



**Assessing e-tendering readiness of construction industry in Egypt:
A conceptual assessment model**

Master thesis

**International Master of Science in Construction and Real Estate Management
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Conceptual formulation



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Conceptual Formulation

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Topic: Assessing e-tendering readiness of construction industry in Egypt

1. Introduction to research

Construction projects shall remain the major force driving world economies. In the UK for instance, the industry represents 10% of total GDP (Keane & Caletka, 2008). It is forecasted that by the year 2030 construction industry shall represent 57% of global growth with a total expected output of USD 15.5 trillion worldwide. Furthermore, there seems a change in trend towards economies driven by services, therefore we shall see the expansion in the education and health care facilities and other social infrastructure (PWC, n.d.). Despite the negative outlook, and the industry's medium to high risks in countries across Europe, Middle East, and North Africa, a recent report by Euler Herms strongly suggested that emerging markets shall lead the growth with an output slightly below USD 7 trillion, and seeing high market potentials in housing construction (Hermes, 2017).

In any construction project lifecycle, tendering is deemed the most critical activity as the nature of contractual obligations and legal framework is defined between different participants of any project (Lou & Alshawi, 2009). Regardless to the project delivery method of choice, governmental procurement procedure came under criticism as an inefficient, non-transparent, time consuming and costly process (Khalil & Waly, 2015). Realizing that, following a pattern of incorporating interactive methods into existing delivery methods (Austroads, 2014), and also to improve the overall management of contracts, governments in MENA region are showing interest in e-Procurement programs as part of an overall e-Government scheme. Egypt, for instance has initiated a two stage e-government program (Gebba & Zakaria, 2015), and has taken steps to introduce electronic means in public procurement since 2010 (OECD, 2016).



e-Procurement which is designed to fundamentally transforming the delivery and performance of public administration, is defined as the exchange of supplies, works and services via electronic means, Electronic Data Interchange (EDI) or Enterprise Resource Planning (ERP) (EUROPEAN COMMISSION, 2010). The term entails publishing paperless call for tenders on the internet along with digital project documents and specifications, followed by receiving tenders in the same means, allowing efficiency in managing procedure and awarding contracts (Beauvallet, Boughzala, & Assar, 2011). It is also concluded from resources that functions of e-procurement (e-sourcing, e-tendering and web based ERP) can already support the traditional construction procurement activities (Interagency Procurement Working Group (IAPWG), 2012). Additionally, Benefits of e-Procurement can be seen in the improvement of overall management of contracts (EUROPEAN COMMISSION, 2010), promoting the values of transparency, reducing corruption (Warnes, 2011; EU, 2005), reduction of procurement cost (BAUSÀ PERIS, et al., 2013; Zou & Seo, 2006), supporting the screening process to disqualify inadequate contractors and identify and evaluate new suppliers (McIntosh & Sloan, 2001).

Governments, however, seem struggling with the Implementation of the program. In addition to the fragmented nature of the construction industry (Rankin, Chen, & Christian, 2006), technical, human and, legal and security barriers are preventing the uptake (Khalil & Waly, 2015). Main barriers of the implementation can be summarized as follows:

- Security concern: Security of document transmittal (Khalil & Waly, 2015; Eadie, Perera, & Heaney, 2010; Eadie, Perera, Heaney, & Carlisle, 2007) , confidentiality of information (Eadie, Perera, & Heaney, 2010).
- Human factors: Resistance to change, the lack of strong initiative (Khalil & Waly, 2015; Issa, Flood, & Caglasin, 2003), reluctance to invest (Eadie, Perera, & Heaney, 2010), the current level of transparency in the construction industry (Weng Lou & Alshawi, 2009), followed by the lack of enthusiasm support of the top management (Isikdag, Underwood, Ezcan, & Arslan, 2011).
- Legal challenges: The unclear legal standing of e-Procurement transmittal (Khalil & Waly, 2015; Issa, Flood, & Caglasin, 2003; Eadie, Perera, Heaney, & Carlisle, 2007; Isikdag, Underwood, Ezcan, & Arslan, 2011)
- Accessibility issues: The lack of training, experience, and sharing of knowledge (Zou & Seo, 2006; Eadie, Perera, Heaney, & Carlisle, Drivers and barriers to public sector e-Procurement within northern Ireland's construction industry, 2007; Weng Lou & Alshawi, 2009; Khalil & Waly, 2015) and concerns over compatibility and interoperability (Eadie, Perera, Heaney, &

Carlisle, 2007; Weng Lou & Alshawi, 2009; Khalil & Waly, 2015), the lack of enthusiasm for technology (Zou & Seo, 2006), the absence of strong initiative (Issa, Flood, & Caglasin, 2003) and tools designed for the industry (Issa, Flood, & Caglasin, 2003).

However, BAUSÀ PERIS, et al., 2013, EU, 2005, McIntosh & Sloan, 2001 and other researchers seem to agree that it remains the role of governments to introduce and facilitate e-Government programs. Perhaps this could address barriers on the levels of security, human factors and legality of the process. Furthermore, Larya and Ibem have established that there is a trend of utilizing innovation into the six (6) procurement activities identified by both Watermeyer (2004) and the ISO 10845 (2010), a trend that started in the seventies of the previous decade and continuing up till present day, suggesting that many technological innovations supporting e-procurement are already in use (Laryea & Ibem, 2014).

Numerous MENA countries seemed to have actually adapted partial e-procurement practices in the form of e-soliciting, allowing registered contractors to purchase tenders documents online (author). It seems that data are also indicating that current uptake of ICT in MENA region is expanding. Data from that region are showing the average use of internet is even above the world average. Countries like Qatar, United Arab Emirates and Saudi Arabia are on par European countries in shares of internet use. Broadband penetration, on the other hand, is on the raising trend (Murphy & Roser, 2017). Evidently, it seems that technology is no longer a formidable barrier, people, however, remain so (Lou & Alshawi, 2009). This raises the question of contractors' readiness to a full implementation of e-Procurement mandated by government agencies. As researchers Azziz and Salleh (2011) indicated that is imperative to assess the readiness of organization prior to the implementation IT technologies (Aziz & Salleh, 2011), consequently, it seem logical to think that assessment of market / contractors / service providers readiness (e-readiness) of a implementation is even more important, should any government consider the implementation of ICT into their procurement procedures.

Azziz and Salleh (2011) in their review of literature in regard found various definition of the term e-readiness, most interestingly ¹; e-readiness is the assessment of how a country, or an economy is capable and prepared to implement the information and communication technology (ICT); and the

¹ to Author

capacity of [existing] ICT to adapt to advancements in both social and economic aspects (Aziz & Salleh, 2011). It is quite interesting to see the apparent conflict in both definitions as the first seems to measure societies and economies readiness to ICT, and the other seems to measure the ICT capacity to respond to advancement of societies. However, Azziz and Salleh, 2011 conclusion seem to be in agreement with the first definition that e-readiness is *“to measure the capability to adopt IT/IS prior to its implementation”* (Aziz & Salleh, 2011, p. 216). Lou and Goulding, 2010, define E-readiness as the measure of how an organization is ready to and willing to gain advantages of the digital economy which requires any organization to implement IT into operations, aligning business and e-readiness strategies (Lou & Goulding, 2010).

The need to assess readiness, or e-readiness, necessitated the developing on e-readiness measuring models. In the presence of numerous assessment models, and to determine most suitable models for use to assess readability of construction industry for the implementation of e-Procurement, Aziz and Salleh (2011) analyzed 10 of the most commonly used models worldwide and determined that Technology Readiness Index (TRI) and Network Readiness Index (NRI) are probably the most suitable (Aziz & Salleh, 2011). NRI seems to evaluate the readiness on society level (macro assessment) by evaluating 10 different pillars² classified into 4 sub-indexes covering environment, readiness, usage and impact (World Economic Forum, 2016). The following tabulation provides an overview of standing of several economies worldwide

Rank	Economy	Value
1	Singapore	6.0
2	Finland	6.0
3	Sweden	5.8
5	United States	5.8
8	United Kingdom	5.7
15	Germany	5.6
26	United Arab Emirates	5.3
27	Qatar	5.2
28	Bahrain	5.1
33	Saudi Arabia	4.8
96	Egypt	3.7

Table 1: Network Readiness Index for several economies (NRI) (World Economic Forum, 2016)

² Those are; Political and Regulatory environment, Business and Innovation, Infrastructure and digital contents, Affordability, Skill, Individual usage, Business usage, Government usage, Economic impacts and finally, Social impacts.



On organization level (micro level), the General Practitioner Information System (GPIS) conceived by Saleh and Alshawi in 2005 to pre-assess the readiness of any organization for the implementation in 4 major elements, namely People, Process, IT and Environment, comparing them to description of the attributes. GPIS also allowed the evaluation of maturity of implementation and ranked them in six levels, therefore, helping in identifying maturity gap (Al-Yahya, Skitmore, Bridge, Nepal, & Cattell, 2017). A more recent study of the Saudi market, Al-Yahya et. al aimed to develop a priori model to measure the readiness of the Saudi construction industry to adopt e-Procurement proposed the utilize the General Practitioner Information System (GPIS) as a base for model further development and proposed introducing a fifth element³ to the original hypotheses designated as "Service Provider Theme" aiming to assess suppliers' capacity for the collaborative environment (Al-Yahya, Skitmore, Bridge, Nepal, & Cattell, 2017). This research, however, intended to focus on building construction contracts awarded to general contractor, it is safe to assume that the general contractor is the service provider. Therefore, the fifth element introduced by Al-Yahya et. al, 2017 may not bear importance to this study.

2. Research problem

World economic forum's NRI ranked Egypt's society e-readiness at 96, but both Laryea & Ibem, 2014 have indicated the technical innovations, particularly those supporting e-procurement have been - for decades - finding their place in the construction industry (Laryea & Ibem, 2014). This research aims to

- Establish an overall assessment of registered contractors' e-readiness, utilizing e-readiness assessment model.
- Determining the barriers of the uptake within the selected pool of contractors.
- Proposing recommendations for bridging existing digital divide existing among the pool of contractors.
- Proposing recommendations for the implementation of e-Tendering based on findings of the research

³ Or theme, as referred to by Al-Yahya et. al

3. Methodology

Tools to determine e-readiness have their own strengths and weakness. Modifications of such tools are always required to compile a model that suites any industry, including construction (Aziz & Salleh, 2011)). To assess contractors' readiness for e-tendering (soliciting and evaluation) implemented and facilitated by government agencies, the research shall be based on literature review to setup definitions, framework and a model for testing. A quantitative research targeting classified contractor involved in government construction projects shall be conducted and analyzed and compared to other studies to make the conclusion pertaining to research problem.

4. Supervisors



Markus Krämer, Prof. Dr.-Ing.

Signature of the Supervisor

Dieter Bunte, Prof. Dr.-Ing.

Signature of the Supervisor

Forward

Due to continuous consultation with the first supervisor, Professor Krämer, and due to the time constraints and the limited scope of the master thesis in general, it was agreed to change the research methodology and tasks according to description in the introductory chapter of this thesis. Research task changes are reflected in the following tabulation;

Conceptual formulation research tasks	Final Thesis research tasks
Establish an overall assessment of registered contractors' e-readiness, utilizing e-readiness assessment model.	Build an assessment model suitable for the construction industry to be used within the constrains assumed by the research.
Determining the barriers of the uptake within the selected pool of contractors.	Validating the assessment model with literature review
Proposing recommendations for bridging existing digital divide existing among the pool of contractors.	Validating the assessment model expert interview
Proposing recommendations for the implementation of e-Tendering based on findings of the research	Propose a methodology to implement the proposed assessment model

Abstract

Realizing the importance and benefits of e-Commerce, many EC and EU directives have set a time frame and deadlines for the implementation e-Procurement within the EU Countries (EU, 2005; Bausà Peris, et al., 2013). Starting from 2018, it became mandatory for all federal project in Germany to use e-Tendering platform (Personal Communicaton, 2018). Construction industry is a major sector in economies (Keane & Caletka, 2008; Hermes, 2017), and may benefits from the adaptation and adoption of e-Procurement as the current procurement and tendering practices within the industry are bureaucratic, ineffective, non-transparent, costly (Khalil & Waly, 2015) and information and paper intensive (Weng Lou & Alshawi, 2009). Adoption of the e-procurement is said to help revolutionize the construction industry and bring it to the information age (McIntosh & Sloan, 2001).

Construction industry, however, has been slow in the uptake of technology. Characteristics of the industry, namely the fragmented nature, the pragmatism, the lack of leadership, the absence of standard in technology and business models, and resistance to change have denied the construction industry the benefits of e-Business (Rankin, et al., 2006). Evidently, there is a need to assess the readiness of any construction organization prior to adoption of ICT projects to avoid the consequence of sub-optimal implementation, or even the total failure and abandonment of the project (Salleh, et al., 2010). A failure that is mainly attributed to the soft issues (Salleh, et al., 2010; Weng Lou & Alshawi, 2009), and therefore, gauging readiness of people and technology before the implementation of the technology is deemed extremely important (Salleh, et al., 2010).

In Egypt, the effort of the government implementing to implement a e-Procurement starting in 2010 (OECD, 2016) had been facing challenges mounted by the same soft issues identified in researches (OECD, 2013). Therefore, this research aims to developing a conceptual assessment model based on similar models, the drivers and the barriers of the adoption of e-Procurement in the construction industry for the pre evaluation of the industry prior to the implementation of the technology project. Assessment model is developed for evaluation of Egyptian construction industry readiness for the uptake of future e-Procurement.

Following the development and validation of the assessment model, a methodology for applying the assessment model based on the EFQM process is proposed. Research shall also reflect on the possible measures to improve e-Readiness of construction organizations. Finally, the research is concluding with recommendations for future research.

Keywords: Egypt, Construction industry, Procurement, Tendering, e-Procurement, e-Tendering, ICT, GPIS, eTRM, EFQM, Assessment Model

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List of abbreviations

GDP: Gross Domestic Product

OECD: Organization for Economic Co-operation and Development

MENA: Middle-East and North Africa

e-Procurement: Electronic procurement

EDI: Electronic Data Interchange

ERP: Enterprise Resource Planning

ICT: Information and communication technology

RFP: Request for proposal

AEC: Architectural, Engineering and Construction

TRI: Technology Readiness Index

NRI: Networked Readiness Index

GPIS: General Practitioner Information System

B2B: Business-to-business

B2C: Business-to-consumer

NPV: Net Present Value

BIM: Building information Modeling

BIMe: BIM Excellence

ITU: International Communication Union

UNESCO: The United Nations Educational and Cultural Organization

CIFE: Stanford University's Center for Facility Engineering

VDC: Virtual Design & Construction

EOS: World Economic Forum Executive Opinion Survey

EDA: Exploratory Data Analysis

NIST: National Institutes of Standards and Technology

EFQM: European Foundation for Quality Management

Chapter 1. Introduction

1.1. Introduction to research

Construction projects shall remain the major force driving world economies. In the UK for instance, the industry represents 10% of total GDP (Keane & Caletka, 2008, p. 1). It is forecasted that by the year 2030 construction industry shall represent 57% of global growth with a total expected output of 15.5 trillion US Dollars worldwide, and despite the negative outlook, a recent report by Euler Herms strongly suggested that emerging markets will lead the growth with an output of Seven Trillions US Dollars, and seeing high market potentials in housing construction (Hermes, 2017).

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tendering and web-based ERP) can support the traditional construction procurement activities (Interagency Procurement Working Group (IAPWG), 2012).

Governments, however, seem struggling with the Implementation of the program. In addition to the fragmented nature of the construction industry (Rankin, et al., 2006), technical, human and, legal and security barriers are preventing the uptake (Khalil & Waly, 2015). However, Bausà Peris, et al., 2013, EU, 2005, McIntosh & Sloan, 2001 and other researchers seem to agree that it remains the role of governments to introduce and facilitate e-Government programs. Perhaps this could address barriers on the levels of security, and legality of the process.

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1.2. Research problem

This research aims to the following;

- Build an assessment model suitable for the construction industry to be used within the constraints assumed by the research.
- Validating the assessment model with literature review
- Validating the assessment model expert interview
- Propose a methodology to implement the proposed assessment model

1.3. Research assumptions

This research shall be based on the following assumptions:

- Research shall only focus on construction organization e-Readiness. Legal and technical barriers related to government strategy and ICT plans are not a subject or within the scope of this thesis.
- Research is addressing e-Readiness of registered and classified contractors currently undertaking construction contracts in the capacity of main contractors.

1.4. Methodology

Research shall be based on literature review of both e-Procurement and e-Tendering technologies, the importance, the directives, and the extent of implementation in Europe and MENA regions. The research will establish the level new technology supports the existing procurement practices. Further review shall be performed to establish the benefits and the drivers of the implementation in the construction industry, and barriers preventing the same.

Due to the lack of e-Readiness assessment models, and as tools to determine e-Readiness have their own strengths and weakness, necessitating the modifications of such tools to compile a model that suits any industry, including construction (Aziz & Salleh, 2011),

researcher shall attempt to review different available assessment models used in the same field or utilized in closely related field (e.g. BIM maturity assessment) to establish the state of the art.

For developing an assessment model, a kickstart model shall be selected for further development. Model development shall take place in two phases. In the first phase, A base model elements shall be adopted and adapted. The second phase will see the development of model indicators and sub indicator form literature review. Validation of model structure will be based on;

- literature review and the identified benefits, drivers and barriers for the adoption of the e-Procurement into construction industry.
- Interview with an expert form the Egyptian construction industry.

A complete breakdown of the conceived assessment model shall be presented at the end of the development process.

Following the development and validation of model, the research shall attempt to provide a guideline and expert recommendations on the implementation of the assessment model and the adoption of e-Procurement, and finally proposing a set of recommendation to improve e-Readiness of the construction organizations. A graphical representation of the methodology is reflected in Figure 1-1

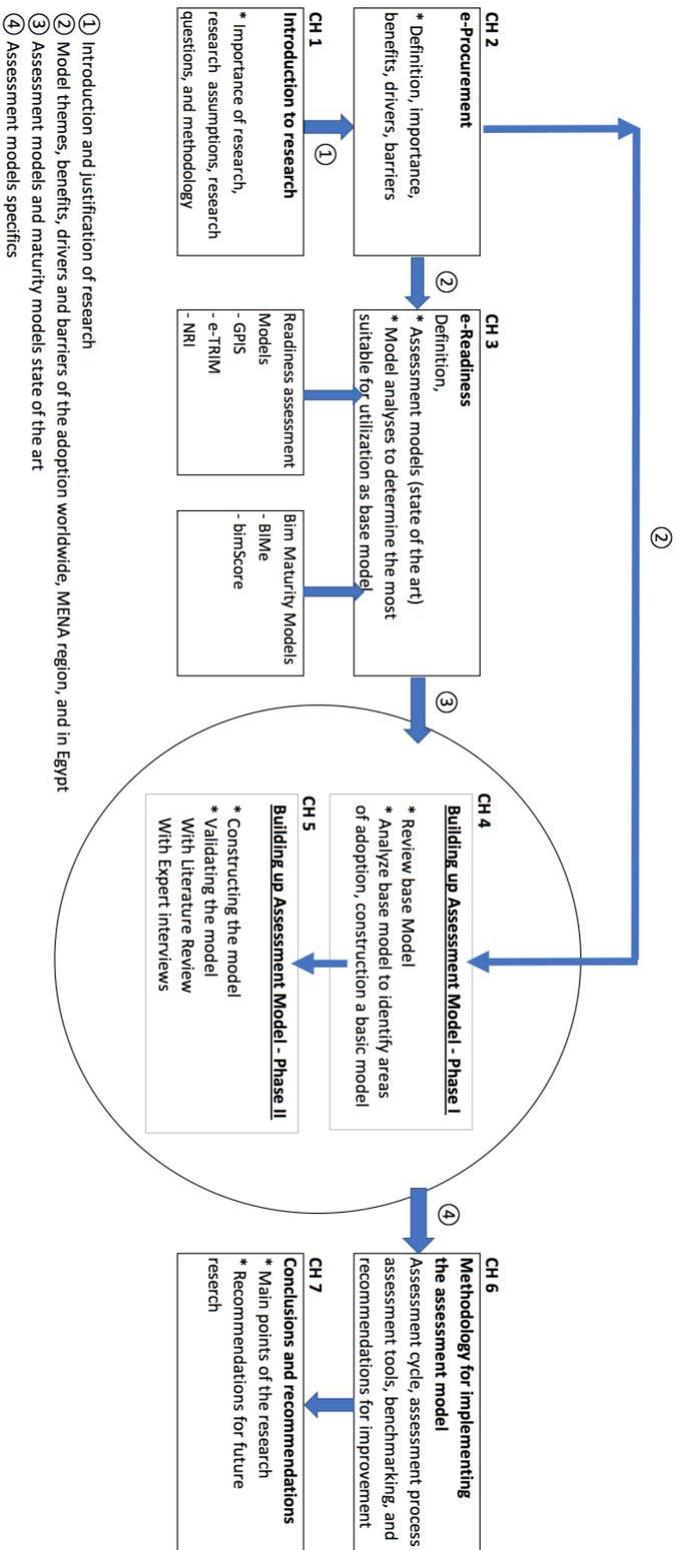


Figure 1-1 Research Methodology¹

¹ Source: Author

Chapter 2. e-Procurement

2.1. e-Procurement definition

As part of government initiative designed to fundamentally transforming the delivery and performance of public administration, e-Procurement is the exchange of supplies, works and services via electronic means, Electronic Data Interchange (EDI) or Enterprise Resource Planning (ERP) (European Commission, 2010). The term entails publishing paperless call for tenders on the internet along with digital project documents and specifications, followed by receiving tenders in the same means, allowing efficiency in managing procedure and awarding contracts. However, it is argued that viewing e-Procurement as a mere change in medium is insufficient to realize the benefits of implementation as such step requires a complete review of the process and further organizational improvements (Beauvallet, et al., 2011)

A green paper on expanding the use of the technology in the EU defined e-Procurement as *“use of electronic communications and transaction processing by government institutions and other public sector organizations when buying supplies and services or tendering public works”* (European Commission, 2010, p. 2). It is a term for the replacement of paper-based procurement with an Information and Communication Technology (ICT) involving the support for *“publication of tender notices, provision of tender documents, submission of tenders, evaluation, award, ordering, invoicing and payment”* (European Commission, 2010, p. 3) .

The United Nations Practitioner’s Handbook published in 2006 indicated that e-Procurement has been adopted for quite sometime now in a form of Electronic Data Interchange (EDI). Currently, it is often relying on internet technologies as internet offers platforms and tools to support it in the functions of ; e-Sourcing; e-Tendering; e-Auctioning; e-Ordering; and finally, e-Information (Interagency Procurement Working Group (IAPWG), 2012). The following Figure 2-1 shows that functions of e-procurement can support all traditional construction activities procurement.

