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A review of models for assessing readiness of construction organisations to innovate

Stephen Akunyumu, Frank D. K. Fugar, Emmanuel Adinyira and James Cofie Danku

Department of Construction Technology and Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

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Abstract

Purpose – There is an urgent need for the construction industry to improve its current performance to increase productivity and satisfy the complex and varying needs of project clients. To be successful, construction companies must innovate. Unfortunately, the extant literature has revealed some inertia towards innovation which in several cases is because of lack of the organisational readiness required to embrace innovation. Various models for assessing organisational readiness are proposed in the literature. Accordingly, the purpose of this paper is to determine the applicability of existing models for assessing the readiness of construction organisations to innovate.

Design/methodology/approach – A desk study of the extant literature was conducted to identify perspectives of readiness assessment and, based on a comparative framework, a set of readiness assessment models identified was examined to ascertain their perspectives on organisational readiness assessment.

Findings – Five models/tools of organisational readiness assessments were identified and compared based on a set of identified criteria. The comparative analysis revealed that three of the models can be used to assess the readiness of construction organisations to innovate, albeit with varied scopes of modification.

Practical implications – The paper presents an overview of readiness assessment perspectives developed through models that could help organisations in selecting the most appropriate tool to assess their readiness.

Originality/value – The paper uses a comparative framework as a basis for analysing the identified models. It further discusses the strengths and weaknesses inherent in each model noting critical areas of omission.

Keywords Innovation, Construction industry, Construction organisations, Comparative framework, Readiness assessment, Readiness models

Paper type Literature review

Introduction

There is a continuous growth of competition in every industry owing to companies' strategic policy directions, increased number of players in the industry and clients' requests for improved processes and products. As a result, the need for firms to innovate to remain competitive and deliver improved products that meet the ever-increasing high client's standards is almost inevitable. Firms that innovate are able to improve their performance,

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remain competitive and deliver value for their stakeholders (Karabulut, 2015). Innovation is often seen as the new channel through which performance can be improved across several industries (Maghsoudi *et al.*, 2016), including construction. To increase profit margins, many firms have explored different types or ways to innovate (Chen, 2017). As a key industry contributing 5%–10% to the growth of economies, innovation is especially crucial for the construction industry (Meng and Brown, 2018; Reichstein *et al.*, 2008). Furthermore, ensuring progressive organisational success and the development of the construction industry could be enhanced by the extent of innovation in the industry (Gambatese and Hallowell, 2011). Thus, the focus on innovation as a critical subject for research is key.

To measure and ascertain what constitutes firms' innovation, several scholars have sought to initially define innovation and what it entails. Innovation, being a multidisciplinary concept, has been defined in different contexts and has been a subject of debate in the literature. Consequently, many scholars and institutions have defined innovation from the perspectives of their respective backgrounds. For instance, an often-cited definition is contained in the third edition of the Oslo Manual of the Organisation for Economic and Community Development (OECD). The OECD Oslo Manual, which offers guidelines for collecting and interpreting innovation data, defined innovation as:

> the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation, or external relations (OECD, 2005, p. 46).

According to the Advisory Committee on Measuring Innovation in the 21st Century Economy, innovation is:

> the design, invention, development, and/or implementation of new or altered products, services, processes, systems, organisational structures, or business models to create new value for customers and financial returns for the firm (Schramm *et al.*, 2008, p. 1).

Furthermore, Rogers (1995) posits innovation as an idea, practice or object deemed to be novel by either an individual or other unit of adoption. Considering the project-based nature of the construction industry, Slaughter (1998) explained innovation to involve the use of non-trivial change and advancement in product, process or system considered to be novel to the initiator of the innovation. A change is deemed to be non-trivial when the changes effectively affect the characteristics of a product or the selected means of its implementation, or the processes and systems adopted by a company (Gambatese and Hallowell, 2011). When the change is trivial, only a small portion of the work executed is affected (Gambatese and Hallowell, 2011). Ling (2003) also considered construction innovation as implementing new ideas aimed at stemming further benefits amidst project risks and uncertainties. This new idea may be the introduction of new technology, design, material component, or construction method used in a project (Asad *et al.*, 2005). In a recent study, Dansoh *et al.* (2017) considered construction firms who have developed practical methods to solve problems they encountered on projects they executed to have innovated.

Innovation in organisations can assume many forms. It is either deemed to be radical when the focus is to offer a response to external pressures or incremental where step-by-step changes are commonplace (Ebgu, 2004). Typically, innovation is by default regarded in the literature to encompass process or product innovation (Cozzarin, 2017; OECD, 2005). However, within construction context, innovation is broadly classified as either technical or organisational innovation (Asad *et al.*, 2005). Technical innovation is related to the primary work activity of an organisation, producing changes in its operating systems (Damanpour and Aravind, 2012). Technical innovation can take the form of either product (e.g. new

products or services) or process innovation (e.g. new methods of production or new forms of organisation) (Armbruster *et al.*, 2008; Asad *et al.*, 2005). Organisational innovation may be as a consequence of implementing changes within the organisational structure, implementing unconventional techniques of management and the introduction of original corporate strategic orientation (Anderson and Manseau, 1999). Organisational innovation on the other hand involves human resource practices, functional practices such as logistics and external relations to other organisations through alliances (Cozzarin, 2017). Armbruster *et al.* (2008) further differentiated organisational innovation along intra-organisational and inter-organisational innovation. As implied in their names, intra-organisational innovation occurs within the organisation while inter-organisational innovation is manifested through new organisational structures beyond the boundaries of the organisation (e.g. cooperations, networks, external alliances) (Armbruster *et al.*, 2008).

