THE EFFICACY OF APPLYING MATURITY MODELS TO PUBLIC E-PROCUREMENT AND E-GOVERNMENT

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ABSTRACT: As a public policy tool, adoption of e-government holds out hope of a potentially large payoff in terms of enhancing democratic accountability and possibly lowering operational costs. Moreover, its attractiveness also spans the broad public procurement space in the widespread belief that transforming government through the increasing use of information and communications technology (ICT) support can help improve efficiency and accountability. This paper explores e-government and e-procurement by examining its deployment and integration. Utilizing a recent survey of governments in the U.S. and Canada, the paper discusses the relevance of applying maturity models to ICT within public procurement.

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INTRODUCTION

It is estimated that when wages and interest payments are excluded, an average of approximately 70% of central government expenditure turns one way or another into contracts (Transparency International 2012), and much of that money is funnelled through government procurement agencies. Increasingly, it is believed that a greater proportion of operations are being conducted through electronic procurement (e-procurement) which falls under the broader umbrella of electronic government (e-government). E-government refers to the use of information technology and the worldwide web to enhance and transform government business processes as well as enable greater interaction with citizens and stakeholders, and its use through government websites is exploding across the globe (Jaeger 2003; Kraemer and King 2003; Norris and Lloyd 2006; World Bank n.d.). It is no secret that electronic or webportals are increasingly the interface between citizens and governments and as such, they are important elements for successful public administration.

However the record of implementing information and communications technology (ICT) in the public sector has been patchy from the start (Eglizeau, Frey, & Newman, 1996). Yet since the dawn of the "e-government era" (Curtin, Sommer, & Vis-Sommer, 2004) expectations have been heightened (Weerakkody, Janssen, & Dwivedi, 2009; McNabb & Barnowe, 2009), despite uncertainties about whether the tide of implementation failures has turned (Heeks, 2003; Bolgherini, 2007). Recent studies of citizen-centred e-government accomplishments have been reported, but there is ample evidence that turning e-government (eGov) initiatives into successful practice is not a straightforward exercise of implementing IT systems or introducing new technology solutions (Andersen & Henriksen, 2006; Beynon-Davies, 2007; Homburg, 2009). Nonetheless, the attractiveness of such endeavours is claimed to hold out the promise of radically changing how governments change their internal processes and conduct their business (Robb, 2000; Ibrahim & Irani, 2005).

In an era of budget austerity and outright economic recessions, there is mounting pressure for governments to become more efficient, and ICT-enabled programs are increasingly being initiated

with the intent to transform government processes (Weerakkody, Janssen, & Dwivedi, 2009) and change relations between a governments and their citizens (King & Cotterill, 2007). However as the increasing number of detailed case studies in the field suggests (for a review see Weerakkody, Janssen, & Dwivedi, 2009), eGov activities are inherently complex and do not always follow the expectations expressed in linear, normative and evolutionary growth models often advocated under the umbrella of "maturity" (Coursey & Norris, 2008). Although there are likely many reasons for the failure of many maturity models to predict or outline transformational schemes, there is little doubt that the presence of a large number of stakeholders with different agendas, expectations and concerns – and the breadth of areas that are typically affected – can affect the transformative nature of intended outcomes (see Pardo & Scholl, 2002; Azad & Faraj, 2008; also see Beynon-Davies, 2007).

This paper explores the deployment and integration of electronic public procurement within the framework of maturity models. Due to its unique position and the centrality procurement holds in program and process administration, e-procurement can be a powerful vehicle for successful administrative reforms that center on efficient process control and reducing operational costs. The paper examines e-government initiatives within the public procurement context, and it investigates the extent to which governments have deployed and integrated thirteen e-procurement tools across numerous governments in the U.S. and Canada. It examines some relevant indicators within public procurement and how those measures might be interpreted within a maturity model perspective. A recent survey of public procurement practitioners allows a focus on the potential for operational efficiencies and toolset integration.

