*Review*

# Enhancing IT investment preparedness in the construction sector: A model perspective

## Nur Mardhiyah Aziz* and Hafez Salleh

Faculty of Built Environment, University of Malaya, 50603 Kuala Lumpur, Malaysia.

The issues of IT failures have led to wide investigations efforts over the years. Ample evidence discovered that inability to evaluate organisation readiness among the main factor contributes to the failure. Most of the current IT/IS evaluation model focused on the post-implementation which failed to address the readiness of the organisation prior to the implementation. Assessing organisation readiness is critically important as a means for planning and adopting IT in organisation. Construction industry is among the critical industry that used IT extensively to support its long production processes. However, it is noted that the failure rate of IT project in this industry was also high, and one of the reasons identified was that the IT investment decision was made through ad-hoc manner without any adequate preparation. To date, it is found that only three readiness models available for IT evaluation in construction industry. Therefore, this paper will review the current available readiness model relating to IT investment in construction industry. It is anticipated that the findings can highlight the importance of developing an IT readiness model specifically for construction industry that focus on one aspect only that is the 'soft issue'.

**Key words:** Readiness, construction, IT evaluation, IT construction, readiness model.

## INTRODUCTION

In the new global economy, IT can be regarded as a vital tool in assisting the construction industry to cope with the increasing complexity and demand. Empirical evidence on positive impacts of its usage in construction firms' performance had been well documented (Gaith et al., 2009). Its practical benefits, for example, include an increase in the quality and timeliness of documentation, an increase in speed of work, better financial controls and communications, simpler and faster access to common data, and a decrease in documentation errors (Nitithamyong and Skibniewski, 2006).

Even though the significant of IT is undeniable, it is surprising that after over 40 years since the introduction of IT in construction industry, organisations are still unable to obtain the many benefits of IT investment (Stewart et al., 2002). The growing evidence on the failure of IT had encouraged researchers to find out reasons behind it. Extensive research on the failure

originated back in the 1960s, concerning hardware or software deficiencies (Bartis and Mitev, 2008). According to Wade and Hulland, (2004) IT failures are caused by deficit in organizational capabilities to manage IT-related change, practices and capabilities for information processing, ability to experiment with new technologies and conduct technical innovation, and ability to assimilate IT resources into organizational processes. Factors that contribute to the failures had been analyzed by researchers to formulate successful strategies to implement IT. Nitithamyong and Skibniewski (2006) identified that, to successfully implement IT require a state of readiness not only within one organization, but also within all organizations involved in the construction processes. Therefore, in reducing the number of failure, there is a need to assess the readiness capability prior to IT implementation for the industry to identify and plan their IT implementation in order to attain a better and higher success rate. A systematic e-readiness assessment models evaluation of e-readiness assessment models both short term and long term is an essential means of plan implementation (Vaezi and Bimar, 2009).

---
*Corresponding author. E-mail nurmardhiyah@gmail.com.

## DEFINITION OF READINESS

Various definition of readiness could be found from literature on the subject. The first efforts in defining readiness were undertaken by the Computer Systems Policy Project (CSPP) in 1998, in which readiness was defined with respect to a community that had high-speed access in a competitive market; with constant access and application of ITs in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are favourable to promote connectedness and use of the network (Beig et al., 2007).

Dada (2006) on the other hand, defined readiness as "the measure of the degree to which a country, nation or economy may be ready, willing or prepared to obtain benefits that arise from information and communication technologies (ICT)". Harvard University Centre for International Development's (CID, 2000) defined the term readiness as "the degree to which a community is prepared to participate in the networked world - a world in which everyone, everywhere, has the potential to reap the benefits of connectivity to the network". McConnell International came out with their own definition on readiness, which is "the capacity of nations to participate in the digital economy" (Budhiraja and Sachdeva, 2002). From the above listed definitions, it is obvious that there is no specific definition for the concept of readiness because it depends on various contexts, different situations and different users. Generally, the term readiness is to measure the capability to adopt IT prior to its implementation.

## EVALUATION ON THE CONSTRUCTION READINESS ASSESSMENT TOOLS

Three models identified to be specifically developed for use in construction industry were analysed and their differences identified. These models comprise the BEACON (benchmarking and readiness assessment for concurrent engineering in construction) model, the VERDICT (verify end-user readiness using a diagnostic tool) model and the SPICE (structured process improvement for construction environments) model. All of these models were evaluated in terms of their purpose, the criteria assessed, evaluation phase, people involved, methods of assessment as well as their strength and weaknesses.

