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Al-Yahya, Moath; Skitmore, Martin; Bridge, Adrian; Nepal, Madhav P.; Cattell, David

Published in:
International Journal of Procurement Management

DOI:
10.1504/IJPM.2018.094356

Licence:
Other

E-TENDERING READINESS IN CONSTRUCTION: AN A PRIORI MODEL

Authors and Biographical Statements

Eng. Moath Al-Yahya

Moath Al-Yahya is a PhD candidate at the School of Civil Engineering and the Built Environment, QUT (Queensland University of Technology) Brisbane, Australia and sponsored student by Ministry of Education, Saudi Arabia.

Prof. Martin Skitmore

Visiting Professor, Faculty of Computing, Engineering and the Built Environment, Birmingham City University, Birmingham, UK.

A/Prof. Adrian Bridge

Associate Professor in Project Management, Science and Engineering Faculty, QUT, Brisbane, Australia.

Dr. Madhav Nepal

Lecturer in Science and Engineering Faculty, QUT, Brisbane, Australia.

Dr. David Cattell

BSc(QS)[Wits] PhD [UCT], Founder & CEO of Auticus.

ABSTRACT

Purpose

To develop a conceptual model to assess the e-Tendering readiness in any construction organisation prior to implementation.

Design/methodology/approach

This involves a review of previous e-Tendering models, the importance of e-Tendering models for the construction industry and the requirements for developing e-TRMs.

Findings

A model contains five themes: People, Process, Work Environment, Technology and Service Providers. The e-TRM themes consist of thirteen constructs representing the basic items for e-Tendering readiness.

Research limitations/implications

Ultimately, the e-TRM can be used worldwide; however, the model needs to be tested empirically for verification.

Practical implications

To update previous IT/IS models by developing the themes that partially contribute to the research literature on traditional and electronic tendering and the body of knowledge in the construction industry.

Originality/value

The Service Providers theme with its constructs (communication, market and technical) is proposed for the first time as a necessary support for successful e-Tendering implementation.

Keywords

E-Tendering, e-Procurement

Paper type

Conceptual paper

1. INTRODUCTION

The purpose of this paper is to describe the development of the e-Tendering Readiness Model (e-TRM). This includes the e-Tendering general models, the importance of having one specific model for the field, and what is required to develop this model. A conceptual model and hypotheses are proposed based on a review of previous models in either e-Tendering, e-Procurement or e-Readiness. Thus, the e-TRM is developed as a measuring application and designed to facilitate organisational readiness to adopt e-Tendering, while promoting feedback about the status of the organisation.

Firstly, e-Tendering is a member of the e-Procurement family. E-Procurement involves a set of technologies such as e-Tendering, e-Auctions, e-Catalogue/Purchasing, e-Marketplace and e-Invoicing (Soar, Vaidya, Riquelme, and Gao (2004); the literature relating to e-Procurement often uses the term e-Tendering as default, which is defined by Betts et al. (2006) as the procurement process simply conducted online. Moreover, Ibem and Laryea (2015) believe that it is necessary to considered the access to Internet facilities as part of a core strategy of any organisation to promote e-Procurement use.

1.1 What are the benefits of e-Tendering?

E-Tendering can enhance tendering practice in many ways. For example, both the construction industry and government organisations agree that the traditional tendering process takes too much money and time, and the process would be much cheaper and faster if e-Tendering was used instead (Kajewski & Weippert, 2004). Cost and time would be saved and productivity would increase, along with an enhanced competitiveness and improvement in an organisation's market share opportunities (Lenin, 2011). Ibem and Laryea (2017) find the main benefits when using e-Tendering are reduction in transaction costs and turnaround time of the tendering process.

Trkman and McCormack (2010) posit that one of the main benefits of e-Procurement is an increase in the competitiveness, both financial and technical, of the tenderer's proposal. Additionally, contractors have benefited from the reduction in tender papers; hence, they are willing to profit from the significant time and cost savings in their e-Tendering work (McAllister & McClave, 2010).

Lavelle and Bardon (2009) identify five main benefits that can be gained from e-Tendering: less administration costs for paperwork; improved two-way communications between the parties (contractors and sub-contractors); faster response to enquiries; a lesser timeframe for the tendering life cycle; and help in analysing the tenders. Farzin and Nezhad (2010) also identify the benefits of e-Procurement in three main areas of construction: strategies, opportunities and operations. Research by Zhang and Yang (2011) also highlights a number of other benefits from using e-Tendering that can minimise collusion or make it more difficult for it to take place.

Also, establishing or improving the use of e-Tendering promises to allow construction organisations to update to best practice by exploiting the potentials of technology. As the move to e-Tendering use becomes a global norm, even though there is a slow

uptake in construction, e-Tendering users are benefiting from the savings in time and money, improvements in quality and performance, and increases in their competitive advantage. Tenderers who use traditional tendering miss opportunities through not keeping pace with new technology.

1.2 Why has construction been slow to adopt e-Tendering?

In the last decade, the use of e-Procurement has increased in construction procurement technologies; however, the construction sector has been slower to adopt it than the manufacturing and retailing sectors (Laryea & Ibem, 2014). This may be because the organisation is not ready to shift to electronic practice, or is not focused on post-adoption.

In the other hand, e-Procurement in the construction industry is more complicated than in other industries such as goods and services. The reasons for this become clearer when comparing the adoption of e-Procurement barriers and challenges in construction to the barriers in other industries (R. Eadie, Perera, & Heaney, 2011). The late implementation of IT/IS in the construction process is due to the construction industry itself having unique characteristics in terms of its product, complexity, size and location of projects (Aziz & Salleh, 2011). Finally, Lee, Seaw, and Ling (2014) find that the government level plays a key role in encouraging the industry stakeholders to switch to e-Tendering.

There are two possible reasons why the adoption of e-Tendering has been limited in the construction industry. Firstly**,** research into construction e-Tendering is not consistent, but varies according to whether it focuses on factors such as people, processes, work environments or technology. Moreover, as Robert Eadie, Perera, and Heaney (2012) reveal in their review, IT/IS research in general focuses on post-adoption. In support, Wendler (2012, p. 1317) states that "most publications deal with the development of maturity models and empirical studies*."* Wendler (2012) has conducted a systematic review of maturity models in Information Systems (IS), reflecting their development in each area of research. As an indicator, there were 89 software development/engineering models by 2012, due to the dissemination and success of maturity models emerging from the software industry.

On the other hand, there were 17 project management models, 10 construction process/engineering models, and 10 process management models, demonstrating the

impact of continuous research in the software development/engineering field. However, the construction industry is still failing to achieve comparable rates of IT use (Aziz & Salleh, 2011).

The second issue is the lack of an effective and specialised model or framework to assess the readiness for use of construction organisations' e-Tendering processes. As Aziz and Salleh (2011, p. 219) observe, "a commonly cited problem that exists with e-Readiness is the fact that there are many different types of measures available today and that there is no standardization of these measures."

None of these models and frameworks are suitable for assessing the readiness of a construction organisation to adopt e-Tendering since they do not cover the full range of construction tendering activities, are outdated, and are not designed for general e-Procurement purposes. Moreover, the other available e-Readiness models are also not suitable for construction use as they vary in their economic and social use, which makes them difficult to apply to construction procurement Aziz and Salleh (2011).

2. THE NEED FOR A CONSTRUCTION E-TENDERING READINESS MODEL

2.1 E-Tendering and implementation

There is a growing interest in e-Tendering and its models and frameworks (technical or functional), which tend to vary according to the different aspects of e-Tendering. However, the lack of clear guidelines leads to confusion, especially among those seeking to use e-Tendering. The e-Tendering guidelines for organisations cover the requirements for successful implementation. Vaidya, Sajeev, and Callender (2006) identify the five stages of implementation as initiation, adoption, acceptance, routinisation and infusion. All these stages cover the organisational aspects: people, process, work environment, technology and service providers. This raises the question of what exactly needs to be done to implement e-Tendering successfully. Therefore, there is a need for a structured framework to guide organisations towards e-Tendering implementation. Zunk, Marchner, Uitz, Lerch, and Schiele (2014) reveal that e-Tendering in construction has a low implementation rate compared to other industries. According to Tran, Huang, Liu, and Ekram (2011, p. 133), the main themes and factors that are viewed as challenges and obstacles when an organisation is implementing e-

procurement in construction are technology, management, organisation and the environment.