The paper is structured into five sections. In the first section, the literature on both private and public sector e-procurement studies is briefly reviewed and it discusses how the view of the role of public procurement has been changed including the arrival of e-procurement. The second section reviews issues and models of e-government including stage models leading to transformational government. The third section describes the research methodology and operationalization of the variables while the fourth delineates the

data findings and results. The fifth and final section discusses the data and its relevance to maturity models before concluding with final remarks.

THE CHANGING ROLE OF PUBLIC PROCURMENT AND THE RISE OF E-PROCUREMENT INITIATIVES

Procurement as a process spans a range of activities, from identification of needs through to the end of a services contract or the end of the useful life of an asset (Hughes, 2005). It includes the design and delivery of works, products or services, the assessment of their quality, as well as the evaluations and reviews that will lead to further procurement. The whole process contains a string of decisions about the products and services that will be delivered to users. The outcome of the process often has far-reaching, long term effects. While in the private sector the purchasing function has gradually developed from 'buying' to 'supply chain management' (Christopher, 2004), from purchasing goods at lowest price to managing supplier relations in order to enhance the creation of value (van Weele, 2001), the evidence to date is that this does not seem to be the case in the public sector and if change has been taking place, the very nature of it may be quite different (IRSPP 3, 2007).

Public procurement (PP) is the acquisition of goods, works and services required by public sector organizations for their missions to support services provided to taxpayers. As one of many governmental functions PP provides services that will be delivered to local authorities and the communities they serve (Hughes, 2005). Inevitably, governments are the biggest 'spenders' world-wide and public procurement is increasingly recognized as a dominant economic factor (Thai, 2005). It has also been advocated as an important overall policy tool (Walker, Harland, & Knight, 2005; Caldwell et al., 2005; Thai, 2005). Expectations regarding the goals and principles of public service in general include ensuring traceability, accountability and transparency and generally acting fairly within rationalized processes. Public procurement as a policy implementation instrument is often used to achieve social and other

objectives (Thai, 2004) such as sustainability, supporting SMEs, addressing environmental concerns, dealing with diversity and equality considerations, and delivering Value for Money policies.

However a potential argument against pursuing socio-economic, environmental or other 'non-supply' goals in public procurement is that they may increase costs (Erridge & Hennigan, 2007). Moreover, the operational architecture coordinating government organizations, their purchasers, and their suppliers, is an important factor in the success of government programs. Given its centrality in public policy administration, the way public procurement is delivered has room for exploitation. Conceptually thinking about what public procurement is and what its practitioners do and why, requires theoretical and empirical accounts across three important domains that describe any public procurement system and these include 1) the legal basis for practitioners' activities in discharging their responsibilities; 2) the organizational and structural boundaries of operative activities; and 3) the functional tasks and intended outcomes of the practices used in the pursuit of governmental obligations (see Prier & McCue, 2009). This is why the entire procurement process has been conceptualized as a system replete with feedback loops and homeostatic tolerance levels for essential variables (Waelchli, 1985), or as a "nested structure of systems within systems" (Thai, 2001, p. 40). In thinking about public procurement in these ways, a hierarchical purchasing process can be but one component in a dynamic environment, and thus a non-recursive decision-making environment is implied (Prier & Csáki, 2010).

Similar to their counterparts in the commercial sector, public procurement practitioners require skill sets spanning several disciplines and in their jobs, the participation of many organizations and departments (Thai, 2001; Harland, Gibbs, & Sutton, 2000). Users of government services are citizens who often have different interests or specific needs such as the elderly, or people with various health problems (Walker, Harland, & Knight, 2005). Furthermore, "the consumer of a public service is very often not the paying customer. What may please the government purchaser may not suit the individual client" (Smyth, 1997, p. 30). So what is e-procurement, and why is it important?