The construction industry is however seen as an industry that is slow to innovate (Loosemore, 2015). Reasons often cited for the slow pace of innovation in the construction industry include the one-off nature of projects and the collaboration required from multiple participants (Maghsoudi *et al.*, 2016). The slow pace of innovation in the industry can also be attributed to the risky nature of innovation and the fact that its returns are often felt in the long term and not the short term (Ozorhon and Oral, 2016). Furthermore, the vast majority of construction firms are also small (Meng and Brown, 2018), and the financial investment required to innovate is often a demotivator underscored by the fact that only few clients are willing to pay for innovation (Loosemore, 2015). However, in a recent study, Walker (2016) observed that the construction industry has attained significant levels of innovation maturity. This innovation drive is not the privilege of firms of a particular size. All construction firms can innovate irrespective of the size (Meng and Brown, 2018). When construction firms innovate, they have the advantage to demonstrate their creative abilities to remain competitive (Loosemore, 2015), improve project and corporate performance, productivity and client satisfaction (Ozorhon, 2013), profitable operation (Owusu-Manu *et al.*, 2015), enhanced corporate image and client satisfaction (Xue *et al.*, 2014).

However, to benefit from the advantages offered by innovating, firms must assess their internal environment to ascertain the possibility of innovation implementation and diffusion. Because innovation implementation in firms is enabled by internal factors such as structure, policy, culture, resources, etc. Thus, firms need to examine those factors to determine their readiness or preparedness to innovate (Panuwatwanich and Rodney, 2012). According to Gudergan *et al.* (2015), an organisation's efforts towards transformation may fail in the face of lack of adequate preparation to be in a state of readiness for the change. As such, it has been argued that a major factor in determining the success of an organisational innovation or change is to assess not only the readiness of the organisation but also the level of readiness of the people among which the transformation is to be implemented (Gudergan *et al.*, 2015; Stevens, 2013). When an organisation's readiness status is high, its employees are likely to take part in the initiation of the change process resulting in the successful implementation of the proposed change. On the contrary, when the organisations readiness is low, employees are likely to view the proposed change as undesirable and are likely to resist the implementation of the change (Shea *et al.*, 2014). Thus, the need to assess an organisation's readiness before the adoption of new ideas is paramount.

Generally, the readiness of organisations has been proposed to be assessed broadly through two methods in the literature. While some studies developed and tested hypotheses using a set of critical factors required for organisational readiness (Yusof and Shafiei, 2011), others developed and tested models as the bases for assessing the readiness of organisations. This paper focusses on the latter and reviews the various methodological

perspectives of models developed in literature and compares them in terms of their purpose of development, scope of readiness assessment, method of assessment, the status of the model and the applicability of the model in the construction industry. This paper harmonises the different assessment perspectives contained in each of the models reviewed, making it possible to identify possible strengths and weaknesses contained in each model. More importantly, it provides scope for selecting the most appropriate model for assessing the readiness of organisations willing to innovate in the construction industry. The rest of the paper defines the concept of readiness and proceed to review models of assessing organisational readiness and reports its findings using an adopted comparative framework.

Organisational readiness to innovate

Definition of readiness

Readiness has been defined by several people and it possesses different meanings to different people in different contexts. Generally, readiness has been used to measure the ability to adopt any new technology before its implementation (Bendi, 2017). However, there is no singular definition for the concept, because different meanings are attached depending on the context, situation and users (Tran *et al.*, 2011; Luo and Goulding, 2010). The concept, however, has received substantial attention from studies focussed on information technology (IT) implementation in manufacturing and construction organisations. Within the IT context, the concept is often referred to as "e-readiness". The concept also relates to the measure of the readiness of individuals, communities, organisations and nations. For instance, Goulding and Lou (2013) defined e-readiness as the assessment of the extent to which a firm may be in preparedness or the extent of willingness by an organisation to derive benefits associated with the digital economy. According to Tran *et al.* (2014, p. 202) e-readiness is:

> a measure of the extent of a construction enterprise's internal resources and external resources to which the enterprise should make an adoption decision and the enterprise will more likely use and gain basic benefits from the technology.

Ruikar *et al.* (2006, p. 99) also defined e-readiness as "the ability of an organisation, department or workgroup to successfully adopt, use and benefit from information and communication technologies such as e-commerce". Defining the readiness for a country, Dada (2006, p. 1) defined readiness as "a measure of the degree to which a country, nation or economy may be ready, willing or prepared to obtain benefits which arise from information and communication technologies (ICTs)". A country's e-readiness was also defined by the Economic Intelligence Unit (2009) as the "state of play" of the infrastructure of a country's ICT and the ability of its consumers, businesses and government to harness the ICT to their advantage. As earlier stated, the definition of readiness carries varied meanings and its definition has depended on the contexts, situations and users. Hence, there is the need to provide a definition necessary to provide a basis for this study to be tractable and offer clarity to its objective. To this end, readiness is defined in this study as the measure of the extent to which an organisation is prepared, ready or willing to adopt a new business initiative and its ability to harness the benefits of the new initiative to its (organisation's) advantage.