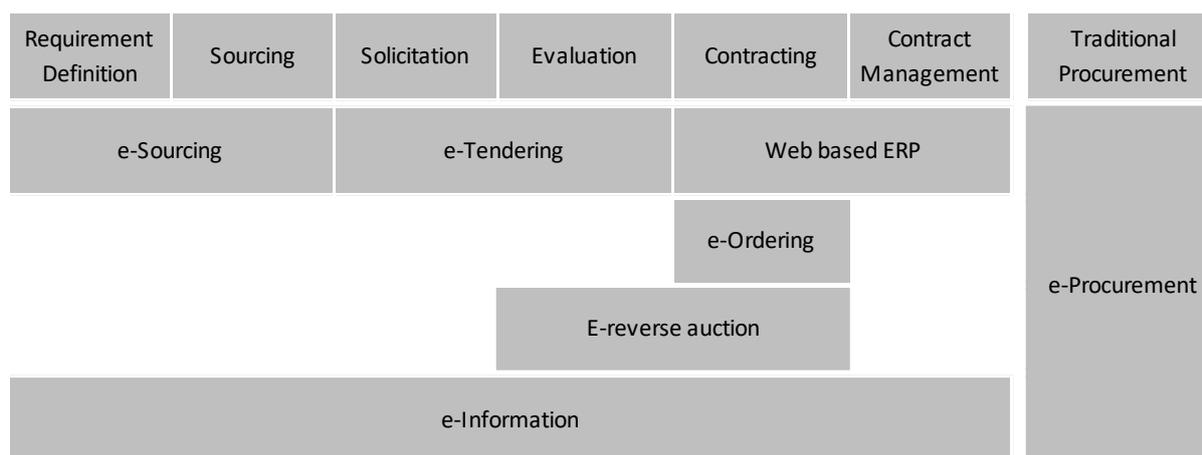


Figure 2-1 Forms of e-procurement plotted in the procurement process ²

The UN Practitioner's Handbook explained forms of e-Procurement in the following context (Interagency Procurement Working Group (IAPWG), 2012);

- e-Sourcing is the phase of definition and specification of requirements, it can be used to prequalify and identify suppliers.
- E-tendering supports both solicitation and evaluation of received offers. It represents the communication between the owner and contractor through RFP, analyses and assessment.
- E-ordering and web-based ERP is supporting ordering or awarding the contract, and managing delivery.
- E-Informing is concerned with the collection of information throughout the entire procurement process and not associated with any stage in particular

Al-Yahya et.al, noted that despite e-Procurement involves a number of different technologies that supports the procurement practices such as e-Tendering, e-Auctions, e-Catalogue/Purchasing, e Marketplace and e-Invoicing, the term e-Tendering is often used to refer to the entire process (Al-Yahya, et al., 2017).

Evidently, the adoption of e-Procurement has not been on the same level globally. While EU government have set a clear schedule and milestone for the adoption, other regions are still in an early stage of implementation. The research will attempt to explore the levels of adoption worldwide

² Source: (Interagency Procurement Working Group (IAPWG), 2012)

2.1.1. e-Procurement adoption in the EU

Researchers **Issa, et al., 2003**, indicated that many construction companies across the Atlantic decided to join efforts to establish the first e-Market in the construction industry, and regardless of the outcome, the step was aiming of revolutionize the AEC industry. Remarkably, Bechtel seemed more successful in their implementation of e-Business. Their procurement system known as Bechtel Procurement System posted the entire RFP package to bidders online. At the time the study was conducted, Bechtel channeled what is roughly equal to 25% of year 2000 procurement through the online RFP, and made purchases of a what is equal to 6% of the same year purchases through the same system. The researchers finally concluded that the lack of strong initiative and absence of proper tools specifically designed for the industry are the main reasons for the slow implantation of e-Business (Issa, et al., 2003).

The EU e-Government ministers attending the Manchester meeting in 2005 agreed that the improvement in services and the positive effect on transparency and accountability and the greater participation in decision-making can be achieved through the implementation of Internet-supported information and communication technology (ICT). EU ministers also agreed that the implementation of ICT can significantly improve the effectiveness of the public sector. Realizing the benefits of IT, EU ministers finally called for European Commission (EC) to adopt into their action plan for e-Government the following goals should be met by 2010 (EU, 2005).

- All EU citizens shall benefit from e-Government
- Considerable improvement of public sector will be achieved through the use of ICT.
- Efficiency and burden reduction can be achieved with the implementation of electronic data provision or partly pre-filled electronic forms.
- Transparency and accountability will be increased by the use of ICT
- All government establishment shall have the capacity of processing all procurement via ICT
- 50% or more of all public procurement shall be channeled through e-Procurement

In the e-Procurement Golden Book of Good Practices published in 2013, it was suggested that contracting authorities and public entities that already implemented e-Procurement reported are savings of between 5% and 20% of their procurement expenditure. However, the average use of e-procurement in 2010 remain at 13% low compared to total use of above 80% of e-Government practices in the EU member states. As a result, in December 2011, the European Commission proposed a new directive to introduce mandatory public e-procurement post 2016 (Bausà Peris, et al., 2013).

2.1.2. e-Procurement adoption in Germany

According to communication with an expert at the Federal Office for Building and Regional Planning in Germany show in Appendix 1 – Communication with GAEB professional, the use of e-tendering platforms will be mandatory from 2018 for most of the public projects, effectively utilizing GAEB in two areas (Perosnal Communicaton, 2018) ;

- STLB-Bau Dynamische BauDaten: a tool for the creation of generic standard specifications for construction work/products that are mandatory for federal building projects (GAEB, n.d.).
- GAEB data exchange XML: Neutral data exchange format for bill of quantities that is used during the whole procurement procedure and during the construction phase until invoicing, which is mandatory for federal building projects and most of the state projects as well. This includes also the tendering phase. It is used by 90% of the participants of the tendering process in the German construction industry (GAEB, n.d.).

According to the same expert, all federal building administrations and also these of the 16 states have e-tendering platforms in use.

2.1.3. e-Procurement in MENA region

A report by Organization for Economic Co-operation and Development (OECD) published in 2016 about the status public procurement in six Middle East and North Africa (MENA) states indicated that there is an ongoing process to improve the procurement system in coordination with stakeholders include suppliers, industry associates, civil society, chamber of commerce, Federation of Construction and Building Contractors, universities/academia and even the public ³ (OECD, 2016). The ongoing reform in the surveyed countries can be seen in areas summarized in the following Table 2-1

Jordan	<ul style="list-style-type: none"> * SMEs * Independent complaint unit and policies unit * Green procurement * Central unified legislation for all governmental entities * e-Portal/e-Procurement
Egypt	<ul style="list-style-type: none"> * Joint Steering Committee comprised of inter-ministerial team together with experts from non-governmental organizations and representatives from consultant and contractors' unions
Libya	<ul style="list-style-type: none"> * Reform the law: draft text under consultation * e-Procurement * Increasing transparency

Table 2-1 Ongoing procurement reforms in MENA countries ⁴

The OECD report further emphasized the important role of the central procurement agency to achieve efficient performance and minimize reworks. At the time of the report publication, four MENA countries have already established central departments with roles varying from developing a procurement strategy and involving in centralized purchases ⁵ monitoring and follow up. The OECD report moves forward to mention some of the challenges facing respondent countries ranging from adopting new procurement laws; unifying legislation, strengthening of infrastructures; the required legal skill and procurement knowledge; the lack of control and audit specialties; training of staff; and finally, adoption of e-Procurement systems, and the use of electronic platforms (OECD, 2016).

³ In Morocco (OECD, 2016).

⁴ Source: (OECD, 2013)

⁵ In Jordan (OECD, 2013)

In Egypt, electronic means in public procurement were introduced in 2010 (OECD, 2016). The Egyptian e-Procurement portal at etenders.gov.eg allowing registered bidders to purchase and download tender documents. Tender submission, however, seems to be in person which only allow the partial implementation of the function of e-Tendering. Figure 2-2 shows snapshot of the Egyptian Procurement portal;



Figure 2-2 Egypt's e-Procurement portal⁶

The following Table 2-2 is showing the actual status of e-Tendering uptake by five MENA states.

Country	Web Page	Remarks	Accessed on
Saudi Arabia	www.saudiegp.sa/tenders	Partial implementation of e-Tendering: Registered suppliers / contractors can purchase and download tender documents. Tender submission and evaluation are manual. Physical address is provided to submit tender	Sept 20th, 2017
Egypt	etenders.gov.eg	Partial implementation of e-Tendering: Registered suppliers / contractors can purchase. Tender submission and evaluation are manual. Physical address is provided to submit tender	Sept 7th, 2017
Bahrain	www.tenderboard.gov.bh	Partial implementation of e-Tendering: Registered suppliers / contractors can purchase tender documents. Tender submission and evaluation are	Sept 20th, 2017

⁶ Source: etenders.gov.eg, accessed on Sept 7th, 2017

	manual. Physical address is provided to submit tender
Emirates	There does not seem a single portal. Rather, each agency / department runs their own system
Qatar	There does not seem a single portal. Rather, each agency / department runs their own system

Table 2-2 Actual status of e-Procurement in MENA region ⁷

A comprehensive study by **OECD** focusing on the Egyptian e-Government program highlighted the missed opportunities denying the Egyptian government the full realization of adoption of ICT benefits caused by the lack of comprehensive strategies. The report also added that Egyptian e-Government goals are hindered by the fragmented decision-making process, the insufficient arrangements and the lack of enthusiasm and incentives for collaboration among government employees. This overall position is resulting in the inadequate attention being paid to benefits of adopting the ICT as a means to a further objective of increasing efficiency, effectiveness, and promoting value of transparency and accountability (OECD, 2013).

Egyptian officials seem to realize that e-Government programs did not achieve the desirable affects sought in achieving efficiency and cost saving as the government work plan seemed to be focused on the expansion rather than consolidation of the program. The report also indicated that the digital divide⁸ in Egypt remains large and suggested that attempts to uptake the e-Government programs could be coupled with efforts to promote the use of IT. The report also noted the limited use of online portals attributed to the limited awareness of provided services, a factor which the government is attempting to address with further coordination (OECD, 2013). The report also indicated that compared to the MENA region average, the ICT infrastructure in Egypt remain under developed, however, mobile networks are well developed and have a penetration among the population, therefore may be utilized for the distribution of government services (OECD, 2013).

⁷ Source: Author

⁸ The gap between IT user and non-IT users

2.1.4. Exploring the possibilities of e-Procurement adoption in the Egyptian Construction industry

In an effort to explore the feasibility of e-Tendering in the perception of construction specialists, a free form interview with Projects Manager at a construction company in Alexandria, Egypt was conducted. According to interviewee, ICT is currently utilized for procurement activities including (Expert, 2018)

- Request for proposals, which is performed via email
- Transmittal of service orders prior to contracting out utilizing email, on the conditions of previous experiences.
- Exploring market and finding suppliers and service providers, performed via world wide web
- Transmittal of purchase orders, performed via emails

On further discussion regarding the impressions towards the e-Tendering, it was suggested that it may be implemented optionally at the beginning, as there remains barriers including regulatory issues concerning the purchasing the tender document, fulfilling the tender bond, and refunding the tender bond in case of tender failure. The non-disclosure of the entire tender documents represented an issue as well. Furthermore, the technical submittal required for any tender is challenging as well, forwarding a copy of organization's regulatory documents may not be satisfactory to client, suggestion the need for an overhaul of submittal procedure and maybe the need to establish new criteria – in terms of requirements and documents - for submission to support further uptake of ICT into governmental procedures.

When asked about the ICT infrastructure and people skills, interview indicted that they are both capable of handling e-Tendering, the network conditions, in the interviewee's opinion, is capable to support the data interchange, including the large volume of drawing and other technical documents. Personnel, according to the same expert, are currently capable to adapt and handle the implementations. Furthermore, the expert suggested that it may prove beneficial if contractors with certain levels of skills can provide consultancy services to government agencies on the effectiveness of the technology, and advice on which contractors possess the capacity to adopt the new technology (Expert, 2018).

2.2. Benefits of adoption of e-Procurement in the construction industry

A European Commission paper suggested that e-procurement has the potentials of improving not only the one-time purchases, but and the overall management of public procurement contract. Consequently, there seem many of government agencies have adopted an e-portal for the announcement of notices and provision of tender documents. Tender submission and evaluation is less common. Until the publication of the EU Green Paper, the EU managed to setup and use a common electronic platform for publication tender notices (European Commission, 2010). Additionally, Transparency international suggested that not only the implementation of e-Procurement can bring competitiveness and efficiency to the process, it is a high-value tool in reducing corruption. Transparency international also recommended that stakeholders of public interest groups should somehow be embedded into the system as such groups are working for the public's interest in combating corruption (Warnes, 2011). Promoting transparency is another approach to promote transparency in the e-procurement (Warnes, 2011).

McIntosh and Sloan, 2011 conducted a research based on literature review on the potential benefits of adopting e-Procurement into the UK construction industry and suggested that the construction industry differs from others as it has its own characteristics, structure and production process, but the industry, remains inefficient. The study indicated that there remains a room for improvement, specifically within the current procurement system and that construction industry shall benefit for that improvement citing Kashiwagi, 1999 that "The construction delivery system of the information age" and that benefits derived from IT will assist in the screening process to disqualify inadequate contractors, promoting competition and providing motivation for contractors to improve their performance . The study also cited the UK construct IT Initiative that the identification and evaluation of new suppliers is only one of numerous benefits gained from the introduction of IT in construction. The researchers emphasized the role of the owner setting up a functioning management structure for the project procurement and reinforced that position with the notion that the government of the UK has been the major enforcer of the uptake of e-Procurement (McIntosh & Sloan, 2001).

In an effort to explore the current implementation of e-commerce in the Australian Architecture, Engineering and Construction (AEC) industry , and the areas where

improvements are possible, researchers Zou & Seo conducted a study based on a questionnaire and free from interviews about current practices and future improvements of e-Commerce technologies, such as emails, internet searches and computer aided design. Researchers focused on contractors and sub-contractors as they are the most exposed to interactions with both owners and consultants on one end, suppliers and subcontractors on the other. Study concluded that the main drivers and benefits from using such technologies are the reduction of both time and cost, maintaining market competitiveness, improving project document/information quality to meet the client/market demand and requirements. Lack of training and sharing of knowledge was the main reason behind the limited experience. The lack of enthusiasm for the implementation of such technologies and the lack of experience and differences in organizational cultures are the main challenges to the adoption of this technology (Zou & Seo, 2006).

2.3. Drivers and barriers of implementation of e-Procurement into construction

The research will attempt to identify and highlight the drivers supporting the implementation of e-Procurement, the and barriers preventing the same into the construction industry (Eadie, et al., 2010) as identified by previous researches carried out worldwide. Benefits, drivers and barriers of the adoption will be later utilized in the development of the assessment model.

In a study of current practices e-Procurement in the Canadian AEC industry, Rankin, et al., 2006 began with the notion that characteristics of the construction industry, namely the fragmented nature, the pragmatism, the lack of leadership, and the absence of standard in technology and business models, and resistance to change have denied the construction industry the benefits of e-Business (Rankin, et al., 2006). As the industry seems adopting collaboration tools, it seems awaiting the development and consolidation of e-solution for its own requirements. This particular stance is preventing the construction industry from benefits that could be realized through improvements in procurement process allowing better management over the supply chain, and achieving the transparency of the market.

Regardless to all that, researchers are still seeing a room for improvement regardless as adopting of e-Procurement shall introduce automation, streamline the bidding process and bidder evaluation. The study concluded that while the majority of respondents reported the use of e-procurement tools, the industry as a whole remains resistive to the new technology (Rankin, et al., 2006).

Beauvallet, et al., 2011 presented a paper investigating the level of adoption and challenges to implementations of electronic means in the public sector. The study was conducted in a span of three years following the January 2005 regulation requiring public entities to implement e-Procurement⁹. As a result of the regulation, a joint procurement platform for government agencies was established, however, it has been perceived as mere facilitator for information exchange (Beauvallet, et al., 2011).

Regardless to the generally positive image of ICT, most of participants expressed confidentiality concerns resulting in the limited response to solicitations forwarded electronically. Security concerns preventing using documents that require manual certification was another reports barrier. Furthermore, the cost of implementation and the digital divide barriers were persistent. Nonetheless, respondents seemed to indicate that the future implementations shall achieve efficiency, improving the procurement and management of the process (Beauvallet, et al., 2011). Further surveys carried out in 2007 and 2008 found out that that use of technology has been expanding, but digital divide and legal concerns remain the main obstacles to the implementation. Researchers recommended developing and adoption common standards in regard to platform and interface and standardization of procurement process including orders, and invoices. Additionally, researchers also suggested the introduction electronic solutions for contractor registration (Beauvallet, et al., 2011).

In their research to examine the drivers and obstacles to the implementation of e-Procurement in Northern Ireland, researchers Eadie, et al., 2007 also indicated that the complex nature of the construction industry differentiates it from others. Therefore, less than 30% of construction tenders are being processed electronically. Researchers found that the

⁹ According to article 56 of French Law (Beauvallet, et al., 2011)

main drivers for the adoption are the better communication, minimizing the administration and tendering costs, having an edge over competitors. Whereas the obstacles to adoption were the concerns over the security of the document transmittal, the unclear legal standing of the e-Procurement, the lack of knowledge and experience of the system and concerns over compatibility and interoperability. The researchers concluded that the ranking drivers and barriers of implementation in the construction industry differs from those in other industries confirming their initial assumptions. Researchers concluded that any implementation system designed for the industry should emphasize on the drivers and address the barriers according to ranking of both (Eadie, et al., 2007).

Complementing their previous study, Eadie, et al., 2010 carried out a new research aiming to compile the first comprehensive and cross-discipline list of drivers and barriers of the implementation of e-Procurement into the construction industry. A web-based questionnaire was delivered to respondents from all disciplines in both public and private sectors of the industry, aiming to rank each identified factor accordingly. The ease of processing, management and cost savings, the convenience of storing works completed, improvement of quality of work, increase of accuracy, and the short cycle of communications were identified as top ranking drivers. Barriers of the adoptions where found in the concerns over the security of documents; the confidentiality of information; resistance to change; and reluctance to invest into such systems (Eadie, et al., 2010) .

Researchers reaffirmed their previous position that the construction industry- being fragmented and varying from one project to another - differs from other industries. However, it was found out that sets of drivers and barriers from goods and service industries apply to construction as well. Additional drivers and barriers seemed industry specific where identified as well. With the majority of responses came from the public sector, Researchers were able to recognize that the public sector is the major user of this technology (Eadie, et al., 2010).

Weng Lou & Alshawi, 2009 indicated that the current the tendering phase as *"information-intensive and paper-heavy"* manual process that requires manual efforts prone to various problems due to human errors and that the tendering process could greatly benefit for the introduction of electronic processing to address the problems of the manual process on the side of the owner. The contractor could also appreciate the benefit of the competitive bidding in such environment. However, researchers seem to suggest that problems accepting and

adopting technology come mostly from human factors and the way IT is being perceived by management as a separate entity. The human factor is seen to be detrimental in the success and failure of the uptake of e-tendering technology. Management commitment and support is essential to initiate and drive the change towards a more productive environment. The provision of proper training to gain acquaintance with IT system is seen as success factor (Weng Lou & Alshawi, 2009).

Researchers noted that numerous organization had made the move into e-Tendering environment motivated by benefits seen in the collaborative work environment, positive return of investment (ROI), the long-term relationship with partners, the readily available management plans of project information, and the improvements to the supply chain. In contrast, barriers remain in peoples' resistance to technology resulted from the limited awareness of potential benefits derived from the technology, the lack of success metrics, limited skills of personnel, the level transparency in the construction industry, the poor communication between different disciplines, the disorganized and fragmented supply chain, and the lack industry standards for such implementations. Additionally, the suspicion and reluctance towards new technology will remain as long as the traditional pattern of thinking of industry professional remains dominant. Consequently, the benefits of the technology seem less attracting (Weng Lou & Alshawi, 2009).

In another research paper on barriers to implementation of e-Procurement into Turkish construction industry, Isikdag, et al., 2011 highlighted that barriers for the implementation can originate from different areas including the technology and network infrastructure, policy and legislation, market and human related categories. On technology category; concerns over security of data and safety of financial transactions were perceived as key issues, highlighting the need to adopt digital security measures over the network. On barriers concerning to policy and legislation, respondents seem to identify lack of legal framework supporting the e-Commerce as the top barrier, followed by the lack of enthusiasm and support of the top management being consumed in the daily routines. At the same ranking came the lack of guidelines and studies on the implementation of technology followed by the lack of informational and promotional activity. On market concerns, responses indicated the perception that potential customer pool may not be large enough to justify the shift to new technology. Responses also seemed to confirm the perception that the traditional media

remains a dominant marketing tool. The lack of confidence in online platform was the most frequently reported reason in human related category, followed by the limited skills in IT within the staff. Concerns over security of information seemed to be reemphasized. Furthermore, the training issues and concerns over the remodeling of business processes to enable and support the adoption of e-Procurement were also deemed as barriers to the implementation (Isikdag, et al., 2011).

Focusing on Egyptian construction industry, although the industry accounts for 7% of Gross Domestic Product (GDP), the industry remains heavily reliant on tendering procedure prone to flaws such as the inclination to bureaucracy and lack of transparency as researches Khalil & Waly, 2015 stated. To establish the need for a new and more effective methodology, researchers highlighted that the lack of transparency is major challenge to construction industry worldwide as researchers suggested the issue is persistent, and also the high cost of current tendering practices that could mount to 5.85% of the overall construction cost. While preserving traditional tender procedure, e-Tendering implemented via secured client portals is providing a new method for the tender documents to be exchanged over the internet with the foreseen benefits of reduction of paper use and facilitate the information exchange between various participants, thus, improving the tendering efficiency, assist in eliminating unqualified contractors, promote transparency and increase competitiveness and allowing governments to standardize the tendering practices, and providing computerized analyses achieving fair evaluation of received tenders. The researchers attempted to present an overview barriers to the adoption of e-Tendering in developing countries, focusing on the case Egypt. Adopting a qualitative approach as a research methodology, researchers identified nineteen (19) factors preventing the adoption and classified them into four categories; Security concerns, human resistance, legal and accessibility issues. The identified factors then presented to expert in semi-structured interviews for their opinions on the issue and to establish a ranking accordingly through statistical data analyses. The most frequently reported reasons preventing the adoption were different than other studies, as follows (Khalil & Waly, 2015);

- Small and medium enterprises (SME's)¹⁰ access to such system is the most critical concern as the researchers suggested such enterprises lack IT equipment and are computer illiterate, therefore, preventing their participation in tenders
- The foreseen technical problems of tendering portal barriers were ranked second as there seem a general distrust in government's provisions.
- Human tendency to resist change.
- Fear over the security of information provided
- Concerns over sending signed document online
- Fears of the unauthorized modification of tender documents by corrupt personnel.
- The lack of support of upper management as most think that the existing system works, and also driven by the mistrust in own employees.
- Power shortages was reported as another obstacle to the adoption of e-Tenders
- Poor status of communication infrastructure was reported as another reason blocking the shift to the new system, as interviewed experts also suggested that internet access may not be available in some areas of the state.
- Non-compatible and non-complaint software that can negatively affect the processing and submission of tender documents was also seen important.
- Corruption was seen as another obstacle preventing the implementation of e-Tendering as the corrupt on all sides realizing it may not serve their purposes may use their powers to resist the implementation of such plans

2.4. Overview of ICT infrastructure in MENA region

The (OECD, 2013) report casted doubts on the capability of ICT infrastructure and penetration of technology to support the uptake of e-Procurement. However, (Murphy & Roser, 2017)

¹⁰ According to EC (European Commission, 2017);

- A medium size company has less than 250 employees, a turnover of equal or less than 50 million Euros, or a balance sheet total of 43 million Euros
- A small size company has less than 50 employees, a turnover of equal or less than 10 million Euros, or a balance sheet total of 10 million Euros
- Small and medium-sized enterprises (SMEs) represent 99% of all businesses in the EU

indicated that the internet use is booming worldwide. Although remains lower in developing countries, access to the internet is expanding. Figure 2-3 shows shares of individuals using internet worldwide. MENA region countries, Egypt, Saudi Arabia and Qatar were shown by researcher. Finland and Germany were also added for the purpose of comparison. The figure indicated that entire MENA region came slightly higher than world average at 44.31%. It seems there has been growth of internet use in Egypt from 29.4% in 2013¹¹ to 37.82% in 2015, not far below the 43.9% world average. It is fair to conclude that the numbers of internet users in the MENA region is on the rise, hence the digital divide is seemingly shrinking.

