Multidisciplinary approach to defining public e-procurement and evaluating its impact on procurement efficiency

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Abstract Utilising the methodology of content analysis, this study uses a multidisciplinary approach to define public e-procurement. Various aspects of e-procurement have been discussed from information systems, supply chain management, electronic commerce/electronic government, and public procurement to come up with an integrated definition of public e-procurement. Following this, e-procurement assimilation has been defined and its impact on procurement efficiency has been evaluated. Following the confirmatory factor analysis in structural equation modelling, dimensional level analysis in ANOVA has been undertaken for the three forms of e-procurement technologies namely e-tendering, e-catalogue management systems, and e-marketplace. The results show the positive and significant impact of the assimilation process on procurement efficiency.

Keywords E-procurement · Content analysis · Supply chain management

1 Introduction and background

Governments aspire to use public procurement as a lever of economic, technological or social reform. This is evident from a recent study conducted by the International Research Study of Public Procurement (IRSPP). The IRSPP study also provides evidence of growing interest in modernizing public procurement, which accounts for significant proportions of countries' total spend (Harland et al. 2005). In fact, the public

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sector spends between 10 and 20 percent of its earnings in procurement activities (Thai and Grimm 2000).

Public electronic procurement (e-procurement) has been defined as the use of information and communication technology (especially the Internet) by governments in conducting their procurement relationships with suppliers for the acquisition of goods, works, and consultancy services required by the public sector" (World Bank 2003). Given that organizations often under-utilize expensive information technology (IT) enabled work processes that automate routines or processes that were previously carried out manually (Rau and Haerem 2010), e-procurement has been recognized as a powerful tool for procurement reform in the public sector. Many governments worldwide are increasingly under pressure to reduce costs and, in many cases, their fiscal deficits. Reforming public procurement through e-procurement could be one way to achieve these objectives. However, such reform is not without its challenges. In fact, one of the most important challenges for organizations is how to best assimilate the new technologies to obtain expected organizational efficiencies (Rai et al. 2009).

The past few years have seen an increase in popularity of e-procurement systems in that governments in both advanced and emerging economies have committed to e-procurement initiatives as part of their Electronic Government (e-Government) agendas. In fact, the implementation of e-procurement has experienced explosive growth in some organizations while others have resisted its assimilation over the last several years (Minhan 2005). Although many past predictions about the over-stated benefits of e-procurement proved to be exaggerated (Johnson and Klassen 2005; Vaidya et al. 2006), a benchmark report by Aberdeen Group asserted that e-procurement was "here to stay" and e-procurement can do "more with less" (Aberdeen 2008). According to this benchmark report, public sector organizations have increased their spend under management by 17 % while having reduced their

average requisition-to-order cycles by 12.4 days, requisition-to-order costs by 34 %, and maverick spend by 16 %. Very ambitious amounts in savings have been estimated for some European countries, for example, a potential saving of between Euro 15 and 75 billion Euros for the German budget (Wirtz et al. 2009).

In order to address the above mentioned challenges, there is a need for multidisciplinary research on public e-procurement. An extensive literature review revealed that only a few academic empirical studies have investigated e-procurement in the public sector (Vaidya 2007; Concha et al. 2012). Most of the e-procurement initiatives in the public sector have so far been documented mainly through practitioner literature (e.g. NePP 2003, World Bank 2003, AGMIO 2006 etc.). While findings from these studies have been insightful, our understanding of antecedents for successful e-procurement has remained limited and anecdotal. It is important that public e-procurement research should build upon accumulated knowledge in Information Systems (IS), e-commerce, e-Government and Public Procurement, as well as in reference discipline such as Supply Chain Management (SCM). Hence, there is a need for studies that adopt a multidisciplinary perspective on public e-procurement.

2 A brief history of procurement and its multidisciplinary nature

(Callender and Matthews 2003) briefly summarized the history of procurement practice tracing back over 2,800 years and citing interesting examples from 215BC to modern day web-based procurement practices. Some of these include the procurement practices of Roman armies in Spain in 215BC, supplier management principles adopted by King Gustavus of Sweden in the 16th Century, elements of procurement suggested by Adam Smith in the 17th Century, procurement policy of the British Navy in the 18th Century, recognition of procurement as part of new concepts like "supply chain" in 1982, and "value chain" in 1990. Important contributions to

the literature were made by Ellram and Carr in Ellram and Carr 1994 who classified the procurement research into three categories focusing on strategy: the role of strategy on procurement, the role of procurement on strategy, and strategic procurement. It appears that this emphasis on strategy is still the paradigm of today's procurement practices (Vaidya and Hyde 2010). So, if the emphasis shifts from tactical to a strategic role, as argued by Narasimhan and Carter (1998: P. 3), then procurement "must shift its focus from efficiency to effectiveness". As concluded by Callender (Callender and Matthews 2003: P. 8), "the purchase requisition of yesterday has not entirely disappeared, but e-commerce or e-business, electronic ordering will free the procurement professional to focus on the strategic issues".

As shown in Table 1, Callender and Matthews (2003) regard procurement and supply chain as consisting of a number of bodies of knowledge. They provide examples to show how various disciplines such as information science, accounting and finance, economics and law, marketing, organizational behaviour, sociology and even psychology are related to procurement and supply chain issues as shown in the following table.

3 Public electronic procurement: Technologies and assimilation

The relevant literature falls into two broad categories, practitioner and academic. E-procurement is a fast moving set of technologies and therefore much of the information available on public e-procurement is located within practitioner-based body of literature, especially government reports (Vaidya 2007). However, this literature tends to be biased in favour of adoption and implementation successes because of the apparent hesitation of governments to publicize their failures. A consensus does not seem to exist with respect to what public e-procurement is and what its main characteristics are (Vaidya and Hyde 2010). The purpose of this section is to present different definitions of e-procurement and analyze their

Table 1 Related disciplines of procurement and Supply (Adapted from: Callender and Matthews 2003)

Disciplines related to procurement and supply chain	Representative examples
Information science	E-commerce, e-business, inventory management, communications and information management, e-marketplace etc.
Accounting and finance	Activity Based Costing, financial modeling, net present value techniques to evaluate contracting opportunities and measure whole-of-life costs.
Economics and law	Evaluation of procurement policies, and contracts (terms and conditions etc.) management.
Sociology and marketing	Organizational and markets management, management of customer service and B2B relationships
Organization behaviour and psychology	Change management, supplier performance management, and buyer–supplier relationship management

conceptual amplitudes and distinguishing characteristics. Then, the main characteristics from the different definitions and approaches are highlighted and a more comprehensive definition of public e-procurement is developed in the following sections.