2.2 Assessment level

The e-Tendering processes used in construction projects are not smart enough to complete the full cycle of the e-Tendering process (Lenin (2011). While there is no specific e-Tendering readiness measure, it is hard to develop any Key Performance Indicators (KPIs) without benchmarks for the organisation's readiness for e-Tendering. Therefore, prior to implementing e-Procurement in general or e-Tendering in particular, Chen and Rankin (2006) advise setting benchmarks for the organisation. In general, the e-Readiness model makes an assessment at a particular moment in time with positive or negative results (Robert Eadie et al. (2012). However, as Eric Choen Wong Lou and Goulding (2010, p. 190) observe, "e-Readiness at the organisational level is still in its infancy" in the construction sector. Finally, the organisation must reach a required level of readiness to successfully integrate innovation into its work practices prior to investment (E. C. Lou, 2010).

2.3 Measuring e-Tendering readiness

Nowadays, organisations that consider partially or fully shifting to the digital world need to measure themselves prior this change (Rafferty, Jimmieson, & Armenakis, 2013). As Goulding and Lou (2013, p. 268) comment, "the term e-Readiness is coined to measure the degree to which an organisation may be ready, prepared, or willing to obtain benefits, which arises from the digital economy". Therefore, Eric Choen Weng Lou and Alshawi (2009, p. 107), in their study of critical success factors (CSFs) in implementing e-Tendering suggest further research into whether "organisations could adopt a 'measured approach' to help them be 'e-ready'." Finally, a measured approach helps organisations to increase their capability and results in a practical framework to ensure their e-Readiness prior to implementation.

2.4 Lack of specific Model

The literature review in this paper examines models that have been developed in relation to construction practice, including e-Readiness, e-Procurement and e-Tendering. The review reveals some deficiencies in e-Tendering readiness in the construction sector. One of the main shortcomings is the lack of a specific model to measure the readiness of construction organisations to adopt e-Tendering (Eric Choen

Weng Lou & Alshawi, 2009). Robert Eadie et al. (2012) review the available ICT models for construction that are hard to apply for several reasons. For instance, theoretical models not specifically for e-Tendering may lack important constructs, may cover e-Tendering only partially, or may be specific for certain countries. In addition, some previous studies focus more on e-Tendering tools or concepts such as process, people, systems, implementation, solution, cases studies, barriers, drivers or critical success factors (CSFs). Moreover, it is hard to apply any general model to estimate the readiness of e-Tendering for construction usage (Aziz & Salleh, 2011). Furthermore, organisations tend to focus on technology, which is no longer a barrier; human resources are the main factor influencing the successful implementation of e-Tendering, in terms of employee motivation, interest in IT, and attitude and prior experience within collaborative environments (Eric Choen Weng Lou & Alshawi, 2009). It is important to combine both academic and industrial practices for an organisation to be able to embrace IT/IS successfully; failure to do this has resulted in many investments in IT/IS failing to meet their intended business objectives over the past decade.

2.5 A specific model at the right stage

As e-Readiness comes first in the preparatory stage for any e-system, it is essential to focus at the beginning rather than jump to the later stages. As such, the primary objective of the e-TRM is to measure e-Tendering readiness for the construction organisations. It is also intended to improve the efficiency of e-Procurement in general, and particularly e-Tendering, as it plays a key role in e-Procurement. However, to achieve this objective, a well-developed model is required. For that, developing a specific model is the key to measuring the e-Tendering readiness of construction organisations. In addition, to develop a verified e-TRM for the construction industry, it is important to know where the organisation should start from, and what is required to be ready, especially for e-Tendering. The main aim of this paper is to develop a conceptual model to measure a construction organisation's readiness for implementing e-Tendering.

3. METHODOLOGY

Prior to designing the assessment items to be used in this model, existing items are considered. While there are many items for assessing e-Tendering, some items are

either not appropriate or need to be identified. This is because some of the available assessment items focus on IT/IS in construction organisations in general or on non-e-construction organisations' readiness for IT/IS. Therefore, representative samples of items are generated and developed, the area of constructs defined, further data is collected and refined, and the validity and reliability of the model assessed through the Delphi method.

In order to ensure the accuracy and validity of the items and the model, the model development procedure suggested by Fellows and Liu (2008) is followed. This involves specifying the objectives of the model, analysing the reality, specifying components of the model, verifying the model and validating the model. Therefore, representative samples of items are generated and developed, the area of constructs defined, further data is collected and refined, and the validity and reliability of the model assessed through the Delphi method. The importance of the Delphi technique is to obtain the most reliable consensus of the opinions of a group of experts, collected through a series of intensive questionnaires with controlled opinion feedback (Dalkey & Helmer, 1963).

Due to its importance, the model will be developed in the correct methodological manner to ensure that MacKenzie (2003) checkpoints are carefully followed to define the constructs of interest, which are; (a) specifying the construct's conceptual theme; (b) unambiguous terms; (c) in a manner that is consistent with prior research; and (d) clearly distinguishes it from related constructs.

4. ITEM DEVELOPMENT PROCESS

As suggested by Cronbach and Thorndike (1971), a measurement process is required to involve the field constructs and sample items. Here, the constructs and items are drawn mainly from the relevant literature, and this section gathers all the potential items and categorises them into suitable themes.

4.1 Pool of Literature Items

The items identified from the review of the literature include e-Tendering, e-Procurement, IT/IS in construction, e-Readiness, and change management domains, and are presented with their supporting references in the Table 1. Some studies suggest

many representative items for measuring particular constructs. These constructs fall into four themes: People, Process, Technology and Work Environment. In the literature, these items are either hypothesised or tested for a particular study, country or specific situation, but not for e-Tendering readiness in particular.

While the extant studies provide items for the measurement of the four themes (People, Process, Technology and Work Environment), there is a lack of research regarding a fifth theme, which this paper assumes is necessary for e-Tendering readiness, namely Service Provider. Some items are allocated from the literature and gathered under the Service Provider theme. Additionally, to identify measurement items for the e-Tendering readiness construct, items have been allocated from the literature review, especially from e-Readiness, e-Organisation readiness and the Change Management domain. All items have been identified and updated to fit measuring e-Tendering Readiness. Overall, the representative items to cover the five themes and the constructs are presented in the Appendix Table 3.

4.2 Self-developed items

The items are categorised accordingly to their theme and constructs. Additionally, the gathered sample items are assessed using the Delphi method. The importance of the Delphi technique is to get the most reliable consensus of the opinions of a group of experts, which were collected through a series of intensive questionnaires with controlled opinion feedback (Dalkey & Helmer, 1963).. Regarding the sample size, to attain statistical power and significant findings, Okoli and Pawlowski (2004, p. 5) say that "the Delphi group size does not depend on statistical power, but rather on group dynamics for arriving at a consensus among experts". Also, on construct validity, Okoli and Pawlowski (2004, p. 5) indicate that the "Delphi method can employ further construct validation by asking experts to validate the researcher's interpretation and categorisation of the variables". Consequently, during the Delphi process in this paper, the range of the items is reduced, and the experts review the correct items and constructs.

To apply the Delphi process in this paper, scholar engineers were asked in three rounds to evaluate and review generated items, constructs and themes from the literature review. The evaluation included making any necessary changes in order to eliminate repetitive, non-user-oriented and ambiguous items. This ensured that the final register

of items was cleared and confirmed, including compiling the final item register, clarifying, adding, replacing and deleting items.

