LEED (Al Salmi, Al Kadi and Leao 2013; Khogali 2016). Second, there is a large literature which has been focusing in developing new methods to address specific regions, for example the development of assessment methods in Saudi Arabia (Banani et al 2016), again most of the work of this stream is based on comparing and contrasting different elements of the assessment methods with little focus on its use by project teams. Critiques of this literature call for further investigation of the factors, which influence the choice of the assessment methods.

While most of the environmental assessment methods are voluntary, a lot of governments around the world are increasingly mandating these methods for government projects, thus, it would be useful to compare between voluntary adoption by the private sector for example with publicly funded projects which has to follow mandated methods. Furthermore, the development of buildings is a creative complex process, which involves: various stakeholders and team players, different stages and phases, and wide range of resources and information (Emmitt 2014). The adoption of any environmental assessment method in either a voluntary or mandated base needs to be realized and managed within this complex process of design and construction, which in itself is a big challenge.

Growing literature is investigating different project characteristics that influence sustainability outcomes in the form of scores or ratings resulting from environmental assessment methods. Mollaoglu-Korkmaz, Swarup and Riley (2013) investigated the influence of project delivery methods on the LEED rating of 12 commercial buildings in the US and found that higher levels of integration found in design-build and construction management delivery methods has led to higher sustainability outcomes, however, they also found that there are important factors which led to greater integration and consequently higher rating regardless of the delivery method; these factors are: design charrette, project team member's compatibility, and commitment to project sustainability goals. In a similar attempt to reveal the intersection of environmental assessment methods with design and construction project work, Schweber and Haroglu (2014) examined the fit between BREEAM and design processes in 8 commercial buildings in the UK, they found that prior experience with environmental assessment was key for sustainability outcome.

This literature is useful for this research as it turns the attention to important issues related to the adoption of environmental assessment methods, such as: integration, communication, and collaboration processes, as well as the role of assessors or key project professionals as champions for the adoption of the different practices leading to improved sustainability outcomes.

Diffusion of innovations theory as an analytical tool

Diffusion of innovations theory is very useful for explaining how individuals and organizations adopt and implement a new process or technology such as energy assessment methods. It is an established theory which was started in in the 1940s and 1950s within rural sociology and education, and then gradually emerged within other research traditions such as: anthropology, early sociology, public health and medical sociology, communication, marketing and management, geography and general sociology (Rogers, 2003). Diffusion of innovations theory have been adopted as a guiding analytical theory by construction researchers to investigate a wide range of issues such as: the specifications of building materials (Emmitt 2001); the spread of digital innovations in construction projects and firms in Australia (Peansupap and Walker 2005), America (Mitropoulos and Tatum 1999, 2000), and the UK (Shibeika and Harty 2015); as well as the adoption of renewable technologies in the UK housing sector (Lees and Sexton 2013).

Diffusion of innovations theory pioneered by Rogers considers four important constructs: the innovation itself, the communication channels through which knowledge about this innovation spread, the social system within which diffusion occur, and the adoption process as it unfolds over time (Rogers 2003). Research related to the diffusion of innovations in construction has advanced these constructs to provide more context-specific explanations; for example, one innovation in construction could lead to wakes of other innovations across projects and firms (Bolland et al 2009), this is due to the project-based collaborative nature of construction work. The concept of communication channels is viewed from the point of the network effect of the highly collaborative, and information intensive construction work (Larsen and Ballal 2005), to the consideration of the construction innovation itself as the communication channel as in the case of the diffusion of BIM technologies in a UK engineering firm (Shibeika and Harty 2015). Most importantly, the innovation adoption process in construction is found to be non-linear following different paths across multiple organizational levels (Shibeika and Harty 2015). Champions are also found to be key for adoption and diffusion of innovations in construction; their roles could range from specification architects (Emmitt 2001), to technology managers (Shibeika and Harty 2015) to energy assessors (Schweber and Haroglu 2014).

This research is a scoping study for a new two-years research project to investigate sustainable development in the UAE built environment. It adopts diffusion of innovations theory as analytical tool, and interpretive content analysis of key policy documents and guidance as the research method to explore the diffusion of sustainable development framework "Estidama" and its associated assessment system PEARL in Abu Dhabi.