The broadband penetration in countries of the MENA region in 2014, shown in Figure 2-4, was rather disappointing. Saudi Arabia broadband distribution was estimated at 10.36%, followed by Qatar at 9.9%, however, growth in both countries seemed flattened between 2013 and 2014. Penetration in Egypt, on the other hand, was estimated at 3.68%, but with a seemingly on steady growth (Murphy & Roser, 2017).

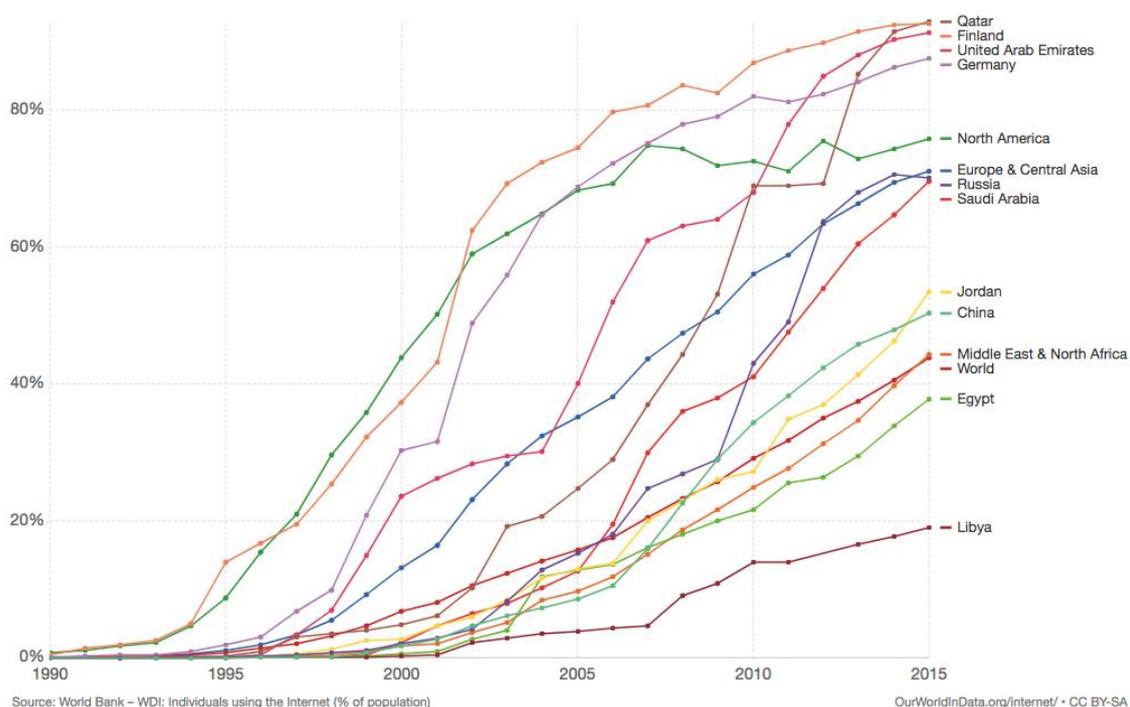


Figure 2-3 Share of individuals using the internet, 1990-2015¹²

¹¹ The year the OECD report was issued

¹² Source: (Murphy & Roser, 2017)

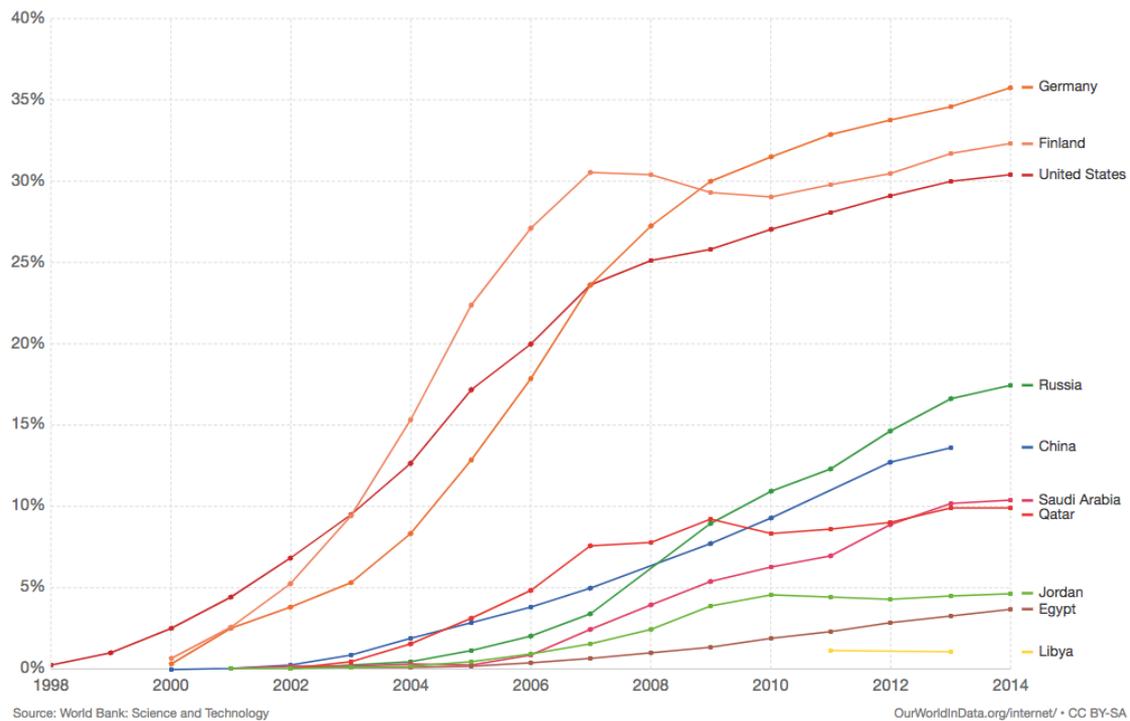


Figure 2-4 Broadband penetration by country ¹³

2.5. Conclusions

The uptake of e-Procurement remains limited, even within the EU (European Commission, 2010). However, the EC (Bausà Peris, et al., 2013; EU, 2005) and other researchers (McIntosh & Sloan, 2001) seem to agree that it remains the role of governments to introduce and facilitate e-Government programs. OECD went further to emphasize the role central procurement agency in achieving efficiency of performance (OECD, 2016). The lack of legal framework supporting e-Commerce (Issa, et al., 2003; Eadie, et al., 2007; Isikdag, et al., 2011; Khalil & Waly, 2015) is a strong motivation for government to take initiative and introduce e-Procurement. There are numerous benefits and drivers for the construction industry to adopt the e-Procurement technology, and evidently, the ICT infrastructure is generally improving in the MENA region. Barriers of the adoptions, however, are co-existing as well. The drivers and barriers (elements) identified in literature review can be categorized into a theme of questions to investigate and evaluate the readiness of construction organization. The theme

¹³ Source: (Murphy & Roser, 2017)

of questions also facilitates the validation process of the assessment model developed in later steps. The theme of questions is reflected in the following Table 2-3

Element	Driver / Benefit	Barrier	Supporting reference	Theme question
Promoting competition and providing motivation for contractors to develop	X		(McIntosh & Sloan, 2001; Zou & Seo, 2006; Eadie, et al., 2007; Khalil & Waly, 2015)	Organization's view of the ICT adoption and the improvement of market competitiveness
Resistance to change, the lack of strong initiative		X	(Khalil & Waly, 2015; Issa, et al., 2003)	Organization's management position on technology
Lack of support of the top management.		X	(Isikdag, et al., 2011)	Commitment and support of the organization's management to technology
Lack of enthusiasm for technology		X	(Zou & Seo, 2006)	Commitment and support of the organization's management to technology
Concerns over compatibility and interoperability		X	(Eadie, et al., 2007; Weng Lou & Alshawi, 2009; Khalil & Waly, 2015)	Level of development of organization's IT/IS
The lack of training, experience, and sharing of knowledge		X	(Zou & Seo, 2006; Eadie, et al., 2007; Weng Lou & Alshawi, 2009; Khalil & Waly, 2015; OECD, 2016)	Qualifications and skills of owners of the business process (procurement)
Develops the technical skills, knowledge and expertise of procurement staff	X		(Eadie, et al., 2010).	Organization's commitments to the training of their staff
lack of tools designed for the industry		X	(Issa, et al., 2003)	Level of development of organization's ICT based business solutions
Facilitate the information exchange between various participants	X		(Khalil & Waly, 2015).	ICT utilization in Business transactions
Improve decision making and market intelligence	X		(Eadie, et al., 2007)	The impact of the organization's ICT adoption
Improvement to communications	X		(Issa, et al., 2003; Eadie, et al., 2007)	The impact of the organization's ICT adoption
Improved quality through improved communication	X		(Eadie, et al., 2010)	The impact of the organization's ICT adoption

Promote collaborative work environment	X	(Weng Lou & Alshawi, 2009)
Cost savings, increasing profit margins, improve quality with benchmarking	X	(Eadie, et al., 2010)
Reduction of time and cost, improving project document and information quality to meet market demand and requirements	X	(Zou & Seo, 2006)
Identification and evaluation of new suppliers	X	(McIntosh & Sloan, 2001)
Improve management over the supply chain	X	(Rankin, et al., 2006)

Table 2-3 Model theme developed form literature review ¹⁴

¹⁴ Source: Author

Chapter 3. e-Readiness

3.1. e-Readiness definitions

In their review of literature in regard, researchers Azziz & Salleh, 2011 found various definitions of the term e-readiness. Most interestingly ¹⁵ ; e-Readiness is the assessment of how a country, or an economy is capable and prepared to implement the Information and Communication Technology (ICT) ; and the capacity of [existing] ICT to adapt to advancements in both social and economic aspects (Aziz & Salleh, 2011). However, Aziz & Salleh, 2011 conclusion seem to be in agreement with the first definition that e-readiness is *“to measure the capability to adopt IT/IS prior to its implementation”* (Aziz & Salleh, 2011, p. 216). Lou & Goulding, 2010, defined e-Readiness as the measure of how an organization is ready to and willing to gain advantages of the digital economy which requires any organization to implement IT into operations, aligning business and e-readiness strategies (Lou & Goulding, 2010).

In this chapter, the research will attempt to review assessment models utilized. The review is not exhaustive but aims to establish the state-of-the-art in this field and identify an existing model as a prototype for further development an assessment model.

3.2. e-Readiness assessment models

In a research into a conceptual model for e-Readiness assessment, researchers Salleh et.al., 2010 stated that models to evaluate IT/IS have long existed, however, most of such models are post investment in nature and they are there for the project closure, and not the project improvement (Salleh, et al., 2010). It was also stated that existing assessment models are generally lacking as they are basically focusing on the post implementation of the technology, and ignoring both people and process – the so called soft issues – that technology is aiming to influence (Salleh, et al., 2010) . Additionally, researchers are justifying the need for a new comprehensive and cross discipline model to assess readiness of organizations by focusing on

¹⁵ to Author

the financial burdens of the implementation (Salleh, et al., 2010). Cost and expenses of the implementation are estimated at 5% of revenues (Graeser, et al., 1998, cited in Salleh, et al., 2010). Despite the high costs of investments, the probability of implementation budget overruns or even the abandonment of the entire IT/IS project remains high (Ashurst & Doherty, et al., 2008; Standish Group, 1999, cited in Salleh, et al., 2010). Researchers attributed this to the focus on the implementations of the technology rather than monitoring performance, and to the inadequate state of readiness of the organizations (Standig, Guilfoyle et al., 2006; Lin & Pervan et al., 2007, cited in Salleh, et al., 2010). Furthermore, researchers indicated that reasons for failures of implementation of IT/IS are the “soft issues” of the organization (Lou & Alshawi, 2009) reiterating the importance of the pre-assessment of organizations capacities prior to the adoption to avoid dealing with the consequence of improper implementations, including the failure. The main motivations of any assessment of readiness are (Duta et al., 2003 cited in Aziz & Salleh, 2011);

- Assisting in setting up a national strategy for development.
- Measuring the penetration of IT in a certain community.
- Evaluate the expansion of use of IT globally.

The need for an e-Readiness assessment model motivated many researchers to adapt models that are suitable for the pre-assessment or organization’s readiness prior to implementation, avoiding the deficiencies of the already existing and known models. The following is a review of some existing researches in the area.

3.2.1. Research by Salleh, et al., 2010

Researchers Salleh et.al., 2010 put forward a holistic assessment model that is to be used prior to the implementation of the technology. The model is focusing on the soft issues and investigate the key elements of organizations; IT, environment, process and people (Salleh, et al., 2010), as classified in the following Table 3-1

Key element	Attribute	Sub-attributes	Characteristic
IT/IS Infrastructure	Top management perception	i) Drivers ii) Aims of application iii) The Requirements	Describes top management strategic thinking and direction towards the development and utilization of IT/IS in their organizations.
	System and Communication	i) Focus ii) Application iii) Communication	The development and utilization of IT/IS applications in support of organizations' direction and strategic plan. The IT/IS network to support the communication and information exchange.
People	Users Involvement	i) Relationship	The level of involvement of staff in the IT/IS developments in organizations and the relationship between users and developers.
	Roles and responsibility of IT staff	i) Position ii) Roles	The roles and responsibility of IT staff in organizations who are involved in the development, implementation and management of IT/IS
	Skills	i) Type of skills ii) Training	Skills available/required to effectively implement the IT/IS in organizations
Process	Business Processes	i) Business Process ii) Success	Represented by the process "Practices" within the organization
Work environment	Organizational Behavior	i) Characteristics	Organizations' perceptions on the use of IT/IS
	Leadership	i) Participation ii) Communication	The leadership style at both operational and strategic level
	IT Department	i) IT Governance	The role and responsibility of the IT departments to provides IT/IS services including infrastructure and applications

Table 3-1 The scope of the model proposed¹⁶

Researchers are indicating that the proposed model is intended for pre-assessment of an organization planning to implement IT/IS, and covering the soft issues that other models overlooked (Salleh, et al., 2010). The model is also presenting a maturity level to determine the readiness gap measured in six levels of progressive and cumulative stages that of any organization can achieve, thus, providing a road-map for bridging the gap in preparation for the implementation (Salleh, et al., 2010), as in the Figure 3-1

¹⁶ Source: (Salleh, et al., 2010)

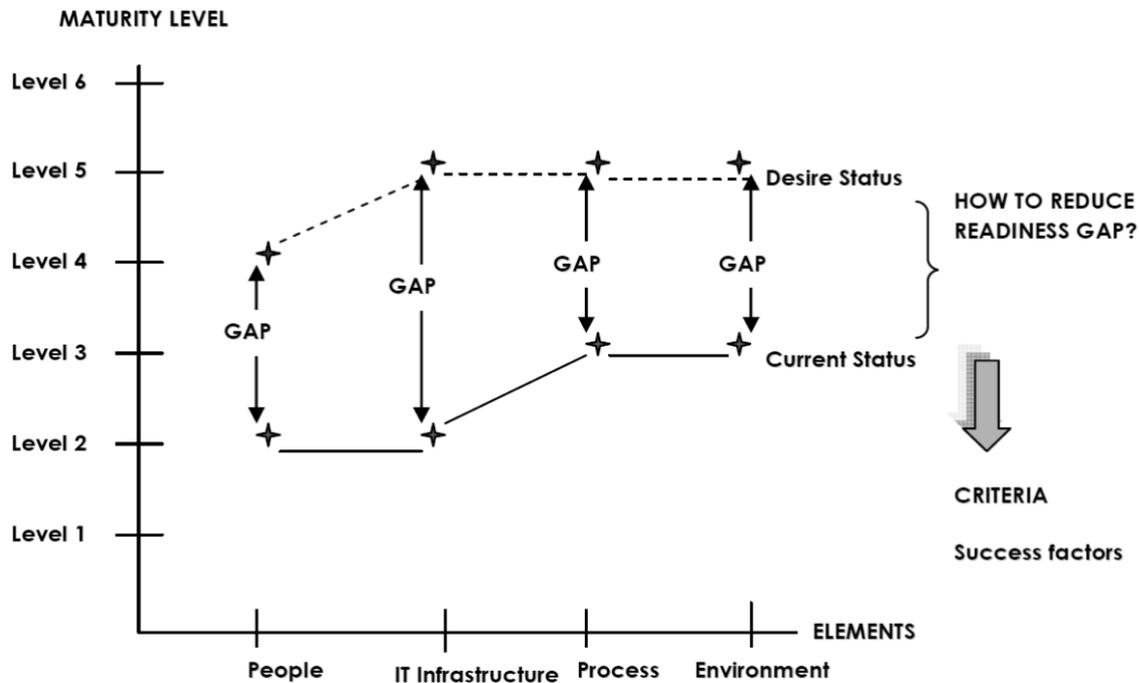


Figure 3-1 Salleh, et al., 2010 readiness model and readiness gap¹⁷

Salleh et al., 2010 indicated that benefits of the model can be seen in the internal evaluation of organizations capacity indicating the readiness prior to the implementation of the IT/IS project, and finally, it can be utilized by organization to forge a development plan to improve their current standing (Salleh, et al., 2010).

It is noticeable that this particular model is drawing parallel with benefits than can be gained from the implementation of IT/IS technology in construction, and the drivers for the uptake. It seems that in order to gain benefit from the adoption, each of these elements should have a certain level of readiness. Salleh et al., 2010, however, argue that the level of readiness should not be necessarily the same in all categories and attributed (Salleh, et al., 2010).

¹⁷ Source: (Salleh, et al., 2010)

3.2.2. Research by Al-Yahya, et al., 2017: A Priori Model (e-TRM)

To justify the need for an assessment model, Al-Yahya, et al., 2017 quoted Zunk et al., 2014 that e-Tendering in construction has a low implementation rate compared to other industries (Al-Yahya, et al., 2017), and also cited Tran et al., 2011, that the main barriers of the implementations of e-Procurement in the construction industry lay within the “ *technology, management, organization and the environment*” (Al-Yahya, et al., 2017, p. 5), and there is need to understand how those barriers are preventing the successful implementation of technology. Furthermore, researchers argued that the confusion due to absence of clear implementation guideline is requiring a structured process to guide organizations through the implementation. Moreover, as there is no assessment model readily available, finding KPI's of the implementation for any specific organization is challenging. Evidently, Assessing and benchmarking the organization prior to implementation of ICT project is a necessity (A Chen & Rankin, 2006, as cited in Al-Yahya, et al., 2017).

Al-Yahya, et al., 2017 based the proposed assessment model on the General Practitioner Information System (GPIS) proposed by Saleh & Alshawi, 2005 and updated by Salleh, et al., 2010, and therefore is built upon the same key element, or *Themes* as designated by researchers (Al-Yahya, et al., 2017), as shown in the following Table 3-2.

In addition to the four main elements proposed originally by Salleh et.al., 2010, researchers Al-Yahya, et al., 2017 introduced a fifth theme designated as service provider theme, arguing that communication, market and technical constructs are necessary to enable the successful implementation of the e-Tendering process and that establishing a collaborative environment with suppliers is an important factor influencing the success of adoption (Weng Lou & Alshawi, 2009; Vaidya, et al. 2006, as cited in Al-Yahya, et al., 2017).

Though the resulting model was validated and verified through Delphi method (Al-Yahya, et al., 2017), researchers finally concluded that the developed conceptual model lacks the empirical support, and recommended designing a survey based on questionnaire to test the model and verify the relationship between the identified constructs and e-Tendering readiness (Al-Yahya, et al., 2017, p. 31).

e-TRM (Al-Yahya, et al., 2017)		GPIS (Salleh, et al., 2010)	
Theme	Construct	Key Element	Attribute
People	Staff Skill	People	Users Involvement Roles and responsibility of IT staff Skill
Process	Practice Procedure	Process	Business Processes
Work Environment	Leadership Management Culture Structure	Work Environment	Organizational Behavior Leadership IT Department
Technology	System and Software Networking	IT/IS Infrastructure	Organizational Behavior Leadership IT Department
Service Provider	Communication Market Technical		

Table 3-2 Comparison between e-TRM and GPIS¹⁸

3.2.3. Research by Aziz & Salleh, 2011

In their research aiming at comparative analysis of the existing assessment models and highlighting the most suitable for implementation within the construction industry, researchers Aziz & Salleh, 2011 made the following findings;

- Existing assessment models can be categorized into two main groups; e-Economy¹⁹ and e-Society²⁰ groups.
- Each of the reviewed assessment models have their own purpose and objective, and therefore differ in method and assessment criteria, and having a different definition of e-Readiness.

¹⁸ Compiled by Author

¹⁹ e-Economy is concerned with the nation's infrastructure or readiness for economic expansion (Aziz & Salleh, 2011)

²⁰ e-Society is concerned with the capacity of the overall society to reap from ICT (Aziz & Salleh, 2011)

- Generally, the results of any assessment process may be categorized into three groups; Description, diagnostic and proscriptio. Almost all models are describing the actual status and focusing on areas believed problematic, but only few models that are offering ways of improvement.
- Majority of models are built upon quantitative research and statistical analysis. However, no explanation was provided of how indices were determined.
- Most of the reviewed models are utilized for post implementation assessment.

Researchers Aziz & Salleh identified two models that are suitable for the use to assess construction industry readiness; The Technology Readiness Index (TRI), and the Networked Readiness Index (NRI). While the TRI is assessing people's readiness to interrelate with technology, NRI is focusing on the expansion of infrastructure. Researcher cited Bridges.org, 2005a that it is the best practice to always chose a model suitable for the user goals (Aziz & Salleh, 2011).

Aziz & Salleh, 2011 finally concluded by reiterating the importance of the assessment tools not only to evaluate the current readiness status of the organization, but also to propose strategies for the improvement, and therefore, recommended further research for the development of a maturity model to enable the organizations to take full advantage of existing IT/IS prior to the implementation (Aziz & Salleh, 2011).