This stage also helped to explore additional potential items, especially for the Service Provider theme, which had not been previously measured as a dimension of e-Tendering readiness in the literature. Table 3 lists the developed items for merging with the final items.

three evaluation rounds using the Delphi method, 102 items remained in the list. Six items are for the People Theme, 21 items for the Process theme, 30 items for the Work Environment theme, 16 items for Technology themes, 15 items for Service Provider themes and 6 items for the e-Tendering readiness theme**.**

5. MODEL THEMES AND CONSTRUCTS

This section aims to recategorize the e-Tendering items thematically to their potential construct. The literature review revealed several constructs, as listed in Table 5 in the Appendix. However, in this paper the constructs and their potential items were first code and then groups of items compared with their suitable constructs or relocated to more accurate constructs. Each construct was then allocated to a specific theme based on its meaning. This revealed the five potential themes with thirteen constructs. The themes comprise the following constructs: people [skill and staff]; process [practice and procurers]; technology [system and software and networking]; work environment [leadership, management, culture and structure]; and service provider [communication, market and technical]. Each of these themes and its constructs are discussed in the following sub-sections.

5.1 People

The people theme comprises two constructs; skill and staff. Although these constructs have less items gathered from the literature review, they are important items. The justification for selecting each of the people's constructs is further discussed in the next subsection. According to Goulding and Lou (2013, p. 268), "there are three critical elements that can significantly influence the level of ICT project integration, [one of them is the] people: the ability of employees to accept and adapt to the system".

5.1.1 Skill:

A person who is engaging with e-Tendering practice has to have the minimum required skills and procurement knowledge, verify these two items as important drivers, based on quantity surveyors' views. Also, Robert Eadie, Perera, Heaney, and Carlisle (2007) list lack of e-Procurement knowledge/skilled personnel as barriers related to personnel issues. Another issue arises when the relevant departments lack knowhow for e-Procurement, which could be considered as one of the barriers to implementation (Zunk et al., 2014).. To summarise, the following readiness hypothesis is therefore proposed:

H01: e-Tendering readiness requires the appropriate skills to carry the roles and responsibilities that are defined by the organisation.

5.1.2 Staff

In this case, human resources refers to the availability of adequate staff with sufficient experience in ICT and other skills that are necessary for the organisation's initiatives and projects (Tran et al., 2011). Hawking, Stein, Wyld, and Foster (2004) list a lack of qualified employees as one of the five main barriers to e-Procurement. Thus, Tran et al. (2011) suggest that staff confidence in using new technologies needs to be developed; Wirtz, Lütje, and Schierz (2009) point out that lack of self-confidence is risky when using a new system. Also, staff turnover has been confirmed as one of the barriers in cross-disciplinary construction organisations by Robert Eadie, Srinath Perera, and George Heaney (2010a). The importance of having the right environment is expressed in the following readiness hypothesis:

H02: e-Tendering readiness requires the organisation to have established the necessary supports and confidence among staff.

5.2 Process

The process theme consists of two critical constructs of practice and procurers. This theme with its constructs covers how an organisation needs to implement IT successfully, especially in terms of legal processes, data transactions and confidentiality. According to Alshawi (2007), the success of IT implementation is highly related to the ability of the organisation to absorb and integrate the proposed systems into the current practice. The following subsections detail these two constructs.

5.2.1 Practice

Electronic practice in construction has legal aspects. Betts et al. (2006) indicates that careful consideration of legal aspects is needed in the implementation of an e-Tendering system. This issue remains a barrier to adopting e-Tendering in large-scale use. confirms that legal and regulatory infrastructures are significant factors for the implementation of e-Procurement.

In the literature review, several legal issues were identified. Examples of these items in e-Tendering include the legal position, different national legal approaches, pertinent case law, availability of an effective regulation system, clarity of tenderers' and tenderee information, the legality of electronic signatures, and enforceability of electronic contracts. These factors are serious issues that should be considered carefully and solved perfectly. Finally, the practice construct includes the nature of the project, electronic format, complexity, gathering information, and reassembling data flow. The need to have the right process for practice is expressed in the following readiness hypothesis:

H03: The practice in the theme of Process significantly influences the organisation's level of readiness to implement e-Tendering.

5.2.2 Procurers

Adoption of e-Procurement can imply greater scalability for the business process in larger organisations (Abu-Elsamen, Chakraborty, & Warren, 2010). Since the tendering Request for Proposal (RFP) begins with massive tender documents up to the time the tender is awarded, a well-organised process leads to success. Ajam, Alshawi, and Mezher (2010) state that the key problematic elements that affect the construction tendering process are communication, integration, management and authority. Most of the items allocated to the procurer's construct are obtained from these four key themes. Zunk et al. (2014, p. 19) state that e-Procurement is "a good way to reduce complexity in the purchasing process and helps to reduce costs caused by the purchasing department and thus has to be seen as an operational measure which needs a strategic decision." The need to have the correct procedure is expressed in the following readiness hypothesis:

H04: The procurers in the theme of Process influence, significantly affect the organisation's level of readiness to implement e-Tendering.

5.3 Work Environment

The work environment theme is the largest theme in terms of constructs and item numbers. It has thirty items, divided into four constructs, namely: leadership, management, culture and structure. This theme is critical, as it has become the basis of decisional and financial support. Also, organisational behaviours and structures are often strongly influenced by the demands of players on whom the organisations depend for resources or rules (Doherty, McConnell, & Ellis-Chadwick, 2013). Moreover, to create the right organisational culture and structures, the appropriate environment infrastructure (Obalde, 2004) is needed. The following subsections outline the theme's constructs.

5.3.1 Leadership

Leadership's commitment to e-Tendering is recognised as a fundamental component of an organisation's readiness to adopt e-Tendering. In the construction sector, leadership is identified as the top enabler for successful e-Procurement implementation (Goulding & Lou, 2013). According to Stewart, Mohamed, and Marosszeky (2004), the involvement of leadership in IT implementation occurs at three levels: industrial, organisational, and project levels. However, the focus is on industrial and project levels. Stewart et al. (2014) also found that lack of IT leadership on the project level is one of the most significant barriers to e-Tendering implementation.

Additionally, Alshawi and Salleh (2011) list leadership as one of three constructs under the work environment theme. They also developed six maturity levels of leadership, highlighting the lack of consistency in the improvement of IT/IS activities management.

Further, the construction sectors' leadership readiness for e-Tendering can be examined using a number of associated items. An example of leadership items is the commitment of top management, which Gunasekaran and Ngai (2008) link to successful strategic alliances in e-Procurement implementation. Other items are effective leadership, clear vision and objectives, flexible organisation, law and policy, forum to exchange ideas, quantifiable indicators of success, and awareness of corruption issues. Therefore, another hypothesis for readiness to adopt e-Tendering and leadership is proposed as follows:

H05: *Leadership in the work environment, particularly concerning the organisation's level of readiness to implement e-Tendering.*

5.3.2 Management

Firstly, within the work environment theme, nine e-Tendering items are identified and sorted in terms of their construct, management. The objective of including the management construct is to ensure that management is aware of their current practice, of the need for changes in management and ICT assessment before the adoption of e-Tendering, including financial requirements. Any failure in these areas could mean that implementation of e-Tendering is unsuccessful. It is necessary to ensure that management oversee the completion of e-Tendering implementation, and they have the authority to support the project team for decisions and help them financially.

