

E-PROCUREMENT USE IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

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SUMMARY: *The advent of internet technology has resulted to increasing use of e-Commerce applications, particularly e-Procurement systems in supply chain management by firms across the different industrial sectors. However, there is a paucity of empirical studies on e-Procurement use in the construction sector of African countries. This study therefore investigated the use of e-Procurement in the South African construction industry. The data were derived from an online questionnaire survey involving 603 respondents and interviews with seven experts conducted in South Africa between March and July 2014. Descriptive statistical and content analyses were used to analyse the data. Findings show that the four categories of e-Procurement used were e-mail, static websites, web.2.0 technologies and portals that have capabilities of supporting the execution of functions limited to intra and inter firm communication and exchange of project information and data. Consequently, between 11 percent and 12 percent of the respondents used these e-Procurement technologies for communication of information, exchange of bill of quantities, CAD drawings and project specifications. Whereas the factors with the highest positive impact on the use of these technologies in the firms were the speed of transactions, lower transaction cost and ease of use; unreliable IT infrastructure, established cultures and security concerns were the main impediments to the uptake of these e-Procurement technologies in the South African construction industry. The study implies that construction firms in South Africa predominantly use e-mails and websites to support the execution of pre-award phase of construction procurement; and that the factors that affect the adoption of these e-Procurement technologies in the South African construction industry can be explained using Rogers's diffusion of innovation theory. It also implies that in addition to technological issues, culturally related challenges are hampering the adoption of e-Procurement in the South African construction industry. The study suggests that to accelerate the rate of uptake of e-Procurement and maximize its benefits in the South African construction industry, there is a need to improve the quality and quantity of ICT infrastructure across the country; and to embark on aggressive enlightenment campaigns, training and skill development programmes in the use of e-Procurement in the construction industry in this country. It also suggests that future studies be carried out to identify how the existing e-Procurement technologies and tools can be innovatively used to suit the needs of the construction sector and people of diverse cultures.*

KEYWORDS: *e-Procurement, e-Procurement Technologies and Tools, Construction industry, Survey, South Africa*

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1. INTRODUCTION

E-procurement is the use of electronic communications and transaction processes when buying supplies and services or conducting tendering for works (Bausa *et al.*, 2013). The UN Procurement Practitioner's Handbook UN (2006) identified two main phases in the e-Procurement process. These are the pre-award phase comprising e-Notification; e-Submission; e-Evaluation; and e-Awarding; and the post-award phase consisting of activities such as e-Ordering; e-Invoicing; and e-Payment. Each activity in these two phases can be executed using a wide range of e-Commerce communication media and/or e-Procurement technologies and tools (Hashim *et al.*, 2013; Laryea and Ibem, 2014).

Studies (Puschmann and Alt, 2005; Gunasekaran and Ngai, 2008) have indicated that the use of e-Procurement to support the execution of procurement activities in the different industrial sectors has been on the increase since the mid-1990s when the web and e-mail services of the Internet became popular. Teo *et al.* (2009) linked this to the strategic, opportunistic and operational benefits of e-Procurement in supply chain management. In the construction industry, the existing studies (Rankin *et al.*, 2006; Eadie *et al.*, 2007; Eadie *et al.*, 2011) provide insights into the actual use; benefits; and the challenges of e-Procurement in developed countries. Eadie *et al.* (2010a) however observed that the use of e-Procurement in the construction industry has not been adequately researched. This is particularly evident in African countries, where e-Procurement adoption is at its nascent stage. Apart from the studies on the potential applications of e-Commerce in the South African construction industry (Chege *et al.*, 2001) and e-Tendering in Nigeria (Oyediran and Akintola, 2011), there is a paucity of published empirical studies on e-Procurement in construction supply chain management; and the key issues associated with it in the African context. As a result, very little is known of e-Procurement use in the construction sectors of African countries.

Therefore, the aim of this study was to investigate the use of e-Procurement technologies and tools to conduct construction procurement activities related to e-Notification; e-Exchange of project information and data; and e-Submission of tender/bids or proposals by South African construction firms. The study sought to address the following research questions:

- i. Which categories of e-Procurement technologies and tools are more widely used to execution e-Notification, e-Exchange and e-Submission aspects of construction procurement by firms in South Africa;
- ii. How are e-Procurement technologies and tools used to support the execution of these three construction procurement activities;
- iii. What are the factors that have positive influence on the use of e-Procurement technologies; and
- iv. What are the key challenges associated with the use of the identified e-Procurement systems and tools in the aforementioned aspects of construction procurement process in South Africa?

This study contributes to knowledge by providing a fresh insight into the e-Procurement technologies most widely used; and how they are used to support the execution of three specific aspects of construction procurement activities: e-Notification, e-Exchange and e-Submission in South Africa. It also identifies and analyses the key factors and challenges associated with the adoption of e-Procurement in three specific areas of construction procurement process in South Africa. The remaining part of this paper is divided into four sections. The first section is the review of literature, followed by the presentation of the research methods. Next are the presentation of result, and discussion sections, respectively. The paper ends with some conclusions and recommendations.

2. REVIEW OF LITERATURE

The review of literature reveals that there are several categories of e-Procurement systems and tools in the market that can be used to support the execution of construction procurement activities (Laryea and Ibem, 2014). In terms of the number of functions e-Procurement technologies and tools can support, three broad categories of e-Procurement systems have been identified by Percy *et al.* (2008). The first category represents those that can support the execution of single function; the second group has the capabilities of facilitating integration across multiple functions within a firm; while the third category provides integration and coordination of functions across firms. Also from the existing literature, several factors are known to influence the decision to adopt the different categories of e-Procurement technologies and tools by individuals and firms. These factors have been identified and explained from the perspective of different theories and models (Al-Qirim, 2007; Azadegan and Teich, 2010). Oliveira and Martins (2011) however noted that among the existing theories, the diffusion of innovation (DOI) theory has been used to investigate technology adoption at firm/organizational level.

From the lens of Roger's (1995) DOI theory, innovation diffusion and adoption are influenced by five perceived attributes of innovation/technology. These are: (i) the relative advantage (the degree to which the innovation is perceived to be better than the existing idea, practice, knowledge or tool by a particular group of users; i.e. perceived cost and benefits) (ii) compatibility (the extent to which an innovation is consistent with the existing practice, experience, norms, needs and value system of the potential adopters)(iii) complexity (the degree to which an innovation is perceived as difficult to understand and use) (pg.242) (iv) trialability (the degree to which an innovation may be experimented with on a limited basis); and (v) observability (the degree to which the results of an innovation are visible to others) (pg. 243-244). Although Rogers (1995:206) explained that these five attributes account for between 49% and 87% of variation in the adoption of innovation, evidence from diffusion studies however shows that relative advantage, compatibility and complexity are the three attributes most consistently connected to the adoption of new technologies, ideas and processes in the different industrial sectors.