3.2.4. Networked Readiness Index (NRI)

According to The Global Information Technology Report for the year 2016 (the report), The Networked Readiness Index (NRI) is considered one of the most important tools assessing the readiness of any individual nation to benefit from the emerging technologies and seize opportunities of development in different field presented by the digital revolution. Since its introduction in 2001 by the World Economic Forum, NRI has established itself as critical tool to point out readiness gaps, addressing areas of weakness, and track progress of readiness in time. Whether a nation possess the drivers for technology, and whether such technologies are positively influencing the economy and the society of that nation, is where Network

Readiness lays (Baller, et al., 2016). The following Table 3-3 provides an overview of several economies worldwide;

Rank	Economy	Value
1	Singapore	6.0
2	Finland	6.0
3	Sweden	5.8
5	United States	5.8
8	United Kingdom	5.7
15	Germany	5.6
26	United Arab Emirates	5.3
27	Qatar	5.2
28	Bahrain	5.1
33	Saudi Arabia	4.8
96	Egypt	3.7

Table 3-3 Networked Readiness Index for several economies (NRI) ²¹

The Global Information Technology Report for the year 2016 indicated that drivers assessed by NRI are categorized into the following four sub-indexes (Baller, et al., 2016)

- Environment sub-index: Aiming to assess the level at which a country / economy legal and regulatory establishment and network, and market conditions foster and support innovation, ICT development, and free enterprise. Environment Subindex is built upon two pillars; Political and regulatory environment pillar, and Business and innovation environment pillar.
- Readiness sub-index: Quantifying the extents the current infrastructure a country/economy has supporting the uptake of technologies. Readiness sub-index is built upon three pillars; Infrastructure Pillar, Affordability Pillar and Skills Pillars.
- Usage sub-index: Assessing the adoption and use of technology in government operations, private sector and user level. Usage sub-index is built upon; The individual usage pillar, the business usage pillar, and the government usage pillar.
- Impact sub-index: Impacts of the use of technology on social and economic levels, and built upon the following pillars; The economic impacts pillar, and the social impacts pillar.

²¹ Source: (World Economic Forum, 2016)

Subindexes are grouped into two categories, drivers and impacts, and also further structured into ten pillars and Fifty-three as shown into the following Table 3-4

Category	Sub index	Pillars
Drivers	A. Environment subindex	1. Political and regulatory environment (9 indicators) 2. Business and innovation environment (9 indicators)
	B. Readiness subindex	3. Infrastructure (4 indicators) 4. Affordability (3 indicators) 5. Skills (4 indicators)
	C. Usage subindex	6. Individual usage (7 indicators) 7. Business usage (6 indicators) 8. Government usage (3 indicators)
Impacts	D. Impact subindex	9. Economic impacts (4 indicators) 10. Social impacts (4 indicators)

*Table 3-4 NRI Structure*²²

According to the report, almost half of the indicators are fulfilled from the International bodies such as the International Telecommunication Union (ITU), the World Bank, The United Nations Educational and Cultural Organization (UNESCO), and other UN agencies. The remaining data are gathered from World Economic Forum Executives Opinion Survey (Baller, et al., 2016)

The computation of the NRI is based on successive aggregations of scores from indicators up to the most overall NRI score (Baller, et al., 2016). Information are presented in terms of country /economy profile listing an overall scoring of a certain economy, and scoring in in every subindex – as arithmetic mean of all pillars under the same – for all subindexes, along with a spider diagram, and a detailed breakdown of all pillars and indicators, as in the following Figure 3-2;

²² Compiled by Author

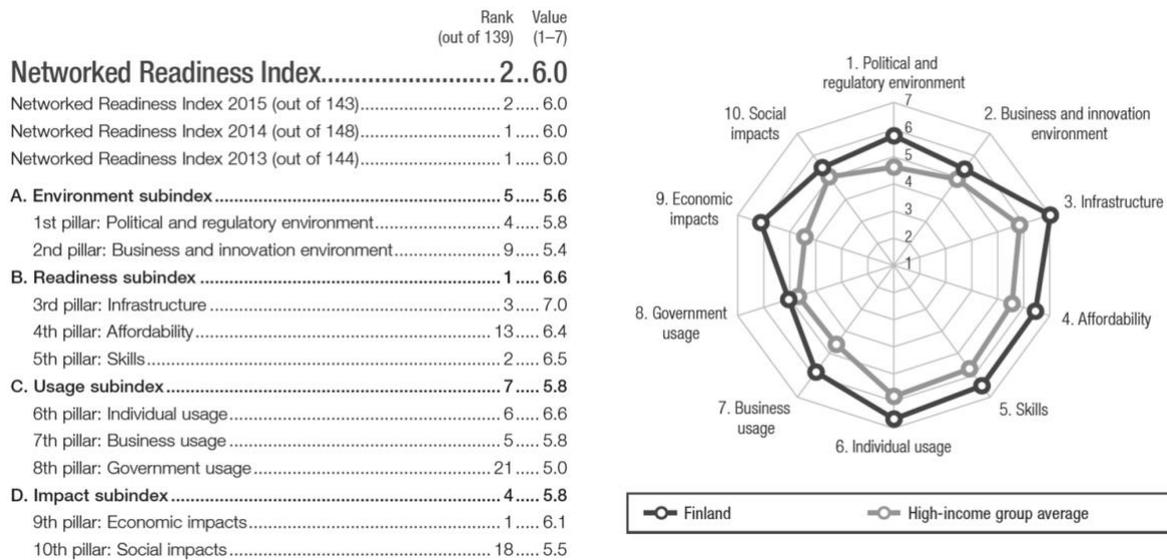


Figure 3-2 Finnish Economy NRI profile ²³

The report which included the year 2016 iteration of the NRI had interesting findings in the following areas (Baller, et al., 2016):

- There seems to be a consensus amongst business leaders worldwide that innovation capacity has been expanding. The number of patents against population size which can be considered as an indicator for innovation, has been increasing worldwide. The trend is particularly noticeable in Emerging Europe, Middle East and North Africa Regions.
- Although there is a raising trend innovation worldwide, the report indicated that seven countries are standing from the rest of the world in terms of performance, namely; Finland, Switzerland, Sweden, Israel, Singapore, the Netherlands, and the United States. Upon a closer inspection of what make the previously mentioned countries unique, another pattern has emerged; all those economies are known to have high level of absorption and utilization of digital technologies in the business usage, performing well in areas including business-to-business (B2B) , business-to-consumer (B2C), internet utilization and training on ICT. Innovative environment is another characteristic that is seen in highly innovative economies. The speed of which

²³ Source: (Baller, et al., 2016, p. 94)

new technologies are brought into business is pivotal factor achieving good standing and gaining edge market.

- Currently, the demand for digital innovation by consumer is much higher than the realized or met by businesses. Businesses are required take initiative in order to gain a foothold in the new emerging market. The reports also pointed out to the gap between the expansion of ICT on individual level and the government adoption is suggesting that public sector is lagging behind. This offers a great opportunity for governments consider the digital innovations and improve services offered by the public sector.
- Providing the proper environment for the digital economy is vital to achieve sustainable development. New economic and social patterns presented by the digital economy need to be managed to ensure the long terms gains of the digital drive are realized.

3.3. BIM Maturity Models

it may be beneficial to review other similar and closely related maturity models aimed at other fields such as BIM. Similar to e-Readiness assessment models, BIM maturity models are aiming to evaluate the current status of organization, identify the capability gap, and finally proposing a strategy to bridge such gaps (ChangeAgents AEC, n.d.). BIM Maturity is typically used to indicate quality, the frequency and level of performance in delivering a BIM based product or service (Succar, 2010, cited in Kassem, et al., 2013). The maturity level usually reflects the progress of the implementation of BIM from entry to optimization (Lockamy III & McCormack; McCormack, et al., 2008, cited in Kassem, et al., 2013). BIM maturity assessment models have existed for some time, amongst which are the BIM excellence (BIMe) discussed in the following section.

3.3.1. BIM excellence (BIMe) organizational assessment model

Developed by Change Agents AEC in 2004 to assess and improve BIM competency for the individual, teams and organizations involved in design, construction and facility management, BIMe is utilizing a set of online and onsite assessment tools to collect and verify data related to individual competencies, organizational systems, historical performance, and the structure of project teams for the purpose of generating an assessment report. The organizational model elements are categorized into fifty-six competency topics covering diverse areas such as; Information management, procurement management and skills management. The model is and aiming at (ChangeAgents AEC, n.d.; ChangeAgents AEC Pty Ltd, n.d.) :

- Depicting the organization’s actual status of BIM capability, and the deliverables an organization can offer to potential clients.
- Establish Organization BIM adoption readiness.
- Pointing out to the main obstacles of BIM Implementation.
- Purposing a BIM development strategy, protocol and workflow tailored for the organizations, based on compiled data and analyses.
- Pointing out to organizational systems that may have impacts on BIM productivity
- Assist in improving the current standing of an organizations against the industry benchmark on the same model.

BIM Excellence utilizes a combination of online tools and onsite services to collect and validate data, and generate online charts and detailed reports. These are used – not only to establish current capabilities but - to provide clear routes for professional development, organizational learning and overall performance improvement (Change Agents AEC, 2017)

The resulting BIMe organization assessment resembles a pyramid, and therefore designated as “*Assessment Pyramid*” where the “*Overall BIM Capability Maturity Profile*” at the top of the model is aggregated from the data of the areas investigated; Individuals, organizational systems and previous performances information (ChangeAgents AEC, n.d.), , as represented in the following Figure 3-3

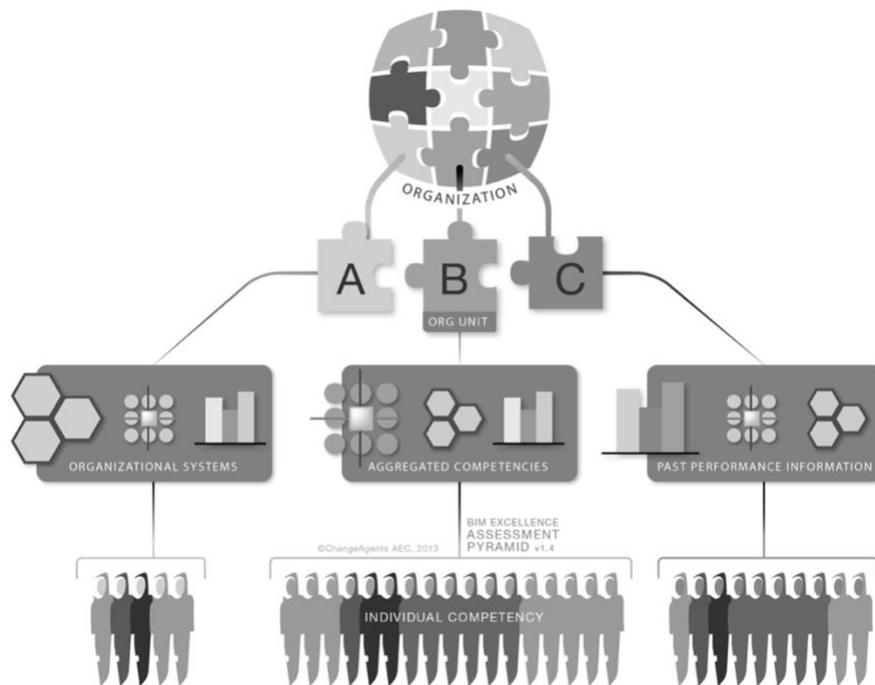


Figure 3-3 BIMe assessment pyramid ²⁴

3.3.2. Strategic Building Innovation - bimSCORE

Developed the Stanford University's Center for Facility Engineering (CIFE) and applied across AEC industries, and implemented by all construction participants including owners consultants and contractors, providing insight and justifying decisions (Oldfield, et al., 2015), bimSCORE aims to *"evaluate the maturity of Virtual Design & Construction (VDC) in practice based on an industry performance rating framework on four different areas"* : planning, adoption, technology, and performance (Stanford University's Centre for Facility Engineering, n.d.). Each of these areas, or score cards have a different weight, and further divided into ten divisions or dimensions (Stanford University's Centre for Facility Engineering, n.d.; Kam, 2012), as in the following Figure 3-4

²⁴ Source: (ChangeAgents AEC, n.d.)

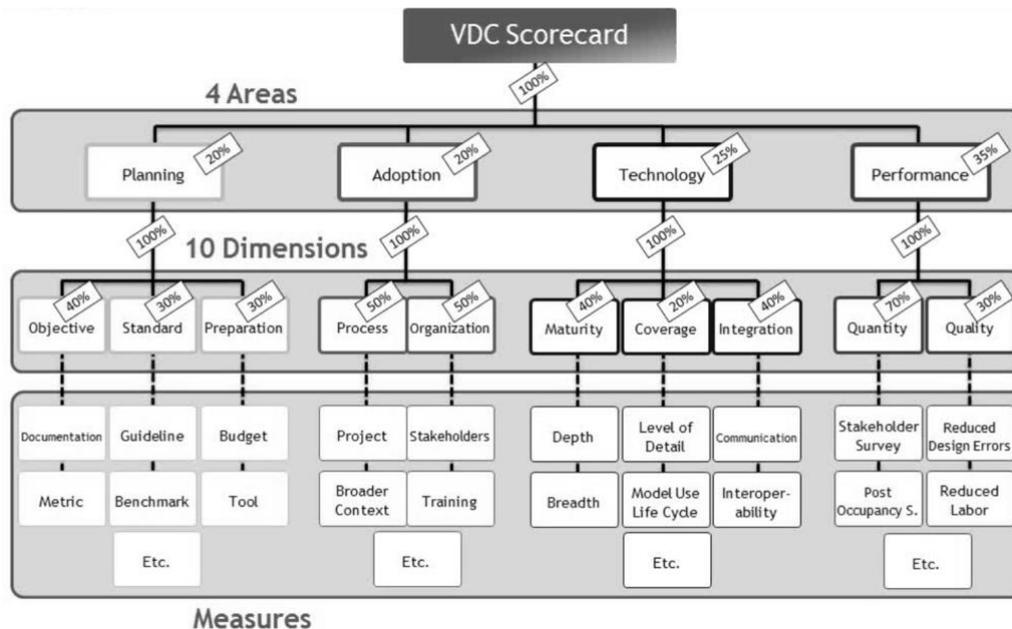


Figure 3-4 VDC Scorecard²⁵

Dimensions of the model are aiming to capture the following (Kam, 2012);

- Objectives and Standards divisions: The aim and measurements of BIM implementation success
- Preparation division: In terms of training, budget, and the BIM execution plan
- Organization (people): Whether the right contractual incentive is available or not, the assignment of risk.
- Process division: whether BIM is one phase or continuous, in planning and facility management.
- Maturity, Coverage and Integration divisions: the level of which BIM is being used (e.g. clash detection or mature BIM application such as optimization, cloud and high-performance computing), and the reactive / proactive BIM use
- Quantity and Quality divisions: The actual measure of performance, not only based on user feed-back, but also on quantifiable evidence.

Determining the scoring system was done by survey against the best innovative practice that was found to be both unique and proven, and then converted into a percentile (Stanford University's Centre for Facility Engineering, n.d.; Kam, 2012). Furthermore, the Confidence level shown on figure below refers to the certainty of the VDC score (Stanford University's

²⁵ Source: (Kam, 2012)

Centre for Facility Engineering, n.d.), based upon the number and depth of interviews of participants (Kam, 2012).

The model aims to create a common term that are agreed upon, and by which, evaluation and assessment can be done. Such evaluations are performed in quantifiable way by assessing for example; the people, the planning, the technology against the outcome of the implementation (Stanford University's Centre for Facility Engineering, n.d.). Benefits of bimSCORE can be realized in the following (bimSCORE, 2012);

- Indicating the current organizational readiness,
- providing the roadmap, clearly marking the goals of BIM implementation
- evaluating different approaches indicating the most suitable to achieve goals
- measuring the speed and rate of progress towards implementation goals

Furthermore, bimScore is presenting a scalable dashboard enabling decision maker to clearly view benchmarks and information gained from survey, and forecast impacts of different BIM managements models on business (Strategic Building Innovation, 2018), as shown in the following Figure 3-5;

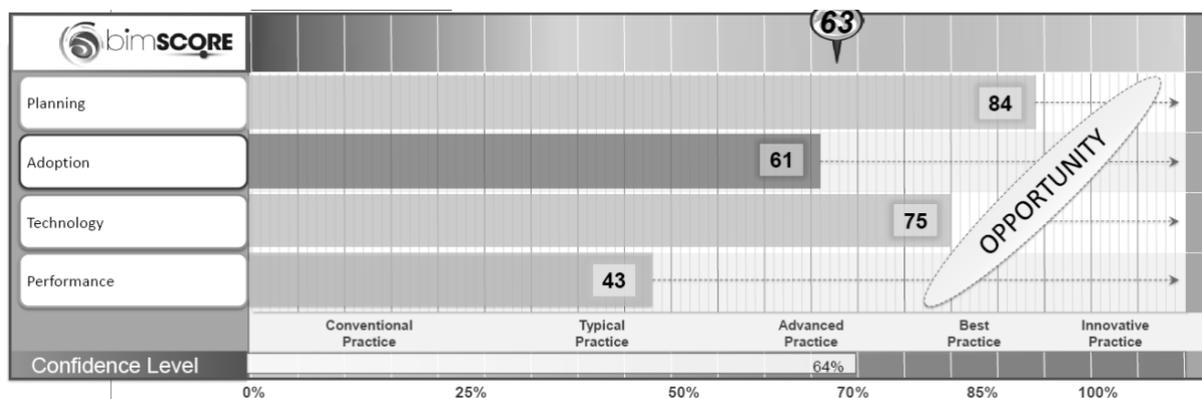


Figure 3-5 bimSCORE express evaluation ²⁶

²⁶ Source: (Oldfield, et al., 2015)

3.4. Overview and analyses of reviewed models

The followed Table 3-5 provides an overview of the reviewed models, their target disciplines, method of assessment along with SOWT analysis for each, from the point of view of research;

Characteristic	Readiness assessment models			BIM Maturity	
	GPIS	e-TRM	NRI	BIMe	bimSCORE
Developed by	Salleh, et al., 2010	Al-Yahya, et al., 2017 Based on GPIS	Center for international development (CID) at Harvard & the World Economic Forum	Change Agents AEC	Stanford University's Center for Facility Engineering (CIFE)
In	2005, updated in 2010	2017	2001	2004	2013
For	organizations' state of readiness for IT/IS	Construction organizations' state of readiness for IT/IS	for use by communities to measure technological capabilities	assess and improve the competency of individuals, organizations, projects and teams within the Construction Industry	evaluate the maturity of Virtual Design & Construction (VDC) in practice based on an industry performance rating framework
Measuring	- IT/IS Infrastructure - People - Process - Work environment	- IT/IS Infrastructure - People - Process - Work environment - Service Provider	- Environment - Readiness - Usage - Impacts	- competency of individuals, organizations, projects and teams within the Construction Industry	- planning, adoption, technology and performance of BIM
Proposes recommendations for improvement	Yes	Yes	No	Yes	Yes
Method	Survey	Survey	EOS and data form international organizations	Online tools and site visits	Survey
Tested	Applied in 4 case studies ²⁷	No	Yes	Yes	Yes

²⁷ According to (Al-Yahya, et al., 2017)

Availability of information	No	Model description and Survey are available	Model description, evaluation and Survey are available	No	Model description and Survey are available
Strength	<ul style="list-style-type: none"> - addressing soft issue identified as the main reasons for the poor adoption of ICT within the construction industry - recommends areas for improvement 	<ul style="list-style-type: none"> - developed from the GPIS - addressing soft issue identified as the main reasons for the poor adoption of ICT within the construction industry - availability of information on model 	<ul style="list-style-type: none"> - developed by recognized body - repeatedly tested and improved - recommended as one model for the use of evaluation of construction industry - addressing soft issue - availability of information on model - availability of assessment tools - availability of evaluation methodology 	<ul style="list-style-type: none"> - availability of some information on model - developed for the use with the AEC industry 	<ul style="list-style-type: none"> - developed by recognized body for the use with the AEC industry - repeatedly tested - availability of information survey
Weakness	<ul style="list-style-type: none"> - very difficult to obtain information about model 	<ul style="list-style-type: none"> - new and untested model - base model was modified to some extent 	<ul style="list-style-type: none"> - no recommendations for improvement 	<ul style="list-style-type: none"> - unclear - may not be adaptable for other assessment models 	<ul style="list-style-type: none"> - basic documents explaining the model are available.
Opportunity	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> - may be utilized as a base model for development of other models 	<ul style="list-style-type: none"> - may be utilized as a base model for development of other models 	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> - scoring and benchmarking methodology may be utilized for the assessment model
Threats	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> -

Table 3-5 Comparison of reviewed models and SWOT analyses ²⁸

²⁸ Source: Author

A value benefit analysis has been conducted on the set of model characteristics deemed important for the selection of the base model for further development; as following

- Developer
- Target industry of model
- Recommendation / use with Construction industry
- Extents of implementation and testing of model
- The Continuous development
- Availability of Literature
- Availability of assessment tools
- Availability of evaluation methodology
- Evaluation of soft issues
- Offers Recommendation for improvements
- Adaptability for/into other assessment models

A level of satisfaction corresponding to each characteristic was assigned based on the findings of the literature review. The output clearly identifies the Networked Readiness Index Model as the most suitable model, as shown in Table 3-6;

characteristic	GPIS		e-TRM		NRI		BIMe		bimSCORE		
	weight	Value benefit	weight	Value benefit							
Developer	80.0 %	10.0 %	8.0 %	10.0 %	8.0 %	15.0 %	12.0 %	10.0 %	8.0 %	10.0 %	8.0 %
Developed for AEC	60.0 %	10.0 %	6.0 %	20.0 %	12.0 %	0.0 %	0.0 %	15.0 %	9.0 %	15.0 %	9.0 %
Recommendation / use with Construction industry	80.0 %	5.0 %	4.0 %	5.0 %	4.0 %	10.0 %	8.0 %	10.0 %	8.0 %	5.0 %	4.0 %
Testing and Continuous development	80.0 %	10.0 %	8.0 %	0.0 %	0.0 %	15.0 %	12.0 %	7.5 %	6.0 %	5.0 %	4.0 %
Availability of Literature	75.0 %	5.0 %	3.8 %	10.0 %	7.5 %	10.0 %	7.5 %	5.0 %	3.8 %	10.0 %	7.5 %
Availability of assessment tools	75.0 %	0.0 %	0.0 %	10.0 %	7.5 %	10.0 %	7.5 %	5.0 %	3.8 %	10.0 %	7.5 %
Availability of evaluation methodology	75.0 %	0.0 %	0.0 %	10.0 %	7.5 %	10.0 %	7.5 %	5.0 %	3.8 %	5.0 %	3.8 %
Assessing soft issues	80.0 %	20.0 %	16.0 %	20.0 %	16.0 %	10.0 %	8.0 %	15.0 %	12.0 %	20.0 %	16.0 %
Offers Recommendation for improvements	70.0 %	20.0 %	14.0 %	0.0 %	0.0 %	0.0 %	0.0 %	10.0 %	7.0 %	5.0 %	3.5 %
Adaptability for/into other assessment models	70.0 %	15.0 %	10.5 %	10.0 %	7.0 %	10.0 %	7.0 %	10.0 %	7.0 %	10.0 %	7.0 %
Value benefit total		100.0 %	73.8 %	100.0 %	73.0 %	100.0 %	76.5 %	100.0 %	73.5 %	100.0 %	73.8 %
Ranking			2		3		1		4		2

Table 3-6 Value Benefit analysis for reviewed models ²⁹

²⁹ Source: Author

3.5. Conclusions

e-Readiness is concerned with measurement how of the capacity to adopt the Information and Communication Technology (ICT) and actually benefit from the adoption (Aziz & Salleh, 2011). IT/IS implementation assessment models have been existing but are only focusing on post implementation (Aziz & Salleh, 2011; Salleh, et al., 2010) and the project closing (Salleh, et al., 2010), and are depicting the actual status of organization but offering no recommendations for improvements (Aziz & Salleh, 2011). Importance of assessment tools are seen not only in determining the current status of organization, but also to set out strategies for improvement (Aziz & Salleh, 2011; Salleh, et al., 2010). The financial costs of IT/IS implementation and the wish to avoid the dealing with the shortcomings of improper implementation are justifying the need for the introduction of pre-assessment models (Salleh, et al., 2010). Furthermore, the limited implementation rate of e-Tendring in construction industry is yet another justification for the development of an assessment model to understand how barriers within the technology, management, organization and the environment prevent the implementation of the technology (Al-Yahya, et al., 2017).