### Purpose of evaluation

Every models developed have their own intended purpose. BEACON was created to evaluate the construction companies' readiness level in implementing concurrent engineering with the aim of improving the project delivery process while VERDICT was develop to assesses the overall readiness of end-users involve in construction industry in using the e-commerce technologies. SPICE FM on the other hand was created to help organisations understand their level of process capability in terms of their process maturity in facilities management context. SPICE FM is scoped to only incorporate the processes directly related to the design, construction and maintenance procedures of a construction organisation (Finnemore and Sarshar, 2000).

### The criteria assessed

The criteria assessed in each of the model would depend on the objective of developing the models. For the BEACON model, the four elements assessed were: Process, people, project and technology. These were divided into four quadrants (Figure 1). Five criteria of process elements were assessed in the first quadrant, which include management system, process focus, organisational arrangements, strategy deployment and agility. In the second quadrant, four critical factors relating to the people element were used to evaluate the readiness level in organisation. The third element which is project comprises three critical project factors: facility design, quality assurance and client focus. The final quadrant focuses on the technology highlighting five critical technology criteria which comprises of task support, integration support, information sharing, co-ordination support and communication support. Five levels of maturity were adopted for all the four elements. The levels are Ad-hoc, repeatable, characterised, managed and optimising.

Four key elements were used to assess readiness levels in the VERDICT model. The elements include management, processes, people and technology. These four elements were chosen because the developer believed they were important in order for the organisation to be e-ready. Management was identified as the critical elements that will affect the success of IT implementation in the organisation. Full commitment from management is essential to acquire full benefits of adopting the technology. Process was defined as a series of actions, changes, or functions bringing about result, making it one of the important elements for successful IT implementation. Analysing companies' existing process is crucial in order to identify weaknesses and find ways of solutions. The third element which is people factor, is an important issue that can affect an organisation's overall readiness as the introduction of any new technology (or change) will affect the workforce within that organisation (Ruikar et al, 2006). The final element, technology, is necessary to support the business functions and it includes the usage of both hardware and software.

SPICE FM: Which was developed based on the capability maturity model (CMM) have five maturity levels in its framework (Figure 2). These maturity levels define a scale for measuring the maturity of a construction organisation's processes, and evaluating its process
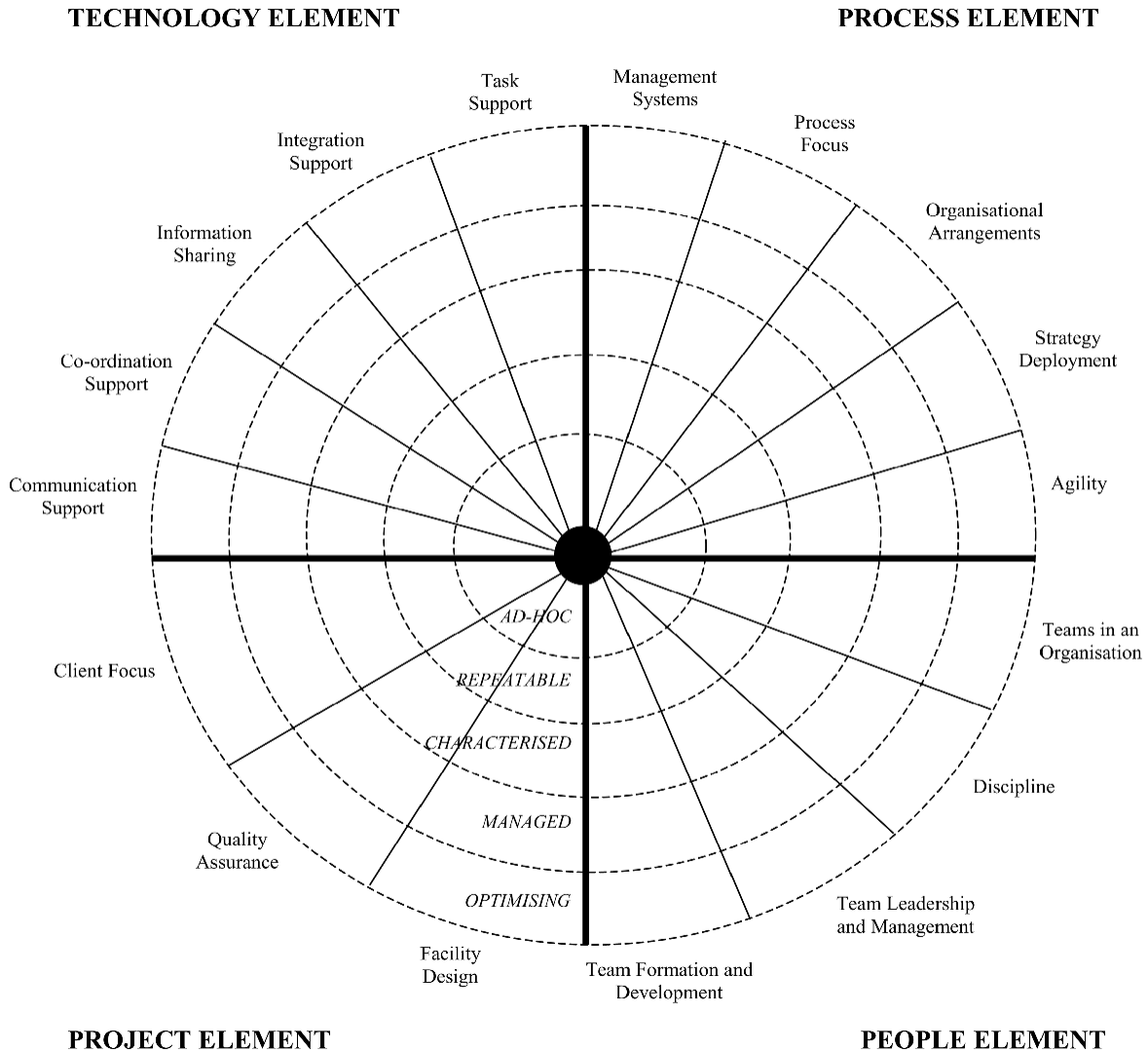
**TECHNOLOGY ELEMENT**