Regarding the studies on e-Procurement use in the construction industry, evidence from the published literature shows that the existing literature on the subject can be classified into adoption studies (e.g. Issa *et al.*, 2003; Rankin *et al.*, 2006); impact studies (Alarcon *et al.*, 2009); studies on the drivers and barriers (Eadie *et al.*, 2007; 2010a); e-readiness (Tran *et al.*, 2011); and e-Tendering (Oyediran and Akintola, 2011). In this section, we present a review of the existing literature on e-Procurement adoption in the construction industry. Table 1 presents a summary of the existing studies on e-Procurement use and the challenges associated with it in the construction sector.

Table 1: Summary of studies on e-Procurement in Construction

Authors	Studies	Countries	Findings
Chege <i>et al.</i> (2001).	The prospects and challenges of the applications of e-Commerce in value chain management in the construction industry	South Africa	The challenges of e-Commerce adoption in construction were: (i) how to create an enabling environment to allow SMMEs to reap the benefits of e-Commerce; (ii) security concern; (iii) taxation; (iv) legal barriers;(v) accessibility to e-Commerce systems; (vi) lack of technical standardization of e-Commerce systems
Issa <i>et al.</i> (2003)	Questionnaire survey of 91 contracting firms to determine the level of adoption of e-Business within their project management systems.	The USA	70 percent used project management software packages, 65% used Extranet/Intranet (65 percent); 60% used the Internet. Also 80% used e-mail and fax in communicating with their partners; and 55% used EDI for communication and exchange of data
IT Construction Forum (2004)	Questionnaire survey to 373 firms of contractors, specialists, designers and consultants on "IT in construction – use, intentions and aspirations in the	The UK	Most firms used the Internet to source information about construction products. Extensive use of e-mails for communications and placing orders for products/materials and services were observed.
Rankin <i>et al.</i> (2006)	Questionnaire survey of 226 of general and trade contractors, suppliers and associates on the use of e-procurement	Canada	E-Procurement activities identified were: (i) searching and finding production information (94% of the respondents); (ii) responding to bidding opportunities (77 % of the respondents); (iii) transferring bidding information and documents online (70% of the respondents). The key Challenges with e-Procurement use were: (i) integration of e-Procurement system with the existing work process and procurement system (technical) ; (ii) cost ; ownership of information used in tender process (copyright);m responsibility-roles and responsibilities during tender process; and (iii) the capacity of the entire bidding community to adopt; connectivity of bidders, accessibility to documents unhindered , download time
Zuo and Seo (2006)	A survey of 127 contractors, sub-contractors, clients, consulting engineers, suppliers, facility/asset	Australia	All the respondents used e-mail, 37% used Intranet and 30% used extranet. The activities executed by the use of these technologies were: online search; exchange of CAD drawings;

Authors	Studies	Countries	Findings
	managers and quantity surveyors on the application of e-Commerce technologies in construction supply chain		project management; placement of orders; and receiving bid invitation and tender online. The challenges were: (i) reluctance/inability to adopt computer technologies among sub-contractors and suppliers; (ii) lack of in-house technical expertise and personnel (iii) different organisational culture; (iv) lack of integrated information management system; and (v) fear of implementing a business process change
Eadie <i>et al.</i> (2007)	Web-based survey of 70 contracting firms the use of two e-procurement systems: fully web-based system and the Compact Disk Write once (CDR) in construction	Northern Ireland	The use of electronic technologies to support the exchange of contract documents between clients and contractors was identified. The challenges identified were: (i) legality e-Procurement contracts; (ii) company culture; (iii) lack of upper management support; (iv) lack of access to IT infrastructure; and (v) high cost of IT systems; (vi) lack of technical expertise; (vii) lack of e-procurement knowledge / skilled personnel; (viii) lack of business relationship with suppliers providing e-procurement; (ix) security of transactions; (x) interoperability of e-procurement systems
Eadie <i>et al.</i> (2010a)	A cross discipline comparison of rankings for e-procurement drivers and barriers within the UK construction organisations using web-based survey of 775 construction organisations, including 483 surveyors, 42 Public Sector clients, 172 Architects, 35 Private sector clients and 43 Consulting Engineers.	The UK	The UK public sector was found to be leading in using e-procurement, with 74% of organisations involved in e-procurement. The study identified the three most important drivers for UK construction organisations in both public and private sectors were Process, Transaction and Administration Cost Savings; Convenience of archiving completed work; and Increased quality through increased accuracy (i.e. elimination of errors through computer use. On the other hand the most important barriers for UK construction organisations were Prevention of Tampering with Documents (i.e. changes to documents”, followed by “Confidentiality of Information (i.e. unauthorised viewing of documents); and resistance to change
Eadie <i>et al.</i> (2010b)	Web-based survey 483 Quantity Surveyors in UK construction organizations on the drivers and barriers of e-procurement	The UK	Quantity Surveyors in the UK identified the top four barriers in that country to include: (i) prevention of tampering with document; (ii) reluctance to buy-into one off system; (iii) prove of intent-electronic signatures; (iv) enforceability of electronic contracts; and (v) insufficient assessment of systems prior to installation
Eadie <i>et al.</i> (2011)	A survey of 483 surveyors, 42 Public Sector clients, 172 Architects, 35 Private sector clients and 43 Consulting Engineers on the use of e-Procurement in the public and private sectors of the construction industry	The UK	Around 53% of the sample who were contractors and tendered for Roads Service, received between 11% and 30% of documentation in electronic form. A majority of their procurement activities was done electronically on write-once CD. The authors conclude that E-Procurement adoption rate across the UK construction industry was 27%; and that the private sector lagged behind the public sector in the e-Procurement use in construction.
Isikdag <i>et al.</i> (2011)	Web-based questionnaire survey involving 200 participants including engineers, architects and providers of e-Procurement	Turkey	The survey results show that the two technology related key barriers to the successful implementation of e-procurement in the Turkish AEC industry are related to security; both in terms of the actual security of exchanging