This research tends to agree with Aziz & Salleh, 2011 notion that assessment models have their own purposes and therefore differ in methodology and assessment criteria (Aziz & Salleh, 2011). However, all reviewed models are sharing the similarities in terms of goals as follows:

- Assessing the level of readiness of and capacity for adoption of IT/IS the AEC organization currently possess
- Determining the readiness gap between what is desired and the actual state
- Assist in forging a strategy for improvement and bridging the readiness gap
- Focus on and address the soft issues (people and technology) as the main reason for failure of implementation (Aziz & Salleh, 2011; Salleh, et al., 2010).

The bimSCORE assessment model is sharing similarities to the NRI in terms that overall scoring is based successive aggregations of scores from indicators up to the overall score, according to weights of dimensions and measures. However, bimSCORE offers an easy to understand graphical representation of that is based on a bar chart, clearly identifying the areas of

strengths, weakness and opportunities for improvement. Such presentation may be a very effective. While bimSCORE evaluation questions seem better developed, the NRI is extensively covered, explained and used. Similarities between bimSCORE and NRI are seen. However, the NRI and bimSCORE are designed with different aims and targeting different groups.

Although none of the reviewed models exhibited an apparent threats, performed SWOT and value benefit analysis indicated that the most suitable model to be used as a base for the development of the Assessment Model. NRI was one of two tools for the use to assess the readiness of construction industry in terms of adopting the IT/IS (Aziz & Salleh, 2011), however no guidelines for such implementation was offered.

Chapter 4. e-Readiness assessment model development phase I

In pervious chapters, importance of establishing an AEC organization's capacity to implement the IT/IS technology, namely the e-Tendering, have been established. Assessment models of both e-Readiness and BIM maturity have been reviewed to determine the most suitable base for the purpose of this research and assumptions.

This chapter will discuss the development and validation of an assessment model for the Egyptian construction organizations. Development process will utilize a base model reviewed in the previous chapter. The development of the model shall be carried out in chapter 4 and 5. Chapter 4 represents the first phase of the development where the structure and elements of the base model will be reviewed to identify areas of adaptation and adoption. The outcome of this phase shall represent a basic structure of the assessment model.

4.1. Base Model for the development of assessment model

As concluded from analyses conducted in the previous chapter, Networked Readiness Index (NRI) developed by the Center for international development (CID) at Harvard & the World Economic Forum is selected as a base model for further development. This is justified by the following:

- NRI is one of two models recommended by researchers for the use in assessing e-Readiness within the construction industry (Aziz & Salleh, 2011).
- NRI is developed by widely recognized bodies, The center for international development (CID) at Harvard, and the World Economic Forum (Aziz & Salleh, 2011; Baller, et al., 2016).
- The model has been introduced in 2001, and since then, it has been tested, revised, and repeatedly utilized (Baller, et al., 2016)
- The model clearly evaluates and ranks economies in four different areas; Environment, readiness, usage and impacts, and in ten different pillars pointing out to readiness gaps, addressing areas of weakness, and track progress of readiness in time (Baller, et al., 2016).

- Extensive information about the NRI are available in the public domain, providing the opportunities to adjust and modify model to suit the purpose of research.
- NRI takes into consideration the soft issues that are reported by researchers to be the reason of IT/IS implementations failures within the construction industry (Aziz & Salleh, 2011; Salleh, et al., 2010).

4.2. Review of the base model

The NRI is designed and originally intended to be used as an e-Society tool (Aziz & Salleh, 2011). Figure 4-1 is an overview of the subindexes and indicators that are reviewed in this chapter to determine the most suitable for the adoption and adaptation for the research.

4.2.1. Environment Subindex

Environment subindex is built upon two pillars; Political and regulatory environment, and the Business and innovation environment (Baller, et al., 2016), discussed as follows;

4.2.1.1. *The Political and Political and regulatory environment pillar:*

The Political and Political and regulatory environment pillar is consisting of nine indicators for assessing the extents of which an economy's "*political and regulatory environments facilitate ICT penetration and the development of business activities*" (Baller, et al., 2016, p. 34).

NETWORKED READINESS INDEX 2016

Networked Readiness

$$\begin{aligned} \text{Index} &= 1/4 \text{ Environment subindex} \\ &+ 1/4 \text{ Readiness subindex} \\ &+ 1/4 \text{ Usage subindex} \\ &+ 1/4 \text{ Impact subindex} \end{aligned}$$

ENVIRONMENT SUBINDEX

$$\begin{aligned} \text{Environment subindex} &= 1/2 \text{ Political and regulatory} \\ &\quad \text{environment} \\ &+ 1/2 \text{ Business and innovation} \\ &\quad \text{environment} \end{aligned}$$

1st pillar: Political and regulatory environment

- 1.01 Effectiveness of law-making bodies*
- 1.02 Laws relating to ICTs*
- 1.03 Judicial independence*
- 1.04 Efficiency of legal system in settling disputes⁵
- 1.05 Efficiency of legal system in challenging regulations⁵
- 1.06 Intellectual property protection*
- 1.07 Software piracy rate, % software installed
- 1.08 Number of procedures to enforce a contract⁶
- 1.09 Number of days to enforce a contract⁶

2nd pillar: Business and innovation environment

- 2.01 Availability of latest technologies*
- 2.02 Venture capital availability*
- 2.03 Total tax rate, % profits
- 2.04 Number of days to start a business⁷
- 2.05 Number of procedures to start a business⁷
- 2.06 Intensity of local competition*
- 2.07 Tertiary education gross enrollment rate, %
- 2.08 Quality of management schools*
- 2.09 Government procurement of advanced technology products*

READINESS SUBINDEX

$$\begin{aligned} \text{Readiness subindex} &= 1/3 \text{ Infrastructure} \\ &+ 1/3 \text{ Affordability} \\ &+ 1/3 \text{ Skills} \end{aligned}$$

3rd pillar: Infrastructure

- 3.01 Electricity production, kWh/capita
- 3.02 Mobile network coverage, % population
- 3.03 International Internet bandwidth, kb/s per user
- 3.04 Secure Internet servers per million population

4th pillar: Affordability⁸

- 4.01 Prepaid mobile cellular tariffs, PPP \$/min.
- 4.02 Fixed broadband Internet tariffs, PPP \$/month
- 4.03 Internet and telephony sectors competition index, 0–2 (best)

5th pillar: Skills

- 5.01 Quality of education system*
- 5.02 Quality of math and science education*
- 5.03 Secondary education gross enrollment rate, %
- 5.04 Adult literacy rate, %

USAGE SUBINDEX

$$\begin{aligned} \text{Usage subindex} &= 1/3 \text{ Individual usage} \\ &+ 1/3 \text{ Business usage} \\ &+ 1/3 \text{ Government usage} \end{aligned}$$

6th pillar: Individual usage

- 6.01 Mobile phone subscriptions per 100 population
- 6.02 Percentage of individuals using the Internet
- 6.03 Percentage of households with computer
- 6.04 Households with Internet access, %
- 6.05 Fixed broadband Internet subscriptions per 100 population
- 6.06 Mobile broadband Internet subscriptions per 100 population
- 6.07 Use of virtual social networks*

7th pillar: Business usage

- 7.01 Firm-level technology absorption*
- 7.02 Capacity for innovation*
- 7.03 PCT patent applications per million population
- 7.04 ICT use for business-to-business transactions⁹
- 7.05 Business-to-consumer Internet use⁹
- 7.06 Extent of staff training*

8th pillar: Government usage

- 8.01 Importance of ICTs to government vision*
- 8.02 Government Online Service Index, 0–1 (best)
- 8.03 Government success in ICT promotion*

IMPACT SUBINDEX

$$\begin{aligned} \text{Impact subindex} &= 1/2 \text{ Economic impacts} \\ &+ 1/2 \text{ Social impacts} \end{aligned}$$

9th pillar: Economic impacts

- 9.01 Impact of ICTs on business models*
- 9.02 ICT PCT patent applications per million population
- 9.03 Impact of ICTs on organizational models*
- 9.04 Knowledge intensive jobs, % workforce

10th pillar: Social impacts

- 10.01 Impact of ICTs on access to basic services*
- 10.02 Internet access in schools*
- 10.03 ICT use and government efficiency*
- 10.04 E-Participation Index, 0–1 (best)

Figure 4-1 Networked Readiness Index ³⁰

³⁰ Source: (Baller, et al., 2016)

4.2.1.2. *Business and innovation environment pillar:*

According to the Global Information Technology Report 2016, the Business and innovation environment pillar is built on nine indicators and aims to measure how business environment supports entrepreneurship (Baller, et al., 2016).

4.2.2. Readiness Subindex:

Readiness subindex is consisting of three pillars; Infrastructure, Affordability, and Skills, assessing the suitability of economy's infrastructure to support the adoption of ICT (Baller, et al., 2016), as follows;

4.2.2.1. *Infrastructure pillar*

The infrastructure pillar is consisting of four indicators aiming to capture the current state of country's ICT infrastructure and other infrastructures (electricity production) influencing the uptake of ICT (Baller, et al., 2016).

4.2.2.2. *Affordability pillar*

The affordability pillar is assessing the affordability of ICT in any country by evaluating three indicators relating to the costs of cellular phones, internet access and completions index within the internet and telephony sector (Baller, et al., 2016).

4.2.2.3. *Skills pillar*

Skills pillar captures the peoples' capacity to benefit from the ICT. Skills pillar is built on four indicators that are concerned with quality of education, enrollment in secondary education and adult illiteracy (Baller, et al., 2016).

4.2.3. Usage subindex

Usage subindex aims to capturing the level of use of ICT by assessing the usage in economy's three main pillars; Individual usage pillar, Business usage, and Government usage (Baller, et al., 2016), as follows;

4.2.3.1. *Individual usage pillar*

Individual usage pillar captures the level of individual use of ICT with seven indicators concerned with cellular phone subscriptions, use of internet, ratios pertaining to the volume households with Personal Computers and fixed internet connections, and the use of the social networks (Baller, et al., 2016).

4.2.3.2. *Business usage pillar*

The Business usage pillar is evaluating businesses usage of ICT in six indicates related to the capacity of business to adopt technologies, capacity for innovation, ratios of patent in relation to population, the use in business to business or consumer transition and extents of training of staff (Baller, et al., 2016).

4.2.3.3. *Government usage pillar*

The government usage pillar intends to capture the success of government in evolving and putting in practice a development strategy for ICT. This assessment is done with three indicators concerned with the government vision pertaining to ICT, maturity of government online services and government success promoting ICT (Baller, et al., 2016).

4.2.4. Impact Subindex

Impacts subindex measures the accumulating economic and social impacts realized through the adoption of ICT (Baller, et al., 2016), as follows;

4.2.4.1. *Economic impacts pillar*

Economic impacts pillar measure impacts on competitiveness in an economy through the adoption of ICT by assessing four indicators related to the effects on business models, ICT patents in relation to population, impacts on organizational models, and percentage of jobs the requires intensive knowledge (Baller, et al., 2016).

4.2.4.2. *Social impacts pillar*

Social impacts pillar is measuring the social progress enabled and supported by the adoption of ICT with four indicators related the access to basic services, internet at schools, government efficiency enabled by ICT, and the participation of e-Programs (Baller, et al., 2016).

4.3. Analysis of the base model

The following matrix is conceived to identify NRI indicators relevant to the research by attempting to correlated model pillars and indicators to the research theme identified in chapter 2. The first rows represent the subindexes and indicators of NRI, and the left foremost column represent the model themes identified in chapter 2, Table 2-3.

Evidently, very low rate of adoptions is seen across the matrix. This is explained by the fact that NRI was designed to initially measure the overall readiness of an economy, and that the characteristic and complexities of the construction industry required deeper understanding.

Based on the matrix shown in Figure 4-2 and Figure 4-3 , the following indicators are adopted;

- Intensity of local competition indicator is found significant to this research as competition and competitiveness are two important benefits and drivers of the adoption of ICT (Zou & Seo, 2006; Eadie, et al., 2007).
- The internet bandwidth indicator is deemed important (Baller, et al., 2016) and shall be adopted and adapted for this research.
- Skills pillar is very significant for this research. However, new sets of indicators to assess the skills should be developed. Skills is a very important factor influencing the adoption of ICT (Salleh, et al., 2010; OECD, 2016; Weng Lou & Alshawi, 2009). Skills and knowledge are required to carry on procurement (Al-Yahya, et al., 2017).
- Firm-level technology absorption and ICT use for business-to-business transactions Business usage of ICT are seen as indicators of organization's readiness to adopt e-Procurement technology (Al-Yahya, et al., 2017), therefore, the importance of assessing business usage is evident.
- Extent of staff training of is a proxy for the capacity of management and staff to innovate (Baller, et al., 2016). It may be more effective to evaluate the Extent of staff training indicator within the same context of assessing skills. This position is supported by both e-TRM model (Al-Yahya, et al., 2017) and GPIS model (Salleh, et al., 2010).
- Impact of ICTs on business models is an important indicator to assess the improvement to competitiveness of an economy through the adoption of ICT (Baller, et al., 2016). This is also important to assess the improvement to the overall competitiveness of an organization.
- Impact of ICT on organizational models indicator is assessed by measuring the collaborative tools and models enabled by ICT (Baller, et al., 2016). Collaboration is considered a benefit and driver of the uptake of technology (Weng Lou & Alshawi, 2009).

Adopted indicators shall be further discussed and validated over the next chapter.

Assessment Model Theme	ENVIRONMENT SUBINDEX										READINESS SUBINDEX									
	1st pillar: Political and regulatory environment					2nd pillar: Business and innovation environment					3rd pillar: Infrastructure			4th pillar: Affordability		5th pillar: Skills				
Organization's view of the ICT adoption and the improvement of market competitiveness	Effectiveness of law-making bodies																			
	Laws relating to ICTs																			
	Judicial independence																			
	Efficiency of legal system in settling disputes																			
	Efficiency of legal system in challenging regulations																			
	Intellectual property protection																			
	Software piracy rate, % software installed																			
	Number of procedures to enforce a contract																			
	Number of days to enforce a contract																			
	Organization's management position on technology	Availability of latest technologies																		
Venture capital availability																				
Total tax rate, % profits																				
Number of days to start a business																				
Number of procedures to start a business																				
Intensity of local competition										●										
Tertiary education gross enrollment rate																				
Quality of management schools																				
Government procurement of advanced technology products																				
Commitment and support of the organization's management to technology		Electricity production, kWh/capita																		
	Mobile network coverage, % population																			
	International Internet bandwidth, kb/s per user																			
	Secure Internet servers per million population																			
	Number of procedures to start a business																			
	Fixed broadband Internet tariffs, PPP \$/month																			
	Internet and telephony sectors competition index,																			
	Quality of education system																			
	Quality of math and science education																			
	Level of development of organization's IT/IS	Secondary education gross enrollment rate,																		
Adult literacy rate																				
Qualifications and skills of owners of the business process (procurement)																				
Organization's commitments to the training of their staff																				
ICT utilization in Business transactions																				
Level of development of organization's ICT based business solutions																				
The impact of the organization's ICT adoption																				

● Full adoption ○ Adaptation required

Figure 4-2 Analysis of the base model ³¹

³¹ Source: Author

Assessment Model Theme	USAGE SUBINDEX						IMPACT SUBINDEX													
	6th pillar: Individual usage			7th pillar: Business usage			8th pillar: Govt. usage			9th pillar: Economic impacts			10th pillar: Social impacts							
Organization's view of the ICT adoption and the improvement of market competitiveness	Mobile phone subscriptions per 100 population																			
Organization's management position on technology	Percentage of individuals using the Internet																			
Commitment and support of the organization's management to technology	Percentage of households with computer																			
Level of development of organization's IT/IS	Households with Internet access, %																			
Qualifications and skills of owners of the business process (procurement)	Fixed broadband Internet subscriptions per 100 population																			
Organization's commitments to the training of their staff	Mobile broadband Internet subscriptions per 100 population																			
ICT utilization in Business transactions	Use of virtual social networks																			
Level of development of organization's ICT based business solutions	Firm-level technology absorption																			
The impact of the organization's ICT adoption	Capacity for innovation																			
	PCT patent applications per million population																			
	ICT use for business-to-business transactions																			
	Business-to-consumer Internet use																			
	Extent of staff training																			
	Importance of ICTs to government vision																			
	Government Online Service Index																			
	Government success in ICT promotion																			
	Impact of ICTs on business models																			
	ICT PCT patent applications per million population																			
	Impact of ICTs on organizational models																			
	Knowledge intensive jobs, % workforce																			
	Impact of ICTs on access to basic services																			
	Internet access in schools																			
	E-Participation Index																			

● Full adoption
○ Adaptation required

Figure 4-3 Analysis of the base model ³²

³² Source: Author

4.4. Conclusions

The base model has been reviewed and analyzed to determine areas of adoption and adaptation into this research. For that purpose, literature review has been conducted along with a matrix to correlate NRI indicator to the research model theme. Table 4-1 summarizes the NRI areas of the adoption into the research models against the research themes;

Research Themes	Research Preliminary Assessment Model		
	Subindex	Pillar	Indicator
Organization's view of the ICT adoption and the improvement of market competitiveness	A. Environment subindex	1. Business environment	Intensity of local competition
Organization's management position on technology		-	-
Commitment and support of the organization's management to technology		-	-
Level of development of organization's IT/IS	B. Readiness subindex	2. Infrastructure	internet bandwidth indicator
Qualifications and skills of owners of the business process (procurement)		3. Skills	Extent of staff training (Moved from Usage Subindex)
Organization's commitments to the training of their staff		-	-
ICT utilization in Business transactions	C. Usage subindex	4. Business usage	ICT use for business-to-business transactions Business
Level of development of organization's ICT based business solutions		-	-
The impact of the organization's ICT adoption	D. Impact subindex	5. Economic impacts	Impact of ICTs on business models
			Impact of ICTs on organizational models

Table 4-1 Research and research preliminary assessment model³³

³³ Source: Autor

Chapter 5. e-Readiness model development phase II – development and validation of model with literature review

In this chapter, the second phase of model development will be conducted. The indicators and sub indicators of the research assessment model shown in Table 4-1 will be developed with the identified benefits, drivers and barriers of e-Procurement in the construction industry, and from other similar models.

Validation of the model is required to assess the importance of the entire model and its elements for the assessment of e-readiness of construction organizations in Egypt. Model validation covers the second and third objectives of research. Due to time constraints of this research, validation shall be carried through literature review. The model theme and the self-developed elements shall be validated with opinions of experts from the construction industry gathered with semi-structured interviews. Finally, an overview of the assessment model is presented at the end of this chapter.

The following sections of this chapter present the development of the assessment model and provide argumentation for the necessity of gauging the indicators and sub indicators of the conceived model. Table 5-1 represents a generic structure of the assessment model

A. Model Subindex
<ul style="list-style-type: none"> • Model Pillar <ul style="list-style-type: none"> ○ Model Indicator
Model Sub indicator

*Table 5-1 Generic structure of the assessment model*³⁴

5.1. Environment subindex

Construction industry environment has been perceived as fragmented (Eadie, et al., 2010; Rankin, et al., 2006), and resistive to changes (Rankin, et al., 2006; Weng Lou & Alshawi, 2009). Evidently, internal environment of an organization will have a pivotal role for the successful

³⁴ Source: Author

uptake of the technology. The Organization Environment Subindex shall focus on the following pillars;

5.1.1. Business Environment Pillar

The Business environment pillar is built on two indicators that are aiming to assess the external business environment internal work organization of an organization as enablers of uptake of technology. Accordingly, the business and innovation environment pillar shall assess the following indicators;

5.1.1.1. Local competition indicator

e-Procurement on its own merits can bring competitiveness and efficiency to the procurement process (Warnes, 2011; Khalil & Waly, 2015), assisting in disqualify inadequate contractors, promoting competition and motivating competitiveness (McIntosh & Sloan, 2001). Furthermore, maintaining market standing and competitiveness is a driver for the adoption of technology (Zou & Seo, 2006; Eadie, et al., 2007). Consequently, it may be concluded that local competition is a motivation for the adoption of the new technology which in turn drives local competition even further. Intensity of the local competitions shall be assessed with the following;

- Sub indicator 1 - Intensity of competition in the construction Industry: Sub indicator is derived from NRI (Baller, et al., 2016) and shall assess how intense is the local competition as perceived by construction organizations.
- Sub indicator 2 - Competitiveness and ICT adoption: Adoption motivates contractors to maintain competitiveness and market standing. This view is supported by McIntosh & Sloan, 2001; Zou & Seo, 2006; Eadie, Perera, Heaney, & Carlisle, 2007; Weng Lou & Alshawi, 2009; and Warnes, 2011.

5.1.1.2. Work Environment indicator

Internal organization work environment is a key element³⁵ or construct³⁶ in both GPIS (Salleh, et al., 2010) and e-TRM (Al-Yahya, et al., 2017) models. Al-Yahya, et al., 2017 reconstructed this element around leadership, management, culture and structure, and classified the work environment as critical justifying that as it is the source of decision making and financial support (Al-Yahya, et al., 2017). For this research, work environment indicator shall assess the following;

- Sub indicator 1 - Effective leadership: Sub indicator is supported by the view that the lack of strong initiative (Issa, et al., 2003), and leadership (Rankin, et al., 2006) are barriers standing between construction industry and the uptake of technology. Furthermore, Al-Yahya, et al., 2017 cited Goulding and Lou, 2013 that leadership being perceived as the most important enabler of the uptake of technology (Al-Yahya, et al., 2017).
- Sub indicator 2 - Management views and commitment towards technology: Sub indicator is supported by the notions that management commitment and support is essential to initiate and drive the change towards a more productive environment (Weng Lou & Alshawi, 2009). Additionally, according to Al-Yahya et.al., 2017, management is deemed significantly effective to *“influences the organization’s level of readiness to implement e-Tendering”* (Al-Yahya, et al., 2017, p. 14). Commitment of management is among items that leadership readiness may be assessed (Al-Yahya, et al., 2017).
- Sub indicator 3 – Organizational Culture: Sub indicator is supported by the notion that the lack of enthusiasm (Zou & Seo, 2006), the suspicion and reluctance towards new technology in the traditional mindset of industry is a barrier to the implementation of new technologies (Weng Lou & Alshawi, 2009). The industry wants to maintain the current practices even after realizing the advantages of technology (Rankin, et al.,

³⁵ According to (Salleh, et al., 2010)

³⁶ According to (Al-Yahya, et al., 2017)

2006). Furthermore, the organizational culture plays an important role in implementing innovation that requires collaboration between different professionals by promoting the ideas of cooperation instead blaming, and motivate experimentation with new concepts (Ling, 2003, cited in Zou & Seo, 2006). Organizational culture is an important factor to consider during initial studies ICT implementation (Hawking, et al. 2004, cited in Al-Yahya, et al., 2017).