Importantly, Alshawi (2007, p. xv) states that "the system can only achieve their intended business objectives if they are fully integrated into the organisation's current work practice and are accepted and supported by both employees and management." A study conducted by Zunk et al. (2014) shows that involvement of the organisation's management is beneficial during e-Procurement implementation. The benefits include: a) reduced complexity in the procurement process; b) improved collaboration with their suppliers; and c) the possibility of reducing process costs. Therefore, management plays a major role in maintaining the organisation's goals by implementing the right changes, management plans and awareness, and complying with budgeting. The need to have the right work environment through the management construct is expressed in the following hypothesis:

H06: *The management in the theme of work environment significantly influences the organisation's level of readiness to implement e-Tendering.*

5.3.3 Culture

Another construct in the work environment theme that may influence the adoption and implementation of the e-Tendering system is the organisational culture. The culture construct has a variety of items, including and not limited to bureaucracy, national IT policy, publicity and cross-organisational culture. Hawking et al. (2004) suggest considering the issue of culture, especially in organisations that are at the stage of investigating e-Procurement solutions. Additionally, Doherty et al. (2013) argue that the success of an e-Procurement initiative is dependent on having an appropriate organisational culture. The need to have the right work environment through an appropriate organisational culture is expressed in the following readiness hypothesis:

H07: *Culture in the theme of work environment influences, significantly, an organisation's level of readiness to implement e-Tendering.*

5.3.4 Structure

Within the organisation, the hierarchical structure plays a major role in the successful adoption of e-Procurement, which involves different organisational departments (Tai, 2013). However, Eric Choen Weng Lou and Alshawi (2009) highlight that cross-disciplinary communication is one of the barriers to adoption of e-Tendering. Tran et al. (2011, p. 136) point out that "most of the businesses in developing countries tend to have a highly centralised structure. This suggests that the perception of the managers about their organisation, innovation, and their environment is likely to be critical in adopting e-Commerce." The need to have the right work environment within the structure is expressed in the following readiness hypothesis:

H08: *In the theme of working environment, the structure construct has a significant influence on the organisation's level of readiness to implement e-Tendering.*

5.4 Technology

Technology is the second largest theme in terms of the number of items. This theme has been used in most e-Readiness, e-Procurement and ICT construction models. The items are categorised into the system and software construct and the networking construct. With the advancement of technology, the items involved are continuously being updated. Therefore, the hardware items are a part of the infrastructure under the networking construct.

5.4.1 System and Software

The systems and software construct includes integration, implementation, architecture, and compatibility. Each item has a different effect on the success of adoption of an e-Tendering system. For example, a company may implement world-class e-Tendering software but fail to integrate it into the existing organisational system because of implementing it in an ad hoc manner. Therefore, related items should be gathered from the literature review to be tested and associated carefully to be fully aware of the level of an organisation's readiness before the implementation process commences.

Importantly, systems or software may take the form of a package of systems or a single complete system to deliver a complete e-Tendering cycle. Laryea and Ibem (2014) conducted a systematic review of construction procurement activities and associated

the systems with their use, as shown in Table 1. A review of systems is necessary because readiness should be determined first.

Whatever e-Tendering system/software an organisation selects should be determined by its level of e-Readiness. If an organisation has a prominent level of e-Tendering readiness, especially in terms of systems and software, they can easily adopt an advanced solution. A single complex system/software that serves the whole organisation is referred to as All-in-One, while a couple of systems that work together to serve the whole organisation are called Best-of-All. To sum up, the higher the level of the organisation's readiness to adopt e-Tendering in terms of systems and software, the better.

Although the selection of the most appropriate software for e-Tendering is very important for an organisation, it is not the main reason for unsuccessful implementation. Eric Choen Weng Lou and Alshawi (2009, p. 99) state that "the main reasons for the high percentage of systems failure are rarely purely technical in origin." The fact that having the right technology increases an organisation's readiness level leads to the next readiness hypothesis:

H09*: An organisation's readiness level to implement e-Tendering may be significantly affected by systems and software requirements.*

5.4.2 Networking

One of the most reliable network measures is the Network Readiness Index (NRI), which is designed and produced by World Economic Forum and their partners. NRI is designed by Baller, Dutta, and Lanvin (2016) to measure readiness at the country level. The NRI measure covers four main areas, namely environment sub index, readiness sub index, usage sub index, and impact sub index. The focus here is the readiness sub-index, which stands on three pillars: infrastructure, affordability and skills. Only infrastructure is considered, with four indicators, two of which are related to internet access and internet security.

It is important to establish and facilitate networking while evaluating the level of e-Tendering readiness (Goulding & Lou, 2013) and the identified factors in the networking construct play a major role in shaping organisational readiness for successful e-Tendering implementation.. This leads to the next readiness hypothesis, which is proposed as follows:

***H10**: An organisation's level of readiness to implement e-Tendering may be significantly affected by the extent of networking within the organisation.*

5.5 Service Provider

When service providers have a collaborative environment, successful implementation is enabled (Eric Choen Weng Lou & Alshawi, 2009). In addition, Vaidya et al. (2006) relate successful e-Procurement implementation to early supplier involvement. Here, it is assumed that the service providers affect the successful implementation of e-Tendering in the construction sector. In the past, the service provider has not been included as a major theme or construct in any readiness measure in construction IT/IS. However, for e-Tendering in particular, it is argued that service provider as a theme and its associated items should be included in the readiness assessment.

Since the service provider theme has not been previously measured as a dimension of e-Tendering readiness in literature, the items contained in the theme are discussed in the self-development section. However, some potential items drawn from previous studies and others derived from the Delphi method are also added to the final representative items.

Service providers include contractors, suppliers, project managers and engineering officers. Some studies refer to them as external environments, which seems to be a general terminology rather than a specific one. The service provider theme and its potential constructs and items were first introduced by Eric Choen Weng Lou and Alshawi (2009) as a characteristics for CSFs for the implementation of collaborative environments for construction industry. The International Organisation for Standardisation (ISO) has also used this terminology [ISO 10845-6:2011(en)], especially when detailing the relationship between construction procurement and contractors.

Since the literature does not include the service provider construct, it is important to include constructs and their potential items in the proposed model. Additionally, the model will be assessed for its structural and measurement fitness to validate the model in general and the service provider theme with its proposed constructs in particular. The three proposed constructs of the service provider theme are discussed and described in the following subsections.

5.5.1 Communication

Communication among the tender stakeholders is one of the new hypothesised constructs for measuring the level of e-Tendering readiness in the construction sector. Several items have been identified and allocated or reallocated to this construct. They include the need to have personal contacts, which are beneficial for long-term relationships with customers, and to increase the learning curve of using new system technologies (Rankin, Chen, & Christian, 2006).

According to Teo, Lin, and Lai (2009), there is a need for e-Procurement to cooperate and coordinate with tender partners to reach its full potential. Communication helps to establish professional relationships with enterprises that provide e-Tendering solutions.

Through the Delphi method, it is established that the involvement of engineering or design officers in the e-Tendering process is an important item for this construct. The reason is that queries from the tenderees require expert answers during the bidding process. Most of the responses come from the engineering office. Therefore, failure to involve the design office in the e-Tendering system could slow the process down or make it more complex. The important service providers' communication construct is expressed in the readiness hypothesis below:

H11: *Construction organisation level of readiness to implement e-Tendering would likely be significantly affected by the organisation's external communication.*

5.5.2 Market

Taking the risk of adopting a new system is one of the main concerns for an organisation, especially when the required investment has intangible returns. Many organisations have an issue with assessing the suitability of e-Procurement, so they opt for a 'wait and see' approach (Huber, Sweeney, & Smyth, 2004).

Zou and Seo (2006) mention that market demand for tenderers is another reason to implement e-Procurement. Also, many empirical studies have identified competitive pressure from the market as a driver for ICT (Huber et al., 2004). Consequently, in this construct, pressure from competitors is added as another measuring item because demand (the vertical relationship) and competitiveness (the horizontal relationship) play key roles in the adoption of e-Tendering.

In addition to the market construct items, tenderee failure to win tenders is a result of lack of basic confidence in the existing infrastructure (Robert Eadie et al., 2010a) and is therefore included in the e-Tendering service provider theme. Robert Eadie, Srinath Perera, and George Heaney (2010b) combine a number of items using a Delphi process to include the "lack of a widely accepted e-Procurement software solution" as an e-Procurement item.

A reduction in local companies is another allocated item that has been confirmed by Zhang and Yang (2011) and Purchase and Dooley (2010); fewer local companies could be a barrier to the adoption of an e-Tendering system, because the involvement of national or foreign companies in the process could be costly. Some governments have many restrictions pertaining to the construction industry, which may hamper the adoption of an e-Tendering system.