Preliminary findings

The content analysis of key policy documents , related to Estidama framework has revealed the following:

Estidama as the infrastructure for sustainable development of the built environment in the UAE

In the UAE, Estidama is the sustainability program pioneered by Abu Dhabi Emirate, it is the first of its kind in the Middle East region, to ensure *well-integrated built environment with efficient resources, reliable and comfortable to inhabit buildings* (Abu Dhabi Urban Planning Council 2010). Developed by the Urban Planning Council (UPC) of Abu Dhabi, Estidama promoted as the *symbol of an inspired vision for governance of sustainable buildings from inception, to design, through construction, to operation* (Abu Dhabi Urban Planning Council 2011). Not itself a rating system, Estidama is rather a methodology to address the four pillars of sustainability: environmental, economic, cultural and social.

Estidama is different from other international systems such as BREEAM and LEED which draw from existing building codes and legislations, while Estidama has influenced and induced the development of

the UAE building codes (Al Salmi, Al Kadi and Leao 2013). The realization of Estidama program is driven by the Pearl Building Rating System (PBRS), which was first introduced in 2010. From September 2010 all new buildings are required to achieve Pearl 1 rating, while all new government-funded buildings are required to achieve Pearl 2 rating. This mandate has led to the alignment of PBRS with other Abu Dhabi Development and Building Codes, and UPC embedding Estidama elements as the minimum sustainability requirements for the approval of developments. By 2013 More than 400 buildings were rated under the system About 10,000 villas are rated, about 7,500 of which have at least two pearls) .

This co-development of Estidama as the methodology to transform Abu Dhabi into *a model of sustainable urbanization*, and the evolvement of Abu Dhabi building codes around sustainable elements introduced by Estidama resonates with the conceptualization of construction innovations as foundational and infrastructure for the development of built environment (Shibeika & Harty 2015). Furthermore, the innovation adoption decision for sustainable approaches in Abu Dhabi developments range from mandatory through the building codes or Pearl 1 rating for government buildings, to more voluntary adoption by achieving higher Pearl ratings, which call for further investigation of the adoption processes for both the mandatory and voluntary adoption of Estidama framework and whether there are any similarities and differences especially with regard to decision processes taken during the design and construction of new sustainable developments, or the role and influence of key team members such as the Pearl assessor who represent Estidama and the Pearl Qualified Professional who facilitates the assessment process and provides quality assurance for the rating application of developments.

PEARL rating system components as the communication channels for Estidama

The Pearl rating system is organized around seven categories: integrated development process, natural systems, livable buildings, precious water, resourceful energy, stewarding materials, and innovating practice. For each of these categories there are mandatory and optional credits, mandatory credits don't have points, while optional credits are assigned with points and the more points the development achieve from these optional credits the higher the rating it will achieve. These categories stand as communication channels to promote and diffuse sustainable development principles, as they provide design guidance and indicators for measuring the potential performance of developments.

The Pearl rating system also encourages the involvement of specific professional roles through the whole lifecycle of sustainable development projects; examples of these are involving qualified surveyors and cost engineers to provide whole lifecycle cost analysis of sustainability approaches, or environmental specialists to provide design and management strategy for natural systems. Besides promoting integration of multi-disciplinary teams for sustainable developments, the Pearl rating system enforce the adoption of important national and international standards as performance benchmarks; examples of these are some of CIBSE or Ashare standards beside local UAE standards.

Pearl system mobilize multiple communication channels for sustainable development, which flow in a two-way fashion, in one direction from Abu Dhabi UPC to sustainable developments in the form of design guidance and methods for measuring performance through standards and codes, and in the other direction from design and construction teams for sustainable developments to the UPC through providing multi-disciplinary and integrated evidence for sustainable design and construction strategies. The question is how these strategies actually are developed in practice. Moreover, different media is used to facilitate these communication channels such as: narratives, plans, photos, calculations, specifications, maps, etc. This turn the attention to the changing nature of communication channels from classic diffusion of innovations research, and pose questions for further investigations of the development of these channels through either top-down policy or bottom-up design and construction practice evidence.

Final discussion and next steps

This research is concerned with sustainable development of the built environment in the UAE, Estidama is the framework for sustainable development adopted by the UAE and the Pearl rating system is the assessment method developed to diffuse Estidama principles. While considering literature in building and construction innovation discussed above, adopting diffusion of innovations concepts as the analytical lens to explore the diffusion of sustainable development in Abu Dhabi requires great attention to the complex nature of design and construction work which is described as *complex web of contractual relationships* (Mike and Nick, 2001: p 339), and to the current and future role of environmental assessment methods such as Pearl as foundational and a *market transformation tool,* which not only provide objective evaluation of environmental performance but also enable green design guidance and encourage communication and integration within sustainable project teams (Cole 2005). Furthermore, the role of assessors and key sustainable design advocates and champions need to be considered as well as the effect of government policy and its discourse which emphasize *innovation regulatory framework, technology infrastructure, enabling services, and investment and incentives* as main parts of an innovation-enabling environment (Ministry of Cabinet Affairs 2015).