**PROCESS ELEMENT**



**Figure 1**. BEACON model.

capability (Amaratunga et al., 2002). Level one which is the lowest level of the model shows that process in the organisation is unpredictable and constantly changed as the work progresses. Level two is when the organisation has established policies and procedures for managing the major project-based processes. Level three is when the organisation is better defined with all the manage-ment and engineering activities well documented. Level four is when the organisation has the ability to set aims for the product and when the productivity and quality are measured. The final level, level five is when the organisation is looking towards continuous process improvement by identifying the process weaknesses and strengthening it before any problems arises.

### Evaluation phase

The evaluation phase refers to the time of conducting the

evaluation. It can either be predictive (ex-ante) evaluations or post-implementation (ex-post) evaluations. Predictive (ex-ante) evaluations are normally conducted prior to IT investment, while post-implementation (ex-post) evaluations are conducted after IT implementation (Salleh, 2007). All the three models can be used to evaluate the readiness level prior to IT investment or after adopting it. The VERDICT model however, was designed to assess the readiness level not only for companies that are currently adopting IT into their work practise but also for those who have yet to use the technology.

### People involved

The people involved in the assessment comprise those who are closely related to the purpose of developing the model. Evaluations using the BEACON model will involve clients, consultants, contractors, sub-contractors and
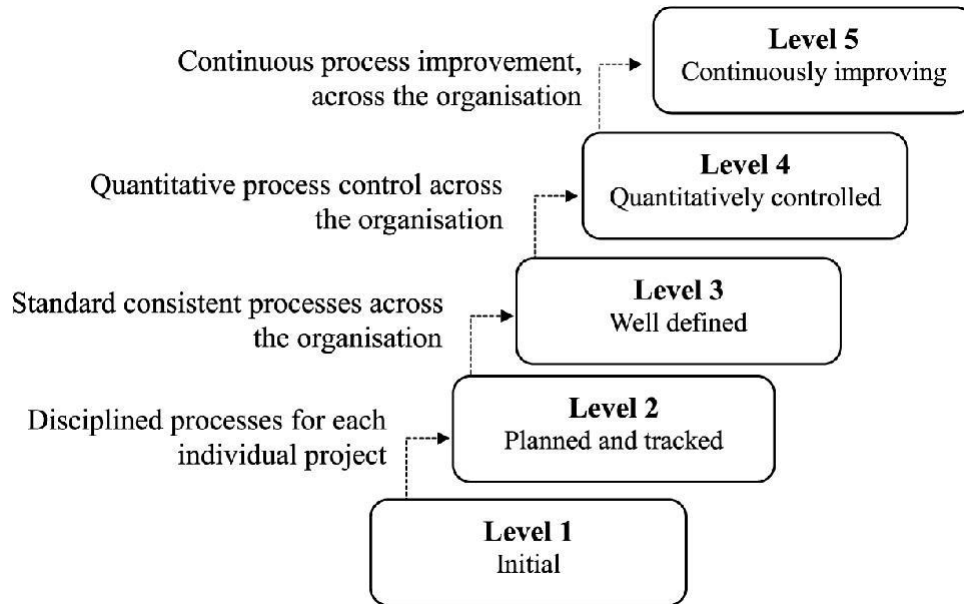
**Figure 2.** SPICE framework (Sarshar et al., 1998).