E-procurement in the public sector is defined as the "use of the Internet-based Inter-organizational Information System, which automates and integrates any part of the procurement process in order to improve … efficiency and quality" (Vaidya, Callender, & Sajeev, 2009, p. 477). ICT-based procurement solutions may benefit the administration and distribution aspects of supply internally (de Boer, Harink, & Heijboer, 2002), but they can also be used to enhance information sharing and cooperation utilizing the Internet (Lancioni, Smith, & Olivia, 2000). They also promise greater transparency. However, in reality the main reason behind the use of these solutions in the public sector is to achieve purchase process and operational efficiency gains – typically resulting in lower transaction costs – and to provide internal service improvements (Croom & Brandon-Jones, 2009). Thus system integration is a critical issue when done poorly or not at all, and the results can often hinder success (Croom & Brandon-Jones, 2009; Vaidya, Callender, & Sajeev, 2009).

The main functions of an advanced e-procurement or SCM information system are vendor identification (e-Sourcing), online quotation handling (e-Requests), collection and evaluation of offers and vendor selection (e-Tendering), offering electronic catalogues (e-Catalogue and e-Purchasing), inventory management, order processing (e-Ordering), transportation control, customer service, vendor relationships management, and production scheduling (Lancioni, Smith, & Olivia, 2000; de Boer, Harink, & Heijboer, 2002; Vaidya, Callender, & Sajeev, 2009). However despite this broad coverage of activities, it appears that e-procurement as a support tool has had limited impact on process changes or decision making.

While the expected benefits of utilizing technology in support of procurement processes have been investigated (Croom & Brandon-Jones, 2009; Vaidya, Callender, & Sajeev, 2009), there has been a relative lack of investigating the interaction between public procurement processes and technology. If full integration of underlying processes and enabling technologies is to be achieved within the context of maturity models and e-government, a clear understanding of the nature and state of e-procurement in eventually promoting best practices and implementing transformative changes

is necessary. Indeed, most e-procurement initiatives are advanced in the context of e-government and the next section looks at its evolution and the way this change is discussed in the scientific literature.

E-GOVERNMENT, T-GOVERNMENT, AND STAGE MODELS

The introduction and use of ICT in the public sector is often termed e-government (Grant and Chau, 2005). As a research area it focuses on the fundamental concern of change in governmental services enacted through the application of technology (Homburg, 2009; Cordella and Iannacci, 2010). The first initiatives thus often addressed issues of increased efficiency and improved capabilities, including better access to services by citizens and businesses in their dealings with government (Danzinger and Andersen, 2002). However during the last few years there has been an increased awareness of the need and opportunity to change internal processes of government operations (Weerakkody, Jansen & Hjort-Madsen, 2007). Such activities are regularly termed Transformational Government (tGov) emphasizing the changing nature of government work and relationships from the inside (Danziger & Andersen, 2002; Weerakkody, Janssen, & Dwivedi, 2009; Foley and Alfonso, 2009). While even basic access to government information or individual services may require data integration "behind the scenes", it is reorganization of intra- and inter-unit processes that differentiate tGov from eGov (Andersen & Henriksen, 2006; Dhillon, Weerakkody, & Dwivedy, 2008).

These trends are discussed in the context of various evolution or readiness models (for an overview see Beynon-Davies, 2007 or Coursey & Norris, 2008). One of the most quoted models is presented by Layne & Lee (2001) who differentiate four stages:

- Cataloguing: making information and downloadable forms and documents available;
- Transaction: connecting internal systems and live databases to on-line interfaces, allowing citizens to transact with government;

- Vertical integration: integrating systems and processes within similar functionalities at different levels through the Intranet;
- Horizontal integration: integrating different functions and services across agencies thereby allowing a "one-stop shopping" solution.

Other models have been offered that discuss up to six phases (see comparisons by Beynon-Davies, 2007). The most advanced stage often requires going beyond transparent, integrated, efficient service delivery by achieving social inclusion and accountability through ICT-based participation and access (Andersen & Henriksen, 2006; King & Cotterill, 2007). These levels of an extended model thus aim to achieve the following:

- Information availability;
- Service availability;
- Functional integration over various levels of government (internally);
- (Internal) integration across units and agencies of various functional areas;
- Availability of one point of access to citizens and businesses; and
- Full inclusion based on availability of participatory functions.