Theories of organisational readiness

Assessment for organisational readiness to innovate or change is considered a multilevel construct capable of being conducted at individual or supra-individual (organisational) levels (Shea *et al.*, 2014). The models considered in this paper are those conceptualised on the

supra-individual (organisational) readiness level underlined by organisational readiness theoretical perspectives. According to Nilson (2015), the theoretical approaches underlying organisational change implementation can be categorised into five classes as process models, determinant frameworks, classic theories, evaluation frameworks and implementation theories. For this paper, implementation theories, which are based on the adaptation and modification of existing theories or concepts to aid the understanding and explanation of organisational change implementation are explored. Nilson (2015) catalogued these implementation theories to include Implementation Climate developed by Klein and Sorra (1996), Absorptive Capacity (ACAP) (Zahra and George, 2002), Normalization Process Theory (May and Finch, 2009) and Organisational Readiness theory (Weiner, 2009).

The Implementation Climate theory is premised on the conception that effective innovation implementation is determined by the following:

- the organisational climate for implementing a proposed innovation; and
- the perceptions of targeted organisational members of how the proposed innovation is in tandem with their values.

Innovation effectiveness is conceptualised at the organisational level – an innovation is considered to be effective when all members of the organisation consistently make use of the innovation than when only a handful of the organisation's members use the innovation consistently (Klein and Sorra, 1996). Thus, an organisation's effort at innovating is deemed successful when it benefits from the innovation through an organisation-wide application of the innovation.

ACAP is conceptualised to encompass the dynamic capability of an organisation relating to knowledge creation and utilization that increases an organisation's competitive advantage. Prior empirical research provide strong justification for the relationship between an organisation's innovative output and the creation of competitive advantage (Zahra and George, 2002). Zahra and George (2002) further conceptualised ACAP to include four different yet complementary dimensions that constitute an organisation's absorptive capability: acquisition, assimilation, transformation and exploitation.

The Normalization Process Theory was first developed as a model to explain the processes through which complex interventions become an embedded routine within health-care circles (May *et al.*, 2007). The application of the model revealed limited utility in highlighting factors inhibiting and promoting collective action in implementing practices (May and Finch, 2009). Subsequently, expansion of the model into a theory followed the description of the interrelation between constructs (Nilson, 2015). The theory is "concerned with the social organisation of the work (implementation), of making practices routine elements of everyday life (embedding), and of sustaining embedded practices in the social contexts (integration)" (May and Finch, 2009, p. 538). Thus, it considers how organisations can implement innovation and their ability to operationalize innovation as a routine practice.

The organisational readiness theory, relevant to this paper, was developed by Weiner (2009). Weiner (2009), theorised organisational readiness to change along two facets: change commitment and change efficacy. Change commitment is reflected in the shared resolve in pursuing the courses of action required to implement change. Change commitment is demonstrated by organisational members through three motives: because they want to (they value it), they have to (have no choice), or they ought to (obligatory). Drawing on motivation theory, change commitment is hypothesised to be determined by change valence. Organisational members would demonstrate commitment if they value the change. Thus, change commitment is highest when it is based on the "want to" motive (Weiner, 2009). Change efficacy reflects the shared belief demonstrated by organisational members in their

capability to implement change. Relying on social cognitive theory, change efficacy is hypothesised to be determined by the courses of action necessary (task demands), the resources required (the availability of resources), the time required, and sequencing of activities (situational factors) (Weiner, 2009). Change-related efforts of organisational members facilitate readiness. When an organisation's readiness is high, there is the likelihood of members initiating change, exerting greater effort and exhibiting resilience even when difficulties are encountered (Shea *et al.*, 2014). Overall, organisational readiness is heightened when organisational members want to implement the change (change valence) and when they believe in their capacity to do so (change efficacy).

Research methodology

This paper aimed to determine the applicability of existing models for assessing the readiness of construction organisations to innovate. The paper adopted a desk study of the relevant literature to identify and analyse the approaches proposed by the models for organisational readiness to innovate. The search was conducted in powerful databases such as Scopus, Web of Science and Google Scholar, using keywords such as "organisational readiness", "readiness assessment", "readiness models" and "construction innovation". The choice of keywords used was arrived at considering the subject focus of the paper and the initial reading of published articles. While this is not a guarantee for generating a complete population of papers in the subject area, it helped to ensure a workable number of relevant papers were selected. To ensure that an adequate number of papers were retrieved and to include seminal works upon which recent studies are based, the search was conducted without any limitation to the year of publication. Articles included were as follows:

- empirical studies that developed readiness models/frameworks; and
- articles published in refereed journals.

The former criterion was informed by the focus of this paper and the latter criterion was because of the wealth of reputation accorded refereed journal articles owing to the rigorous process of peer reviews such articles are subjected. Similar protocols have been used in previous reviews concerning other areas of the built environment (Wuni *et al.*, 2019; Darko *et al.*, 2017; Osei-Kyei and Chan, 2015). The literature search revealed two classes of models:

(1) models focussed on assessing a country and its government's readiness to adopt innovative technologies; and

(2) models developed to assess the readiness of organisations to innovate.

Given that this paper focussed on readiness assessment at the organisational level, models reviewed are those identified in the latter class. This is also in tandem with the explored organisational readiness theories, which explains the nuances of readiness assessment at the organisational level. This resulted in the identification of five organisational readiness assessment models for further analyses. The review was conducted using a comparative framework adapted from Khalfan *et al.* (2005), comparing models based on a set of criteria defined as follows:

- Purpose of the model: the main purpose for which the model was originally designed.
- Aspects covered: major areas of assessment of the model.
- Method of Assessment: method of data collection of the model for readiness assessment (i.e. questionnaire, interview, focussed groups, etc.)