3.1 Technologies

Electronic tendering E-Tendering is the complete web-based tendering process from the advertising of the requirement through to the placing of the contract, including exchange of all relevant documents in electronic format (NePP 2003). Similar terms include RFQ (request for quotation), RFT (request for tender), and e-bidding.

E-catalogue management systems E-catalogues are a special form of e-procurement and e-supply chain management. E-Catalogues are the web-based representations of supplier information (such as scanned pictures, servicing information and links) about the products and/or services that may or may not be incorporated into the buyer's e-procurement system (Segev et al. 1998).

Electronic marketplaces E-markets are web-based applications that bring multiple buyers and suppliers together in one central virtual marketplace and facilitate the electronic trade between buyers and suppliers at a dynamic price that is determined in accordance with the rules of the exchanges (Davila et al. 2003; NePP 2003). There are mainly three types of e-marketplaces. Private marketplaces are owned by an individual organization or consortia, regional marketplaces are owned by a group of consortia of buyers from a geographical region, and vertical marketplaces specialize in the trading of products related to a single industry sector (NePP 2003).

3.2 E-procurement assimilation

It is important to note that Theories of Technology Assimilation distinguish assimilation from the concept of adoption (Fichman and Kemerer 1997). Adoption is a dichotomous variable and indicates whether the organisation has reached a decision of whether or not to utilise e-procurement, whereas assimilation is the extent of collective results of activities by individuals and departments within the organisation. Also while there has been much research undertaken on the issues of technology adoption, very little empirical research has been done on assimilation issues.

E-procurement assimilation, for the purpose of this study, is defined as the extent to which the organisational use of e-procurement technologies diffuses across the procurement process and becomes standard business practice in facilitating transactional and strategic procurement activities associated with that process. It is conceptualized as an important construct in the causal chain of influence from organizational adoption of e-procurement to the evidence of its impact on procurement performance. This definition is consistent with the theories of technology assimilation which regard organizations as innovation systems for attaining differential levels of technology assimilation successes (Rai et al. 2009; Chatterjee et al. 2002; Fichman and Kemerer 1997).

Overall, e-procurement assimilation is perceived to be a vital issue that influences the survival of e-procurement systems and needs to be studied extensively. Despite numerous studies undertaken in e-procurement, very few of them focus thoroughly on developing a holistic model of e-procurement assimilation (e.g. Hardy and Williams 2008; Rai et al. 2009; Concha et al. 2012; Vaggelis 2013). Besides, the number of empirical studies is very limited. Lack of empirical verification may make those studies less persuasive for public sector organizations that have implemented or are considering implementing e-procurement. In this study, we identified a set of antecedents that are likely to influence e-procurement assimilation. Rather than to prepare a comprehensive list of all potential antecedents and revalidate them, our objective is to identify and examine the key antecedents through a field survey.

3.3 Stages of the assimilation process

Meyer and Goes (1988) conceptualized the assimilation process as the penetration of the technology through the various stages such as awareness, evaluation, utilization, and institutionalization. The IT assimilation captures the concept of assimilation stage (Fichman and Kemerer 1997; Ramiller and Swanson 2003) for each e-procurement technology. Most researchers now agree IT assimilation process occurs in stages. The assimilation process that includes adoption, implementation and routinization (Kwon and Zmud 1987), (Prescott and Conger 1995) has been modeled as containing the following six stages (Fichman and Kemerer 1997; Ramiller and Swanson 2003; Vaidya 2007; Concha et al. 2012):

1. Intention to implement (the organization has an e-procurement strategy in place or is preparing concrete plans to investigate e-procurement within the next 12 months or in the near future);
2. Evaluation or Pilot use (the organization has purchased 'trial' capabilities or implemented 'pilot' projects and is currently evaluating the possible use of e-procurement);
3. Commitment (the organization has specific plans and made formal commitments to utilise e-procurement);
4. Limited deployment (the organization has established a programme of regular but limited use of e-procurement);
5. Generalized deployment (the organization has deployed one or more forms of e-procurement and in its generalized

capacity as integrated e-procurement in the majority of information systems); and

6. Rejection (the organization has evaluated and rejected the use of e-procurement).

The sixth stage can be justified by the authors' arguments that the implementation of an innovation cannot be considered successful even if it survives through the deployment stage, as the innovation may ultimately be rejected by its users (Ramiller and Swanson 2003). In fact, organizations are very diversified and the assimilation of e-procurement may also depend on other unique variables: the assimilation gap, the aggregated stage of the assimilation and the size of the organization (Fichman and Kemerer 1997, 1999). Further variables in e-procurement context include percentage of procurement spending through e-procurement, number of e-procurement technologies utilized, and the type of e-procurement technologies utilized.

IT assimilation is an ongoing process (Rai et al. 2009). The authors assert that organizations need to decide whether a granular or aggregated conceptualization of innovation is appropriate when investigating IT assimilation. An aggregate strategy has been chosen to represent the various dimensions of e-procurement technologies in order for the findings to be more robust and generalizable (Fichman and Kemerer 1997, 1999). The authors believe that such strategy facilitates the identification of antecedents with consistent characteristics across the class of technology (e.g. e-procurement). While prior studies in MIS (e.g. Cooper and Zmud 1990) have also utilized this approach, it was (Fichman and Kemerer 1997, 1999) study on software process innovations that provided a conceptual evaluation of aggregated measures (conditions). These following are six conditions that favour aggregation of e-procurement technologies in the context of this research.

•   We aim is to generalize our conceptual model of e-procurement assimilation across the assimilation stages.
•   We expect that the antecedents of technologies do not have different directional effects across the assimilation stages.
•   Most of the public sector are serviced-based and mostly procure indirect goods and services.
•   This study considers the secondary characteristics of various e-procurement technologies.
•   The innovation in this study (i.e., e-procurement) can include substitutes or moderate complements.
•   We expect to minimize this noise by studying a class of technology and adopting the aggregate strategy.

As such, e-procurement assimilation will be aggregated across various technologies in order to identify the antecedents that influence the assimilation or to asses the impact of assimilation on the procurement process. Following this

aggregated strategy, we also plan to undertake a dimensional-level analysis on each e-procurement technology.