Organizational maturity models which tend to focus on private entities, their processes, and capabilities, are rooted in management studies and were established as early as the 1970s in relation to quality. One of the most cited is Crosby's (1979) "Quality Management Maturity Grid." However the first widespread application was the so-called "capability maturity model" (CMM) developed during the late 1980s to the early 1990s which was embraced mainly by the software industry as early as 1985 (Humphrey, 1987 and 1988). This line of research culminated in the Software Process Development CMM (Paulk et al., 1993). From there, maturity models became extremely popular in the mid-1990s with the dawn of ISO quality certification (ISO 9000, ISO 14000 – see for example Mallak, Bringelson, & Lyth, 1997).

The concept of maturity as it has been applied to an organization has been referred to as the "state where the organisation is in a

perfect condition to achieve its objectives" (Andersen & Jessen, 2003, p. 457). Maturity then may be defined for various organizational functions with the shared meaning that the organization or parts thereof are perfectly conditioned to deal with a given domain or area (such as project management – Andersen & Jessen, 2003; or knowledge management – Hsieh, Lin, & Lin, 2009). But it wasn't until the early 2000s that maturity models were widely applied to the public sector with the arrival of the concept of "e-government" (Layne & Lee, 2000).[2] To date there are close to a dozen versions within the scientific literature (see Bekkers & Homburg, 2007; Beynon-Davies, 2007; Coursey & Norris, 2008; Andersen & Henriksen, 2006).

To summarize, the key idea beyond maturity models is that an organization's readiness with regards to a given dimension evolves along a certain path and exhibits special characteristics with regards to a few key indicators within a given area (e.g. production quality as in ISO or ICT readiness as in eGov). In reference to these evolutionary changes, such models are often called "growth" models. It is noteworthy that practically all maturity models have an unstated assumption at their core and it is that there is an increasing level of technological and organizational complexity behind the progress from one stage to the next (Layne and Lee, 2001; Andersen and Henriksen, 2006), and more mature stages hold the potential for increased levels of benefits to service recipients (Foley & Ghani, 2005). However, such a linear – and thus somewhat simplified – evolution is increasingly contested (Coursey & Norris, 2008; Beynon-Davies, 2007; Bekkers & Homburg 2007) because there is more than just the question of (internal) integration or functionality (Andersen & Henriksen, 2006; Homburg 2008 and 2009). As Kolsaker & Lee-Kelley (2007) point out, it is difficult to go beyond plain modernization and achieve real (technology-enabled) transformation, because providing complex functionality that requires true internal integration and (ICT-based) collaboration lead to complexities which are easier to

[2] The most-quoted paper in the e-government literature – with 1000+ citations and counting – is the proposal by Layne and Lee (2001) discussing a full-scale eGov maturity model.

talk about than to describe, let alone actually resolve (Persson, Axelsson, & Melin, 2006).

There are other issues with maturity models and they often involve differences in terminology and interpretation of various concepts (Curtin, Sommer, & Vis-Sommer, 2004; Beynon-Davies, 2007). For instance, ambiguities associated with the meaning behind "one-stop" service provision may refer to all services, certain types of services (such as getting information about all levels of government operations), or services related to a given domain (e.g. payments, licensing, etc.). Furthermore, behaviours and preferences at the individual level do influence choices when it comes to considering offline versus online options (Kolsaker & Lee-Kelley, 2007). Consequently, progressing from eGov to tGov might be a much slower process than typically expected, and accurately predicting and describing what may be transformative may be difficult to pin down.

Even if one rejects the validity of (stage-based) evolution models (Coursey and Norris, 2008) it is indeed possible to name certain characteristics of government activities that would indicate "transformation" (Homburg, 2009; Weerakkody, Janssen, & Dwivedi, 2009; Foley & Alfonso, 2009) including:

- Cross-functional data exchange or accessibility;
- Deliberate process reorganisation based on ICT utilisation;
- Offering integrated service solutions based on one common technology base;
- Change in the governmental approach to offering services (sometimes called "citizen-centric" service delivery);
- Increased social inclusion – in one area or another;
- Change in how people think about their government and their relationship with it;
- Change in citizen behaviour affecting "society at large".