- Status of the tool/model: the developmental state of the model relating to whether it is a commercial tool, a research prototype, or is currently under development.
- Applicability of model in the construction industry: this criterion assessed whether the models can be used in the construction industry.

The remainder of the paper reviews the literature and reports its results and findings from the comparative analyses of identified models. Furthermore, case study experiences emerging from the application of some of the reviewed models have been explored and discussed. Relevant lessons from the case application of the reviewed models would help understand areas requiring further development with practical implications.

Models of organisational readiness assessment

Owing to the need to succeed, the assessment of readiness is accepted as a good foundation to study in adopting a new paradigm. Assessment of an organisation's readiness to adopt innovations is also seen as a necessary prerequisite for developing and being abreast with the demands of the present-day volatile market environment (Aboelmaged, 2014). As a result, models of readiness assessment have been developed by several individual researchers, institutions and organisations. Generally, these models on the surface measure the readiness of a society or economy to benefit from IT and e-commerce. A closer check, however, reveals a difference in the definition of readiness and methods of measurement.

It must be pointed out at this stage that models for assessment of readiness have seen enormous development in the IT space because of the rapid pace of innovation in the IT industry. Further, as earlier indicated, whereas some of the models are focused on assessing a country and its government's readiness to adopt innovative technologies, other models focus on the readiness of organisations to adopt new engineering concepts and approaches. For instance, the Asian Pacific Economic Cooperation (APEC, 2000) developed a guideline for economies to enable each member economy to examine its extent of readiness to engage in e-commerce and include the business community to implement ways to adequately position themselves for the digital economy. It provides six indicators of measuring e-commerce readiness through the development of a series of questions, providing directions as to the required policies needed to promote e-commerce (Luo and Goulding, 2010). Similarly, the Economic Intelligence Unit has in collaboration with the IBM Institute for Business Value developed a global annual e-ranking tool since 2000. The ranking essentially provides governments with information that enables them to gauge the success of their technology initiative against other nations (Economic Intelligence Unit, 2006). The networked readiness index has also been developed by World Economic Forum, INSEAD and infoDev. It is a composite index of three components, including an enabling environment for IT provided by a country or community, its stakeholders' readiness to use the IT and the actual use by the stakeholder community of the IT. It essentially measures current network connectivity and the ability of a country to use existing networks and create new ones (Ghavamifar *et al.*, 2008; Beig *et al.*, 2007). The Center for International Development of Harvard University developed the readiness for the networked world guide, published in 2000, to assess the readiness of a community in the developing world. It has in its scope 19 different categories to enable communities to estimate their current extent of development for each category (Benssam *et al.*, 2016; Luo and Goulding, 2010). Other e-readiness models have been developed by other reputable institutions and organisations such as the United Nations Conference on Trade and Development (ICT Development Index), United Nations Development Program (Technology Achievement Index), McConnel International (Ready?Net.Go tool) and the Mosaic Group (Framework for Assessing

Diffusion of the internet) (Benssam *et al.*, 2016; Ghavamifar *et al.*, 2008; Mutula and van Brakel, 2006).

The aforementioned models focussed on the assessment of readiness at the macro-level (i.e. countries and governments) to benefit from the networked or digital economy. However, several other models have been developed that focus mainly on the assessment of companies and institutions. Given that the objective of this paper is to review the models for assessing the readiness of companies to innovate, the following sections discuss, in detail, models applicable for assessing companies' readiness.

Readiness assessment for concurrent engineering model

This model was developed by the Concurrent Engineering Research Center (CERC) purposely for assessing the readiness of organisations to implement concurrent engineering. It is contended that increasing the pace at which an organisation implements concurrent engineering is incumbent on the assessment of the organisation's readiness. It built on existing models such as the computer aided acquisition and logistic support/concurrent engineering model, the Mentor Graphics model, Software Engineering Institute's engineering maturity model concept and the Malcolm Baldrige award criteria (Karandikar *et al.*, 1993). It was developed for assessing the readiness of organisations in industries such as manufacturing and software engineering. Consequently, the model may require modification before use in the construction industry because of the uniqueness of the industry. Unlike other sectors, construction products have unique characteristics, for example, the products, for the most part, are constructed on site and work teams and organisations are transient (Khalfan *et al.*, 2005). The model is conceptualised in two major elements: technology and process. Data collection is conducted with the help of a questionnaire designed to obtain information covering all key elements in the process and technology elements. The readiness of an organisation is assessed in five process element stages and three technology element stages.

IQ net readiness scorecard

This readiness model is a Web-based application developed by Cisco to assess the readiness of an organisation to migrate to an internet business model. The developers argue that an organisation's productivity and profitability targets are within reach if the company is "Net-Ready". It assesses readiness through statements covering four thematic areas of leadership, governance, technologies and organisational competencies. The readiness of the organisations is then assessed based on their responses to the statements across the four thematic areas and presented with their IQ Net Readiness profile (Ruikar *et al.*, 2006).

Standardised process improvement for construction enterprises model

Standardised process improvement for construction enterprises (SPICE) is a model developed to enable construction organisations to assess the maturity level of their construction processes. It draws on experiences from the software industry and borrows concepts from the Capability Maturity Model (Sarshar *et al.*, 2000). It argues that organisations can achieve process maturity with focus on many small and evolutionary steps. This model breaks the evolutionary steps into five levels of maturity with successive levels providing bases for consistent improvement in processes (Amaratunga *et al.*, 2002). The first level being the lowest level of the model is the level where the process capability of the organisation is unpredictable with processes not specified and constantly subject to change as work progresses. At the second level, policies and procedures are established and documented and the processes can be repeated. The third level is the level where

management and engineering activities are well defined, documented and integrated into the organisation. At the fourth level, an organisation is capable of setting quality targets and requirements for products, processes and supply chain relationships. Productivity and quality at this level can be measured. At the final level (level five), the organisation can proactively identify its weaknesses and strengths and address before further problems arise.