4 Definition of public e-procurement from different multidisciplinary perspectives

E-Commerce technologies, specifically the Internet and procurement are the two major elements of e-procurement. E-procurement is a subset of e-commerce. Wigand (1997) views e-commerce through five different approaches: transaction cost theory, marketing, diffusion, information retrieval, and strategic networking. As part of the government e-commerce initiative, public e-procurement is also a subset of e-Government. Furthermore, e-procurement is a subset of e-supply chain/logistics management. As such, public e-procurement is obviously a multi-disciplinary research area. Because of its multidisciplinary nature, it can be argued that public e-procurement allows multiple theories and perspectives to be used in the identification and solution of procurement-related problems and issues.

4.1 E-procurement from supply chain/logistics management perspective

Procurement is a subset of supply chain management (SCM). SCM involves the activities associated with moving goods and services including sourcing and procurement, order processing, inventory management and customer service. The Internet provides a great opportunity to automate the supply chain and provide organizations with real-time information across various points in their value chain. The goal of e-Supply Chain/Logistics Management is to reduce procurement costs and improve procurement quality of the goods and services. In order to achieve desired SCM objectives, as Mentzer (2001, p. 448) argues, procurement requirements must be understood within the context of organizational strategy, supplier selection process must meet the strategic requirements, and the relationship must be managed strategically.

Two strategic issues in SCM are integration and coordination. Lee et al. (1997) assert that if a network of customers and suppliers is not effectively integrated and coordinated, various intricacies such as ordering delays, lower quality of goods and services, and long customer lead-times can result. It can be said that e-procurement greatly supports integration and coordination in procurement and supply because of its information sharing capabilities. E-procurement has thus gained strategic visibility in inter-organizational relationships and has emerged as the driving force behind several e-supply chain and e-logistics practices. Lee et al. (1997) include purchasing, logistics and procurement as inherent part of the supply chain

processes. In fact, the concept of logistics is broader (Callender and Matthews 2003; Singh and Thomson 2002) regard e-procurement as an important entity of SCM and e-Logistics for timely acquisition of goods and services. As procurement is a significant part of supply chain management, increasing the assimilation of e-procurement can be expected to have a strong impact on supply chains and organizations need to have a clear understanding about how the assimilation of different e-procurement technologies will impact their operations.

4.2 E-procurement from e-commerce perspective

The concept of Electronic Commerce (e-Commerce) is broad. The literature on e-procurement is grounded in many of the research efforts within the field of e-Commerce. Kalakota and Whinston (1997) define e-Commerce from four perspectives of communication, business process, service and online. E-procurement is such a sub-set of e-commerce that meets the definitional requirements from all four perspectives. E-commerce is defined as the application of technology toward the automation of business transaction and workflow (Kalakota and Whinston, 1997) facilitating communication and information exchange (Min and Galle, 1999). Min and Galle (1999) define e-commerce as "an inter-organizational information system that is intended to facilitate business-to-business communication, information exchange and transaction support through a web access or private value added network". E-procurement, in fact, is the use of e-Commerce technologies such as the Internet, Word Wide Web (WWW), Extensible Markup Language (XML), and public key infrastructure (PKI). There is no doubt that the utilization of e-commerce has changed the traditional perspectives on procurement and supply chain across various points in the value chain. According to Min and Galle (1999), e-commerce can bring operational benefits including reduction in paper transactions, shorter order cycle time and the subsequent inventory reduction due to speedy transmission of purchase order related information and enhanced partnership between buyers and suppliers.

4.3 E-procurement from inter-organizational information system (IOIS) perspective

An Inter-organizational Information System (IOIS) is an infrastructure of computers and communication crossing organization boundaries and permitting information sharing. A more straightforward definition has been provided by Hyde (2002) that defines inter-organizational system as information and communication technology-based systems that is shared by two or more organizations for performing revenue-generating transactions. The Internet, a means of organizational collaboration, can be regarded as the ultimate inter-

organizational system (Hyde 2002). The Internet is an extremely important technology and provides better opportunities for organizations to establish distinctive strategic positions than older generations of IT (Porter 2001). So, e-commerce, and thus public e-procurement as explained above, is an Internet-based inter-organizational information system that is intended to facilitate government-to-business (G2B) or government-to-government (G2G) electronic communication, information exchange and transaction support through a web access or value-added network. In this context, Bharati et al. (2014) assert that the organizations should encourage and provide incentives to employees for experimentation with IOIS technologies. This research is primarily built upon theoretical work in the IOIS adoption and diffusion area. IOIS can be traditional (EDI-based) or innovative (web-based), the latter being our focus of research. The next chapter will review this area in greater details.

4.4 E-procurement public procurement perspective

An innovation is defined as an idea or artifact perceived to be new by the relevant unit that may adopt the innovation (Rogers 1995). E-procurement can be considered as a radical innovation that transforms the traditional public procurement environment. E-procurement in the public sector has a lot of promise regarding significant savings through increased efficiency and effectiveness. The e-procurement system when interconnected with an organization's internal financial system minimizes the transaction processing costs. E-procurement via automating several administrative procedures and by enhanced monitoring abilities minimizes opportunistic behavior among purchasing officials (Benjamin and Wigand 1995). Furthermore, e-procurement systems are particularly suitable to control spending on low value and routine commodities. Commodity goods (which have low asset specificity) such as computers, stationery materials and air tickets are easier to procure electronically than complex products such as construction contracts (Choudhury et al. 1998).

Public e-procurement is a tool for modernization of the public sector and realization of benefits both in administrations and businesses. Modernization of the public sector is necessary in order to ensure future welfare for the citizens. Governments worldwide are therefore focusing on electronically procuring commodity goods and using e-procurement as an innovation in public procurement. The overall goal for the electronic public procurement initiative is then to attain a higher level of assimilation in the public sector in order to realize the benefits from this innovation in public procurement. For governments, public e-procurement can also act as a compliance management system to capture and incorporate the relevant legislative and policy requirements in the public procurement system (Butler and McGovern 2012).