Although a project, program, or initiative does not need to display all of these characteristics, the question is whether any of these may be achieved independently of each other or whether they may only be achieved in a specified sequential order. Interestingly, the argument for logical dependency does not even consider the potential for nonlinear combinations and if it did, the models become

contentiously complex. For these reasons, stage models often lack a unifying theory that would allow the researcher to investigate upcoming or ongoing programs (Scholl, 2007) in a way that allows for easy comparison. Beyond complexity, another difficulty in analysing the e-government agenda is the wide range of views and interpretations exhibited by various stakeholders based on their background, expectations, and values (Pardo & Scholl, 2002; Hirschheim & Klein, 2003). Indeed various frameworks offer different sets of key dimensions along which analysis may be structured (Almarabeh & AbuAli, 2010; Ghapanchi, Albadvi, & Zarei, 2008; Grant & Chau, 2005; etc.), and for these reasons, Beynon-Davies (2007) proposes that a multi-framework approach is necessary.

E-PROCUREMENT, T-PROCUREMENT, AND PUBLIC PROCUREMENT STAGE MODELS?

Public procurement is recognized as a complex field that requires the integrated use of domain, legal, and economic knowledge (Thai, 2001). Traditionally, public procurement professionals "were responsible mainly for executing procurement actions in response to requirements" (Snider, 2006, p. 275). But with the changing role of public procurement, that is PP becoming part of policy execution and governmental strategy it became clear that "skills and expertise of procurement staff need to be enhanced…" (Erridge & Greer, 2002, p. 519). This led to the realization that capability building and the corresponding management of capacity was essential for the success of PP and it had been identified as a key development area (Harland et al., 2005; IRSPP 3, 2007). Yet, despite its importance and complexity, public procurement professionals do not seem to receive respect and recognition matching the pressure they face or the needs raised against their performance (Snider, 2006; Harland et al, 2005). This relatively low level of respect is especially surprising in the face of the increased strategic importance of purchasing in governmental policy. As the findings by McCue & Gianakis (2001) reveal, this is partly voluntary as many public procurement practitioners do not believe that they have a role to play in organizational leadership.

The first sign of readiness for a maturity model is the establishing and use of Critical Success Factors (CSF) for related projects in the given domain or program area. CSFs are extracted from experience and case studies in relation to projects that have far-reaching impact and indeed induce changes. This happened in software development in the 1980s and during the dawn of e-government projects in the 1990s. The same appears to be happening for e-procurement development projects – which might be a promising precursor (Vaidya, Callender, & Sajeev, 2009; Croom & Brandon-Jones, 2009). However there may be reason to suspect that successful application in the private sector may not necessarily be appropriate to the public sector. Although it is true that the mission of the supply function may be similar (see Johnson et al., 2003; Muller, 1991), there may also be some key differences (Self, 1993; Page, 1980; Harland, Gibbs, & Sutton 2000; Johnson, Leenders, & McCue, 2003). The most obvious is that while the private sector may be claimed to be driven by the bottom line, public sector policies are created based on public interest (Erridge & Greer, 2002).

Because governments lack a single goal and have responsibilities related to fulfilling non-financial policy objectives, Erridge (2005) points out that public value cannot be defined by commercial categories only. In fact, embracing and fulfilling non-commercial goals may actually increase costs (Erridge & Hennigan, 2007), and this may help explain why procurement may have more of a strategic character in the private sector than in the public sector (Snider 2006, 277). Simply put, public procurement tends to be characterized by high levels of public transparency and a heavy reliance on the bid process compared to private sector organizations (Osborne & Pastrik, 1997). Consider, however, that the nature of much of public bidding and tendering is based on the principle of arm's length relationships with little information sharing, and this runs contrary to the recent fad favouring partnership agreements and closer buyer-supplier relationships (Neff 2001; Parker & Hartley 1997).