Authors	Studies	Countries	Findings
	services; and 22 semi-structured interviews with senior construction professionals within government and private organizations. The aim was to examine the barriers to e-Procurement in the Turkish AEC industry.		information and the mechanisms (technologies) by which the security of the information can be ensured such as digital signatures, SSL signatures. Other barriers were legal issues and the lack of rules and regulations in support of e-Procurement(legal infrastructure); and the lack of awareness towards the real benefits of e-Procurement
Oyediran and Akintola (2011)	Questionnaire survey of 66 registered quantity surveyors, architects, engineers and contractors registered on the state of the art of e-tendering in Nigeria.	Nigeria	16% of the respondents used e-mails, websites and portals to exchange contact documents; receive/disseminate tender notifications; contract documents and tenders. The challenges were: (i) irregular power supply; (ii) high cost of e-procurement systems;(iii) poor ICT infrastructure; (iv) lack of ICT skill; (v) scepticism about the systems; (vi) reluctance to change; (viii)lack of interoperability of software used by construction professionals; (ix) security issues; and (x)general ignorance of the benefits of e-procurement.
Bello and Iyagba (2013)	Questionnaire survey of 63 Quantity Surveyors in Nigeria on the barriers to e-Procurement adoption. The finding was compared with the result obtained in the study of 483 Quantity Surveyors in UK construction organizations by Eadie <i>et al.</i> (2010b)	Nigeria	The top four barriers to e-Procurement adoption in Nigeria were: (i) the lack of a national IT policy relating to e-procurement issues; (ii) other competing initiatives; (iii) prove of intent-electronic signatures; and (iv) internal and external interoperability of e-procurement software. These were compared with the findings by Eadie <i>et al.</i> (2010b) and the authors concluded that there was no significant difference in the barriers to e-procurement assessment between Nigeria and the UK.

From Table 1, it is evident that most published works on e-Procurement in construction are from developed countries; and that the research focus has been skewed towards e-Procurement systems and tools in general; and the challenges associated with their use in construction supply chain management. It can also be seen from Table 1 that one of the earliest published works on e-Procurement in construction in South Africa was a conceptual paper on the prospects and challenges of e-Commerce in value chain management in the construction industry. Although that study is related to the current study by examining the challenges of e-Commerce adoption in the South African construction industry, it is different from our study as it was based on the review of the existing literature.

Further examination of the works cited in Table 1 also reveals that except Chege *et al.* (2001) all the other studies are based on empirical data derived from questionnaire survey of construction industry stakeholders in the different countries. Specifically, the data used in the studies by Eadie *et al.* (2007; 2010a, 2010b and 2011) and Isikdag *et al.* (2011) were sourced from web-based questionnaire survey. This informs the adoption of this approach in the current study. In terms of the target population of these studies, it is evident that whereas Issa *et al.* (2003) and Eadie *et al.* (2007) focused on contracting firms only, Rankin *et al.* (2006) investigated e-Procurement use of amongst general and trade contractors, suppliers and their associates in Canada; Eadie *et al.*, (2010b) and Bello and Iyagba (2013) examined the views of Quantity Surveyors on e-Procurement. Therefore, these studies were considered relevant to the current study because they examined issues related to the drivers and barriers to e-Procurement adoption in the construction industry in the different countries. Also the studies by Issa *et al.* (2003) and Eadie *et al.* (2007) are specifically important here as they examined the different types of e-Procurement systems used (e.g. the Internet, Intranet, e-mail, EDI and CDR) and what they are used for in the construction procurement process.

The other studies reviewed (e.g. IT Construction Forum, 2004; Zuo and Seo, 2006; Eadie *et al.*, 2010a; 2011, Isikdag *et al.*, 2011 and Laryea and Ibem, 2014) provide a cross disciplinary perspective to e-Procurement use in the construction industry. For examples, the studies by IT Construction Forum (2004) identified e-Ordering; Zuo

and Seo (2006) focused on e-Notification and e-Submission, while Oyediran and Akintola (2011) focused on e-Tendering aspects of construction procurement. Although Laryea and Ibem (2014) is a review paper on the patterns of technological innovations in the use of e-Procurement in construction, it investigated the different categories of e-Procurement technologies and applications used to support the execution of the six basic construction procurement activities outlined in ISO 10845 (2010) as reported in the research literature. That study is relevant to the current study because it identified the e-Procurement technologies used for e-Notification, e-Exchange and e-Submission aspects of construction procurement. Among the e-Procurement technologies identified in that study are Web 2.0 Technologies such as blog and instant messaging used in soliciting for tender offers. Also, studies (Isikdag *et al.* 2011 and Bello and Iyagba, 2013) were reviewed because they examined the barriers to e-Procurement use in the construction industry. Put succinctly, the works reviewed here and those listed in Table were included in the current study for the purpose of providing the basis for comparing the results of our study with findings of the existing studies.

From the studies reviewed here, it can be inferred that most published works on e-Procurement use in construction are from the UK, USA, Australia, Canada and other developed countries. However, very little research attention has been given to e-Procurement in developing countries, which justifies the current research in South Africa. In addition, it is also obvious that in these countries where significant progress has been made on e-Procurement research in construction, the e-Procurement systems and tools used in facilitating effective and efficient communication, exchange of project information and data among participants are mainly e-mail technology, websites and portals, while the key barriers to successful adoption of these electronic technologies and tools are related to technical, organizational, cultural, security and legal issues.

3. RESEARCH METHODS

This exploratory study was designed to provide a better understanding of the current state of e-Procurement use in three main areas: e-Announcing/ Notification/Informing/); e- Exchange of project information and data; and e-Submission of proposals, tenders or bids in South Africa. Based on the research questions of the study, two strategies; namely, a questionnaire survey and semi-structured oral interviews were adopted in the collection of primary data for the research. The merits of this approach are well documented in the literature. For example, Creswell and Plano-Clark (2007) explained that mixed method allows collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. They further explained that the central premise of this method is that the use of both quantitative and qualitative approaches provides a better understanding of research problems than either approach alone. To this end, it was important for the current research to take advantage of the mixed method to enhance the validity of the findings. Moreover, the study by Isikdag *et al.* (2011) in Turkey had followed a similar approach. Therefore, in order to capture both quantitative and qualitative data in the current study, two instruments: questionnaire and interview guide assisted the researchers in collecting the primary data used for the research. The questionnaire instrument comprised both close and open-ended questions and was designed based on findings from the review of literature (see Appendix I). It had 16 questions related to the professional background of the respondents; their level of awareness of e-Procurement in construction; the type of e-Procurement technologies and tools used; the extent of their use in notification/ informing/ and announcing of opportunities for tenders; exchange of project information; and submission of tender/bids and proposals. Others were questions on the factors influencing the adoption of e-Procurement technologies and tools; and the main issues of concern in the use of the identified e-Procurement technologies and tools.