4.5 E-procurement from e-government perspective

As part of their electronic government initiatives, almost all governments worldwide are examining ways to leverage the Internet for establishing contractual relationships with the private sector. These contractual relationships can be created through one-off supply contracts, but more commonly through panel contracts where suppliers provide standing offers for goods and services of a particular kind and quality. Electronic Government (e-Government) has been defined as the use of information and communication technologies in government to provide public services, to improve managerial effectiveness and to improve managerial effectiveness and to promote democratic values and mechanisms; as well as a regulatory framework that facilitates information intensive initiatives and fosters the knowledge society (Gil-Garcia and Luna-Reyes 2006). Marche and McNiven (2003) clarify the confusion between e-Government and e-Governance. While e-Governance is about making decisions, e-Government is about implementing them either in citizen-centric way (e.g. e-voting) or in organization-centric way (e-procurement).

4.6 Organization-centric interactions of public e-procurement

As mentioned above, e-Commerce lies within the area of IOIS. The public sector equivalent of e-Business is e-Government. E-Business can be organization centric, that is, an organization can either interact with another business (B2B) or Government (B2G) through various applications including e-procurement. In the same way as an organization can be consumer centric and can interact with a consumer (B2C) through various e-Business applications, the government can be citizen centric and can interact with a citizen (G2C). Of the several organizations centric Government-to-Government (G2G) or Government-to-Business (G2B) e-Government interactions, e-procurement as an e-Government application holds enormous promise, and is the focus of this research. The following figure puts public procurement in perspective.

The predominant organization centric e-commerce models can be categorized into Government-to-Government/Government-to-Business (G2G/G2B) or Business-to-Business/Business-to-Government (B2B/B2G) interactions – the focus of this study being the former. B2B interaction can be considered as the main form of e-business, which encompasses all internal and external organizational e-commerce along the supply chain of the organization. While, the retailing interaction of e-commerce has been labelled B2C, G2G is the interaction of various levels of governments transacting business via e-commerce applications. Electronic procurement is an example of both G2G/G2B and B2B/B2G interactions and can be studied as an innovation in public procurement and as part of e-supply chain/logistics management – our focus also being the former.

5 Impact of the internet on procurement

5.1 The characteristics of the internet

The characteristics of the Internet, such as "ubiquity and connectivity, immediacy and interactivity, multimedia and universal interface and ease of use" (Ware et al. 1998), have the potential to elicit significant changes in traditional procurement (Gebauer et al. 1998). The Internet's commercialization in the mid-1990s increased the interest of procurement practitioners trying to use new technology. In fact, the catalyst for the growth of e-procurement is the Internet. The Internet creates a base infrastructure, which allows equal access to governments, businesses, citizens and consumers in a many-to-many environment. What has enabled the Internet to replace EDI is the development of XML, i.e., extensible mark-up language. As envisioned by OECD in the late nineties, the Internet would transform the marketplace, have a catalytic effect on business, increase interactivity in the world wide economy, create openness in operations, and alter the relative importance of time (OECD 1998). This proved to be true in how the Governments do business today. In fact, the Internet has profoundly transformed the Governments' procurement process exceeding the policy makers' expectations (Concha et al. 2012).

5.2 Inconsistencies in the existing definitions of e-procurement

Because of its short history, e-procurement has been defined differently and there is a lack of consistent definition (Vaidya et al. 2006). Most definitions of e-procurement assume the role of the Internet as an "electronic" technology. While some focus on automation, others focus on integration and management. For example, Chaffey (2004) define e-procurement as the electronic integration and management of all procurement activities including purchase request, authorization, ordering, delivery and payment between a purchaser and a supplier. Another definition is provided by Boer et al. (2002) who define e-procurement "as using internet technology in the purchasing process". While this definition covers both the use of the Internet as well as the purchasing process, similar definitions by AGMIO (2006) and Concha (Concha et al. 2012) define e-procurement as the automation of any part of the procurement to payment process with electronic tools.

According to Davila et al. (2003), e-procurement is "any technology designed to facilitate the acquisition of goods over the Internet". Without referring to the Internet, Turban et al. (2006) defines e-procurement as the electronic acquisition of goods and services in an organization. However, both of the definitions have focused on the part of the procurement process (e.g. acquisition). Lindskog and Wennberg, (2002) cover

the procurement process in their definition, which defines e-procurement as the use of web-based technology to support key procurement processes: 1. requisitioning 2, sourcing, 3. contracting, 4. ordering and, 5. payment. However, procurement is not only an operational process within the organisation; it has become a strategic source to support the organization's activities to achieve its long term goals (Ellram and Carr 1994). So, while the definition of e-procurement provided by Lindskog and Wennberg, (2002) has covered the operational procurement process, it appears to have lacked the strategic focus and the concept of value for money.

However, the definition presented by the World Bank is more precise in covering both operational and strategic processes. It has categorized the term "Electronic Government Procurement" (e-GP) in three levels. While the second-level definition distinguishes between e-Tendering and e-Purchasing and the third-level definition covers the basic steps as part of the e-Tendering and e-Purchasing process, the first-level definition states that "e-GP is the use of information and communication technology (especially the Internet) by governments in conducting their procurement relationships with suppliers for the acquisition of goods, works, and consultancy services required by the public sector" (World Bank 2003). Nevertheless, this definition does not include the concept of value for money, which is a very important principle of public procurement.

5.3 Defining public e-procurement

As depicted in Fig. 1, public e-procurement research can be studied from at least four disciplinary streams: IT/ Management Information Systems (MIS), Public Procurement, e-Government, and Supply Chain/Logistics Management. Also, at least three different approaches to understand e-procurement exist in the academic and practitioner literature. The First view constructs a concrete definition that contains the main characteristics of what is, or what should be, e-procurement (e.g. Lindskog and Wennberg 2002; Davila et al. 2003). A second approach is to list the different variants or tools or technologies of e-procurement as a way to clarify this concept (e.g. Boer et al. 2002). A third conceptual approach to e-procurement defines public e-procurement by making reference to the different levels that appear to exist in its development (e.g. World Bank 2003).

The definitions in the above section do not provide a homogeneous view of e-procurement, but instead emphasize a single aspect of e-procurement. However, because of the multidisciplinary nature of public e-procurement and various approaches, there are many important concepts and their interrelations to take into consideration in defining public e-procurement, such as the use of specific technologies, procurement processes, procurement activities and their orientation, purpose of public procurement in terms of value for money principles (i.e. how it is differentiated from the private sector). Of particular relevance is the public sector practice of purchase tendering and the use of panel contracts for the supply of goods and services. Based on the discussion in the above sections, this section attempts to integrate the concepts and interrelations in order to devise a working definition of public procurement to guide this study.