5.2. Readiness subindex

Researchers Salleh et.al., 2010 indicated that IT/IS infrastructure is key element in the assessment of the system and communication readiness of any organization, and is characterized by (Salleh, et al., 2010):

- The development of IT/IS applications supporting the long-term plans (Salleh, et al., 2010)
- Adequate IT/IS network supporting the communication and information exchange (Salleh, et al., 2010)

Al-Yahya, et al., 2017 reflected on the importance evaluating IT/IS network of organization while assessing e-Tendring readiness, and stated that IT/IS networking within the organization is pivotal for the implementation of e-Tendering (Goulding & Lou, 2013, cited in Al-Yahya, et al., 2017). Readiness subindex formulated for this research shall focus on organization's ICT infrastructure as follows;

5.2.1. Organization's ICT Infrastructure Pillar

Technology and network infrastructure have been reported as a barrier to the adoption (Isikdag, et al., 2011). Consequently, for this research, the infrastructure pillar will assess organization's ICT, as in the following indicators:

5.2.1.1. Reliability of ICT indicator

In general sense, IT/IS technology significantly influences the organization's readiness to adopt e-Tendering technologies (Al-Yahya, et al., 2017). Accordingly, Organization's IT/IS indicator shall consist of the following;

- Sub indicator 1 - Standardization of technology (vs ad hoc implementation): It was suggested that the absence of technology standards is one of the main factors denying the construction industry from benefiting of e-Businesses (Rankin, et al., 2006). The lack of industry standard is one of the main reported barriers to the uptake of technology (Weng Lou & Alshawi, 2009). The poor IT planning and ad hoc implementation is one of two factors of technology resistance within an organization (Jaafar, et al, 2007, cited in Al-Yahya, et al., 2017). Evidently, assessing the level of technology standardization is essential to measure the overall readiness of organization.
- Sub indicator 2 - Compatibility issues: Compatibility and interoperability issues preventing the uptake of technologies had been reported by researchers (Eadie, et al., 2007; Khalil & Waly, 2015; Al-Yahya, et al., 2017). Furthermore Al-Yahya et.al reported that the incompatibility found in the Saudi Arabia construction organizations have impacted the e-Tendering readiness and therefore remains an item to be evaluated for assessing readiness of organization (Al-Yahya, et al., 2017).

5.2.1.2. Organization's IT/IS capacity indicator

International Internet bandwidth is one of many indicators under the Infrastructure pillar the NRI (Baller, et al., 2016). Focusing on organization's readiness, this research shall investigate the following items;

- Sub indicator 1 - Current bandwidth supports high-speed communications: In their 2013 report about the Egyptian e-Government program, the Organization for Economic Co-operation and Development indicated that the current ICT infrastructure

is underdeveloped compared to the region's average, suggesting it could negatively affect the efforts towards e-Government programs (OECD, 2013). Access to internet is an element to be investigated within the Technology Perspective of readiness assessment model proposed by Al-Yahya et.al, 2017. Current bandwidth is seemingly an important element to measure for the evaluation of construction organization e-Readiness.

- Sub indicator 2 - Support of large volumes of data transfer: e-Procurement utilizes the electronic means of communications for the exchange of supplies, works and services (European Commission, 2010) by publishing paperless call for tenders on the internet along with digital project documents and specifications, followed by receiving tenders in the same means (Beauvallet, et al., 2011) indicating the necessity of ICT being capable of supporting the large volume of data and documents transactions, and therefore the need to investigate the capacity of ICT pertaining to the assessment of organization's e-Readiness.

5.2.2. Skills Pillar

The importance of assessing skills has been highlighted in previous researched. Skills are required to effectively implement the IT/IS technologies (Salleh, et al., 2010), and to achieve organization's readiness for ICT (Al-Yahya, et al., 2017). Researchers strongly recommended assessing staff skills to measure organization's e-Readiness and included that in assessment models (Salleh, et al., 2010; Al-Yahya, et al., 2017; Baller, et al., 2016). Assessment of skills is based on the following indicators;

5.2.2.1. Competence of staff indicator:

Competence of staff shall be assessed with the following;

- Sub indicator 1 - Sufficient staff skills (technical expertise): According to the report of the Organization for Economic Co-Operation and Development about the efforts of

the improvement of public procurement in MENA region, the lack of procurement skills is one of the main challenges facing governments procurement development efforts (OECD, 2016). The limited skills of staff remain a major barriers for the implementation of e-Procurement in the construction industry (Weng Lou & Alshawi, 2009). Furthermore, it was indicated that there is a minimum set of skills and knowledge required to carry on procurement (Al-Yahya, et al., 2017). Therefore, investigating the people skills was deemed important assessing organization's e-Readiness (Salleh, et al., 2010; Al-Yahya, et al., 2017; Baller, et al., 2016).

- Sub indicator 2 - Staff ICT experience: Researchers pointed out that the limited knowledge and skills of ICT are barrier for the implementation of e-Procurement (Isikdag, et al., 2011). The report of Organization for Economic Co-Operation and Development focusing on e-Government programs in Egypt indicated that the digital divide in Egypt remains large (OECD, 2013). Digital divide is a barrier to the adoption of e-Procurement in construction (Beauvallet, et al., 2011). The availability of sufficient skills and adequate ICT experience among the staff is a necessity to support organization's adoption (Tran et al., 2011, cited in Al-Yahya, et al., 2017). Construction industry readiness assessment models also indicated the necessity of assessing ICT skills among staff of organization (Salleh, et al., 2010; Al-Yahya, et al., 2017).
- Sub indicator 3 - e-Tendering knowledge of staff: The lack of knowledge and experience in e-Procurement systems was reported as a barrier of the adoption (Eadie, et al., 2007). According to Al-Yahya et.al., 2017, the knowledge of staff in e-Tendering should be assessed as part of evaluation of organization's e-Readiness (Al-Yahya, et al., 2017).

5.2.2.2. Extents of staff continuous training indicator:

- Sub indicator 1 - Regular training offered by organization: The OECD report of about governmental procurement in MENA region suggested the training is also one challenges to government development programs (OECD, 2016). Furthermore, The lack of training, experience, and sharing of knowledge are seen by researchers as barriers to the implementation technologies (Zou & Seo, 2006; Eadie, et al., 2007; Weng Lou & Alshawi, 2009; Khalil & Waly, 2015; Isikdag, et al., 2011). Researchers recommended Initiating workshops, education and training programs were parts of four-point proposal made for government to assist the introduction of e-Procurement into operation (Rankin, et al., 2006).
- Sub indicator 2 - Training on new technologies: Organization's staff will probably require training on new technologies to increase their level of self confidence using the new technology (Tran et. al., 2011, cited in Al-Yahya, et al., 2017). According to researchers, training to familiarize with new ICT systems is seen as success factor for the implementation of new technology. (Weng Lou & Alshawi, 2009). Training is an important attribute to be assessed for the evaluation organization's BIM readiness (Stanford Univeristy's Centre for Facility Engineering, n.d.; Kam, 2012), and e-Readiness (Salleh, et al., 2010).

5.3. Usage subindex

To measure the usage of ICT within an economy, the NRI model assesses levels of utilization within the major components; Government, businesses, and individual. The government pillar assesses governmental initiative and success of planning and utilizing ICT. The Business usage pillar assesses the business use of ICT to facilitate operations with other businesses or individuals, and the level of training provided to staff. The individual usage pillar assesses the level of ICT penetration such as the use of personal computers, internet access and cellular phones within the population of a country (Baller, et al., 2016). Usage subindex shall be

restructured to suit the aims and scope of the research measuring organization's uses focusing on business usage.

5.3.1. Business usage pillar

ICT utilization in business can be interpreted as a proxy of the organization's commitment to the IT/IS, which is considered as a "*fundamental component of an organization's readiness to adopt e-Tendering*" (Al-Yahya, et al., 2017, p. 13). The business usage pillar assessed depending on the following indicators;

5.3.1.1. ICT use for business-to-business transactions indicator

This indicator aims at assessing the level of utilizing ICT in transactions between business.

- Sub indicator 1 - ICT utilization in Business – to – Business transactions: An earlier research about the adoption e-Business in construction industry indicated that communications are still being carried out with traditional technologies such as faxes and phones (Issa, et al., 2003). However, participant indicated the need for improving the communications (Issa, et al., 2003). Sub indicator is a key in capturing the extents of utilization of ICT in Business Usage for and overall evaluation of e-Readiness of an individual economy (Baller, et al., 2016). Evidently, assessing construction organization's business to business transaction is seemingly important to evaluates its overall readiness.

5.3.1.2. Utilization of Integrated Business Applications (e.g. ERP) indicator

Utilization of integrated business applications within an organization is an indicator of organization's commitment and willingness to adopt technologies within operations, and the realization of the benefits of the adoption. Such adoption is a strong indicator of staff acquaintance with technologies resulting from higher level of training among staff (Tran et.

al., 2011, cited in Al-Yahya et.al., 2017). Accordingly, it seems that the high commitment of organization coupled with high levels of training on Business Applications, both manifested with the presence and use of Integrated Business Applications, are indicators of higher level of e-Readiness of the organization. This indicator will be assessed by the following;

- Sub indicator 1 - Organization utilizing Business Applications (e.g. ERP) : According to software vendor SAP, ERP is an integration of business process in a single system, providing provide visibility, analytics, and efficiency across every aspect of a business (SAP, n.d.), and enabling the integration of different business activities including finance, HR, manufacturing, supply chain, services, procurement, and others (SAP, n.d.). e-Procurement is known for the capacity of supporting the functions of contracting and contract management via web-Based ERP (Interagency Procurement Working Group (IAPWG), 2012), a statement that supports the hypothesis that organization's readiness is influenced by the level of adoption of business application.

5.4. Impacts subindex

The base model utilized for this research was designed to capture the effects of ICT adoption on both social and economic aspects. (Baller, et al., 2016). Similarly, positive impacts of the implementation of ICT in general, and the adoption of e-Tendering into the construction industry had been discussed in the first chapter of the research. Evidently, measuring the impacts of the adoption of ICT within Egyptian construction organizations is an important aspect to assess e-Readiness. Impacts subindex shall assess the following pillars;

5.4.1. Business Impacts Pillar

Business impacts pillar shall assess ICT impacts on organization with the following Indicators;

5.4.1.1. ICT impacts on business models indicator:

The impacts of ICT on business model are realized in the better management over the supply chain (Rankin, et al., 2006), improvements to the supply chain (Weng Lou & Alshawi, 2009), the cost saving on service, material and product, reduction of evaluation time (Eadie, et al., 2010). Furthermore, e-Procurement is able to support function of traditional procurement process (Interagency Procurement Working Group (IAPWG), 2012), supporting the need to assess the impact on organization's economic, as follows;

- Sub indicator 1 – ICT impacts on Business Model: The impacts on business models is an important indicator to assess the improvement to competitiveness of an economy through the adoption of ICT (Baller, et al., 2016). Similarly, the impacts of the adoption of ICT is an essential element to assess the improvement to the overall competitiveness of an organization.

5.4.1.2. Impact of ICTs on organizational models indicator:

According to NRI, virtual teams, remote working, and telecommunicating are new organizational models enabled by the adoption of ICT (Baller, et al., 2016). Such tools are supporting and enabling the collaborative work environment that is considered by researchers as benefits and drivers of the uptake of technology (Weng Lou & Alshawi, 2009). This indicator shall assess the extents of which, the adopted ICT technology within Egyptian construction organization enables and supports new models, as follows;

- Sub indicator 1 - ICT support for collaborative work environment: Collaborative environment tools are considered important success factor for e-Tendering (Weng Lou & Alshawi, 2009) as the lack of collaborative environment is considered a major barrier for the implementation of e-governmental programs in Egypt (OECD, 2013). Therefore, the presence of a collaborative environment supported by ICT is imperative for the successful implementation. Assessing the impact of exiting IT/IS in terms of enabling and supporting the collaborative environment is an important aspect to evaluate organization's overall e-Readiness, and influencing the adoption of e-Procurement (Vaidya, et al. 2006, cited by Al-Yahya et.al, 2017)

5.5. Overview of Assessment Model

The second phase of development discussed in the previous section resulted in the assessment model in four sub indexes, five pillars, ten indicators, and eighteen sub indicators, as reflected in Figure 5-1;

A. Environment subindex		B. Readiness Subindex				C. Usage subindex		D. Impacts subindex	
1. Business Environment Pillar		2. Organization's ICT Infrastructure Pillar		3. Skills Pillar		4. Business usage pillar		5. Business Impacts Pillar	
Local competition indicator	Work Environment indicator	Reliability of ICT indicator	Organization's IT/IS capacity indicator	Competence of staff indicator	Extents of staff continuous training indicator	ICT use for B2B transactions indicator	Utilization of Integrated Business Applications indicator	ICT impacts on business models indicator	Impact of ICTs on organizational models indicator
Sub indicator 1: Intensity of competition in the construction Industry	Sub indicator 1 - Effective leadership	Sub indicator 1 - Standardization of technology	Sub indicator 1 - Current bandwidth supports high-speed communications	Sub indicator 1 - Sufficient staff skills (technical expertise)	Sub indicator 1 - Regular training offered by organization	Sub indicator 1 - ICT utilization in Business – to – Business transactions	Sub indicator 1 - Organization utilizing Business Applications (e.g. ERP)	Sub indicator 1 – ICT impacts on Business Model	Sub indicator 1 - ICT support for collaborative work environment
Sub indicator 2: Competitiveness and ICT adoption	Sub indicator 2 - Management views and commitment towards technology	Sub indicator 2 - Compatibility issues	Sub indicator 2 - Support of large volumes of data transfer	Sub indicator 2 - Staff ICT experience	Sub indicator 2 - Training on new technologies				
	Sub indicator 3 - Organization culture								

Adapted / Adopted from NRI

Figure 5-1 Outcome model resulting from phase II development process ³⁷

The following matrix in Figure 5-2 shows an overview of the developed model and the correlation to theme questions identified in chapter 2. It is evident that model cover the areas deemed necessary for the investigation of e-Readiness.

Providing literature support for the model sub indexes, pillars, indicators, and sub indicator is considered a validation for the same. However, the main themes of the model and identified sub indicators are requiring further validation. The following sections of this chapter are covering the validation method, process and results.

³⁷ Source: Author

Assessment Model Theme	A. Environment subindex			B. Readiness Subindex				C. Usage subindex		D. Impacts subindex	
	1. Business Environment Pillar			2. Organization's ICT Infrastructure pillar		3. Skills pillar		4. Business usage pillar		5. Business impacts pillar	
Organization's view of the CT adoption and the improvement of market competitiveness	Local competition indicator	Sub indicator 1: Intensity of competition in the construction Industry	●	Sub indicator 2: Competitiveness and ICT adoption	●						
	Work Environment indicator	Sub indicator 1 - Effective leadership	●	Sub indicator 2 - Management views and commitment towards technology	●	Sub indicator 3 - Organization culture	●				
Reliability of ICT indicator		Sub indicator 1 - Standardization of technology	●	Sub indicator 2 - Compatibility issues	●						
		Organization's IT/S capacity indicator	Sub indicator 1 - Current bandwidth supports high-speed communications	●	Sub indicator 2 - Support of large volumes of data transfer	●					
Competence of staff indicator	Sub indicator 1 - Sufficient staff skills (technical expertise)			Sub indicator 2 - Staff ICT experience	●						
	Extents of staff continuous training indicator	Sub indicator 3 - e-Tendering knowledge of staff	●	Sub indicator 1 - Regular training offered by organization	●						
		Sub indicator 2 - Training on new technologies	●								
Commitment and support of the organization's management to technology	ICT use for B2B transactions indicator	Sub indicator 1 - ICT utilization in Business – to – Business transactions	●								
		Sub indicator 1 - Organization utilizing Business Applications (e.g. ERP)	●								
Level of development of organization's IT/S	ICT impacts on business models indicator	Sub indicator 1 – ICT impacts on Business Model	●								
		Sub indicator 1 - ICT support for collaborative work environment	●								
Qualifications and skills of owners of the business process	Impact of ICTs on organizational models indicator										
Organization's commitments to the training of their staff											
ICT utilization in Business transactions											
Level of development of organization's ICT based business solutions											
The impact of the organization's ICT adoption											

Adapted / Adopted from NRI

Figure 5-2 Matrix of assessment model and correlation to model themes ³⁸

³⁸ Source: Author

5.6. Validation of model

In the following sections, the main theme of the assessment model, and sub indicators that require further validation will be brought to examination. The main themes represent the set of questions the assessment model is attempting to answer and measure for an overall assessment of organization. Model sub indicators requiring further validation are those are related to readiness, usage and impacts sub-indexes, as in Table 5-4

To explore the validity of the model theme and sub indicators, an in-depth and semi structure qualitative interview are recommended as they are suitable to seek insight and understand the reasons behind an opinion. (Saunders, et al., 2009, p. 322). Interviews are also said to be the preferred alternative given the time frame required to complete a questionnaire (Saunders, et al., 2009, p. 325). Semi-structured interviews are characterized by the presence of a list of questions and areas to be covered. However, the questions remain flexible, and their order may vary depending on the conversation. Questions may be omitted or added to explore research objectives in certain context (Saunders, et al., 2009, p. 320)

Due to difficulties reaching out to expert from the industry, and the time limitations. The interviews conducted by this research should be considered as a guideline on validation of the model.

5.7. Validation of model themes and interview protocol

To conduct the interview, an interview protocol is required to develop the interview question corresponding to the assessment model theme. The following Table 5-2 developed from matrix depicted in Figure 5-2 reflects the interview protocol matrix;

Indicator	Model Theme	Corresponding Interview Question
Local competition	Organization's view of the ICT adoption and the improvement of market competitiveness	What are your opinions on the importance of assessing organization's view of market competitiveness and the adoption of ICT technology?
Work Environment	Organization's management position on technology	How important assessing the organization's management perception of technology?
	Commitment and support of the organization's management to technology	How important assessing the commitment and support of the organization's management to technology when evaluating construction organization's readiness?
Organization's IT/IS capacity	Level of development of organization's IT/IS	How significant is the assessment of organization's adopted IT/IS
Organization's internal IT/IS capacity indicator		
Competence of staff	Qualifications and skills of owners of the business process (procurement)	How important is assessing the staff skills?
Extent of staff training	Organization's commitments to the training of their staff	How do you feel about assessing organization's commitment to the training of their staff?
ICT use for business-to-business transactions	ICT utilization in Business transactions	How significant is assessing the level of development of organization's ICT based business solutions?
Utilization of Integrated Business Applications (e.g. ERP)	Level of development of organization's ICT based business solutions	How important is assessing the level of adoption of ICT bases business solutions?
ICT impacts on business models	The impact of the organization's ICT adoption	How important is assessing the impacts of the current ICT adoption on Organizations?
Impact of ICTs on new organizational models		

Table 5-2 Interview Protocol Table ³⁹

³⁹ Source: Author

5.7.1. Expert Interview 1a

A semi-structured phone interview with an expert from the Egyptian Construction Industry of 33 years of experience, of which, 11 years are spent with the same construction organization, has been conducted to investigate the validity of the main theme of the assessment model. The following points highlight the important parts of the interview (Expert-1a, 2018). transcript of the interview is available at appendix 2

- Expert thinks that it is important to assess organization's view in of market competitiveness and the adoption of ICT technology. Expert also thinks that any organization may find itself obliged and have no alternatives except moving in certain imposes by market conditions. ICT adoption and switching from paper to paperless operations should not be seen from a different perspective. Generally, an organization is compelled to adopt technological solutions or otherwise risk being left behind.
- The Interviewee thinks that assessing management perception of technology is important, but the researcher will have to possess the knowledge and understanding of the collective thinking of the construction organizations and the dominance of the management trio; quality, time and cost. Organizations are always aiming at profit and therefore, must be addressed in a language that emphasizes that perspective.
- The expert thinks that evaluating management's commitment and support to technology is very important. However, assessing the knowledge and skills of the development team is also as significant as the management's commitment and support to technology.
- It is of the interviewees views that assessing organization level of IT/IS adoption is significant as the interviewee thinks it is unwise to imagine an organization possessing no IT/IS capacity would be capable to adopt e-Procurement. An organization keen to development their internal infrastructure is more capable and have a higher degree of readiness for future adoptions.
- On the importance of assessing the skills of procurement staff, the interviewee thinks that having the academic qualification at the satisfactory level is more important than possessing skills as the latter is acquired with proper training. Training, therefore, in the views of the interviewee is very important factor to asses, justified by the benefits

gained by organization from the staff training. Training is also a necessary tool for the adoption of any new technology. Having the necessary qualification coupled with proper training is necessary for any organization.

- Assessing the level of development of organization's ICT based business solutions is another significant aspect to measure according to the expert. This is justified with the view that an organization's adoption of an ICT solution is an important indicator of a higher level of readiness to adopt another solution. Accordingly, assessing the level of utilization of the Business to Business transaction in terms of information, specifications and data exchange is also an important aspect to measure. However, expert indicated that any assessment model should explain that aspect very well and not to leave it to respondent's own interpretation. The same comment is valid on the aspect related to impacts of ICT adoption on organization. Though assessing this aspect deemed important, the model should be very specific on the what kind of impacts targeted by the assessment.

5.7.2. Analysis of the interview

It may be safe to conclude that Expert-1a interview agreed with the main theme of the assessment model. The expert also suggested investigating the following points (Expert-1a, 2018). Relevant themes and indicators concluded from the context of the interview;

Identified sub indicators of assessment from interview	Relevant Theme	Relevant indicator
Knowledge and the capacity of the development team within the organization	Commitment and support of the organization's management to technology	Work Environment indicator
The level of academic qualification of procurement staff in the organization	Qualifications and skills of owners of the business process	Competence of staff indicator

*Table 5-3 Sub indicators of possible significance for evaluation*⁴⁰

⁴⁰ Source: Author

Assessing the knowledge and the capacity of the development team within the organization seem feasible and supported by the efforts of Researchers Salleh, et al., 2010 aiming to assess level of involvement of staff in the IT/IS developments within organizations and the relationship between users and developers (Salleh, et al., 2010) Evidently, this attribute is important to assess to and therefore shall be included in the assessment model.

The level of academic qualification of procurement staff in the organization is justifiable as tertiary education gross enrollment and the quality of management schools are indicator that NRI is assessing (Baller, et al., 2016, p. 35), and therefore shall be considered in the assessment.