Interestingly, Hawking et al. (2004) describe the availability of regulatory frameworks in e-Procurement as good, arguing that they improves compliance with the contract. On the other hand, regulatory frameworks are classified as an external barrier for implementation of an e-Tendering system (Wirtz et al., 2009). Robert Eadie et al. (2007) also rank the legal position of e-Procurement as the main barrier to the implementation of e-Procurement. Therefore, regarding the importance of service providers' market construct, the following readiness hypothesis is proposed:

H12: *High perceived pressure from the service providers' market to construction organisations has an impact on e-Tendering readiness.*

5.5.3 Technical

The ability of the tender shareholders to interact within one tendering system is a challenging issue (Rankin et al., 2006). Nowadays, the term "platform" is used to mean a shared technical platform between tender parties to exchange documents (Chen & Rankin, 2006).

In previous studies, little attention is paid to involving subcontractors and suppliers as successful e-Tendering enablers. Tran et al. (2011) state that the failure of tenderers to share tender data with trading collaborates may hinder the adoption of an e-Tendering system. Figure 1 illustrates the importance of involving subcontractors and suppliers in the implementation of e-Tendering.

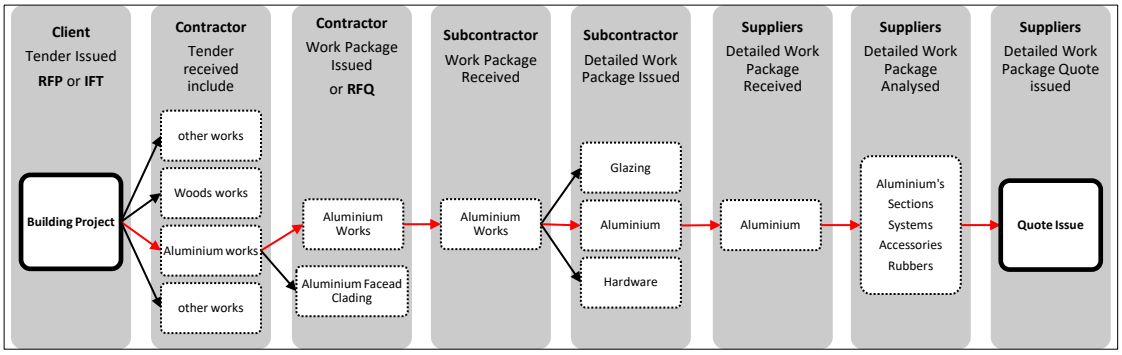

Figure .1 Example of basic process for Request for Quotation (RFQ)

Moreover, the involvement of contractors or suppliers is insufficient. Wirtz et al. (2009) argue that contractors or suppliers should have a minimum standard of technical experience. It is necessary for each of the construction industry's e-Tendering participants to have minimum technical knowhow in order to engage positively within the technical public infrastructure. Another technical issue that affects an organisation's readiness to adopt e-Tendering is poor standards for information exchange among the tender partners (Eric Choen Weng Lou & Alshawi, 2009).

Nowadays, Building Information Modelling (BIM) is one of the leading technologies and its use is increasing, including the tendering function. In addition, the impact of the BIM adoption and implementation process within the organisation is minor if is considered by the organisation while e-Tendering is being implemented. Moreover, the effect is limited within the workflows and developing roles and tasks of the staff involved with BIM (Poirier, Staub-French, & Forgues, 2015). Smith and Tardif (2009) emphasise the importance of having BIM for a successful adoption of an e-Tendering system:

> The full benefits of BIM will be realised only after most of the industry has made the transition from current technology and business practices because the design, construction, operation and on-going maintenance of every building is accomplished by a broad network of people and organisations who need to work together to exchange information in a coordinated fashion. (Smith & Tardif, 2009, p. 57)

On the other hand, it is argued that providing training for all users of the e-Tendering system is crucial. For instance, a certain international company working in a collaborative environment has introduced a smart model for their systems training. They develop a cloud platform to carry out different levels of training with regard to their system. In such a case, the company's stakeholders can pay a small amount of

money to be trained and be certified at different qualification levels. Through this certification, the participants and the service providers will be more confident with the training, training fees and the nature of the system, and at the same time will be able to minimise risks.

Here, four items are developed, as explained earlier, and added to the technical construct: a) tenderer, tenderee, subcontractors and suppliers have symmetry of technical readiness; b) tenderer, tenderee, subcontractors and suppliers have BIM experience; c) training services for e-Tendering systems for the tenderee; and d) inclusion of the training procedures in the contract. With regard to the service providers' technical construct, the following readiness hypothesis is proposed:

H12: *Service Providers' technical maturity within the construction industry is positively related to the perceived readiness for e-Tendering adoption.*

5.6 E-Tendering Readiness

According to Weiner (2009, p. 5), "greater readiness leads to more successful change implementation". On the e-Tendering themes and all their constructs, People, Process, Work Environment, Technology and Service Providers, e-Tendering readiness is the main objective for organisations to achieve. A couple of items have been identified as measures of e-Tendering readiness level through the review of the literature on organisational change, change management, e-Readiness and e-Commerce. The construct of e-Tendering readiness will be examined under several items: staff resistance to change (Rafferty et al., 2013), Proof of intent (Ajzen, 1991; Clark, Cavanaugh, Brown, & Sambamurthy, 1997), the need for change (Armenakis, Harris, & Mossholder, 1993), organisational support for change in the form of resources and information (Armenakis & Harris, 2002), and change supportive work group and positive work group attitudes towards group readiness for change (Rafferty et al., 2013). Each item is briefly described below:

- **Proof of intent.** According to (Clark et al., 1997, p. 439), "changes require the commitment of key stakeholders affected by the change". Furthermore, the authors specify that the key stakeholders for organisational change are not just the managers, professionals or clients but also include subordinate staff. Ajzen (1991) supports individual intention to be applied in the process of change, arguing that perceived behavioural intention can be used directly to predict behavioural achievement. Organisational and individual proof of

intention can be used to assess the organisation's level of readiness to adopt e-Tendering.

- **The change is needed.** Armenakis et al. (1993, p. 681) identify two beliefs as key components of readiness for a change, one of which is "the change is needed". In this paper, this key item is used to measure the e-Tendering readiness, as "The need to adopt e-Tendering".
- **Cooperation with the tenderee improved trading partner relationships**. This enhances trust through increased sharing of information (Iacovou, Benbasat, & Dexter, 1995).
- **Have a business relationship with companies providing system solutions.** Gist (1987) mentioned that the information regarding the change can provide an indirect learning opportunity, which, if the information is generated by one or more external resources to the organisation, can be considered to be more effective and believable.
- **Service providers are to accept the idea of change from the workgroup.** Change-supportive behaviour leads to positive attitudes toward readiness for change (Rafferty et al., 2013).
- **Contractors or suppliers should have minimum technical experience.** **A**ssessing the organisation's business partners such as customers and suppliers allows business to be conducted electronically (Molla & Licker, 2005).

Importantly, an organisation can assess its current readiness level to alert the organisation's decision makers prior to implementation. This practice could help the organisation identify any potential risks that could occur, to avoid time wastage and comply with the allocated budget and resources during implementation.

To conclude this subsection, an explanation of the five main themes and their thirteen constructs, together with their items and the e-Tendering readiness construct, is summarised in the Table 1. These constructs and their items are used later to develop and verify the e-Tendering readiness model for construction organisations, which acts as a measure of the organisations' readiness to implement e-Tendering.

5.7 Items list

To summarise, Table 1 shows a final list of all the verified items, constructs and themes.