Prior to the main survey, a pilot survey was conducted between December 2013 and January 2014. Data for the pilot survey were collected using the qualtrics online survey software. Of the 29 respondents who participated in the pilot survey, 23 provided useful evidence on the actual use of e-Procurement technologies in the South African construction industry. Feedback from the pilot survey was incorporated into the final version of the questionnaire used in the main survey. In the main survey, the refined questionnaire was administered through the qualtrics online survey software. The link to the survey was sent by e-mail to 20,000 contractors registered in the Construction Industry Development Board (CIDB) database; 1,740 firms registered with the South African Council for the Project and Construction Management Professions (SACPCMP); 618 architectural and 878 quantity surveying firms listed in the 2013 Professions and Projects Registers published by the Times Media Limited; and 12,000 registered members of the South African Institution of Civil Engineering (SAICE). To ensure that there was a good response rate in the research, link to the survey was publicised on the official websites of the

SACPCMP, South African Association of Quantity Surveyors (SAAQS) and SAICE, while the researchers engaged with the officials of the South African Institute of Architects (SAIA) to encourage the participation of their members in the research. The survey lasted between March and June 2014. A total of 669 respondents (representing around 2% of all those contacted) participated in the survey, but 603 of the respondents provided data used in this paper. The 2% response rate is relatively low compared to previous studies in other countries presented in Table 1 (that have between 10% and 15% response rates); it is however an indication of one of the challenges associated with web-based surveys, especially in developing countries. This is therefore considered as one of the limitations of the current study.

From the online survey, over 40 respondents indicated their willingness to further engage in the research. They were subsequently invited to participate in the oral interviews, but only 12 of them accepted the invitation. Seven respondents identified to be directly involved in construction procurement activities were then selected and interviewed. The essence of the oral interviews was to obtain in-depth information from the actual users of e-Procurement on the types and descriptions of the e-Procurement systems used; how they use them, the processes and issues involved as well as their experience with the systems used. This information was not captured in detail in the online survey and was considered to be important in providing support to the data obtained through the questionnaire survey. The interviews, conducted between April and July 2014, were based on 12 questions in the interview guide shown in Appendix II. Each interview session lasted between 30 minutes and 60 minutes and was recorded using a digital recorder. After each of the interviews, the audio files were transcribed into word format. The descriptive statistical analysis (frequency; percentages; mean) was used in the analysis of data derived from the questionnaire. Content analysis was used to analyse the open-ended responses in the online questionnaire and the oral interviews. Specifically, this helped in identifying common factors as provided by the respondents and grouping them into themes for a better understanding of the key issues associated with the use of e-Procurement systems in three areas investigated.

4. RESULT

4.1. Professional profile of the Respondents and the Categories of e-Procurement technologies used

The result in Table 2 shows the distribution of the respondents according to their roles in the South African construction industry. From Table 2 it is evident that the survey covered key stakeholders in the South African construction industry. However, of the 603 respondents, the majority (55%) were contractors, while only 2% were members of clients' in-house professional team.

Table 2: Role of Respondents in the construction industry

<i>Respondents</i>	<i>Frequency (N=603)</i>	<i>Percentage (%)</i>
Architects	12	2
Clients	20	3
Construction/Project Managers	42	8
Contractors	331	55
Engineers	97	16
Quantity Surveyors	19	3
Procurement / Supply Chain Official	26	4
Others	56	9

Table 3 is the result showing the different categories of e-Procurement technologies and tools used to support the execution of e-Notification, e-Exchange and e-Submission aspects of construction procurement by the respondents. It can be seen from the result that 71 (12%) of the respondents indicated that they have used e-Procurement systems and tools to receive or disseminate information on tender opportunities (e-Notification/Informing/Announcing); A majority of these respondents who claimed to have used these e-Procurement technologies and tools were in private sector organizations. This result suggests that the majority (88%) of the respondents in survey are not using e-Procurement systems and tools to receive or disseminate information on tender opportunities.

Table 3: Categories of e-Procurement applications and tools used

E-procurement Systems and Tools	n	%
E-Announcing Systems and Tools	71	100.0
E-mail-based system	48	68.0
Portals	5	7.0
Websites-based system	18	25.4
Web 2.0 technology-based System	7	10.0
E-exchange Systems and Applications	64	100.0
E-mail	53	83.0
Cloud systems (e.g Dropbox; Microsoft Share Point)	7	11.0
Portals	2	3.1
Websites	13	20.3
Web 2.0 technology	14	22.0
E-Submission Systems and Applications	64	100.0
E-mail only	31	48.4
E-mail and other web-based applications(e.g. fax, dropbox, Microsoft SharePoint)	11	17.2
Portals	21	33.0

It is also evident in Table 3 that 64 (11%) of the respondents had used e-Procurement systems and tools to exchange construction project information and data; and in the submission of tenders/bids or proposals. Specifically 83% of the respondents used e-mails, 22% used Web 2.0-based systems; 20% used websites, while 11% have used cloud-based systems such as dropbox and Microsoft Share Point. This result also shows that there is a low utilisation of e-Procurement technologies in the exchange of construction project information among the respondents. The study however reveals that the three most commonly used e-Procurement technologies for this purpose in South African construction sector are e-mails, web-based applications and portals.

The study also identified four categories of e-Procurement technologies and tools used by the respondents. As shown in Figure 1, 68% of the respondents used e-mails; around 25.4% used static websites (e.g. Lead 2 Business, CIDB website); 10% used Web.2.0-based tools/interactive websites (e.g. instant messaging; blogs) and 7% used portals (e.g. Ariba).

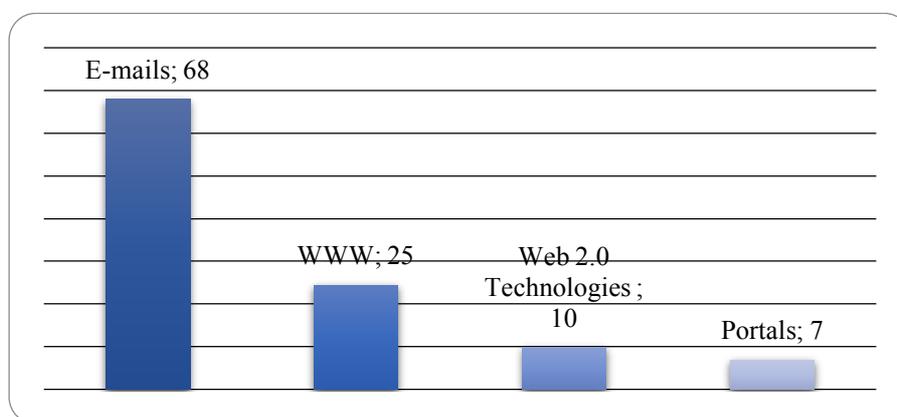


Figure 1: Categories of e-Procurement Technologies and Tools Used

Regarding the different kinds of project information exchanged by the respondents using the identified e-Procurement technologies and tools; Figure 2 shows that around 33% of the respondents indicated that they exchanged bill of quantities electronically, 24% exchanged CAD drawings, 16% (specifications), 11% (project reports) and 8% said they exchanged tender documents and proposals electronically. This result clearly shows that bills of quantities, CAD drawings and specifications were the three most common construction project documents exchanged electronically by the respondents in the survey.