The next steps for this research is a pilot study to explore sustainable development policy and government discourse in relation to Estidama and Pearl, followed by an in-depth case studies of sustainable projects in the UAE which adopt Pearl rating system.

References

Abu Dhabi Urban Council (2010) What is Estidama: Guide for Villa Owners

Abu Dhabi Urban Council (2011) Pearl Community Rating System: Design and Construction, Version 2,0

Al Salmi, H., Elkadi, H. and Leao S. (2013) Environmental Assessment Methods in Abu Dhabi, World Academy of Science, Engineering and Technology 78 2013, pp. 1101,1109.

Banani , R., Vahdati, M. M., Shahrestani, M. and Clements-Croome, D. (2016) The development of building assessment criteria framework for sustainable non-residential buildings in Saudi Arabia. Sustainable Cities and Society, 26. pp. 289-305. ISSN 2210-6707 doi: 10.1016/j.scs.2016.07.007

Boland, J.R.J., Lyytinen, K. and Youngjin, Y. (2007) Wakes of innovation in project networks: the case of digital 3-D representations in architecture, engineering, and construction. Organization Science, 18(4), 631–47.

Cole, R. J. (2005). Building environmental assessment methods: Redefining intentions and roles. Building Research & Information, 33(5), 455–467.

Cole, R.J., and Valdebenito, M.J., (2013) The importation of building environmental certification systems: international usages of BREEAM and LEED, Journal of Building Research & Information, 41(6) 662-676.

Emmitt, S. (2001a) Technological gatekeepers: the management of trade literature by design offices. Engineering Construction and Architectural Management, 8(1), 2–8.

Emmitt, S. (2001b) Observing the act of specification. Design Studies, 22(5), 397–408.

Haapio, A.&Viitaniemi, P. (2008). A critical review of building environmental assessment tools. Environmental Impact Assessment Review, 28, 469–482.

Larsen, G.D. and Ballal, T.M.A. (2005) The diffusion of innovations within a ukci context: an explanatory framework. Construction Management and Economics, 23(1), 81–91.

Lees, T. and Sexton, M. (2014) An evolutionary innovation perspective on the selection of low and zero carbon technologies in new housing. Building Research and Information, 42 (3). pp. 276-287. ISSN 1466-4321 doi: 10.1080/09613218.2013.819547

Mike, B and Nick, M (2001) Understanding the diffusion and application of new management ideas in construction. Engineering, Construction and Architectural Management, 8(5/6), 335-45.

Ministry of Cabinet Affairs (2015) UAE National Innovation Strategy, available at https://government.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/national-innovation-strategy (accessed 13/10/2017)
Mitropoulos, P. and Tatum, C. (1999) Technology adoption decisions in construction organizations. Journal of Construction Engineering and Management, 125(5), 330–8.
Mollaoglu-Korkmaz, S., Swarup, L., & Riley, D. (2013). Delivering sustainable, high-performance buildings: Influence of project delivery methods on integration and project outcomes. Journal of Management in Engineering, 29, 71–78.
Peansupap, V. and Walker, D. (2005) Exploratory factors influencing information and communication technology diffusion and adoption within Australian construction organizations: a micro analysis. Construction Innovation, 5(3), 135–57.
Rogers, E.M. (2003) Diffusion of Innovations, 5th edn, Free Press, New York, NY.
Schweber, L. (2013) The effect of BREEAM on clients and construction professionals. Building Research and Information, 41 (2). pp. 1-17. ISSN 1466-4321 doi: 10.1080/09613218.2013.768495
Schweber, L. and Haroglu, H. (2014) Comparing the fit between BREEAM assessment and design processes. Building Research and Information, 42 (3). pp. 300-317. ISSN 1466-4321 doi: 10.1080/09613218.2014.889490
Shibeika, A. and Harty, C. (2015) Diffusion of digital innovation in construction: a case study of a UK engineering firm. Construction Management and Economics, 33 (5-6). pp. 453-466. ISSN 0144-6193 doi: 10.1080/01446193.2015.1077982
Steffen Gackstatter, Maxim Kotzemir, Dirk Meissner, (2014) "Building an innovation-driven economy – the case of BRIC and GCC countries", Foresight, Vol. 16 Issue: 4, pp.293-308
United Nations. (1992). United Nations Framework Convention on Climate Change