material suppliers as the model was designed to assess the readiness level for concurrent engineering in construction. VERDICT model on the other hand was specifically designed to evaluate the readiness level of the end user of construction organisations, thus the evaluation will include consultants, contractors and project managers (Ruikar et al., 2006). Organisations that are directly involved in construction industry such as contractors, architects, engineers, suppliers, etc will be chosen to participate in the evaluation of the SPICE FM model as information from them are required in identifying their current maturity level.

**Methods of assessment**

A model-based questionnaire (called the BEACON Questionnaire) has been developed for use in assessing construction organisations such that the elements covered in this model would be assessed using this questionnaire (Khalfan et al., 2001). To evaluate the readiness level using VERDICT model, a form of web-based questionnaire had been developed. Several methods were used in collecting data to evaluate the readiness level using the SPICE FM model. The methods involves SPICE FM questionnaire, interviews and analysis of archival records and documentation

**Strengths**

Several strengths of the BEACON model had been identified. The main strength would be that the model is

specifically designed to fit the requirement of the construction industry supply chain which comprise of four main elements of the concurrent engineering. Results from the assessments clearly identify aspects that require improvements. Beside these, the model also provides guideline for effective implementation of concurrent engineering. The survey and assessment could be carried out either in the form of structured interviews or alternatively, an electronic version of the questionnaire could be completed by remote respondents (Khalfan et al., 2001). On top of that, the model can be use to assess the level of readiness of the four elements involve in the organisation even if the organisation have no intention to implement concurrent engineering.

The strong point of the VERDICT model is that it is applicable to assess the readiness level of construction companies, departments within a company, or even individual work groups within a department. Moreover, the traffic light indicator used in this model highlights the organisation strengths and weaknesses, clearly indicating areas that need improvement. On top of that, the using of radar diagram to plot scores on each category gives a visual representation of their readiness level compared to the best-of-breed in construction (Figure 3). In conclusion, areas that need improvement can easily be identified by using the VERDICT model.

Among the benefits identified when adopting the SPICE FM model is that its' usage had been found to create strong platforms to discuss improvements, which is due to its' ability to indentify process strengths and weaknesses. In addition, the maturity concept applied in this model gives a clear guideline for the organisation in identifying ways of improvements
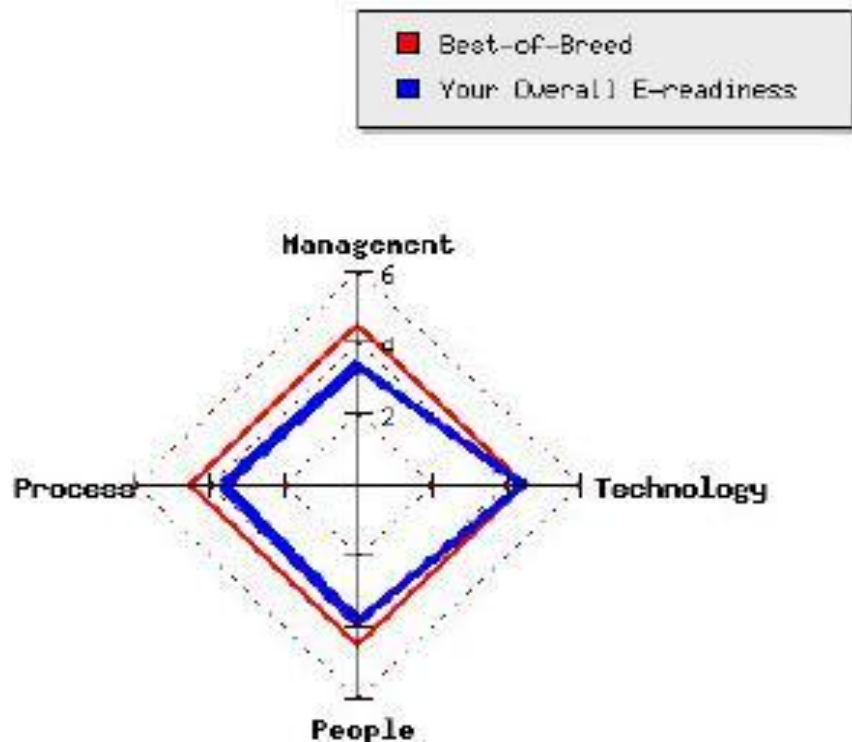
4