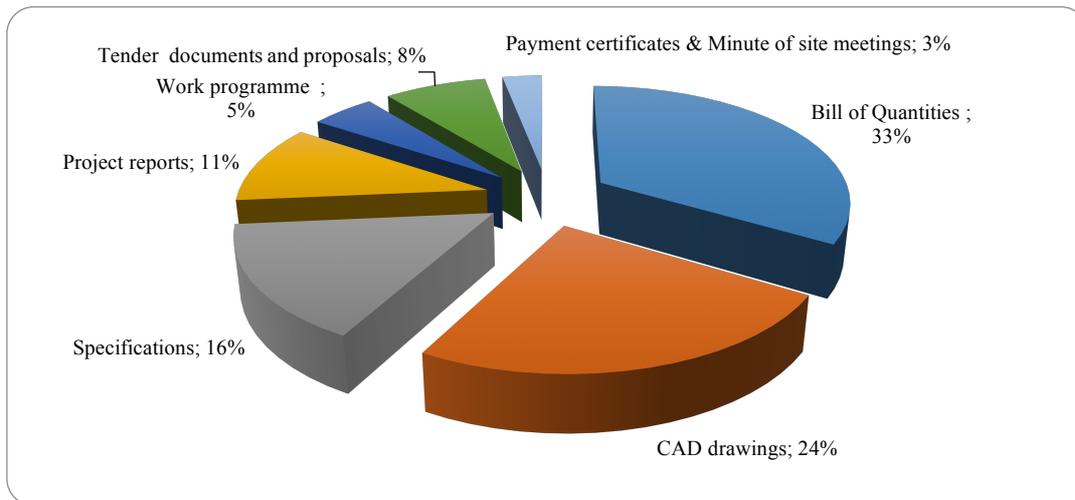


Figure 2: Types of project information exchanged electronically

On how the identified e-Procurement technologies and tools are used to exchange project information and data, the study also reveals that bill of quantities and CAD drawings/specifications were exchanged as excel files and portable document format (pdf), respectively. These vital documents are either sent as e-mail attachments or uploaded onto a portal, websites or dropbox. These practices were confirmed by the clients interviewed. Therefore, this result provides evidence of the extent to which these technologies are supporting the exchange of project information and data electronically between contractors and clients.

4.2 Factors and challenges associated with the use of e-Procurement in the firms

Table 4 presents a summary of the factors that influenced the adoption of the e-Procurement technologies and tools amongst the respondents arranged in the order of importance. Factors ranked 1st to 3rd in Table 4 are considered to have high positive influence; those ranked between 4th and 10th have medium positive influence, while those ranked from 11th to 15th are considered to be of low positive influence. This means of the 15 factors investigated, the speed, and lower cost of transactions associated with e-Procurement transactions; and ease of use of e-Procurement technologies have high positive influence on the adoption of e-Procurement technologies and tools in the South African construction industry. In contrast, factors, including the ease of transiting from paper-based to e-Procurement method; security and data protection challenges; and the availability of good public policy to support the adoption of e-procurement have high negative influence on the use of these technologies in this country.

Table 4: Factors influencing the use of e-Procurement technologies and tools

Factors	Mean Score	Stand. Dev.	Rank	Influence
Greater speed of transaction in e-Procurement	4.05	0.89	1st	High
Lower cost of transaction in e-Procurement	3.97	0.91	2nd	High
Easy for consultants and contractors to respond electronically to job requirements	3.79	0.94	3rd	High
It is easy to use electronic procurement systems and tools	3.68	0.95	4th	Medium
Availability of adequacy of technological and internet infrastructure to support the use of electronic procurement	3.64	1.01	5th	Medium
Reliability of electronic procurement systems and tools	3.64	0.84	6th	Medium
Compatibility of Electronic procurement systems and tools with the existing organizational policies and processes	3.57	0.87	7th	

Factors	Mean Score	Stand. Dev.	Rank	Influence
The ease of integration of e-Procurement systems and tools into the existing organizational processes	3.53	0.93	8th	Medium
Availability of good institutional and organizational infrastructure to promote the use of electronic procurement	3.53	0.93	9th	Medium
The ease at which consultants and contractors engage with electronic procurement systems and tools	3.51	0.94	10th	Medium
Adaptability and willingness of people to switch to the use of electronic procurement systems and tools	3.38	0.98	11th	Low
Interoperability of different e-procurement systems and tools	3.29	0.84	12th	Low
Availability of favourable public policies to promote the use of electronic procurement in South Africa	3.24	1.01	13th	Low
Security and data protection challenges in the use of e-procurement	3.23	0.94	14th	Low
Ease of transitioning from paper-based procurement to electronic systems and tools	3.19	1.01	15th	Low

Regarding the challenges associated with the use identified e-Procurement technologies and tools; the result is as presented in Table 5. It is also evident from Table 5 that only 66(11%) of the respondents identified the challenges associated with the use of these technologies and tools. This was to be expected as not all the respondents were using the e-Procurement technologies identified in this study. Specifically, the respondents identified issues related to unreliable IT infrastructure (46% of the respondents), cultural issues (27% of the respondents), security of data and information (18% of the respondents), lack of access to IT infrastructure by all categories of firms (18% of the respondents); and the others. In the order of severity, these issues are: (i) unreliable IT infrastructure;(ii) cultural issues;(iii) security of data and information; (iv) lack of access to IT infrastructure by all categories of firms;(v) low knowledge on e-procurement technologies across the industry;(vi) legality of e-procurement transactions; and (vii) high cost of e-procurement systems

Table 5: Issues Associated with the use of the identified e-Procurement systems and tools

Issues	No of Respondents n= 66	Percentage (%)
<i>Reliability of IT Infrastructure</i>	30	45.5
Interruption in power supply		
Delay in network response if the receiver's domain is congested due to too much traffic		
System malfunctioning/ failure		
Incomplete or is missing information.		
No proof that the intended recipient has received the documents.		
Poor network reception		
System not being able to accept submissions, or being off line (downtime)		
<i>Cultural issues</i>	18	27.3
Some of the systems are cumbersome and not user friendly		
Lack of personal interaction with people involved in case where clarifications are needed; resulting in queries are not promptly responded to and resolved		
E-Procurement imposes restriction on users		
Bids might be sent to competitors for re-pricing.		