Table.1 Final list of items with their themes and constructs

Theme	Construct	Item Name
People	**Skill**	Skilled staff (technical expertise)
		e-Tendering knowledge for staff
	Staff	Adequate resources
		Staff turnover
		Development of confidence to use new technologies
		Risk-oriented attitude of staff when using e-Tendering
Process	**Practice**	The legal position of e-Tendering
		Different national approaches to e-Tendering law
		Pertinent case law
		Availability of effective regulation system
		Clarity of tenderer information law
		Clarity of tenderee information law
		Clarity of supplier information law
		Legality of electronic signatures
		Enforceability of electronic contracts
		Accepting that the construction tendering is complex
		One-off project feature (organisation has only one project)
		Electronic format not enough for construction work specifications
		Reassembly process of data transmitted
		Locating tendering information
	Procurers	Security of the process
		Data transmission to the wrong person
		Unauthorised viewing
		Confidentiality of information
		Prevention of tampering with documents
		Electronic bid evaluation
		BIM is part of tender document
Work Environment	**Leadership**	Effective leadership
		Top or strategic management commitment for e-Tendering
		Flexibility of organisation's laws and systems
		Forum to exchange ideas
		Clear vision and objectives
		Widely accepted e-Tendering system solution
		Company policy
		Not top priority of the company
		Quantifiable indicators of success for e-Tendering (such as KPI)
		Awareness that e-Tendering leads to corruption
	Management	No business benefits realised
		Satisfied with current practices
		Organisational magnitude of changing management
		Fear of change to a new system
		Insufficient assessment of new system before implementation
		Cost of IT investment (all costs)
		e-Tendering systems cost (includes system licences)
		e-Tendering implementation cost
		Insufficient financial support
	Cultural	Bureaucratic dysfunctions
		National IT policy relating to e-Tendering issues
		Publicity about e-Tendering

		Awareness of best practice solutions
		Different organisational cultures (industry wide)
		Organisational (company) culture
	Structure	Complex organisational hierarchical structure
		Organisational hierarchical structure doesn't support IT implementation
		Cross-disciplinary communication
		Tendering process standardisation
		Quantifiable e-Tendering contribution to the Return On Investment (ROI)
Technology	**System and Software**	External interoperability (integration) of e-Tendering system
		IT systems (e-Tendering excluded) have been implemented in an ad hoc manner
		Investment in incompatible systems
		Internal interoperability (integration) concerns
		Challenge to find an affordable technical solution
		Technical standardisation issues
		Compatibility issues
		System knowledge (immaturity of technology)
		Inadequate knowledge in implementing an e-Tendering system
		Linking e-Tendering system with ERP system
		Difficulty of implementing e-Tendering system
		Interoperability (integration) with current communication systems
	Networking	Company access to the Internet
		Security concerns
		Poor IT infrastructure
		Do not have IT infrastructure for e-Tendering (software, hardware, support and network)
Service Provider	**Communication**	Need for personal contact
		Cooperation with tenderee and subcontractors or suppliers
		Involvement of design office
		Have business relationship with companies providing e-Tendering solutions
	Market	A "wait-and-see" attitude among companies
		Demand from tenderer
		Pressure from competitors
		Reduced number of local companies (national or international companies became targeted)
		Regulatory framework within public procurement
	Technical	Tenderer, tenderee, subcontractors and suppliers have symmetry of technical readiness
		Tenderer and supplier have BIM experience
		Data sharing with subcontractor or supplier partners
		Contractors or suppliers should have minimum technical experience
		Technical infrastructure within the construction industry
		Poor industry standards for information interchange
		Training services for e-Tendering system from tenderee to tenderer
		Include training procedures for e-Tendering system in contract
		Shared technical platform between tender parties to exchange document
e-Tendering Readiness		Proof of intent
		The need for e-Tendering
		Contractors or suppliers should have minimum technical experience
		Cooperation with the tenderee and subcontractors or suppliers
		Accepting the idea of e-Tendering from contractors or suppliers
		Having a business relationship with companies providing e-Tendering solutions

6. DISCUSSION

6.1 A Priori Model

It is clear from the review of e-Readiness, e-Tendering and IT/IS models that no specific model can assess an organisations' readiness to adopt e-Tendering. As Aziz and Salleh (2011, p. 220) conclude in their review of the available general IT/IS readiness models (all focusing on e-Society and e-Economy):

> Two models were found to be suitable for the construction industry, which are; Technology Readiness Index (TRI) and Network Readiness Index (NRI). It is believed that the construction industry may benefit from the adoption of these two models/tools in helping them assess two different elements involved in construction industry. (Aziz & Salleh, 2011).

As a result, none of the readiness models fulfil this paper's objective in the construction context.

Therefore, to create a workable model, it is posited that the development of the model should align with the organisation clusters. In addition, the model is developed under the organisation and procurement umbrella to ensure full consideration and integration of all aspects that affect the implementation of e-Tendering frameworks as seen in Figure 2.

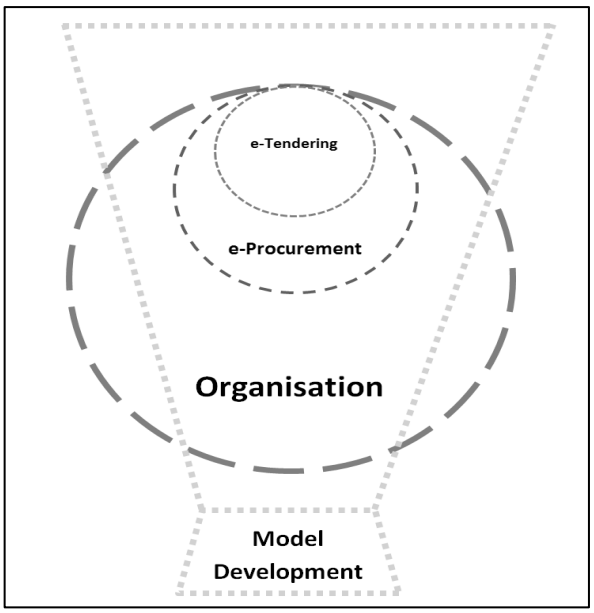

Figure .2 Model Development Inclusion

Such a model will strengthen the communication and processes within the organisation as well as ensuring that integrated research development continues.

Accordingly, there is a need for a start-up model, as suggested by MacKenzie (2003) to align the current research with prior research. Firstly, this will ensure that the model taps into the benefits of previous research and any constructive comments made about the selected model. Secondly, the model could benefit from a general IT/IS readiness model to cover e-Business (Organisation) and e-Procurement clusters initially. According to Matavire and Brown (2008, p. 140), "researchers may start with a pre-conceived a priori theory, then go on to collect empirical data."

The General Practitioner Information System (GPIS) model is selected as a kick-start model. The GPIS model is initially hypothesised by (Saleh & Alshawi, 2005). The model has had minor modifications and updates by Alshawi (2007), followed by an updated version by (Alshawi & Salleh, 2011; Salleh, Alshawi, Sabli, Zolkafli, & Judi, 2011). The variants of this model have the same themes (elements), some shared constructs (attributes) and more importantly, it deals with IT/IS readiness, maturity, or both in construction organisations.

The GPIS authors, Saleh and Alshawi (2005), assumed that the model's users needed to assess the organisation's readiness in terms of each of the four key themes' constructs, then compare the assessment results to the description of the equivalent constructs of the model, in order to identify the level of readiness of the organisation.

However, some issues need to be considered when developing a model to measure an organisation's readiness to adopt e-Tendering:

Any organisation, especially in the construction sector, mainly communicates with parties outside the organisation electronically. These external parties (service providers) are part of the organisational process in a way and should, therefore, be involved in the e-Tendering model development process. Previous studies do not include them as a major theme (element) or even construct (attribute). Thus, Saleh and Alshawi (2005) readiness model is a holistic model for construction organisations, which the GPIS model assumed would cover IT/IS without focusing on e-Tendering or e-Procurement in general.

When developing an e-Tendering model, it is advisable to start with a readiness model that measures the organisation's ability to implement the system before adopting it. Maturity assessment then follows the development of an e-Tendering model. Tetlay and John (2009, p. 5) define maturity assessment as an evaluation of "when [an

organisation has] achieved a defined and implemented system." The GPIS model combines readiness and maturity.

The development of IT/IS is an ongoing process, so the next IT/IS generation will undertake the Cloud approach. Therefore, what Saleh and Alshawi (2005) and Aziz and Salleh (2011) proposed cannot be applied today. However, the proposed model shall not rely on technology as much as the organisation's capability.