5.8. Validation of model sub indicators and interview protocol

An interview protocol is also developed to formulate interview questions corresponding to the model sub indicators targeted with the validation. Table 5-4 reflects the interview protocol matrix;

Subindex	Pillar	Indicator	Sub Indicator	Corresponding Interview Question
B. Readiness subindex	Organization's ICT Infrastructure Pillar	Organization's IT/IS capacity	Current bandwidth supports high-speed communications	To assess organizations e-Readiness, how important is it to assess the measure the speed, and capacity of internet connection for large volumes of data transfer?
			Support of large volumes of data transfer	
C. Usage subindex	Business usage pillar	Utilization of Integrated Business Applications (eg. ERP)	Organization utilization of Business Applications (eg. ERP)	How significant to the assessment is the measuring of organization's utilization business applications? (e.g. ERP)

D. Impacts subindex	Business Impacts Pillar	Impact of ICTs on organizational models	ICT support for collaborative work environment	In your own views, how important for the assessment measuring the organization' ICT's capacity to support the organization internal communication and collaboration?
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Table 5-4 Interview Protocol Table ⁴¹

The developed questions are utilized to conduct two interviews for the validation of the model sub indicators as explained in the following sections

5.8.1. Expert Interview 1b

A semi-structured phone interview with an expert from the Egyptian Construction Industry of 33 years of experience, of which, 11 years are spent with the same construction organization, has been conducted to investigate the validity of the sub indicators in Table 5-4. The following points had been concluded (Expert-1b, 2018);

- The interviewee thinks that investigating the reliability of Internet connection indicator is insignificant to the evaluation of organization's overall readiness. Interviewee believes that Egypt has a good ICT infrastructure, and currently, many medium and large construction organizations are already utilizing some form of online cloud to store and share data among many branches across the country. This fact alone is making any investigation into this point insignificant, unless the study was focusing on a less developed economy.
- The interviewee could not provide any feedback related to the significance of capturing the level of use of Business Applications (e.g. ERP) within the organization. Interviewee cited reasons related to the lack of knowledge and experience in similar systems.

⁴¹ Source: Author

- the interviewee thinks that the impact on the capacity to support internal collaboration and communication sub indicator complements the first point, but considered important for the assessment. The interviewee indicated that large organizations are obliged to utilize tools that enable collaboration. The interviewee also gave personal narrative of using a collaboration tool in its basic form and indicated the need to develop that tool into a fully-fledged system. Interviewee suggested that importance of the management vision and commitment for the adoption of ICT.
- The interviewee expanded in expressing views of the importance of the presence of organizing body managing e-Procurement that all calls for bidding should be performed through this body. Furthermore, interviewee highlighted the need that organizing body should be trustworthy, justifying that by the security concerns related to costly biddings and studies submitted by contractors and the fear of misuses or leaks, compromising the tenderer's efforts and position. Interviewee also expressed interest and enthusiasm for e-Procurement, as it saves time and offers volumes of projects opportunities for contractors in a high level of transparency.

5.8.2. Expert Interview 2

A semi structured interview was conducted with another expert of that has accumulated a total of twenty-six years of experience in the construction industry. Interviewee provided the following feedback (Expert-2, 2018);

- Unless the evaluation has a global extent and intend to investigate all organizations, the capacity to support high speed communications and large volume of data transfer sub indicators are not significant factors to investigate to evaluate the overall readiness of the organizations. Small and unclassified organizations tend not to invest heavily in their own ICT infrastructure. Conversely, well established and classified contractors invest well in their ICT infrastructure.
- Interviewee is strongly supportive of investigating the organization's usage of business applications (e.g. ERP) as such systems are the enablers of e-Procurement adoptions according to the interviewee. Interviewee amplified that e-Procurement is based on

the exchange of information within the organization, between organization and suppliers, and between organization and clients. Information exchange is facilitated by ERP and therefore, the absence of such system will negatively impact the readiness of the organizations.

- Interviewee thinks that the ICT impact of organization internal communication and collaboration is sub indicators worthy of investigation. The absence of communication and collaboration is a barrier to the adoption of e-Procurement which is mainly based on information exchange between various participants.
- The interviewee expressed enthusiasm and optimism adoption e-Procurement and suggested that benefits of the adoption will be experienced in the improvement of performance, saving time and money, and minimizes the wastage. However, this is all must be supported by proper legislation and infrastructure.

5.8.3. Analysis of the interviews

Both experts 1b and 2 shared the enthusiasm for the adoption of e-Procurement as a means to improving and streamlining the procurement process and being time and cost effective (Expert-1b, 2018; Expert-2, 2018) , improving transparency and providing unlimited business opportunities for the contractors (Expert-1b, 2018). While expert-1b indicated the importance of introducing an organizing body managing e-Procurement adoption and implementation (Expert-1b, 2018), expert-2 reiterated on the importance introducing regulations supporting e-Procurement (Expert-2, 2018). All interviews suggested the importance of management's views and commitment towards technology (Expert-1a, 2018; Expert-1b, 2018; Expert-2, 2018) reaffirming importance of assessing the work environment indicator previously discussed. Both interviewees agreed on the insignificance of assessing organization's IT/IS capacity, and therefore, the entire indicator and sub indicators shall be omitted for the assessment model. Table 5-5 shows matrix resulting from both interview, and refinements to assessment model.

Subindex	Pillar	Indicator	Sub indicator	Validation	Impacts on model
A. Environment subindex	Business environment	Work Environment	The capacity and level of skill of IT department and involvement in development of organization	Indicated as an important element to investigate by Expert 1a	Sub indicator is introduced to assessment model
B. Readiness subindex	Organization's ICT Infrastructure Pillar	Organization's IT/IS capacity	Current bandwidth supports high-speed communications	Rejected as insignificant by both Expert 1b and 2	Sub indicator is omitted from models
			Support of large volumes of data transfer	Rejected as insignificant by both Expert 1b and 2	Sub indicator is omitted from models
	Skills	Competence of staff	Procurement staff academic qualification	Indicated as an important element to investigate by Expert 1a	Sub indicator is introduced to assessment model
C. Usage subindex	Business usage pillar	Utilization of Integrated Business Applications (e.g. ERP)	Organization utilization of Business Applications (e.g. ERP)	Expert 1a was unable to provide any feedback. Expert 2 supported the investigation	Sub indicator is retained
D. Impacts subindex	Business Impacts Pillar	Impact of ICTs on organizational models	ICT support for collaborative work environment	Identified as an important element for the investigation by both Expert 1b and 2	Sub indicator is retained

Table 5-5 Refinements to Model based on expert interviews ⁴²

⁴² Source: Author

5.9. Overview of validated assessment model

Experts seem to agree on the relevance of the main theme and sub indicators discussed. As a result of the expert opinions expressed in both interviews, the assessment model shall be modified as reflected in Table 5-6. Matrix in Figure 5-3 which shows the validated model in correlation with the model themes identified earlier in the research.

Category	Pillar	Indicator	Sub Indicator	Supporting Reference
A. Environment sindex	1. Business environment	1.1 Intensity of local competition	1. Intensity of competition in the construction Industry	(Baller, et al., 2016)
			2. Competitiveness and ICT adoption	(McIntosh & Sloan, 2001; Zou & Seo, 2006; Eadie, et al., 2007; Weng Lou & Alshawi, 2009; Warnes, 2011)
		1.2 Work Environment	1. Effective leadership	(Rankin, et al., 2006; Issa, et al., 2003; Al- Yahya, et al., 2017)
			2. Management views and commitment towards technology	(Weng Lou & Alshawi, 2009; Isikdag, et al., 2011; Khalil & Waly, 2015; Al-Yahya, et al., 2017)
B. Readiness subindex	2. Organization's ICT Infrastructure	2.1 Reliability of ICT	3. Organization (company) culture	(Zou & Seo, 2006; Al-Yahya, et al., 2017; Weng Lou & Alshawi, 2009)
			4. The capacity and skills of IT department and involvement in development of organization	(Salleh, et al., 2010; Expert-1a, 2018)
			1. Standardization of technology (vs ad hoc implementation)	(Rankin, et al., 2006; Weng Lou & Alshawi, 2009; Al- Yahya, et al., 2017)
			2. Compatibility issues	(Eadie, et al., 2007; Khalil & Waly, 2015; Al-Yahya, et al., 2017)

		2.2 Reliability of ICT	1. Support of organization internal communication and collaboration	(Weng Lou & Alshawi, 2009; OECD, 2013; Expert-1b, 2018; Expert-2, 2018)
	3. Skills	3.1 Competence of staff	1. Academic qualification of procurement staff	(Expert-1a, 2018; Salleh, et al., 2010)
			2. Sufficient staff skills (technical expertise)	(Weng Lou & Alshawi, 2009; OECD, 2016; Al-Yahya, et al., 2017)
			3. Staff ICT experience	(Isikdag, et al., 2011; Al-Yahya, et al., 2017)
			4. e-Tendering knowledge of staff	(Al-Yahya, et al., 2017)
		3.2 Extent of staff training	1. Regular training is offered by organization	(Zou & Seo, 2006; Eadie, et al., 2007; Weng Lou & Alshawi, 2009; Khalil & Waly, 2015; Isikdag, et al., 2011; OECD, 2016)
			2. Training on new technologies	(Weng Lou & Alshawi, 2009; Al-Yahya, et al., 2017)
C. Usage sub index	4. Business usage	4.1 ICT use for business-to-business transactions	1. ICT utilization in B2B transactions	(Issa, et al., 2003; Baller, et al., 2016)
		4.2 Utilization of Integrated Business Applications (e.g. ERP)	2. Organization utilizing Business Applications (e.g. ERP)	(Interagency Procurement Working Group (IAPWG), 2012; Expert-1b, 2018; Expert-2, 2018)
C. Impacts sub index	5. Business impacts	5.1 ICT impacts on business models	1. impacts on Business Model	(Baller, et al., 2016)
		5.2 Impact of ICTs on new organizational models	2. ICT support for collaborative work environment	(Weng Lou & Alshawi, 2009; Baller, et al., 2016; Al-Yahya, et al., 2017; OECD, 2013)

Table 5-6 Overall structure of the model and supporting reference ⁴³

⁴³ Source: Author

	A. Environment subindex		B. Readiness Subindex				C. Usage subindex		D. Impacts subindex			
	1. Business Environment Pillar		3. Skills Pillar				4. Business usage pillar		5. Business impacts pillar			
	Local competition indicator	Work Environment indicator	Reliability of ICT indicator	Competence of staff indicator				Extents of staff continuous training indicator	ICT use for B2B transactions indicator	Utilization of Integrated Business Applications indicator	ICT impacts on business models indicator	Impact of ICTs on organizational models indicator
Organization's view of the ICT adoption and the improvement of market competitiveness	●											
Organization's management position on technology		●										
Commitment and support of the organization's management to technology				●								
Level of development of organization's IT/IS					●							
Qualifications and skills of owners of the business process						●						
Organization's commitments to the training of their staff							●					
ICT utilization in Business Transactions								●				
Level of development of organization's ICT based business solutions										●		
The impact of the organization's ICT adoption											●	●

Adapted / Adopted from NRI
 From expert interview

Figure 5-3 Overview of the final research validated model and correlation to model themes ⁴⁴

⁴⁴ Source: Author

5.10. Conclusions

At this point, the first three goals of this research had been reached. The second phase of model development has been carried out. During which, model construction of the preliminary model utilizing drivers and barriers of the implementation of e-Procurement, and the previous researches is conducted. A cross check of the developed model against the model theme is performed.

Validation of the significance of model themes and elements are performed in two main steps;

- Validation with literature reviews and previous researches which is performed during the second phase of model construction
- Validation of model theme with expert interviews. Interview questions developed through interview protocols were utilized to conduct Interviews with experts from the construction industry. The model theme and a set of model elements were validated accordingly.

The validated e-Readiness assessment model is consisting of nine indicators categorized in five pillars and four major subindexes; Environment subindex, readiness subindex, usage subindex and impacts subindex, and eighteen assessment elements as shown in Table 5-6

Chapter 6. Methodology for applying the Assessment Model

In this chapter, a methodology for implementing the assessment model will be presented and structured. While several organization assessment models similar to the EFQM exist, assessing e-Readiness differs in terms that it is not a certification on its own. e-Readiness assessment models is aiming for the evaluation of the actual readiness of a construction organization and identify and weaknesses and areas of improvement in preparation for the adaptation for the adoption of e-Procurement technology.

Construction organizations are known for pragmatism (Rankin, et al., 2006) and the focus on profit (Expert-1a, 2018). According to an expert in the field of construction, e-Procurement in Egypt will never be implemented unless organizations feels compelled to adopt either to 1) remain competitive in the market, or 2) realizing the benefits of the adoption (Expert-1a, 2018). Therefore, any drive to for the adoption of e-Procurement must be managed by the government in line with the recommendations of researchers (Bausà Peris, et al., 2013; McIntosh & Sloan, 2001; Khalil & Waly, 2015; Eadie, et al., 2007; Issa, et al., 2003) and other publications (EU, 2005). The establishment of a central procurement agency, similar to the GAEB in Germany seems pivotal for the adoption according (OECD, 2016; Expert-1a, 2018; McIntosh & Sloan, 2001). General responsibilities of the agency are shown it the following Table 6-1;

Task	Support
Develop and manage governmental e-Procurement platform, with; <ul style="list-style-type: none"> • Create construction standards for governmental construction projects • The creation data exchange format for bill of quantities 	(Beauvallet, et al., 2011; Expert-1a, 2018; GAEB, n.d.; GAEB, n.d.)
Receive request to register and allow access to the e-Procurement platform	(Beauvallet, et al., 2011)
Administer the assessment model for organizations	-
Prepare improvement plans for the construction industry, and for individual construction organizations	EFQM, GPIS ⁴⁵

Table 6-1 Tasks of Central Procurement Agency ⁴⁶

⁴⁵ (Salleh, et al., 2010)

⁴⁶ Source: Author

6.1. Assessment cycle

The main and subtasks of assessment are proposed in the following tabulation, which is based on the European Foundation for Quality Management (EFQM) assessment cycle ⁴⁷;

ID	Task	Subtask
01	Planning the Assessment	<ul style="list-style-type: none"> • Design the assessment • Develop the assessment questions based on the assessment model • Selecting the suitable assessment tool
02	Conducting the Assessment	<ul style="list-style-type: none"> • Deliver the assessment model
03	Analyzing results	<ul style="list-style-type: none"> • Benchmarking, analyses of the results of the assessment. • Presenting findings • Identify areas of improvement
04	Proposing improvement plan	<ul style="list-style-type: none"> • develop a tailored improvement solution based on analyses findings

Table 6-2 Tasks and subtasks of the assessment process ⁴⁸

6.2. Assessment process

The assessment cycle is reflected in the assessment process which is initiated upon receiving the request for registration and implement the digital process, the request and submitted documents will be subjected to evaluation and confirmation. A team of expert will review the submitted applications and determine the type of evaluation required. A site visit may be required to validate the application clarify site visit issues ⁴⁹ raised during the visit. Assessment shall be conducted according to the assessment model to determine the level of readiness, present finding and accordingly, the following;

- Allowing implementation of e-Procurement, if organization was found to be ready.
- Identify areas of improvement and propose action plans if organization was found not ready.

⁴⁷ Source: (EFQM, 2013)

⁴⁸ Source: Author

⁴⁹ Source: (Porter & Tanner, 2004, p. 178)

Figure 6-1 reflects pilot process of the assessment procedure, in line with the assessment cycle, in comparison to the EFQM process shown in Figure 6-2

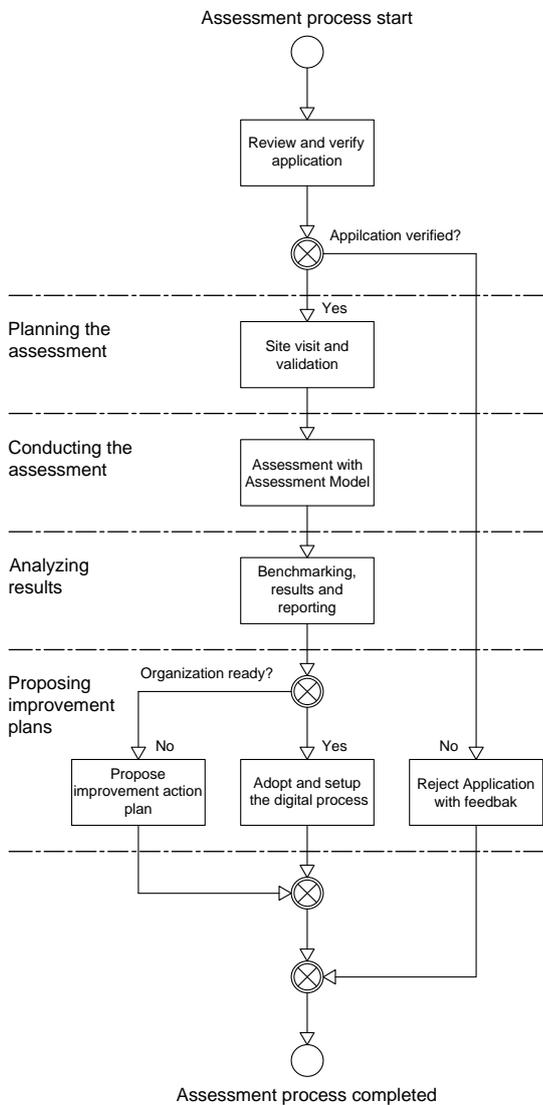


Figure 6-1 Assessment pilot process ⁵⁰

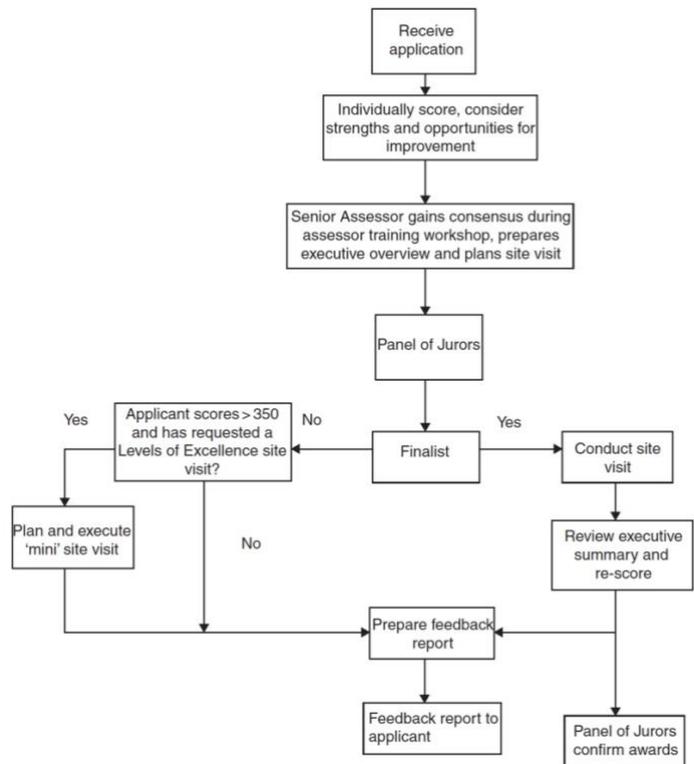


Figure 6-2 Evaluation against the EFQM Excellence ⁵¹

Assessment tools, scoring and benchmarking, and presenting the assessment results will be discussed in the following sections

⁵⁰ Source: Author

⁵¹ Source: (Porter & Tanner, 2004, p. 179)

6.3. Assessment tools

The Networked Readiness Index used as a base for the development of the assessment model utilized the Executive Opinion Survey (EOS) to fulfill half of the indicators of the model, the remaining indicators were fulfilled from information gathered from data from international organizations including the International Telecommunication Union, UNESCO and other UN agencies, and the World Bank (Baller, et al., 2016). The following Figure 6-3 reflects the NRI data sources;

<p>2nd pillar: Business and innovation environment</p> <p>2.01 Availability of latest technologies In your country, to what extent are the latest technologies available? [1 = not at all; 7 = to a great extent] 2014–15 weighted average</p> <p>Source: World Economic Forum, Executive Opinion Survey, 2014 and 2015 editions</p> <p>2.02 Venture capital availability In your country, how easy is it for start-up entrepreneurs with innovative but risky projects to obtain equity funding? [1 = extremely difficult; 7 = extremely easy] 2014–15 weighted average</p> <p>Source: World Economic Forum, Executive Opinion Survey, 2014 and 2015 editions</p>	<p>2.05 Number of procedures required to start a business Number of procedures required to start a business 2015 A <i>procedure</i> is defined as any interaction of the company founders with external parties (e.g., government agencies, lawyers, auditors, or notaries).</p> <p>For details about the methodology employed and the assumptions made to compute this indicator, visit http://www.doingbusiness.org/methodology/starting-a-business.</p> <p>Source: World Bank/International Finance Corporation, <i>Doing Business 2016: Measuring Regulatory Quality and Efficiency</i>; http://www.doingbusiness.org</p> <p>2.06 Intensity of local competition In your country, how intense is competition in the local markets? [1 = not intense at all; 7 = extremely intense] 2014–15 weighted average</p> <p>Source: World Economic Forum, Executive Opinion Survey, 2014 and 2015 editions</p>
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Figure 6-3 NRI Data Collection – EOS and data from international organizations ⁵²

Evidently, a questionnaire remains one of the frequently used data collection tools by researchers (Saunders, et al., 2009). However, delivering a questionnaire that is able to serve the purpose of any study requires the careful design of the questions, the proper explanation of the purpose of the questionnaire (Saunders, et al., 2009, p. 362; Expert-1a, 2018), initial trials, and finally the careful planning and execution of the questionnaire (Saunders, et al., 2009, p. 362). A self-administered internet-based questionnaire is recommended as Saunders, et al., 2009 as it “offers greater control because most users read and respond to their own mail at their personal computer” (Witmer et al. 1999 cited in Saunders, et al., 2009, p 363). However, the main disadvantage found is the possibility of discussions among possible respondents may influence answers (Saunders, et al., 2009, p. 365).