At the heart of the present discussion is the question of what should be considered to be public procurement "production." Indeed different governments exist to deliver different things and they thus perform widely disparate public functions. A special district such as a

school system is set up to deliver a much different "product" (a public policy or program) than is a city or municipal government that is designed to provide a wide array of "products" that can easily rival or best the biggest multinational corporations in the array and diversity of "products." Moreover, it is very likely that private firms can have widely different procurement systems and varying organizational architectures – some may be quite centralized while others may be relatively decentralized – and this fact is apparently absent in the discussion of procurement maturity.

So it can be seen that the nature of public procurement might be different than procurement in the private sector, and perhaps practitioners are different also. Consider that due to the nature of public procurement, certain goods or services are purchased fairly infrequently and as a result, public procurement practitioners have difficulties acquiring commensurate levels of knowledge and expertise compared to their private sector counterparts (Erridge & Greer 2002). Consequently, much of the potential for exploiting many of the recent advances in knowledge from the supply chain management literature is lost, either because recommendations are not compatible with rules found within the public sector, or due to sclerotic bureaucratic procedures required by those regulations (Erridge & Greer 2002; Erridge & McIlroy 2002). Indeed many public sector regulations are promulgated with the underlying assumption that collaboration is inefficient or might breed corruption, and so reliance on arms-length relationships is the best way to breed competition in order to maximize VFM.

So at the same time e-tools can help operational processes, it is open to question how much strategic benefit can be leveraged in the public arena. However this does not preclude monitoring and continual evaluation of supplier performance (e.g. Zeng, 2003), and depending on how it is used, the collection of this data can be helpful in future selection processes (de Boer, Labro, & Morlacchi, 2001). Because there is little doubt that collecting information about suppliers can be cost-intensive, digitization and the proper e-procurement tools can help monitor supplier performance, and this may reduce some of the risks associated with extending partnerships and encouraging competition – all of which can help avert the

downside of becoming captive to suppliers (e.g. see Tan, 2001; also see Parker & Hartley 1997; Walker, 1988). So there is little doubt that integration of procurement processes and activities are an issue, especially considering how ICT might help in producing better and more effective acquisitions based on the expertise of decision support or decision technologies (see Csáki & Gelléri, 2008; also see Csáki & Adam, 2010; Prier & Csáki, 2010). Nonetheless, applying maturity models to e-procurement in the public sector may be problematic, and it is further exploring this issue that the paper operationalizes data in the next section.

Section Two - Operationalization/Research Design/Methodology/Data Collection

The exploratory design of the research used a sample survey methodology based on a theoretically "grounded" questionnaire intended to gain a better understanding of the state of e-procurement as it is practiced across different agencies and entities. Based on quantitative data from different levels of governments in the United States and Canada, the unit of analysis is the procurement agency. Data from a 2011 survey was gathered from the National Institute of Governmental Procurement (NIGP), a professional association of more than 16,000 members across the U.S. and Canada. An email was sent to an opt-in group of NIGP members on May 28th and again on June 1st informing them of the survey issuance. The survey was administered online on June 2, 2011 using surveymonkey.com. On June 9 a reminder email was sent out and June 27, 2011 was the last date responses were accepted. A total of 2,269 procurement practitioners were invited to participate in the survey. Out of those contacted, 499 (22%) completed the survey by the closing date, and after appropriate data-cleaning, there remained 467 usable responses for the whole dataset across 129 variables generated from 30 questions. Appendix A provides the summary questionnaire, and the survey offered the opportunity to answer open-ended responses to a number of questions for the purposes of qualification and to provide more detailed answers than the close-ended options available.

There are a number of challenges to using a sample pool based on organizational affiliation, not least among them is the external validity or generalizability of the findings. Determination of the population of the study is difficult because no list of all procurement practitioners exists – let alone their characteristics, entity or agency affiliations, etc. Thus a major assumption of the data is that they are comprised of appropriate cases of agencies and their respondents who are most likely to be knowledgeable of the specifics concerning each question, and personal communications with knowledgeable practitioners tends to verify the broader findings concerning general deployment patterns.