Benchmarking and readiness assessment model for construction

Benchmarking and readiness assessment model for construction (BEACON) was developed to assess the readiness of the construction industry for the implementation of Concurrent Engineering. It was developed on the premise that the construction industry stands the chance of benefitting from the advantage of concurrent engineering as evident in other industries, such as manufacturing, if the readiness of construction organisations is assessed for the introduction of concurrent engineering (Khalfan *et al.*, 2001). The model bears similar characteristics with the readiness assessment for concurrent engineering (RACE) model in terms of some of the elements of assessment, questionnaire criteria and diagrammatic representation – the differing characteristics being its main focus on construction processes (Khalfan *et al.*, 2001). The model is conceptualised into four elements: process, people, project and technology, and divided into four quadrants (Khalfan *et al.*, 2005). The process maturity of a construction organisation is assessed using five critical process factors in the first quadrant. The second quadrant contains four critical people factors, focussing on project team issues. The project factors, assessing the client's requirements and designed related issues, are contained in the third quadrant with three critical project factors. The fourth quadrant contains five technology related critical factors to assess the technology readiness of a construction organisation over its ability to use advanced tools (Khalfan *et al.*, 2005). Like the other models reviewed, this model assesses readiness by collecting data with a questionnaire (BEACON questionnaire) containing statements organised into the four key elements requiring respondents to rate on a five-scale of options. The readiness of organisations is then assessed by calculating average percentages for the critical factors of the four elements and, depending on the average percentage of each element, the readiness of an organisation is classified into five levels. This is another characteristic of the model adopted from the RACE model. These five levels include "Ad-hoc, Repeatable, Characterized, Managed, and Optimizing" (Khalfan *et al.*, 2005). According to Khalfan *et al.* (2005) an Ad-hoc maturity level indicates a limited conception of an organisation concerning concurrent engineering and thus it is not ready to implement concurrent engineering. On the other hand, obtaining an optimizing maturity status indicates that the organisation has attained readiness and it is prepared to adopt and implement concurrent engineering (Khalfan *et al.*, 2005).

Verify End-user e-Readiness using a Diagnostic Tool (VERDICT) model

Verify End-user e-Readiness using a Diagnostic Tool (VERDICT) was developed for construction companies to ascertain their state of readiness to use e-commerce technologies (Ruikar *et al.*, 2006). The VERDICT model is conceptualised in four elements of management, people, process and technology. The model combines aspects of the IQ Net Readiness Scorecard and the BEACON models and builds on them. The VERDICT model differs from the IQ Net Readiness Scorecard and the BEACON model in terms of its focus of readiness assessment. While the IQ Net Readiness Scorecard focusses on assessing the e-readiness of technology companies (i.e. software companies) and the BEACON model focusses on the ability of construction companies to adopt concurrent engineering, the VERDICT model focusses on assessing the e-readiness of construction organisations to

adopt e-commerce technologies (Ruikar *et al.*, 2006). The VERDICT model uses a questionnaire comprising of statements provided under the four elements of management, process, people and technology for collecting data. On completion, textual and graphical reports are generated and presented to the respondents. These include a summary of a table containing the average of the scores obtained for a category. It also provides the assessor with a radar diagram that permits organisations to benchmark their readiness performance with a set of best performing organisations within the industry grouped as the best-of-breed. VERDICT also provides assessors with a summary of all responses to the statements contained in a category. The readiness of an organisation for a category (i.e. management, people, process and technology) is presented using a traffic light system. An average of scores equal to or greater than 0 but less than 2.5 is red, indicating that an organisation must pay attention to several aspects within a category. Amber means that a category has attained an average score greater than or equal to 2.5 but less than 3.5. Attaining amber for a category indicates that an organisation must focus its attention on addressing certain aspects within the category to attain readiness. A green indication is to the effect that the category has obtained an average score greater than or equal to 3.5 and that the organisation is ready in this aspect. The model considers all four categories to be equally important for attaining optimum readiness. Thus, each category must attain an average score of greater than or equal to 3.5 (green).

Results

The results from the review of identified models are presented in Table 1 according to the comparison done using the aforementioned criteria. The comparative analysis revealed that some of the models were designed to assess readiness for process improvement. The comparison revealed varied scope of readiness assessment for the identified tools. For instance, while the SPICE model focusses on process improvement, the RACE model extends the scope to include the use of technology for the improvement of the development process. The comparative analysis also revealed a consistent method of data collection across several of the reviewed models, namely questionnaire and interviews. The status of the reviewed models suggests a large number are research prototypes with only RACE being a commercial tool.

A review of the applicability or suitability of the identified models in the construction industry showed that they were designed for use in the construction industry and other industries. For instance, the RACE and IQ Net Readiness Scorecard models have enjoyed extensive application in the automotive, software engineering and electronic industries. The SPICE model, originally developed for assessing the capability of construction processes, has also been applied in other related areas of the built environment including Facilities Management.