Issues	No of Respondents n= 66	Percentage (%)
Difficult in getting original documents more especially signed contractual documents		
No response of receipt of your mail and you need to follow up		
Peoples' reluctance to change in the industry as a whole		
Lack of understanding of the benefits by all parties		
Government agencies always want the original copies of documents and not electronic copies		
People are a times slow in responding to e-mails		
People who don't check their e-mail		
Those contractors who were marginalized in the past because most of them are illiterate let alone being computer illiterate.		
Security issues	12	18.2
Lack of confidentiality		
Lack of surety about the security of information in the course of transmission		
The lost of vital documents and data resulting from online scams and system crash		
System hacking leading to violation of privacy		
Viruses in the network can comprise the integrity of data and information		
Accessibility to IT infrastructure	12	18.2
Lack of access to IT infrastructure that supports e-procurement technologies by emerging firms and those in remote areas in the country		
Knowledge of e-procurement systems	8	12.1
Limited understanding of how the e-procurement systems work by people in the industry		
Lack of properly trained people to use e-Procurement systems		
Legal Issues	4	6.1
Lack of aggressive legal control system to report and handle frauds in electronic communication systems.		
The authenticity of documents submitted		
Cost Issues	2	3.0
Subscription charges for the e-procurement systems are high		
Internet is expensive		

5. DISCUSSION

From the result, three issues: (i) the categories of e-procurement systems and applications used to execute the three e-procurement activities: e-Notification; e-Exchange of project information and e-Submission of project data and information; (ii) how the identified e-procurement technologies support the execution of these activities; (iii) and the key issues of concern in the use of e-Procurement technologies to support the execution of these three procurement activities were identified and brought forward for discussion in this section of the paper.

First, the study shows that of the 603 respondents who participated in the online survey, only around 12 percent of them have used e-Procurement systems and applications to receive or disseminate information on tender opportunities, while around 11 percent of them have engaged in the exchange and submission of construction project information and data electronically. The four categories of e-Procurement technologies used were e-Mails; static websites, Web 2.0 technologies and portals. These categories of e-Procurement technologies are similar to those identified in previous studies (Issa *et al.*, 2003; 2008; Oyediran and Akintola, 2011 and Laryea and Ibem, 2014) as previously highlighted. This result suggests that there is generally a low usage of e-Procurement systems

and applications to support the execution of these three aspects of construction procurement activities in South Africa; and the e-Procurement use in this country is at its infancy. Comparing this result with Eadie *et al.* (2011) that revealed 27% adoption rate; and that the private sector was lagging behind the public sector in the adoption of e-Procurement in the UK construction industry; it can be argued that there is 12% adoption rate of e-Notification aspect of e-Procurement in construction and that the private sector is taking the lead in South Africa. The difference in socio-economic and technological contexts between the two countries may help to explain this variation in result.

In addition, the result also reveals that among those who have used e-Procurement systems and applications to execute e-Notification, e-Exchange of information and e-Submission of project information and data, the most commonly used applications were e-mails recording 48%, 53% and 31% of the respondents, respectively followed by websites and portals. This shows that a greater percentage of the respondents used e-mails to exchange project information and data. Notably, e-mail and websites have been identified by Laryea and Ibem (2014) as network technologies that facilitate the transfer and/or exchange of project data and information among participants in construction projects. Therefore, this result appears to be in support of previous studies in the USA by Issa *et al.* (2003), the UK by IT Construction Forum (2004), Australia by Zuo and Seo (2006) and Nigeria by Oyediran and Akintola (2011) indicating the extensive use of e-mail in the communication and exchange of project information. It is also consistent with the finding by Rankin *et al.* (2006) in the Canadian AEC industry showing that e-mail and websites have been extensively used in responding to bidding opportunities and transferring bidding information and documents electronically. Apart from e-mail and websites, the study also identified the use of portals and cloud-based systems such as dropbox and Microsoft Share Point and Web 2.0 technologies; suggesting that the respondents are using e-Procurement tools supported by systems located in their premises and those in the clouds. It was interesting to find that 10% of those who claimed to be using Web 2.0 technologies in construction procurement activities used applications such as blogs and instant messaging, mainly to communicate and share information on the availability of tender opportunities, construction materials and equipment. This is line with the finding by Laryea and Ibem (2014) as previously highlighted.

Second, the study also found that the respondents used the four categories of e-Procurement systems and applications identified in this study carry out two basic kinds of procurement tasks, namely; communication; and exchange seven different types of project data and information. The result specifically shows that 33% of the respondents indicated that they used these applications to exchange or submitted bill of quantities followed by 24 % and 16% of the respondents who used them to exchange CAD drawings and project specifications, respectively. This suggests that the three basic of project information exchanged electronically are bill of quantities, CAD drawings and specifications. This finding is similar to the practice in the UK where Eadie *et al.* (2007 and 2011) reported the use of these e-Procurement technologies and tools in the exchange of project information between clients and contractors. Relating this result to the different categories of e-Procurement technologies identified by Percy *et al.* (2008), it is obvious that the majority of e-Procurement technologies currently used in the South African construction industry are those that support the execution of tasks limited intra and inter firms communication and exchange of project information and data, with little or capabilities for integration and coordination of functions across firms. This was to be expected as the current study is focused three basic procurement activities: e-Notification; e-Exchange and e-Submission of project data and information.

On how the identified e-Procurement technologies were being used to exchange bill of quantities, CAD drawings and specifications, it was observed that the respondents exchanged bill of quantities in excel files, while CAD drawings and specifications are exchanged as pdf. The choice of these file formats is to ensure the integrity of the data during transmission and display at the receivers' end. The majority of the respondents identified e-mail attachments or uploading of documents unto portal systems/websites or dropbox as the main platforms and process used in the exchange of the identified project information and data. The study also shows that the respondents have to download these project information from pass worded online repositories accessed only by registered subscribers. In fact, one of client interviewed explained this process in the following way: *"There are two ways contractors submit bid to us, they can either email it back to us or they upload it to the system. Another interviewee responded thus: "it's a web based system where your information are archived in a type of a download portal where you then get either credentials to an upload site or in a very simplified fashion sometimes where people just say well there's a dropbox folder and you can go and dump your tender there"*. This finding is a clear evidence of the extent to which e-mail, websites and portals are used to support the exchange of project information and data electronically between contractors and clients in the South African construction industry.