**Figure 3.** Radar Diagram Illustrating Overall Readiness of Respondent's Company as Compared to Best-of-Breed

## Weaknesses

Weaknesses of the BEACON model is hard to find as it is considered well developed. However, as the BEACON model was developed almost a decade ago (2001), updating it with the current technology is necessary, in order to be aligned with current industry needs. The main drawback of the VERDICT model on the other hand, is it does not indicate ways of improvement. Expert advice on how readiness can be achieved is therefore essential in producing a comprehensive model. Several weaknesses of the SPICE FM model include that the model is only applicable for design process, construction and maintenance procedures, excluding finance or marketing aspects. As such, modification of the model is necessary to differentiate FM and construction. Moreover, the terminology used in the SPICE FM questionnaire might create confusion among the participants.

## DISCUSSION

Steward and Mohamed (2003), found that compared to other industries, the construction industry is still lagging behind in achieving comparable rates of IT implementation. Many factors contribute to this situation. One of it might be due to the limited number of readiness model developed to be used in the construction industry.

Despite the numerous readiness models develop over the years, only three readiness models were found to be specifically designed for use in the construction industry (Table 1). All the three models described in this paper have unique assessment criteria as well as different assessment methods. These models were developed for specific purposes in finding the intended results. Each of the models has their own advantages and disadvantages, therefore re-designing are crucial in producing comprehensive models. Four aspects were assessed in VERDICT and BEACON models, while thirteen aspects were assessed in SPICE FM. All of these models evaluate the hard and soft issue aspects. Assessing more than one element in the models is deemed to generate less efficient result in identifying the current level of readiness. This is due to the fact that the developer needs to concentrate on all the highlighted elements, thus some important issues may be overlooked. An appropriate model that only addresses a specific element is necessary for the construction industry to evaluate their readiness level. The author believes that it is necessary to develop a model that focuses on the 'soft issues' aspects as it is one of the factors that contribute towards the successful implementation of IT.

Lou and Alshawi (2009) stated that IT failures are more related to the organisational "soft issues", rather than the technical aspects. Rojas and Locsin (2007), Ruikar et al. (2005), and Davis and Songer (2008) also support the

5

**Table 1.** Comparison of IT Construction readiness Model

| Readiness model | Developer / Year | Purpose | Aspect covered | Strength | Weakness |
|---|---|---|---|---|---|
| VERDICT | Ruikar, 2004 | measuring the e-readiness of construction sector end-users | Management<br>Process<br>People<br>Technology | Applicable to assess the e-readiness of construction companies, department(s) within a company, or even individual work groups within a department<br>Show a clear result on the organisation strengths and weaknesses<br>Identifying areas that need improvement | Does not provide guidelines for improvement |
| BEACON | Khalfan, 2001 | assesses readiness of construction companies to improve project delivery processes through implementation of concurrent engineering | Process<br>People<br>Project<br>Technology | Specifically focused on construction supply chain<br>identify aspects of its project delivery process that require improvements<br>provide guideline for effective implementation of concurrent engineering | Need to be update to meet the industry needs as well as the recent technology |
| SPICE | University of Salford, UK, 1998 | evaluate the key construction processes within a construction organisation | Brief Management<br>Project Planning<br>Project Tracking and Monitoring<br>Contract Management<br>Quality Assurance<br>Project Change Management<br>Risk Management<br>Organisation Process Focus<br>Organisation Process Definition<br>Training Programme<br>Inter-disciplinary Co-ordination<br>Peer Review<br>Technology Management | The framework identifies process strength and weaknesses<br>Create strong platforms to discuss improvements<br>Give clear guideline in identifying ways of improvements | The models only can apply for design process, construction and maintenance procedures; finance or marketing aspects are not included<br>Some participants are confused with the terminology used in the questionnaire<br>Modification needed to apply the model in construction industry to<br>differentiate FM and construction |