A counterfactual assumption is that the average agency-respondents – when clustered into groups – typically reflect those who did not participate. Preliminary agency-respondent examination reveals a diverse range and representation of NIGP's membership across different levels, types, and size of governments and organizational architectures (as well as respondent organizational position), so the relative confidence of generalizing the results to other agency and national settings – although it invites caution – also sufficiently contributes to knowledge to warrant consideration within the literature. Finally, the research design is such that the sample and case-units are appropriately definable by reference to particular hypotheses and the corresponding research questions.

When appropriate, preliminary checks of variable distributions were made against those agency-respondents who were excluded from the analysis, and there did not appear to be any systematic bias between those who were included or excluded, and although there is no good way to deal with the issues associated with missing data, this has been adequately discussed elsewhere (see Tabachnick and Fidell 1989, 60-66; also see Cohen and Cohen 1975; and Rummel 1970). It was elected to rely on the data available as opposed to imputing and extrapolating data that was not obtained, either through the intentional withholding of the data or due to other reasons for its absence. Hence the resulting analysis and findings rest upon firmer ground for the exploratory purposes herein. The data analysis package used in this study was SPSS Version 19. In this paper, there are statistics reported on unconditional responses and other

statistics that are contingent upon other variables in order to evaluate e-procurement deployment and capabilities.

Specification and data

It is theoretically plausible that the capability and integration of using e-procurement will be conditioned by three independent variables: procurement reach, procurement role, and agency size. Indeed, the focus of the analysis centers around the impacts that organizational contextual variables and entity characteristics might have on e-procurement capability and levels of integration. The analysis is predicated on the straightforward hypothesis that e-procurement capabilities and integration are possibly conditioned on entity type and on procurement organizational role. In addition, subsequent hypotheses will be explored through evaluation of bivariate and trivariate associations.

Dependent variable

The main objective of this study is to evaluate the capabilities and integration levels of e-procurement tools across different procurement organizational architectures (roles) and entities. This dependent variable has two dimensions: deployment/capability and level/configuration of integration. This former dimension is operationalized using question Q20 (in Appendix A), and the latter dimension is measured by both Q20 and Q19. Thus to gauge both dimensions, there are thirteen variables comprising the total e-procurement toolset. Depending on the issue explored herein, the dependent variable measuring integration (Q20) has been recoded from an original four attributes into three or two in the following manner[3]:

0 = Use tool but not integrated

1 = Use tool but only partially integrated

2 = Use tool and fully integrated

or

0 = Tool not integrated

[3] The attribute "n/a" was recoded as system missing.

1 = Tool fully or partially integrated

In accordance with theoretical expectations, higher values on this variable should indicate greater deployment and integration of e-procurement tools.

In order to further document capabilities and integration, a second measurement of integration utilized Q19 in the following manner:

0 = Built in-house or commercial-off-the-shelf (COTS) software[4]

1 = Part of core ERP/ financial solution

Theoretical expectations suggest that higher values on this variable should indicate greater overall integration of e-procurement tools across the entity and enterprise.

Independent variables

The first independent variable hypothesized to have some impact is the institutional architecture within which procurement functions – how it operates within the bureaucratic structure, and although measuring procurement architecture is not an easy task, the indicator used here is the level of (de)centralization of the procurement *process*. Therefore, the procurement architecture is conceptualized and measured using Q4 and its original four categories as well as in the following scheme (hereafter referred to as the procurement role):[5]

0 = Decentralized with central review

1 = Centralized contracting/decentralized buying from established contracts

2 = Centralized with delegated authority

[4] This includes one of two versions – either the COTS was installed locally or the COTS is cloud-based (software as a service).

[5] The original four categories consisted of "centralized contracting/decentralized buying from established contracts" (29.3% | N=146); "decentralized with central review" (21.4% | N=107); "centralized with delegated authority" (35.3% | N=176); and "centralized" (13.0% | N= 65).