Furthermore, it is also evident from the study that of the 15 factors considered to have influence on the use of the identified e-Procurement technologies and tools, four of them (i.e. factors 1, 2, 6 and 14) are related to the relative advantage of e-Procurement over paper-based method; three factors (7, 8 and 12) are related to compatibility of e-Procurement with the existing work process; while five factors (i.e. 3, 4, 10, 11 and 15) deal with the ease of use (complexity) of e-Procurement technologies. This finding suggests that the main reasons who claimed to be using the identified e-Procurement technologies in the study area are linked to the advantages of these technologies over the paper-based method in terms of speed of transaction, lower transaction cost and ease of use. This finding provides support to that by Eadie *et al.* (2010a) on the drivers of e-procurement in the UK construction industry. As it relates to the speed of transaction, the majority of those who used these technologies were of the view that the reduction in the level of human interference in the transmission of data accounted for the speed in e-Procurement transactions. This view was clearly captured by one of those interviewed, who explained that: *"We use these electronic systems because in other services like postal or courier, there are no guarantees that the information will arrive on time"*. The respondents also identified transportation cost, timely delivery of information, less paper and administrative work, easy communication and exchange of information on real time basis and speed in the delivery of information as the aspects of e-Procurement that engender reduction in transaction cost in construction procurement process. In the words of one of those interviewed *"e-procurement is a fast and reliable service that can reach a lot of people intended to in a short space of time thus ensuring prompt and fair service delivery. It saves time and energy because people in this industry have a tight schedule so it saves them time to do everything electronically instead of marching from this office to that one only to find that at the end of the day you were not assisted and you have wasted a lot of time"*. From this result, it can be inferred that the factors with high positive influence on the use of the identified e-Procurement technologies and tools are related to their relative advantage, compatibility and simplicity. This assertion appears to be in line with the submission by Rogers (1995) that relative advantage, compatibility and complexity are the three attributes most consistently connected to the adoption of new technologies, ideas and processes.

The study also found that in the order of severity, the three most critical issues of concern in the use of e-Procurement technologies identified in the South African construction industry are unreliable IT infrastructure, followed by cultural issues, security concerns and uneven access to IT infrastructure across the country, respectively. Generally speaking, these issues are closely related to those identified in the previous studies (including Rankin *et al.*, 2006; Eadie *et al.*, 2007; Oyediran and Akintola, 2011; Tran *et al.*, 2011 and Isikdag *et al.*, 2011). However, in terms of ranking of these issues, it is evident that in the UK, the most critical issues militating against e-Procurement use in construction as reported by Eadie *et al.* (2010a) were tampering of documents; confidentiality of information; and resistance to change. In Nigeria, the key issues reported by Oyediran and Akintola (2011) were irregular power supply; high cost of e-procurement systems; and poor ICT infrastructure, while in Turkey Isikdag *et al.* (2011) identified security issues, the lack of legal infrastructure and awareness on the benefits of e-Procurement in construction. In contrast, the most three critical issues militating against the successful adoption of e-Procurement in construction in South Africa as identified in this study are: (i) unreliable IT infrastructure; (ii) cultural issues; (iii) security issues and access to IT infrastructure. Relating this result to the earlier submission by Chege *et al.* (2001) that security concerns were key barriers to the adoption of e-Commerce in South African construction sector, it can be concluded that in the UK, Turkey and South Africa, security concerns remain some of the main barriers to e-Procurement use in the construction sector.

Further analysis of the result revealed that most of the security issues identified were related to confidentiality, protection and integrity of data during transmission. For instance, one of the respondents in the interview noted: *"We contractors don't really know how this stuff works. We're not that innocent but really the level of security in these things if somebody that's very clever comes to steal from us I'm sure he can"*. On the security issues with e-mails, one of those interviewed noted that *"The second problem with submitting your tenders by email is that it is open to other tenders,They can receive your tender and make it available to other tenderers so they can see what your price is, the security in terms of your price is a bit uncertain"*. They also mentioned spam mails, corruption of e-mail attachments by computer virus and phishing mails as some of the security issues associated with the use of e-mails in the exchange of construction project information and data. Regarding the lack of reliability of IT infrastructure to support e-Procurement use in the South African construction industry, one of those interviewed explained in the following words: *"Internet bandwidth is another problem. As you can see, one problem with using the Microsoft SharePoint is that it is sometimes very slow because of internet bandwidth"*. This was corroborated by another interviewee, who also stated that: *".... my problem is having access to fast internet, it's a problem because if you don't have fast internet it will take quite a long time to download big files"*. This

implies that unreliable IT infrastructure manifest in the forms of inadequate Internet bandwidth resulting in slow internet.

In addition, the cultural issues identified as barriers to e-Procurement use are related to peoples' perception of e-Procurement. For instance, some of the respondents were of the view that e-Procurement systems are not user-friendly; impose restrictions on users; lack personal touch; can encourage marginalization of those without access to ICT facilities. One of respondents explained: *"So you get a feeling from me there's sort of a cultural issues, relationship, relational issue and clinical coldness from online procurement system"*. Yet another respondent explained: *"The website sends you automatic responses and it's quite impersonal and that's what you have to deal with particularly if you have a problem and the problem needs to be resolved. If there's a mistake in tender documentation for example then the electronic website feels like it's a closed door I can't get to somebody suddenly we are in the last two days of a bid and the client has asked you something which is impossible to review and yet you can't access something because the machine is closed you can't speak to somebody so that's a cultural impact that we are feeling because it's in our culture to be able to talk to people and you don't have that with electronic procurement"*. These submissions suggest the people find e-Procurement technologies not flexible and promoting the kind of relationship expected in the construction sector. This may have adverse implications for the participants in construction procurement process. As Rankin *et al.* (2006) rightly observed, e-Procurement use has a long term effect on relationships with customers due to lack of personal contact. From this study, it is therefore evident that the perceived lack of lack of human touch in the use of e-Procurement systems is a key cultural issue in the South African construction industry.

6. CONCLUSIONS AND RECOMMENDATIONS

In this study, we have examined and analysed e-Procurement use in the South African construction industry using data derived from a survey. From the result, the following conclusions can be made. The first conclusion is that although there is generally low adoption of e-Procurement systems and tools in the pre-award phase of construction procurement activities amongst firms in the South African construction industry when compared to other countries like the UK, the USA, Canada and Australia, the four categories of e-Procurement used in this country were e-Mail, static websites, Web 2.0 technologies and portals. The second one is that in support of the existing studies, the most widely used e-Procurement technologies and tools are e-mails and websites; and these are used for communication and exchange of bill of quantities, CAD drawings and project specifications; meaning that the majority of e-Procurement technology used are those that facilitate intra and inter firms communication and exchange of project information and data. The third conclusion is that the three factors with the highest positive influence on the use of e-Procurement technologies at the pre-award phase of construction procurement are the speed of transactions; lower transaction costs and ease of use of the technologies and tools. The fourth and last conclusion is that the four key areas of concern in the use of e-Procurement in three aspects of construction procurement activities investigated in South Africa are related to unreliable and unequal access to IT infrastructure; cultural and security issues; and limited understanding of how e-Procurement systems work amongst industry stakeholders in this country.