Fig. 1 Putting public e-procurement in multidisciplinary perspective
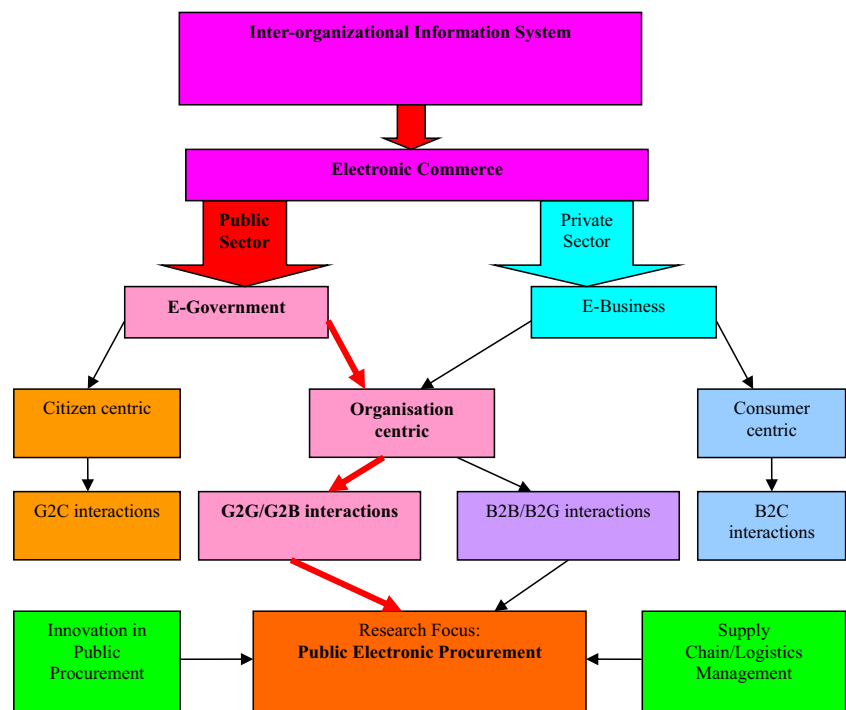
First, e-procurement does not require the automation of the full procurement process. The public sector agencies can choose to perform electronically only some of the procurement practices (stages) in the procurement process. Second, e-procurement is in fact not new. What is new is the use of web-based e-Commerce technologies in procurement. It should be remembered that, although procurement via fax or telephone can be technically regarded as e-procurement, that is not the widely accepted view. It was only after the advent of the World Wide Web that e-procurement using the Internet has been recognized as a powerful tool for procurement reforms in the public sector. So, a definition of e-procurement must mention this technological breakthrough. Third, while the evolutionary approach is mostly about e-Commerce, it seems clear now that e-procurement is more than web applications and the use of the Internet. Public e-procurement is a system that involves the use of different information and communication technologies to improve public procurement performance. As such, the principles of value for money for public procurement should be reflected in the definition. That is to say that the objectives of public e-procurement should differentiate themselves from private sector objectives by promoting public values and mechanisms.

It follows that for a definition of public e-procurement that claims to be useful for academic research and for public procurement practices, it must take into account at least these four elements: the Internet/e-commerce (enabler), process automation and integration (action), public procurement (process), and value for money principles (objective). Table 2 illustrates the focus of each discipline in constructing the definition of public e-procurement.

Thus, based on the above, Vaidya (2007) defines public e-procurement as follows:

Public electronic procurement is the use of the Internet-based Inter-organizational Information System, which automates and integrates any part of the procurement process in order to improve the efficiency and quality in public procurement, and to promote transparency and accountability in the wider public sector.

It should be noted that while this definition may not be fully comprehensive or useful for every purpose, it accommodates most of the theoretical elements found in the literature. It is also practical enough to be used as high-level guidance for e-procurement activities in the public sector. This definition will be used as a working definition for this research.

6 Methodology and data collection

The research methodology for this research is a field survey. Data on research constructs were collected via a structured web-based questionnaire. This section details the methodological procedures that were utilized to test the research model.

Since e-procurement is relatively a new phenomenon and thus used by few large agencies, it makes sense to be selective in surveying only those agencies that have implemented or planned to implement e-procurement – to gauge its assimilation process. Smaller organizations were deemed less likely to have the scale or the scope for deploying e-procurement systems. This still holds true today because of large initial financial investment requirements for such organizations (Vaidya and Hyde 2010). A web-based questionnaire was the main research instrument for this study. A web-link to the survey was emailed to potential participants, with the assistance of various government agencies, with an invitation to access a website and fill out the questionnaire. Participants of web-based surveys were recruited in one of two ways: 1. by way of an invitation sent via regular mail, fax, or email; 2. through advertising in newsgroups and/or websites (Schonlau et al. 2002).

The survey type for this study used a convenience survey which has been widely adopted by other IOIS and public procurement researchers (e.g. Hardy and Williams 2008; Rugayah 2010). For the purpose of this research study, a traditional random sampling of e-procurement users was deemed impossible because a sampling frame was not readily available. Instead, the plan to target the e-procurement user community via public announcements by several government agencies' email list/e-newsletters and then sending emails to their members and subscribers was considered a much more cost-effective and pragmatic approach.

The goal of any research survey is to make sure that the data collected represents the population. In this research, a total of 240 surveys were returned with 217 usable responses. The number of cases required for Structural Equation

Table 2 Four academic disciplines related to public e-procurement

Information systems/e-commerce	Public procurement	Supply chain	e- Government
What it is (enabler)?	What it does (process outputs)?	What it does (operational outcome)?	What it does (strategic outcome)?
the use of the Internet-based Inter-organizational Information System	automates and integrates any part of the procurement process	improves efficiency and quality in supply chain	Promotes transparency and accountability in the wider public sector

Modeling (SEM) is between 200 and 400 (Kline 1998), and thus the sample size of this study is considered adequate for SEM purpose as well.

The preliminary version of the questionnaire was pre-tested during a qualitative pilot study. The survey items have been presented in Table 3 and the literature sources from where the constructs were operationalized are discussed in Section 7 below.