6.2 Features of the A Priori model

Based on the above refined items, hypothesised constructs, proposed themes, and review of models and findings, some conditions have been identified which need to be incorporated into the new theoretical model. They include:

1. The model is intended to be used before e-Tendering implementation.
2. The model is to provide a certain status for an organisation with regard to their e-Tendering readiness while interacting with other organisational areas that have authority in e-Tendering.
3. The model is holistic in coverage and specific in assessment. It focuses on issues related to e-Tendering, which embrace all the key organisational themes such as people, process, technology, work environment and service providers, throughout the departments and stakeholders. In other words, the model is not isolated within the procurement department; rather, it is applicable wherever e-Tendering decisions need to be made.
4. The model is specific for e-Tendering readiness in the construction sector. Therefore, a specific model leads to accurate assessment, which provides organisations with a relevant assessment of their e-Tendering readiness.

6.3 The A Priori model (e-TRM)

In this section, the e-TRM puzzle will be solved by fitting all identified items, constructs, themes, relationship and kick-off models. Also, (Saleh & Alshawi, 2005; Salleh et al., 2011) models will be constructively modified and developed to fit the paper's aim and avoid the highlighted shortcomings. The following updates summarise the applied changes in e-TRM based on the previous models:

- **People Theme:** The IT/IS constructs is divided into People and Technology themes' constructs. The reset constructs are still the same as Saleh and Alshawi (2005), which are Skill and Staff.
- **Process Theme:** the Practice construct is kept as Saleh and Alshawi (2005) proposed, while the Business Process construct is replaced with the Procedures construct.
- **Technology Theme:** the IT/IS Infrastructure Theme is renamed Technology. The System and Communication construct is also replaced with System and Software. Additionally, a networking construct is added.
- **Work Environment Theme:** the Management Culture and Structure construct is added to the theme, from which IT Department and Organisational Behaviour are withdrawn. The Work Environment Theme's constructs become much closer to what Saleh and Alshawi (2005) had in the initial model.
- **Service Provider Theme:** A fifth theme, which includes contractors, subcontractors, suppliers, the engineering office and project management, is proposed. Additionally, the Communication, Market and Technical constructs are added to the Service Provider Theme.

However, the main aim of the themes (elements) is to code, not to measure. Therefore, to make this theoretical model reflect reality and the experiment, the **Error! Reference source not found.**3 shows the final conceptual model which comprises the five themes and their constructs (13 constructs), which can assess pre-determined e-Tendering readiness. The 13 theoretical constructs represent the basic items of the proposed model. Each construct of the proposed model comprises a number of associated items that were carefully selected as explained in detail earlier in this paper.

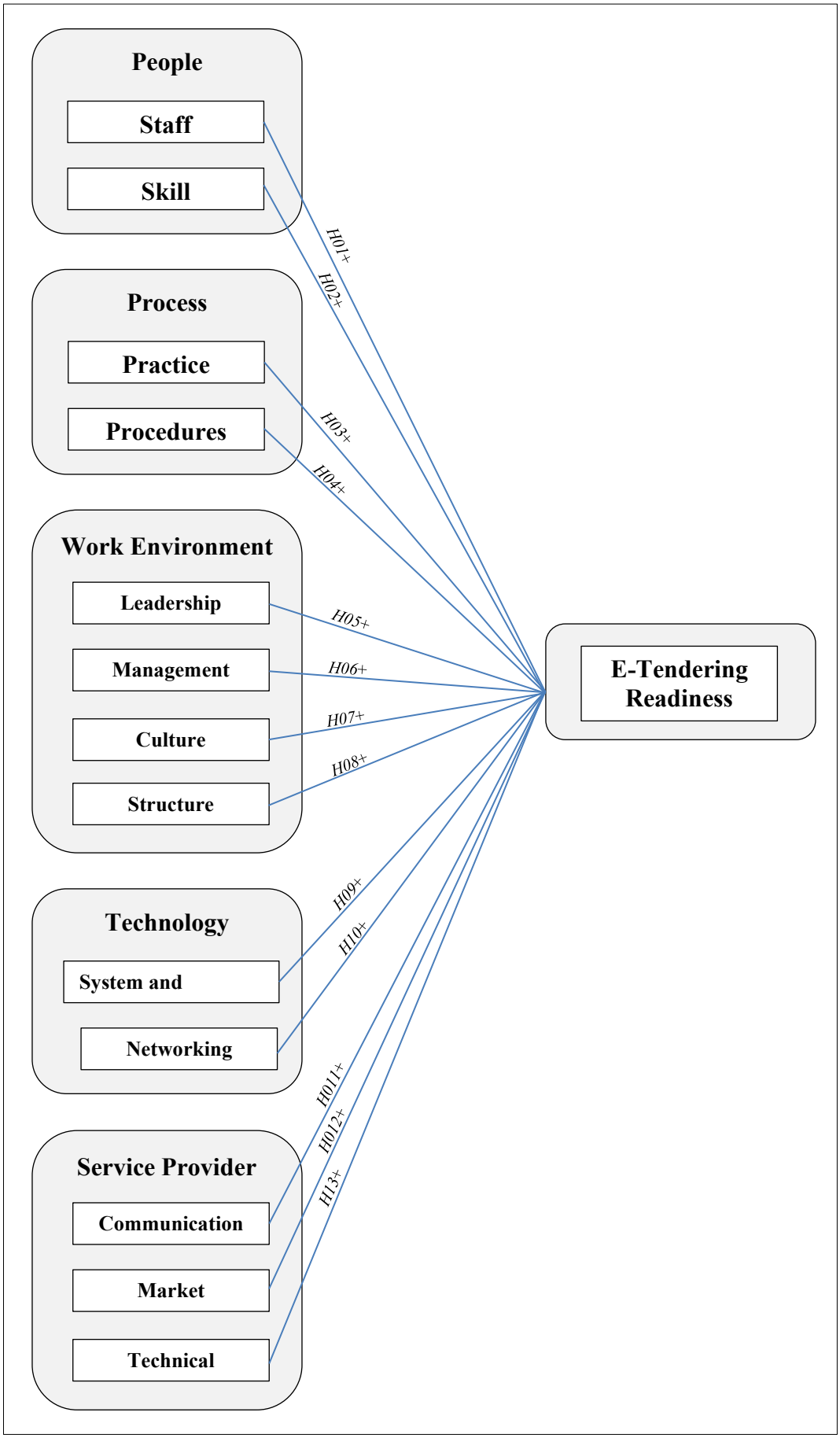
People
Staff
Skill
Process
Practice
Procedures
Work Environment
Leadership
Management
Culture
Structure
Technology
System and
Networking
Service Provider
Communication
Market
Technical
E-Tendering Readiness
H01+
H02+
H03+
H04+
H05+
H06+
H07+
H08+
H09+
H10+
H011+
H012+
H13+

Figure .3 Final theoretical e-TRM

The following figure demonstrates visually the process undertaken to arrive at the conceptual e-TRM.