Findings and discussion

The review further revealed the strengths and weaknesses of the models. For its strength, when applied, the RACE model proved a reliable tool in revealing the improvements required in the business drivers of an organisation. However, it ignores strategy diffusion and product architecture, which are two critical elements considered to be significant in the product creation process (Graaf and Sol, 1994). Furthermore, Khalfan *et al.* (2001) found the technological element of the RACE model to be complicated, requiring only specialists to accurately assess.

One of the major strengths of the SPICE model is in its method of readiness assessment which allows for cross-validation of results through the collection of data using

Table 1. Comparative analysis of readiness assessment models

Criteria	RACE (West Virg. Uni, 1990)	SPICE (Sarshar *et al.*, 2000)	IQ Net Readiness Scorecard (Cisco, 2004)	BEACON (Khalfan *et al.*, 2001)	VERDICT (Ruikar *et al.*, 2006)
Purpose of model design	Developed to assess readiness to adopt concurrent engineering. Mainly applied in software engineering, electronic and automotive industries.	Focusses on evaluating vital process employed by construction organisations.	Developed to assesses an organisation's readiness to operate an internet-based business model.	Focusses on the readiness of the construction industry to implement collaborative and concurrent engineering.	Designed to assess the e-readiness of construction companies to adopt e-commerce tools.
Aspects of coverage	**Process** Customer focus process focus strategies for team formation and development Accommodation of teams within the organisation Management systems Mechanisms for rapid product Assurance Agility Senior leadership commitment Discipline. **Technology** Application tools communication Co-ordination Information sharing services Integration	**Mainly Process Improvement** Brief management Project planning Project tracking and monitoring Contract management Quality assurance Project change management Risk management Organisation process focus Organisation process definition Training programme Inter- disciplinary Co-ordination Peer review Technology management	Leadership Governance Technologies Organisational Competences	**Process** Management systems Process focus Organisational arrangements. Strategy deployment Agility **People** Teams within the organisation Discipline Team leadership and management Team formation and development **Project** Project design Quality assurance Client focus **Technology** Communication support Co-ordination support Information sharing Integration support Task support	**Management** Business Strategies Management Buy-in Performance Reviews Change management **Process** Business Process Rationalisation of procedures Flexibility of existing technology **People** Capability of people Cultural Characteristics Role and responsibilities Work Environment **Technology** Infrastructure Performance of Tech Infrastructure Familiarity with specialist Software
	Questionnaire and interview		Questionnaire	Questionnaire	Questionnaire

(*continued*)

Table 1.

Criteria	RACE (West Virg. Uni, 1990)	SPICE (Sarshar *et al.*, 2000)	IQ Net Readiness Scorecard (Cisco, 2004)	BEACON (Khalfan *et al.*, 2001)	VERDICT (Ruikar *et al.*, 2006)
Method of assessment		Questionnaire, interview, document review			
Status	Commercial	Research prototype	Research prototype	Research prototype	Research Prototype
Applicability in construction	Yes, but require major modifications and limited in scope relative to other models	Yes, but limited in scope to process improvement only.	Yes, but with relative difficulty due to its major focus on IT companies.	Yes, but requires major modifications.	Yes, but requires modifications for successful application.

questionnaire, interviews and document reviews. It also helps to identify process strengths and weaknesses. Conversely, the SPICE model is limited in scope as it only focusses on process readiness of an organisation. When applied, the terminologies contained in the model were not relatable to the participants (Sarshar *et al.*, 2000).

The BEACON model has an extended scope for readiness assessment relative to the RACE and SPICE models. It has in its scope the addition of project and people elements that were not explicitly captured in the RACE and SPICE models. It offers firms in the construction industry the unique opportunity to assess their readiness for the implementation of collaborative concurrent engineering in a manner that helps in fostering the appropriate strategies required for that purpose. Even for organisations not seeking to implement concurrent engineering, the model can prove beneficial for self-assessment based on its four elements – process, project, people and technology. However, it needs to be updated to meet current developments of the construction industry (Aziz and Salleh, 2011).

Like the SPICE model, the VERDICT model also assesses readiness in four critical elements: management, process, people and technology. The model is easy to understand and easy to use. It is capable of identifying critical areas an organisation must address to achieve optimal readiness. The best-of-breed component of the model allows organisations to benchmark their state of readiness in relation to their competitors. Apart from its capability to assess the readiness of an organisation as a whole, it can also be used to assess a company's department's readiness as well as the readiness of individual workgroups in a department. However, even though the model is capable of highlighting critical areas requiring organisational attention to achieve readiness, it falls short of providing any guidelines for improvement. Again, the model considers all four elements to be important, thus, for an organisation to be ready, all four elements must attain high average scores. This might not provide adequate response for an organisation that assigns relative importance to the factors. Because the VERDICT model was developed to gauge companies' readiness (e-readiness) to implement IT, it requires major adaptation before it can be applied to assess the readiness of firms in adopting other innovative ideas beyond IT implementation.

Overall, the review showed that the Models can be applied to assess the readiness of firms in the construction industry, albeit with varied scopes of limitation.