The pilot study mainly involved email communications and also unstructured phone interviews to clarify the participants' views where necessary. Over 40 professionals from the seven states of Australia including the agencies that are actively involved in the implementation of e-procurement such as the Centrelink (a government agency for social security), CorProcure (Australia Post), Australian Government Information and Management Office (AGIMO), Standards Australia, NSW Department of Finance, Australian Antarctic Division (AAD), CSIRO etc. participated in the study. The comments were sought on the length, completeness and readability of the survey and each item was reviewed for content, scope and purpose. The pilot study ensured the content validity and face validity.

The sample characteristics of the survey are shown in Table 4 below.

7 Impact on procurement efficiency

It is obvious that procurement performance below satisfying levels increases risk taking; however, many traditional procurement organizations do not measure their performance (Cammish and Keough 1991). Those who measure only

Table 3 Efficiency variables (survey items)

Item number	Survey items
Efficiency (EFF)	
EFF1	Reduction in purchasing cycle time
EFF2	Increase in throughput (number of transactions during the given time period)
EFF3	Decrease in number of staff in purchasing department (or number of staff responsible for purchasing)
EFF4	Reduction in matching (e.g. invoice, inventory) costs
EFF5	Reduction in overall search (e.g. goods/services, supplier) costs
EFF6	Reduction in communications costs
EFF7	Reduction in information processing costs
EFF8	Reduction in negotiation costs
EFF9	Reduction in monitoring (or enforcement) costs
EFF10	Reduction in maverick (off-contract) purchasing
EFF11	Reduction in the number of suppliers
EFF12	Reduction in the purchase price of goods and services (e.g. because of supplier competition and volume aggregation)

Table 4 Sample characteristics of the survey

Sample characteristics	Description
Sampling frame	The entire e-procurement community in the Australian public sector was targeted via web announcements, email list and newsletters of various organizations
Respondents	Questionnaires were completed by self-selected participants
Sample size	240 questionnaires were completed; of which 23 were inadmissible
Response rate	Cannot be computed as there was no way of knowing how many potential respondents received the questionnaire from multiple sources
Quality of data	High quality of respondents, 60 % respondents were senior managers, see Survey Characteristics in Table 2.
Generalizability	There is no systematic bias in terms of who responded to the survey questionnaire

measure the traditional metrics that are heavily focused on financial performance such as Return on Investment (ROI) and thus their measurement becomes inflexible with no strategic focus (Easton et al., 2002). However, it seems to be a very difficult task to differentiate the net financial benefits that can be derived from the implementation of IT. This can be because organizations' financial statements do not differentiate revenues from online transactions, but rather mix up e-commerce and receipts (Poon and Swatman 1999). It is for this reason the authors conclude that benefits resulting from e-commerce are based on individual experience (perceived benefits, e.g. communications). The authors further argue that unless e-commerce systems are integrated into internal systems, organizations will need to rely on these perceived (indirect) benefits rather than direct benefits such as ROI. It is for this reason that this study seeks to capture performance impacts through the benefits realized by utilizing e-procurement technologies in public procurement.

Very few organizations, in fact, take initiatives to measure the impact of e-procurement on procurement performance. A report by CGEC (2002) mentions that understanding and assessing e-procurement requires aggregation and summarization of data to improve visibility of information to managers and executives. As pointed out by the same report, the lack of effective and holistic framework to assess procurement performance measures results in three consequences: i) user (specialist-users and end-users) accountability deteriorates, ii) management blindness results from assessing progress without reviewing the original aims, goals and activities, iii) management disappointment surfaces when a lack of results becomes evident.

While measuring only the financial factors may be suitable for private sector as profit is, arguably, the predominant goal, the same single-focused approach cannot be used for the

public sector. As mentioned in earlier Section (Section 2.1.3), public sector agencies are more concerned about the value for money (VFM) criterion which is defined as "the optimum combination of whole-life cost and quality (or fitness for purpose) to meet the user's requirement" (Europe Economics 2001, p.9). E-procurement has been expected to increase transparency and transactional efficiency without prejudice to competition. This should allow for easier cost comparisons and examination of tenders. E-procurement, therefore, helps maximize value for money for a public sector agency's expenditure by enhancing the buying power. Transactional efficiency that contributes to value for money can be attributed to cost savings through time savings associated with the processing of various transactions to gain maximum return on investment (Vaidya et al. 2002).

Furthermore, e-procurement aids achieve the value for money criterion in government procurement by meeting various objectives including demand aggregation, reduced inventory costs, total cost of ownership (Vaidya et al. 2002). Turban et al. (2006) add other impact factors to the list: e-procurement streamlines invoice reconciliation and dispute resolution, integrates budgetary controls into the procurement process, minimize human errors in the buying and shipping process, and monitors and regulates buying behaviour.

An important impact of e-procurement technology implementation is the improvement of procurement performance. Cost savings have been identified as the primary rationale for investment in technology (Davila et al. 2003), even though e-procurement also leads to improvement in other performance measures. Some studies have shown that the top four measures of procurement performance are cost, cycle time, user satisfaction, and quality (Croom 2000; Gebauer et al. 1998; Segev, et al. 1998).

8 Data analysis, results and discussion

8.1 Structural equation modeling

Non-parametric techniques are ideal for use when the collected data are measured on nominal (categorical) and ordinal (ranked) scales. They are also useful when the samples are relatively small, and when data do not meet the stringent assumptions of the parametric techniques (Pallant 2005). With this in mind, a Statistical Package (SPSS 15.0) was used to analyse the data.

To validate the constructs, confirmatory factor analysis was used within structural equation modeling. Confirmatory factor analysis in structural equation modeling gives a more true relationship of the dimensions since the measurement error is taken into consideration (Hair et al. 1998). The validity and reliability of this research was found to be significant, as shown in the table below. The measurement model specifies how the latent variables or hypothetical constructs are measured in terms of the observed variables taking into account specification errors (Anderson and Gerbing 1982). Before moving on to testing the proposed measurement models for each construct, various fit indices will be discussed. Although there are a number of fit indices, there is no single test that best describes the fit of a model (Maruyama 1998). Maruyama (1998) categorizes fit measures in three types: absolute, relative, and adjusted (or parsimonious) indexes.