idea that cultural (people) issues are a major barrier to IT implementation in the AEC industry. Far too little attention had been paid to the soft issue which motivate the author to develop a model specifically designed for this particular issue.

## CONCLUSION

With rapid development of the technology, all industries including construction industry are fighting to find the best possible ways to exploit the power of IT for development. Despite the high investment rate for the technology, the failure rate is still increasing. Therefore, being e-ready is a must to fully utilise the technology. Identifying their readiness level is crucial to be aligned with the latest technology. Several readiness models have been developed in an attempt to reduce the failure rates. However, only three models were found to be developed for the construction industry and each of the models was developed for different purposes. Hence, this paper compares existing readiness models developed for the construction industry highlighting their differences. Findings from this study are believed to broaden the area of readiness research in construction industry thus creating awareness among the construction industry players on the importance of assessing the readiness level in organisation to successfully implement IT.

## Future research

The wide aspects covered in the current readiness models in construction industry suggest to the author that some important factors might be left behind. Therefore, developing a new readiness model specifically designed for the construction industry focusing on the soft issue is the author's main intention. The model will be in a form of maturity model that will be able to identify the current readiness level of people involve in construction industry and suggesting ways of improvements in order to maximise the full benefit of IT. The development of the model will involved extensive literature reviews and expert opinion and will further validate through pilot study and case studies.

## REFERENCES

Amaratunga D, Sarshar M, Baldry D (2002). Process improvement in facilities Management: The SPICE approach. Bus. Proc. Manag. J., 8(4): 318 - 337.

Bartis E, Mitev N (2008). A multiple narrative approach to information systems failure: A successful system that failed. Eur. J. Info. Syst., pp. 112-124.

Beig L, Montazer GM, Ghavamifar A (2007). Adoption a proper tool for e-readiness assessment in developing countries (case studies: Iran, Turkey and Malaysia). J. Know. Econ. Know. Manag., 2: 54-69.

Budhiraja R, Sachdeva S (2002). E-Readiness Assessment. Paper presented at the International Conference on Building Effective E-Governance.

Dada D (2006). E-readiness for developing countries: moving the focus from the environment to meet the user. Elect. J. Info. Syst. Dev. Countries. 27(6): 1-14.

Davis KA, Songer AD (2008). Resistance to IT change in the AEC industry: An individual assessment tool.

Finnemore M, Sarshar M (2000). Standardised Process Improvement for Construction Enterprises (SPICE). Salford, UK: University of Salfordo.

Gaith FH, Khalim AR, Ismail A (2009). Usage of Information Technology in construction firms; Malaysian construction industry. Eur. J. Sci. Res., 28(3): 412-421

Khalfan MMA, Anumba CJ, Carrillo PM (2001). Development of a readiness assessment model for concurrent engineering in construction. Benchmark. Int. J., 8(3): 223 - 239.

Lou ECW, Alshawi M (2009). Critical success factors for e-tendering implementation in construction collaborative environments: people and process issues. J. Info. Technol. Constr., 14: 98.

Nitithamyong P, Skibniewski MJ (2006). Success/failure factors and performance measures of web-based construction project management systems: professionals' viewpoint. J. Constr. Eng. Manag., 132(1): 80-87.

Rojas EM, Locsin S (2007). Integrated practice: The road ahead, 2007 ASCE Construction Research Congress, Freeport, Bahamas.

Ruikar K, Anumba CJ, Carrillo PM (2006). VERDICT--An e-readiness assessment application for construction companies. Auto. Const., 15(1): 98-110.

Salleh H (2007). Measuring organisational readiness prior to IT/IS investment. University of Salford, Salford, United Kingdom.

Stewart RA, Mohamed S, Daet R (2002). Strategic implementation of IT/IS projects in construction: a case study. Auto. Constr., 11(6): 681-694.