⁵² Source: (Baller, et al., 2016, p. 272)

EFQM indicated that although the self-assessment tools require little effort to complete, they remain very objective, and not supported with evidence (EFQM, 2013). Currently, the EFQM offers variety of assessment tools. Clearly, the more complex the assessment tools is, the more resources demanding and more accurate the results are (EFQM, 2013), as reflected in Figure 6-4

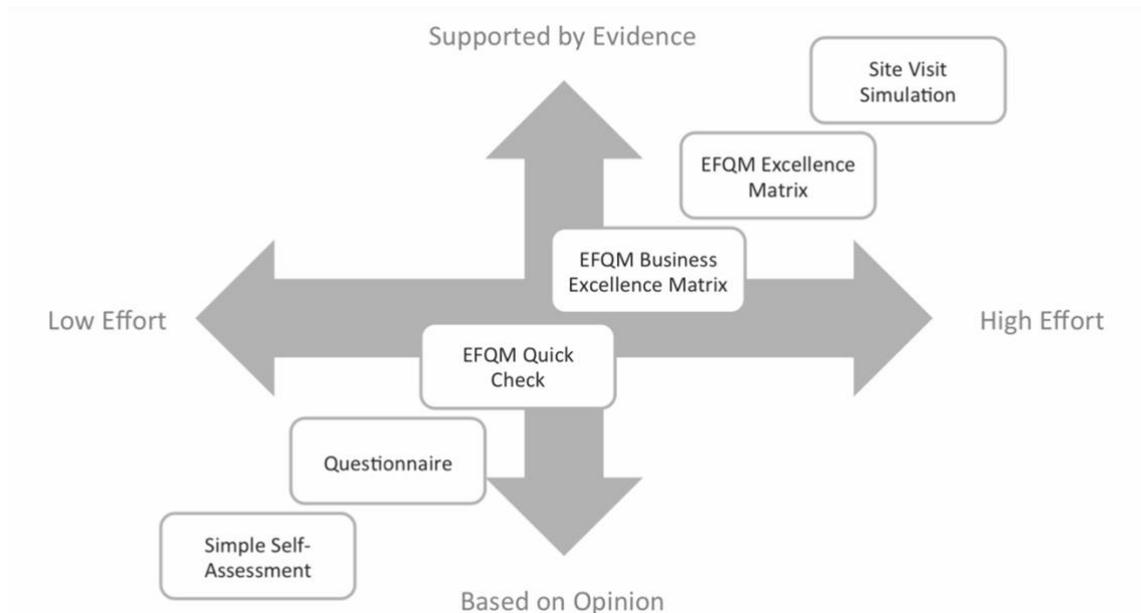


Figure 6-4 EFQM assessment tools and relation between level of efforts, and the support of findings⁵³

Assessment questions however, should be carefully designed. An expert also suggested that the questions should (Expert-1a, 2018) ;

- Use simple language and avoid jargon
- Predetermined answers should be clearly identified. Generic question that depend on respondent's own understanding should be avoided

According to the same expert, the questions similar to the NRI reflected in Figure 6-3 are not favorable are they are not specific and requiring the respondent to correspond a variable to a scale base on respondent's interpretation, which is time consuming, challenging (Expert-1a, 2018), and resulting in inaccuracies of assessment results.

⁵³ Source: (EFQM, 2013)

6.4. Benchmarking

A guideline for benchmarking may be found in efforts to determine a quantitative evidence of performance for the BIM maturity model. Kam, 2012 stated that instead of suggesting a theoretical idea of the highest score, it was elected that the survey is to be based on the best proven example of an innovative practice found worldwide, representing the highest end of the score (Kam, 2012). The scoring is based on a percentile system where each project will be assessed against the industry norm and converted into an industry percentile ranking (Stanford University's Centre for Facility Engineering, n.d.), as reflected in the following Figure 6-5



Figure 6-5 VDC Scoring⁵⁴

6.5. Presenting the assessment results

The scoring values (high and low) do not have visual significance unless represented graphically with tools as bar charts that can provide a more accurate representation and visual clues (Saunders, et al., 2009, p. 431). Instead of utilizing the spider diagram adopted by the NRI as shown in Figure 3-2, representation of organization's assessment results may borrow the bar chart method from the bimSCORE model shown in Figure 3-5. Bar charts offers the benefits of presenting the information to decision makers in a comprehensible way indicating areas of improvement (Strategic Building Innovation, 2018) on both pillar and subindex levels, as in the following Figure 6-6;

⁵⁴ Source: (Stanford University's Centre for Facility Engineering, n.d.)

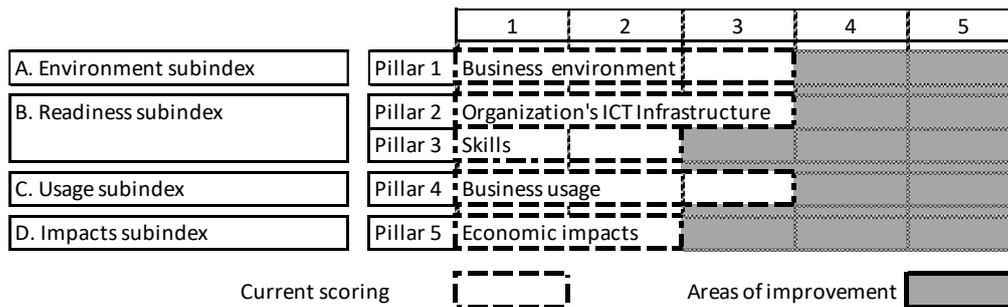


Figure 6-6 Assessment Model scoring⁵⁵

6.6. Recommendations for the improvement of organization's e-Readiness

Without taking the assessment model to practical test, it may be challenging to foresee and pinpoint the actual issues to be addressed. However, Rankin, et al., 2006 suggested to address the organizational capacity by focusing on the readiness of each individual firm, increasing awareness and offering training on new technology (Rankin, et al., 2006). Addressing each organization individually with improvement plans may be challenging and therefore, a multi-tier plan based on the correlation between organizations' grading set by the Egyptian Contractors Federation and level of readiness may prove feasible to improve the overall readiness, as one expert suggested that organizations of different grades will have different levels of readiness (Expert-2, 2018).

Staff skills is an important element that any construction organization should consider (Al-Yahya, et al., 2017). To acquire new skill and expertise, it is imperative for construction organizations to rethink their position in the education process and become a learning organization as well (Kajewski & Weippert, 2004). Furthermore, Kajewski & Weippert, 2004 indicated the importance of tertiary education, specifically undergraduate / postgraduate courses are required to *"develop and support the understanding of how to accept, evaluate and implement technological change and innovation"* (Kajewski & Weippert, 2004, p. 7). Aspects related to tertiary education are among indicators NRI is assessing to evaluate the overall readiness of any economy (Baller, et al., 2016).

⁵⁵ Source: Author

Technical standardization is another important field a construction organization should consider (Al-Yahya, et al., 2017). Technical standardization maybe addressed in two main aspects;

- Implementation of ICT within organization; the utilization of integrated business solutions (e.g. ERP) is extremely important enablers for the adoption of e-Procurement (Expert-2, 2018). The poor IT planning and ad hoc implementation is an important factor for technology resistance within organization (Jaafar, et al, 2007, cited in Al-Yahya, et al., 2017). A standardization and specifications for implementation are required to provide a guideline for any organization aiming to adopt business applications. Any assessment should make recommendations pertaining to the current level of organizational readiness.
- Standardization of procurement process and terminology; the lack of standard is a barrier to the adoption according Rankin, et al., 2006 and Weng Lou & Alshawi, 2009. This may be linked to the importance of an organization being an active participant in the education and training of professionals that was discussed earlier.

Finally, the smooth introduction and transition into the new technology assisted by the promotion of benefits of the adoption, supported and enabled by training programs and workshops, and the continuous monitoring and evaluation of the adoption of the technology are the main points proposed by Rankin, et al., 2006 for the implementation of new processes.

6.7. Conclusions

To adopt e-Procurement technology in the construction industry it is important to introduce a central procurement agency, similar to the GAEB, to supervise and manage the adoption. The central procurement agency is tasked – among others – to take the assessment model into practice. An assessment process that was derived from the EFQM is proposed, along with the assessment tools and scoring and benchmarking. A correlation between construction organization grading and own readiness scoring may be beneficial to allow the categorization of construction organizations based on their grading a level of readiness and enabling development a multi-tier improvement plan targeting each category band.

Recommendations reiterated the importance of the education and training to create an environment that is accepting the technological innovation, and that organizations themselves should transform into education organization to gain the required expertise and addressing the human aspect of the soft issues preventing the adoption of technology. Finally, the sound planning and implementation of ICT are the standardization of both technology and process are very important enablers of the technology.

Chapter 7. Conclusions and recommendations for future researches

7.1. Conclusions

Review of e-Procurement to establish the importance of incorporating the new technology into the construction industry and identify areas of traditional procurement that is supported by ICT has been conducted. Research papers have been reviewed to identify benefits of the adoption into construction industry. Publications focusing on the MENA region and Egypt in have been reviewed to establish to status quo pertaining to the governmental efforts to implement e-Government programs and the challenges facing those efforts. While the poor ICT infrastructure was suggested as a main barrier, data from MENA region are suggesting that the current ICT infrastructure is improving. The use of internet in the MENA is within the world average, indicating that a major barrier is being addressed. The Identified benefits, drivers and barriers of the e-Procurement adoption have been classified into model themes to enable the development of assessment model and facilitate the validation process.

The term e-Readiness has been introduced and defined as the measurement of how capable an organization to adopt and benefit from technologies. Literature review was performed to establish the importance of performing an e-Readiness assessment of construction organization prior to the implementation of technology project to avoid dealing with the consequence of the improper adoptions in terms of the overbudgeting and the possible failure and total abandonment of the project. Researchers identified the soft issues - people and technology - as the main barriers to the adoption and therefore must be evaluated and addressed. A review of the existing models has been conducted to establish the state of the art. Reviewed modes included the GPIS, the eTRM model based on GPIS, and the NRI recommended by researchers for the construction industry.

A review of BIM maturity models has also been conducted. Models reviewed are the BIM excellence (BIMe) and the bimSCORE. An overall review, SWOT and Value Benefit analyses had been conducted to determine the most suitable model to be utilized as a base model for further development into a conceptual assessment model. As result of analyses, Networked readiness index was found the most suitable model for further development and was selected as a base model for this research.

Model development has taken place into two phases; In the first phase, the base model has been reviewed to identify areas of adoption and adaptation. To enable the adoption, a matrix to correlate base model elements to model themes identified earlier in the research to had been developed. Phase I resulted in the preliminary model that was further developed in phase II. During Phase II, the assessment model was built with extensive literature review. Another matrix to correlate the developed model to the model themes had been developed.

Validation of the model has been carried out in two steps; The first validation is performed with the support of literature during the second phase of model development. Further validation of the overall model and elements has been performed with experts' interviews. Semi-structured interview was elected for the benefits of offering the insight into the reasons behind opinion of interviewees and the limited time frame to conclude the research. In the first step of validation, the overview of the developed model has been utilized to develop a protocol for the interview. During which, interview questions corresponding the model themes were determined. An interview with an expert from the Egyptian construction industry was conducted to validate model theme. The interview resulted into identifying additional elements deemed important for the assessment. The identified elements are relating to the following;

- The skills and capacity of the development within the organization
- The academic qualification of the procurement staff

During the second step of validation, an interview protocol was developed from the set of identified model sub indicators requiring validation. Interview questions were developed from protocol. Two semi-structured interviews were conducted with experts from the construction industry. Both interviewees seem to agree on the insignificance of assessing the organization's internal IT/IS capacity as Egypt and the MENA region are witnessing a general improvement in the IT/IS infrastructure.

Findings of the interviews were summarized and used for further refinements to the assessment model. The final conceptual model presented at the end of chapter 5 is assessing the construction organization in four key areas;

- Organization Environment
- Organization's readiness
- Organizations ICT usage
- Impacts of organization's adoptions of ICT

Recommendations for a methodology to implement the assessment model were put forward in chapter 7. For that purpose, the introduction of the regulating centralized government procurement agency is deemed necessary as concluded from the expert interview. The agency shall be tasked, among others, to conduct the assessment of construction organizations wishing to implement e-Procurement. Assessment shall be performed according to predefined steps in the assessment cycle and reflected in the assessment process, both based on the European Foundation for Quality Management (EFQM) processes. Furthermore, a general overview of the assessment tools has been conducted, along with a methodology for benchmarking based on the bimSCORE.

Finally, recommendations for the improvement of e-Readiness of construction organizations had been put forward. Recommendations focused on the following;

- The importance of the education and training, and the necessity that organization should rethink their and consider investing into the further training of personnel
- Standardization of both technology and business process
- The "soft" approach to technology emphasizing the importance and the benefits of the adoption of e-Procurement.

7.2. Recommendations for future researches

This thesis puts forward a conceptual assessment model for the use in assessing Egyptian Construction Organizations' readiness, identifying areas of strengths and weakness within the organization, as originally indicated in the assumptions and constraints of the research. The presented model remains theoretical. Although steps to validate the model theme and elements were carried out, validation relied on literature review and semi-structured interview which may limit the response of the interviewee to the questions being asked. Opportunities to identify other aspects significant to evaluation may exist. Moreover, due to fast development and the expansion of the uptake of ICT in various forms and projects, aspects of the assessment may change in significance; Important significant factors may appear, while others may lose importance. This dynamic is necessitating the periodical revision for the improvement and optimization the model.

Finally, further research into the following areas in relation to the assessment are recommended;

- Identification of further elements deemed significant to assess the Egyptian construction industry, and further refine model accordingly.
- Verify and validate the assessment process proposed in this research
- Design and validate the actual assessment tools. Tools should be very well defined and very specific and avoid ambiguities, and generalities.
- Benchmarking to determine the ends and the intermediate steps of the assessment spectrum, and corresponding each to improvement measures.
- Design an evaluation system for the model based on the successive aggregation from model elements up to the overall scoring.

Declaration of Authorship

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

July 19th, 2018

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Date

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Signature of the student

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Appendices

Appendix 1 – Communication with GAEB professional

Saturday, June 9, 2018 at 4:54:43 PM Central European Summer Time

Subject: AW: Assessment model

Date: Wednesday, 21 February 2018 at 13.11.30 Central European Standard Time

From: [REDACTED]

To: 'Sameh Mahdy'

Dear Mr. Mahdy,

As far as I understand your request I would say GAEB does not fulfil the criteria of a model for assessment concerning the e-readiness for e-tendering.

GAEB provides two major products: On one hand we are creating generic standard specifications for construction work/products that are mandatory for federal building projects. On the other hand GAEB is the German neutral data exchange format for bill of quantities that is used during the whole procurement procedure and during the construction phase until invoicing. It is mandatory for federal building projects and also for most of the state projects. This includes also the tendering phase. It is used by 90% of the participants of the tendering process in the German construction industry.

Concerning the e-tendering in Germany the use of e-tendering platforms (down- and upload of procurement documents will be mandatory from 2018 for most of the public projects. In principle the GAEB formats are used for the exchange of bill of quantities and tenders on these e-tendering platforms. All federal building administrations and also these of the 16 states have e-tendering platforms in use. Most of them can be used with client software that is usually free.

I hope the information clarified what the purpose of GAEB is and how it is connected to e-tendering.

Should you need any further information, please do not hesitate to contact me.

Kind Regards

[REDACTED]

Federal Office for Building and Regional Planning
Division II 4: Building, Construction Industry, GAEB
Deichmanns Aue 31-37
53179 Bonn

Tel.: [REDACTED]
Fax: [REDACTED]

[REDACTED]
www.bbr.bund.de

Appendix 2 – Expert Interview 1a for validation of main themes of assessment model

A semi structured phone interview was conducted on June 26nd, 2018 with an expert from the Egyptian construction industry whom has accumulated a total of 33 years of experience, of which, 11 years are spent with the same organization – a first grade construction contractor based in Alexandria. Currently, the expert is in the position of Projects Manager. Interview was conducted in Arabic language. The following is transcript of the interview.

Interviewer: Thank you. Allow me to start with the first question. What are your opinions on the importance of assessing organization's view of market competitiveness and the adoption of ICT technology?

Interviewee: This must be assessed. An organization is always directed into a path in it must follow that is dictated by the market conditions. This is also true in the case of adoption the technology and switching from the paper-based to paperless operations, and appreciate the benefits, or feel obliged to adopt technology to avoid being left behind of the market.

Interviewer: How about assessing the organization's management perception of technology? How important is that?

Interviewee: Very important. However, the researcher must understand and appreciate the mentality of the construction organizations. Construction organizations are always seeking profit, the faster and less effort-intensive profit. However, construction organizations are operating in an industry that has own characteristics and governed by the quality-time-cost trio. Understanding the mentality of construction organization and addressing that in own terms is very important.

Generally, there are two types of organizations; the first type is concerned in the investment and development as a long-term investment, the second type is more concerned with the immediate profit, and therefore tend to have a shorter cycle of planning.

Interviewer: How about the commitment and support of the organization's management to technology?

Interviewee: Very important, but equally important is the knowledge and the capacity of the development team within the organization and their strong argument in favor of the

adoption. On the other hand, the management must have the necessary knowledge that is based on experience and the willingness to modernize their organizations. This can be seen in two examples, the first is related to BIM; while some organizations are realizing the benefits of BIM and investing into it, others are just utilizing it for its powerful presentation capacity. Other organizations are completely rejective of the idea and still operate traditionally. Another example is the ISO certification, some organization are invested into ISO to achieve the required quality, other organizations are simply seeking the certification, while others are completely uninterested.

Interviewer: How significant is the assessment of organization's adopted IT/IS?

Interviewee: This is very important. To imagine the adoption of an organization that has no IT/IS capacity is ridiculous. An organization that has no server and runs no web site, is incapable of the adoption. On the other hand, an organization that is interested in the development of their own internal infrastructure is on a higher level of readiness than others. An example of that, if we are to imagine the introduction of a new software into an organization, the users must have a previous experience in similar environment and must possess that capacity to adopt and learn the new skills required for the that new software.

Interviewer: How about the staff skills?

Interviewee: Important, but not 100% important. Skills may be acquired with training. More importantly is having the minimum level academic qualification. Training can always be provided if an organization decided to adopt a new technology or a process. For example, a couple of years ago, my organization decided to invest in a warehouse management platform at the value of roughly EGP 350,000 ⁵⁶. At the time, skills to operate the new platform were nonexistent, therefore the organization initiated a training program targeting accountants in HQ, this is followed by another training program for the accountants on different sites, and then training the storekeepers. As the decision was made adopt the new platform, the management decided to invest into training the qualified people. Qualification also implies the experience and the capacity to learn.

⁵⁶ Equals to Euro 35,000 at the time

Interviewer: This would lead to the next question; how do you feel about assessing organization's commitment to the training of their staff?

Interviewee: Very important aspect to be assessed and complements the pervious point. An organization will always benefit from staff training should it decided. An organization may decide to provide training on their own, or attract professional that are capable to provide the training. Sometimes, a combination of the two approaches is adapted.

Interviewer: You previously mentioned that your organization have decided to adopt a warehouse management system. How do you feel about assessing the level of development of organization's ICT based business solutions?

Interviewee: Very important. An organization that is willing to adopt a platform is definitely ready to adopt another platform. An organization that is keen on such adoption is always have a higher level of readiness. Similarly, the number of the original software that an organization has, the training programs offered and the concern with ISO certification, are all aspects revealing the organization's character. Also, an organization realizing the importance of the intellectual properties and respecting it, and appreciating of the benefits of having the original non-pirated software, is an organization that is having a higher level of readiness

Interviewer: How about the utilization in the Business to Business transaction?

Interviewee: Important. However, to assess that, it should be made clear what is the Business to Business transaction, and not to leave that to respondent's own interpretation. Such transactions may indicate a) information exchange b) exchange of specifications or c) data transfer. Any assessment should make a clear indication of intentions and avoid jargons and clichés.

Interviewer: And what are the impact of the organizations ICT adoption?

Interviewee: Also Important, and my previous comment also applies here. An assessment should be very specific and to the point, and the language should be easier to understand and comprehend bey the respondent.

Appendix 3 – Expert Interview 1b for validation of sub indicators of assessment model

A semi structured phone interview was conducted on May 25th, 2018 to validate sub indicators of assessment model. The interviewee is an expert from the Egyptian construction industry whom has accumulated a total of 33 years of experience, of which, 11 years are spent with the same organization – a first grade construction contractor based in Alexandria. Currently, the expert is in the position of Projects Manager. Interview was conducted in Arabic language. The following is transcript of the interview.

Interviewer: In Egypt, to assess the overall construction organization readiness, in your own views, how important is it to assess the measure the speed and capacity of internet connection for large volumes of data transfer?

Interviewee: If we are talking about readiness, organizations are generally ready. Investigating those points is irrelevant. Egypt has witnessed remarkable improvement in the ICT infrastructure and any construction organization will invest into that if interested. Organization's policy and its size are the key elements here, especially when having branches in different cities. For example, when exchanged data is large, organization will rely on cloud storage services, and this is already happening today in most medium and large construction organization. Therefore, I do not see the significance of investigating the that, unless the assessment is being carried out in a developing economy

Interviewer: How about investigating ICT's capacity to support the organization internal communication and collaboration?

Interviewee: This element complements the previous elements, and it is important to investigate. This is a management decision; a large organization is forced to invest into this technology to facilitate the communicating between different parties. For instance, I used to depend heavily on outlook, but now and for so many reasons, I feel it is necessary to improve and develop our systems.

Interviewer: And how about investigation the organization's utilization of ERP? Is a that significant?

Interviewee: I really cannot provide any feedback on this particular point. I have never used ERP, and I do not know what it is

However, I must say that e-Procurement has advantages to any construction organization, imagine the business opportunities that would become possible in a transparent environment where there is no place for personal favors or prejudice, and it will save a time. However, this can only be organized by an organizing body. Organizing body must be trustworthy because for a construction company, preparing a bid is a lengthy and costly process. A leak of any information, however small may be damaging to contractor's chances and efforts.

Appendix 4 – Expert Interview 2 for validation of sub indicators of assessment model

A semi structured phone interview was conducted on June 9th, 2018 to validate sub indicators of assessment model. Interviewee has accumulated a total of twenty-six years of experience. Interview was conducted in Arabic language. The following is transcript of the interview.

Interviewee: If we are discussing the implementation of e-Procurement, then we should not dismiss that there are interlinking participants, mainly; the supplier, the contractor and the consultant. Consultants have a vital role to play, as they are the ones setting the construction project and building materials specifications. Those specifications should be in accordance to what is available in the market.

On the other hand, other aspects should also be considered, the ICT infrastructure and the legislation. Legislations and regulations are the key. Also, implementation of the e-Procurement may necessitate the introduction of contracting standards, for example, the FIDIC.

Interviewer: Thank you for the insight. Legislation and regulations as barriers have been discussed in this research. The research, however, is focusing only on the assessment of construction organization readiness. But since we started discussing the ICT infrastructure, how significant is the evaluation of organization's internet connections speed and capacity for data transfer in the scope of assessing the overall readiness of the organization?

Interviewee: This maybe not very important. However, if we are talking about the evaluation of small organizations that is not classified. Such organizations usually neglect investment into IT/IS.

Interviewer: The research is focusing on classified construction organizations that are working on government projects.

Interviewee: Then this is not important. But please bear in mind that if e-Procurement is aimed for global implementations, not a national one, then those two elements are important to investigate. Also, note that ERP requires certain network performance characteristics that will have to be available in an organization beforehand. ERP is the key stone for any e-Procurement implementations. E-Procurement means the electronic purchase based on the

exchange of information facilitated by ERP. If the ERP is non-existing, that means the organization is not ready for the adoption of e-Procurement. ERP also facilitates the exchange of information within the organization, between the organization and suppliers.

Interviewer: How do you feel about the importance of assessing collaboration enabled by organizations' adoption of the ICT?

Interviewee: This point is very important for the research. The lack of collaboration is very much against the idea of e-Procurement. I also would like to mention some points relating to e-Procurement.

I would like to mention that e-Procurement requires high investment by all parties involved, and dealing with parties that have implemented this system means an increase in cost and higher prices in the short run. But in the long run, as the level of adoption increases, it may prove beneficial. Also, one will have to discuss the advancement taking place in the field of engineering applications, for example, BIM. Such developments are positive and considered enablers to the smooth adoption of e-Procurement. e-Procurement improves performance and saves time and efforts and minimizes waste. However, all this must be supported by proper legislation and infrastructure.