Absolute Fit Indexes provide information about how closely the models fit compared to perfect fit (Maruyama 1998). This can be measured mainly by a χ^2 (normed chi-square) test. A low χ^2 value, which would have a p-value greater than 0.05, indicates that the actual and predicted values are not significantly different. Another index, relative fit index, also known as Comparative Fit Index (CFI), is a measure of how the model compares with other possible models with the same data (Maruyama 1998). CFI provides an estimate of the model's relative misfit to a baseline model. Higher numbers indicate a lower misfit. Normed Fit Index (NFI) also compares the theoretical model to a baseline model. A recommended value of fit for both NFI and CFI is 0.90 (Hair et al. 1998). Another commonly reported statistic is the Root Mean Square Error of Approximation (RMSEA). A value of the RMSEA of about 0.05 or less would indicate a close fit of the model in relation to the degrees of freedom (Maruyama 1998).

8.2 Results of confirmatory factor analysis

Confirmatory factor analysis (CFA) was conducted to check the reliability and validity of the measurement model. This measurement model was estimated using AMOS 7.0. A correlational study investigated the relationship between independent and dependent variables using a Structural Equation Modeling (SEM), a causal modeling statistical tool.

Initial normed chi-square was at 16.233. EFF11 was removed as it had the lowest loading. This improved the normed chi-square but was still not within the acceptable range. Other fit indices were not within the acceptable range. EFF10 and EFF3 were deleted in the third and fourth trials respectively; however this still did not result in acceptable fit indices. As can be seen in Table 5 below, normed chi-square was at 11.046, although other fit indices were closer to the acceptable range.

This necessitated us to delete EFF9 which showed high correlation with EFF5. The normed chi-square came down to 9.48 but it was well above the accepted value. Following the deletion of EFF2 and EFF8, other fit indices were above or closer to acceptable range but the normed chi-square was still a bit higher. So, in the final trial, we deleted EFF6 which gave us the more acceptable normed chi-square of 3.76 and other fit indices were also above the acceptable threshold (.9 for NFI,

Table 5 Procurement performance (efficiency)

Model fit measures	Initial trial	Second trial (after deleting EFF11)	Third trial (after deleting EFF10)	Fourth trial (after deleting EFF3)	Fifth trial (after deleting EFF)	Sixth trial (after deleting EFF2)	Seventh trial (after deleting EFF8)	Final trial (after deleting EFF6)
χ^2/df	16.233	13.209	12.560	11.046	9.487	7.955	6.455	3.768
p-value	.000	.000	.000	.000	.000	.000	.000	.000
NFI	.705	.776	.812	.858	.888	.921	.949	.978
RFI	.574	.664	.705	764	.799	.843	.881	.933
IFI	.718	.789	.825	.870	.899	.931	.957	.983
TLI	.589	.681	.722	.781	.816	.860	.898	.950
CFI	.716	.787	.823	.868	.898	.930	.956	.983
RMSEA	.252	.226	.219	.205	.188	.170	.151	.107
ECVI	3.952	2.895	2.082	1.468	.991	.639	.392	.204

RFI, IFI, TLI and CFI). Figure 2 below depicts the SEM with path loadings.

Dimensional level analysis was also conducted to analyse the correlations in order to assess the impact of each e-procurement technologies (i.e. e-Catalogues, e-Marketplace, and e-Tendering) on procurement efficiency) in various stages of assimilation (i.e. evaluation, limited deployment, generalized deployment etc.). Appendices 1, 2, and 3 present the ANOVA results for e-Catalogue, e-Marketplaces, and e-Tendering respectively.

8.3 Discussion of results

The respondents of this survey reported the reduction in overall search (e.g. goods/services, supplier) cost because of e-procurement. This indicator of efficiency had the most significant and positive association with the efficiency dimension. Next to reduction in search cost, the results showed that reduction in purchasing cycle time and reduction in information process costs had the same degree of significance. This was followed by reduction in matching (e.g. invoice, inventory) costs and reduction in purchase price of goods and services, which showed the least significant relationship with

the e-procurement assimilation. The results are encouraging and consistent with the academic and practitioner literature. The capability of web-based IOIS is that it drastically reduces search cost (Subramaniam and Shaw 2002). It is no surprising that the respondents reported the significant impact of this performance measure. Similarly, other significant performance measures pertain to the automation of the procurement process. The 2006 survey of procurement managers conducted by Aberdeen Group also showed that organizations had been realizing these benefits to a great extent. As one of our respondents commented:

> "There is no doubt that a business can gain financially from the introduction of an eprocurement system (no matter what shape or form). Greater control over spend, process efficiencies and quicker transaction cycles are all common benefits that are enjoyed in both private and public sector."

However, other indicators of efficiency did not show any significant relationship with this dimension. There was little or no support for indicators such as increase in throughput (number of transactions during the given time period), decrease in

Fig. 2 Impact of e-procurement assimilation on procurement efficiency

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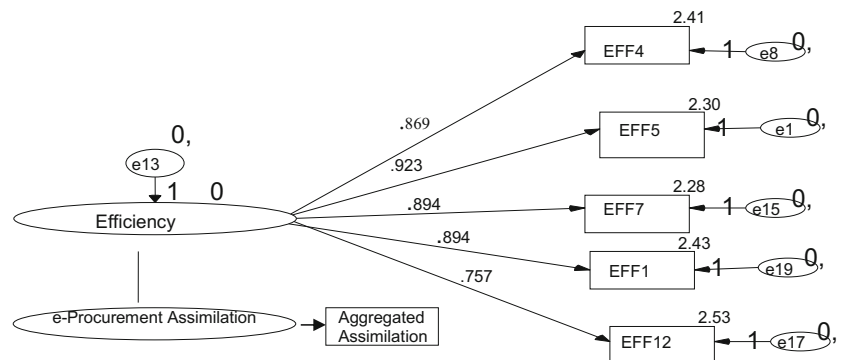
number of staff, reduction in communication costs, reduction in negotiation costs, reduction in monitoring costs, reduction in maverick purchasing, and reduction in the number of suppliers. It follows that most of these efficiency indicators are strategic in nature and it seems that it will take another several years or so before these benefits are fully realized. As discussed in the literature review section, another difference between private and public sector procurement is the number of suppliers, that is, it is not the public sector but the private sector that is concerned about the decreasing number of suppliers. This finding supports the views provided in the literature. As one of our respondents commented:

> "The objective of implementing eProcurement at [...] was to achieve administrative cost savings. The cost of a purchase order has been reduced from approximately $75.00 to $15.00 using eProcurement. The main challenge is enlisting sufficient suppliers in a timely manner to attract staff to use the system."