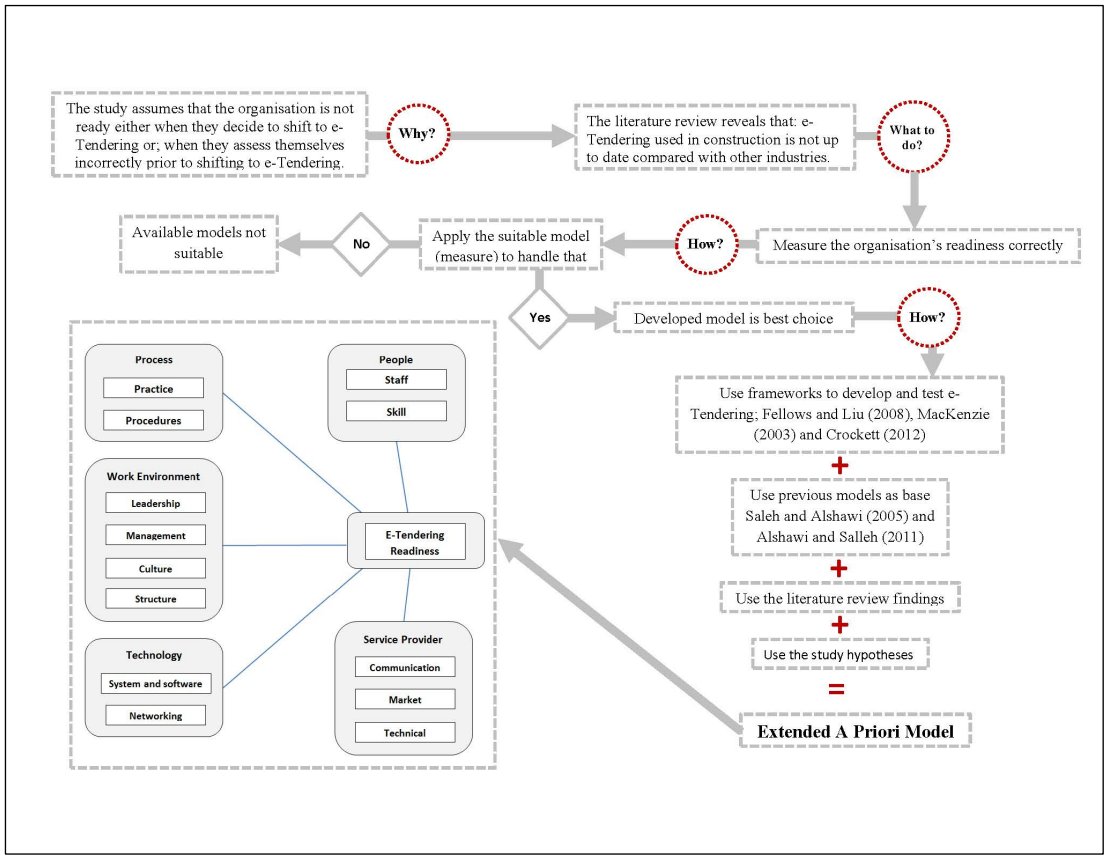

Figure .4 Overall road map to develop the e-TRM

7. CONCLUSION

The purpose of this paper is to develop a conceptual model using a scientific method to achieve its objectives. The first objective is to explore the current level of e-Tendering readiness in construction organisations. Secondly, to build a theoretical model to assist in the e-Tendering readiness in any construction organisation's e-Tendering implementation. Finally, to update the previous IT/IS models by constructively improving and empirically testing the themes that partially contribute to the traditional and electronic tendering research literature in the construction industry and body of knowledge.

The paper provides an overview of the need for an e-Tendering readiness model in the construction sector. Potential items and constructs are carefully identified and coded, followed by development of an e-TRM towards the final conceptual e-TRM that

consists of thirteen constructs with proposed readiness criteria. The e-TRM can contribute to the body of knowledge by updating previous IT/IS models through developing the themes that partially contribute to traditional and electronic tendering in the construction industry. Moreover, industry businesses can use the model to assess themselves prior to implementation. However, although the e-TRM can ultimately be used worldwide, it needs to be tested empirically for verification of the model and posteriori e-TRM. At this stage, the e-TRM can be used theoretically worldwide, as it has not yet been customised for any context.

8. LIMITATION AND FURTHER RESEARCH

The main limitation of this paper is the lack of empirical support of the conceptual model for validation. That can be conducted by further research using the identified items into questionnaire survey and testing the relationship, correlation and significance between the 13 constructs and e-Tendering readiness.

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Appendix

Table.2 Sample Items for e-Tendering

Sample Items for e-Tendering	Supporting References
Skilled staff (technical expertise); knowledge for staff; adequate resources; staff turnover; staff resistance to change; development of confidence to use new technologies; risk-oriented attitude of staff when using the new system; the legal position of e-tendering; different national approaches to e-tendering law; pertinent case law; availability of an effective regulation system; proof of intent; clarity of tenderer, tenderee and supplier information law; legality of electronic signatures; enforceability of electronic contracts; accepting that the construction tendering is complex; one-off project feature; electronic format not enough for construction work specifications; reassembly process of data transmitted; locating tendering information; security of the process; data transmission to the wrong person; unauthorised viewing; confidentiality of information; prevention of tampering with documents; electronic bid evaluation; Building Information Modelling (BIM) is part of tender document; effective leadership; top or strategic management commitment for e-Tendering; flexibility of the organisation's law and system; forum to exchange ideas; clear vision and objectives; widely accepted e-Tendering system solution; company policy; not top priority of the company; quantifiable indicators of success for e-Tendering; awareness of e-Tendering leading to corruption; no business benefit realised; satisfied with current practices; the need for e-Tendering; organisational magnitude of changing management; fear of change to a new system; insufficient assessment of the new system prior to implementation; cost of IT investment; e-Tendering system cost; e-Tendering implementation cost; insufficient financial support; bureaucratic dysfunction; national IT policy relating to e-Tendering issues; publicity about e-Tendering; awareness of best practice solutions; different organisations' culture; organisational culture; complex organisation hierarchical structure; organisation's hierarchical structure does not support IT implementation; cross-disciplinary communication; tendering process standardisation; quantifiable e-Tendering contribution to the return on investment (ROI); external interoperability (integration) of e-Tendering system; IT systems (e-Tendering excluded) have been implemented in an ad hoc manner; investment in incompatible systems; internal interoperability (integration) concerns; challenge to find an affordable technical solution; technical standardisation issues; compatibility issues; system knowledge (immaturity of technology); inadequate knowledge in implementing an e-Tendering system; linking e-Tendering system with enterprise resource planning (ERP) system; difficulty of implementing e-Tendering system; interoperability (integration) with current communication systems; company access to the Internet; security concerns; poor IT infrastructure; do not have IT infrastructure for e-Tendering; need for personal contact; cooperation with tenderee and subcontractors or suppliers; a "wait-and-see" attitude among companies; data sharing with subcontractor or supplier partners; demand from tenderer; pressure from competitors; accepting the idea of e-Tendering from contractors or suppliers; contractors or suppliers should have minimum technical experience; technical infrastructure within the construction industry; reduced local companies; having business relationship with companies providing e-Tendering solutions; poor	(Rankin et al., 2006); (Robert Eadie et al., 2010b); (Tran et al., 2011); (Gunasekaran & Ngai, 2008); (Wirtz et al., 2009) (Eric Choen Weng Lou & Alshawi, 2009); (Robert Eadie et al., 2007); (Purchase & Dooley, 2010; Stewart et al., 2004); (Zhang & Yang, 2011)

industry standards for information interchange; regulatory framework within public procurement; ability to interface with customers' systems.	

Table.3 Self-developed items

Items	Supporting References
Tenderers, tenderee, subcontractors and suppliers have symmetry of technical readiness; Tenderers and supplier have BIM experience; Involvement of design office; Training services for e-Tendering system from tenderee to tenderers; Include training procedures for e-Tendering system in the contract.	Items developed by this study using the Delphi method

Table.4 Possible identified construct

Constructs	Supportive References
Assessment costs; capacity building; communication; compatibility; connectivity; cost; change management; culture; decision making; document management; efficiency; empowerment; general; knowledge sharing; cultural staff; infrastructure; information access; learning; legal; leadership; management; management of information; market; maturity; operation; organisation; performance; policy; practice; procurers; promotion; security; society; skill; staff; structure; supply chain; system architecture; trial of new technologies; technology investments; technology transfer; technical; time; training;	(Abraham, Fuentes, & Abraham, 2004); (Robert Eadie et al., 2007); (R. Eadie, S. Perera, & G. Heaney, 2010); (Goulding & Lou, 2013): (Gunasekaran & Ngai, 2008); (Jaafar, Abdul Aziz, Ramayah, & Saad, 2007); (Eric Choen Weng Lou & Alshawi, 2009); (Purchase & Dooley, 2010); (Rafferty et al., 2013); (Tran et al., 2011); (Wirtz et al., 2009); (Eric Choen Weng Lou & Alshawi, 2009); (Stewart et al., 2004)