Experiences from the application of readiness models

Some of the readiness assessment models have been applied in case projects in a bid to ascertain their applicability in practice and not limit their utility to theoretical propositions. For instance, developers of the SPICE model conducted case studies using two design and build projects with the objectives to establish the comprehensiveness of the model, ascertain the practicality of the Model's assessment recommendations, capture the experience of project team members and examine the effectiveness of its readiness assessment mechanisms (Sarshar *et al.*, 2000). The case study findings highlight certain key strengths of the model. For example, project documentation reviews conducted revealed that key processes concerning organisational directives and guidance for performing various construction processes were defined in the SPICE model, highlighting considerable levels of the model's comprehensiveness. Another observation of the model's strength is highlighted in the model's readiness assessment mechanism allowing for cross-validation of results by conducting documentation reviews, use of questionnaires and interviews. In one instance, interviews conducted among the workers undertaking the work revealed varied perceptions about the goals and critical success factors for the project. This is an indication of the lack of communication between senior management and the workers (Sarshar *et al.*, 2000). While this highlights the need for organisation-wide communication of project objectives, it also

makes a strong case for the general concept of organisational readiness assessment requiring readiness assessors to not limit organisational readiness assessment to only senior managers - as has been the case in reported literature - but also to extend the scope of the assessment to include lower-level workers. This is important because, as indicated in Weiner's theory of organisational readiness, organisational readiness varies as a function of the extent to which organisational members value the change (change valence) and their belief in their collective capability to implement the change (change efficacy). Thus, extending organisational readiness assessment to involve members at all levels could offer a better representation.

The BEACON model was also applied in a case study involving project clients, consultants, contractors, sub-contractors and suppliers of construction materials. The focus of the case studies was to ascertain the collaborative and concurrent engineering readiness of the UK construction industry (Khalfan *et al.*, 2005). The case study revealed consistent attachments of relative importance to the model's aspects of readiness assessment (i.e. project, people, process and technology) across the different categories of study's respondents (i.e. clients, consultants, contractors, sub-contractors and materials suppliers). For instance, all respondent categories considered the people aspect as the most important and the technology element as the least important aspects of BEACON's readiness assessment model. This consideration is in sharp contrast to the concept of VERDICT's readiness assessment which assigns equal weights to all of its elements of readiness assessment (i.e. management, people, process and Technology). The establishment of relative weightings for elements of readiness assessment models is an important consideration for every readiness assessment model development effort since different organisations and sectors attach different priorities to different variables. Though such efforts may prove complex, there is adequate scope and advanced methodologies for achieving this aim, such as the use of the Analytic Hierarchy Process developed by Saaty (1980). A similar application of the VERDICT model to assess the organisational readiness of six UK construction organisations revealed relevant improvements required to the model (Ruikar *et al.*, 2006):

- The need to provide expert advice to the organisation about how to improve certain areas flagged by the model as inhibitors of readiness, given that the model is limited to only identifying areas needing improvement to achieve readiness.
- Continuous improvement to include changes necessary to meet changing industry demands, cosmetic changes and the classification and sub-categorisation of questions with relative orders of priority.

Proposed readiness assessment framework

Drawing on the analysis of the strengths and weaknesses of the reviewed models and the lessons emanating from the application of the models for readiness assessment at the organisational level, a framework is proposed for the usage of construction organisations to assess their readiness towards innovation initiatives (Figure 1). The framework has as its cornerstones of innovation readiness four elements, namely, people, project, process and technology. Consistent with the BEACON and VERDICT models, the people element represents an assessment area that focusses on the readiness of the indispensable human resource of the organisation. In line with the organisational readiness theory, the amount of value and commitment demonstrated by the workforce of every organisation is a significant prerequisite for any innovation efforts. This is particularly important for the construction industry where innovation is often driven by a project team within a project setting. Where

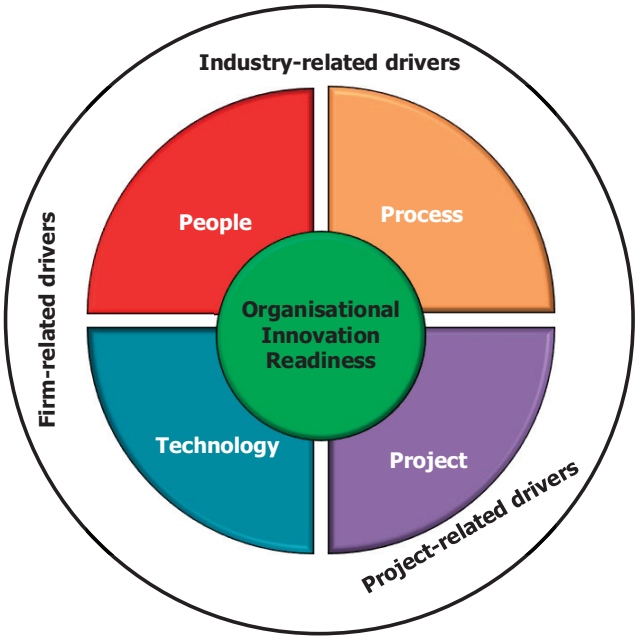

Figure 1.
Proposed readiness assessment framework

members of a project team demonstrate willingness to create new ideas and implement same to solve critical problems, innovation thrives (Ozorhon and Oral, 2016). As noted by Xue *et al.* (2014), the core staff are key elements of the innovation process and their collective commitment acts as relevant initiators and drivers of innovation.

As a proxy to the known characteristic of the construction industry, the proposed framework includes a project component. The project-based nature of the construction industry and project requirements drive the industry's processes and its innovative activities (Ozorhon and Oral, 2016). Similar to the dictates of BEACON, the project element constitutes readiness assessment that considers both design-related and client requirement issues. Among others, the complexity of projects and requirements of clients drive innovation initiatives in the construction industry (Meng and Brown, 2018). Thus, attaining readiness in these areas could stimulate innovation in construction firms.