In terms of dimensional level analysis, there was very small impact of e-Catalogue on the procurement performance in the intention to implement level of assimilation. Therefore, this first level of the assimilation process has not been considered for analysis in the case of e-Catalogue. Since e-Catalogue is considered a very straightforward e-procurement technology, the respondents indicated the assimilation of this technology at the higher level. As expected, the impact of e-Catalogue on efficiency was the most significant in the limited deployment level of the assimilation process, followed by the generalized deployment level. The results indicate that even the e-Catalogue is yet to be fully assimilated in the Australian public sector in order to be able to perceive its highest impact on efficiency measures. Interestingly, the results show that the impact of e-Tendering on efficiency was the most significant in the evaluation level of the assimilation process, followed by limited deployment and then generalized deployment. It seems that the organizations were able to realize the quick gains when they piloted the e-Tendering technology and the impact was less significant as the level of assimilation increased. Similarly, the impact of e-Marketplace on efficiency was shown to be most significant in the limited deployment level of assimilation followed by the generalized level of deployment. This result also means that an organization should at least limitedly deploy the e-Marketplace to realize the efficiency benefits. As one of our respondents commented:

> "I feel that rather then [than] a big bang style adoption across government agencies we will see a gradual gathering of momentum as the ability to successfully implement systems is realised and savings in terms of process cost, compliance and the reduction of maverick purchasing are delivered."

9 Concluding remarks

This paper looked at the disciplines of information systems, e-commerce/e-Government, supply chain management, and public procurement and provided a holistic definition of public e-procurement. Going beyond the concept of 'adoption', this paper further defined e-procurement assimilation.

The respondents of this survey reported the reduction in overall search (e.g. goods/services, supplier) cost because of e-procurement. This indicator of efficiency had the most significant and positive association with the efficiency dimension. As expected, the impact of e-Catalogue on efficiency was the most significant in the limited deployment level of the assimilation process, followed by the generalized deployment level. The results indicate that even the e-Catalogue is yet to be fully assimilated in the Australian public sector in order to be able to perceive its highest impact on efficiency measures. Interestingly, the results show that the impact of e-Tendering on efficiency was the most significant in the evaluation level of the assimilation process, followed by limited deployment and then generalized deployment. Similarly, the impact of e-Marketplace on efficiency was shown to be most significant in the limited deployment level of assimilation followed by the generalized level of deployment. This result also means that an organization should at least limitedly deploy the e-Marketplace to realize the efficiency benefits.

This study did not look at other performance measures such as procurement quality, and transparency and accountability, and also organizational performance that can result because of improvement in procurement performance. Establishing the relationships between e-procurement, procurement performance and organizational performance can be a challenging but interesting research project in the future. As far as we are aware, this research is the first to investigate the very essence of e-procurement assimilation and therefore some of the limitations are related to this being the first study. This study is a snap shot research rather than a longitudinal study. Thus, the findings indicate the current level of the e-procurement assimilation process, its antecedents and their impact on procurement performance. These results do not suggest the trends of the assimilation process, and therefore they do not provide any suggestions on the assimilation rate, where this process is directed and what other strategies public sector agencies should adopt in order to optimize the assimilation process. A longitudinal study of this type in the future can address such concerns.

In addition, as the technologies mature in the future and e-procurement becomes a normal business process, we can expect a time when there will no longer be "e-procurement" but just "procurement". Then obviously, a new set of antecedents and procurement performance measures will need to be developed. As such, a number of case studies in the Australian public sector would also provide further insights and complement the survey research undertaken for this study.

Appendices

Appendix 1

Table 6 Impact of e-catlogue (CATL) on procurement efficiency

(I) CATL	(J) CATL	Efficiency		
		Mean Difference (I-J)	Mean	Std. Dev
Evaluation	Commitment	-.003	2.47	913
	Limited deployment	-.694 (*)		
	Generalized deployment	.087		
Commitment	Evaluation	.003	2.47	907
	Limited deployment	-.691 (*)		
	Generalized deployment	.090		
Limited deployment	Evaluation	.694 (*)	3.16	1.124
	Commitment	.691 (*)		
	Generalized deployment	.781 (*)		
Generalized deployment	Evaluation	-.087	2.38	1.089

*Significance at 0.05

Table 1: Procurement Efficiency of e-Catalogue – ANOVA

Appendix 2

Table 7 Impact of e-marketplace (MARL) on procurement efficiency

(I) MARL	(J) MARL	Efficiency		
		Mean Difference (I-J)	Mean	Std. Dev
Intention	Evaluation	-.443	2.00	1.472
	Commitment	-.646		
	Limited deployment	-.972 (*)		
	Generalized deployment	-.810 (*)		
Evaluation	Intention	.443	2.44	767
	Commitment	-.204		
	Limited deployment	-.530		
	Generalized deployment	-.367		
Commitment	Intention	.646	2.65	1.024
	Evaluation	.204		
	Limited deployment	-.326		
	Generalized deployment	-.164		
Limited deployment	Intention	.972 (*)	2.97	1.294
	Evaluation	.530		
	Commitment	.326		
	Generalized deployment	.162		
Generalized deployment	Intention	.810 (*)	2.81	1.128

*Significance at 0.05

Table 2 Procurement Efficiency of e-Marketplace – ANOVA

Appendix 3

Table 8 Impact of e-Tendering on procurement performance

(I) TENL	(J) TENL	Efficiency		
		Mean Difference (I-J)	Mean	Std. Dev
Intention	Evaluation	−1.322 (*)	1.66	1.320
	Commitment	-.729 (*)		
	Limited deployment	−1.148 (*)		
	Generalized deployment	-.920 (*)		
Evaluation	Intention	1.322 (*)	2.98	1.041
	Commitment	.594 (*)		
	Limited deployment	.174		
	Generalized deployment	.403		
Commitment	Intention	.729 (*)	2.39	842
	Evaluation	-.594 (*)		
	Limited deployment	-.420		
	Generalized deployment	-.191		
Limited deployment	Intention	1.148 (*)	2.81	1.092
	Evaluation	-.174		
	Commitment	.420		
	Generalized deployment	.229		
Generalized deployment	Intention	.920 (*)	2.58	1.010

*Significance at 0.05

Table 3 Procurement Efficiency of e-Tendering – ANOVA

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