Findings of this study have a number of implications for successful adoption of e-Procurement in the construction industry in South Africa. The result indicates that the stakeholders in the South African construction industry are yet to derive the full benefits of e-Procurement in the areas of improving communication and exchange of project information and data due to obvious challenges. Although these challenges are developmental, they must be addressed if the construction sector in this country must develop its full potentials. Therefore, for the use of e-Procurement to be successfully diffused and its benefits maximized in the South African construction industry, the following recommendations are suggested.

- First, there is a need to improve the quality of, and access to ICT infrastructure across the country. With the migration of e-Procurement technologies to the cloud framework in multiple realms, manifesting in anywhere access and cost effective applications; improving access to Internet facilities must be considered as part of a core strategy to promote e-Procurement use in the South African construction sector. Countries like the UK, USA, Australia and Canada known to be leading adopters of e-Procurement in construction have ubiquitous access to reliable internet facilities and this has contributed to critical mass uptake of e-Procurement in these countries.

- Second, it has become imperative that e-Procurement technologies that meet the human relationship requirement of the construction industry be developed. This calls for research into new e-Procurement technologies that meet this requirement; and how the existing e-Procurement technologies can be innovatively used in meeting the peculiarities of the construction sector and the cultural imperatives of the different countries.
- Lastly, intended and current users of e-Procurement need to be aware of the existing security applications and strategies seek to ensure the safety, security and integrity of e-Procurement transactions. To this end, enlightenment campaigns, trainings and skill development programmes are needed in the country's construction sector to improve the knowledge base of stakeholders on e-Procurement. This will on the one hand help to eliminate security concerns over e-Procurement transactions. On the other hand, it would also engender attitudinal change in favour of the use of e-Procurement by construction clients and other stakeholders. Above all, it is high time e-Procurement platform became the main channel for communicating procurement values and culture in this country as this would create more awareness and encourage a quick transition from the traditional paper-based to e-Procurement method in construction procurement.

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APPENDIX I



Online Survey

E-Procurement in the South African construction industry

1. Please indicate your role in the construction industry. Architect Client Contractor

Construction/Project Manager Engineer Quantity Surveyor Procurement/Supply Chain Official
Others (Please specify)

2. In which of the following categories of organization are you employed? Consulting firm Contractor
Client's in-house professional team Government Department/Public-owned Institution Others (Please specify)

3. Do your experiences relate mostly to procurement in the private sector, public sector or both?

Private Sector Public Sector Both Private and Public Sector

4. Are you aware of the use of electronic procurement in construction? Yes No

5. Have you personally been involved in the use of e-procurement in any construction project?

Yes No

6. Have you used electronic communication systems or tools to announce / notify / inform consultants and / or contractors about construction services or works? Yes No

7. If your answer is "Yes", please indicate the system or tool used to inform consultants and / or contractors about services or works

Please give a brief description of the process used to inform consultants and / or contractors about services or works

8. Have you used electronic communication systems or tools to support exchange of project information among client, professional consultants and contractors? Yes No

If your answer to the question 8 is "Yes", please indicate the system or tool used to exchange information among client, consultants and / or contractors about services or works

Please give a brief description of the process used to exchange information among client, consultants and / or contractors about services or works

Have you used electronic communication systems or tools to conduct tendering and submission of proposals, tenders or bids? Yes () No ()

If your answer to the question is “Yes”, please indicate the system or tool used to conduct tendering and submission of proposals, tenders or bids

Please give a brief description of the process used to conduct tendering and submission of proposals, tenders or bids

Based on your experience, please describe the main benefits of using electronic communication systems and tools in the procurement of construction services and works

Based on your experience, please describe the main issues of concern when it comes to using electronic communication systems and tools in the procurement of construction services and works

How will you rate your experience of electronic procurement systems and tools in relation to the following statements?

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The technological and internet infrastructure available to support use of electronic procurement is adequate and reliable					
It is easy to use of electronic procurement systems and tools					
It is easy to integrate e-procurement systems and tools into our existing organisational processes					
It is easy to engage consultants and contractors onto the system					
There is lower cost of transaction					
There is greater speed of transaction					
Reliability of electronic procurement systems and tools					
Compatibility of systems and tools with organisational policies and processes					
We experienced difficulty in transitioning from paper-based procurement to electronic systems and tools					
We have good institutional and organisational infrastructure to promote the use of electronic procurement					
We have good public policies in place to promote the use of electronic procurement					

We experienced little problem with issues of adaptability and willingness of our people to switch to electronic procurement systems and tools					
It is easy for consultants and contractors to respond electronically to our requirements					

Note: Neutral (Neither agree nor disagree)

Please provide us with any additional comments that will help to better understand and contextualize the ratings provided to any of the questions above

Thank you for your time and participation in this research

APPENDIX II



Electronic Procurement Research

Interview Guide

1. Please kindly introduce yourself, your role in the organization, and the role of your organization in the construction industry.
2. What electronic systems and applications do you use to announce / notify / inform Professional consultants and / or contractors about construction services or works?
3. How does this system work and what processes/procedures are involved in using it to announce, notify and inform professional consultants and contractors about construction services and works?
4. What electronic systems and applications do you use to exchange construction projects' information (e.g. drawings, bill of quantities, tender documents etc.) between your organization, professional consultants and contractors?
5. How does this system/application work? What processes or procedures are involved in using this system /application to exchange project information?
6. Do you receive tenders/bids or proposals from professional consultants and/or contractors or conducts tendering electronically?
7. What electronic system/application do you use to receive tenders/bids or proposals from professional consultants and/or contractors or conduct tendering?
8. How does this system work and what processes/ procedures are involved in using it to receive bid/tenders/ proposals from consultants and/or contractors or conduct tendering?
9. From your experience with the use of electronic communication in the procurement of Construction related goods, services and works or conducting tendering, what do you think are the main benefits of e-procurement in construction?
10. What can you identify as the main issues of concern in the use of e-Procurement in construction generally?
11. Describe the specific challenges of using e-Procurement in the South African construction industry.
12. In view of the several benefits of e-Procurement, what ways do you think these benefits can be maximised in the South African construction industry?