The process component of the framework represents the procedures and processes of the industry, such as its risk management, project planning, communication management and other related procedures. Attaining process maturity in construction processes is important for performance. The ability of the organisation to introduce and implement advanced knowledge and technology is represented by a technology component. The complexity of projects means construction firms must invest in advanced technology to remain competitive. But the huge investment required to obtain advanced technologies could become a disincentive. However, advanced technologies help firms to devise innovative solutions to solve construction problems (Ozorhon and Oral, 2016). This is particularly true for smaller firms that are open and more likely to accept technology to help their decision-making processes (Meng and Brown, 2018). The proposed framework also recommends the need for communication of project goals among the organisation to aid organisation-wide readiness. This is informed by lessons learnt from the case-application of the SPICE model

which revealed a gap in communication of project goals by senior management to their workforce, evidenced by the varied perceptions expressed by the workforce when interviewed (see the previous section).

Also included in this framework are drivers of innovation that are conceptualised here as facilitators of innovation readiness. For simplicity, the drivers are categorised under project-related, firm-related and industry-related factors. These are presented as a corollary between the main components of organisational readiness assessment (i.e. people, project, process and technology) and attaining organisation readiness to innovate. A non-exhaustive list of the drivers is provided in a separate table (Table 2).

Conclusion

The need to innovate to remain competitive in an increasingly changing business environment is imminent. Notwithstanding the fast pace of the innovation drive in other industries, the construction industry is adamant to the idea of implementing innovation to solve complex problems for improved performance and productivity, often blamed on the nature of the industry's work – project-based. This paper reviewed the various methodological perspectives developed for assessing the readiness of organisations to innovate or adopt new ways of doing things, focussing on their applicability in the construction industry. This is premised on the background that organisational readiness is a key step towards benefitting from the advantages offered by innovating. The paper further proposed a readiness assessment framework to guide construction firms in assessing their readiness for innovation. Innovation is an expensive venture and organisations seeking to innovate must make concerted efforts to ensure the readiness of the entire organisation. This is because the return on investment is not assured and the benefits, if any, can only be realised in the long term.

The review revealed that three (i.e. SPICE, BEACON and VERDICT) of the models reviewed were developed for use in the construction industry. While the Models have varied

Table 2. Drivers of organisational innovation

Drivers	Factors	Author(s)
Industry related	Development of competitive advantage	Meng and Brown (2018), Ozorhon and Oral (2016)
	Market competition	Ozorhon and Oral (2016), Goffin and Mitchell (2005)
	Technology advances	Meng and Brown (2018), Ozorhon and Oral (2016); CIOB (2007), Goffin and Mitchell (2005)
	Corporate image	Meng and Brown (2018), Chang (2011)
	Compliance to regulations	Ozorhon and Oral (2016), Alin *et al.* (2013); Gann and Salter (2000).
Firm related	Corporate social responsibility	Ozorhon and Oral (2016), Borger and Kruglianskas (2006).
	Leadership	Ozorhon *et al.* (2014), Ozorhon and Oral (2016)
	Organisational innovation policy	Davies *et al.* (2014); Ozorhon and Oral (2016)
Project related	Client/user requirements	Meng and Brown (2018), Ozorhon and Oral (2016); Wandahl *et al.* (2011); Brandon and Lu, (2008); CIOB (2007)
	Project complexity	Ozorhon and Oral (2016)
	Improving project performance	Ozorhon and Oral (2016), Gambatese and Hallowell (2011).
	Cost savings	Meng and Brown (2018), Gambatese and Hallowell (2011); CIOB (2007).

elements on which readiness assessment is focussed, the elements of People and Process are a common feature. Another common feature is the method of data collection. Data is obtained through the use of a questionnaire containing statements requiring the respondent to rate on a scale provided. Some of the Models complement this procedure by further conducting interviews and document reviews. Overall, the models pronounce readiness for an organisation based on a set of stated criteria following the analysis of the collected data.

This paper broadens the horizon of knowledge concerning the assessment of organisational readiness to innovate. It brings to knowledge the various tools available for assessing organisational readiness to innovate and highlights the strengths and weaknesses inherent in each model. Thus, organisations willing to assess their readiness to innovate can make informed decisions on selecting the most appropriate assessment tool. Moreover, by providing a catalogue of available readiness assessment models and explaining their methodological perspectives, organisations and practitioners willing to ascertain their readiness status for an impending innovation motive are afforded better understanding and interpretation of readiness assessment results. Again, the reported experience of the case study application of some of the models provides adequate practical information for organisations willing to assess their organisation's readiness for any change initiative. For instance, the need for senior managers to communicate project goals and key performance indicators could help readiness assessors obtain a true representation of an organisation's readiness status when assessed. Ultimately, senior managers are better informed about the pervasiveness of organisational knowledge among its members necessary to inform any decision to initiate any innovation motives. Overall, readiness assessment for any innovation initiative is imperative because it helps organisations establish levels of maturity acceptable for innovation to thrive. This affords organisations an objective basis to decide the success or otherwise of an intended innovation drive.

Notwithstanding the contribution of this paper to knowledge, it has, like other review papers, some limitations that must be brought to the attention of readers. It is instructive to note that the scope of the review was limited to pre-innovation adoption models and does not include post-innovation adoption models, generally described in the literature as Maturity models.

Future research could focus on developing models that mirror practical considerations by attaching relative weightings to its main elements of readiness assessment as different organisations place priority on different variables. The proposed framework is based on evidence emanating from the review and lessons learnt from the case-application of the reviewed models. Further empirical research is required to establish its adequacy.

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Corresponding author
Stephen Akunyumu can be contacted at: sakunyumu@gmail.com