3 = Centralized

Greater values suggest more centralization of the procurement function.

The second independent variable is procurement reach of the government entity using the procurement agency (Q2). The original dataset had eight entity types that lent themselves to easy reclassification – in this case – into three.[6] Governments empowered to accomplish a wider range of programs and policies for citizens (e.g. states and provinces) will have a broader reach than governments created for more specific tasks, such as special districts or public schools. By collapsing the original eight categories into three, government reach is measured by the type of entity coded in the following way:

0 = Education or Special District (referred to as procurement reach level 1)

1 = City/Municipal Government (includes township and referred to as reach level 2)

2 = County/Regional/State/Provincial/Federal Government (referred to as reach level 3)

Higher values refer to greater government scope and involvement and thus greater procurement reach.

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[6] There were six respondents who indicated working for more than one entity. They were recoded into the most encompassing or hierarchically superior entity which became the controlling code in the following manner: the single respondent (n=1) who ticked the response "City/Municipal Government" and also ticked the response "Special District/Authority (e.g. water, power, transit, airport, judicial district / circuit, etc." was recoded as "City/Municipal Government"; "State/Provincial" and "County/Regional Government" (n=1) became "State/Provincial"; "County/Regional" and "City/Municipal Government" (n=2) became "County/Regional"; "County/Regional" and "Public School District (K-12)" (n=1) became "County/Regional"; and "Federal Agency" and "City/Municipal Government" (n=1) was recoded as "Federal Agency". "Township/Town/Village", "Public College/University", and "Special District/Authority" were consolidated to become "Education or Special District".

The third independent variable (Q6) to be explored examines the potential linear relationship between size of the procurement agency and the extent to which it utilizes e-procurement. Procurement agency size is measured as the total number of full-time equivalent (FTE) employees involved in the procurement function, and it is entered as a decimal number rounded to the nearest half FTE. The trinary measure is the 33.3 and 66.7 percentiles for those agencies in the analysis, and it is an ordinal variable coded in the following way:

0 = 0-3 FTEs

1 = 3.01-7.0 FTEs

2 = 7.01 FTEs or greater

Higher values are theoretically consistent with larger procurement agencies.

These three independent variables are believed to provide important information about the deployment and integration of e-procurement. In exploratory studies, simplification strategies are often employed in the measurement process, and this analysis remains agnostic concerning the exact form of the relationships of these variables. However there is no theoretical reason at this point to suspect that the parameters might not be linearly related, so $Y = f(X_1, X_2, X_3)$; where

Y = capability and integration/configuration of using e-procurement tools

X_1 = procurement reach

X_2 = procurement organizational role

X_3 = procurement agency size

Table1 reports the descriptive statistics for the respondents' procurement positions distributed across entities (the three levels of procurement reach). It reveals that very few of the respondents are clerical staff, and they are heavily skewed toward management and directors (77.7% | N=382). This is good for the purposes here because these are the people most likely to know intimate details

about e-procurement capabilities and other functioning systems within the agencies. Moreover, the table also shows that the three levels of procurement reach are about evenly divided within the dataset. For example, education and special districts comprise 27.8% (N=137); cities and municipalities are 37.4% (N=184); and level three procurement reach consisting of counties, states, regional and the Federal government comprises 34.8% of the data (N=171). Table 2 reports the procurement role as a function of the three levels of procurement reach, and it can be seen that the centralized with delegated authority structure (35.7% | N=176) is the modal role used by the reporting entities. It can also be seen from Table 2 that 29.6% (N=146) of government entities are using a central contacting/decentralized buying roles. The other two role for procurement (decentralized with central review and everything centralized) are used by approximately 1/3 of the entities. What is interesting is that cities and municipalities appear to slightly diverge from their brethren in that cities tend to use decentralized with centralized review organizational configurations more than the others (about ten percentage points more) while cities do not use centralized procurement roles as much as the other two types of entities.

Table 1. Procurement Positions Distributed Across Procurement Reach

	Procurement Reach			
Position	**Education or Spec'l District**	**City / Municipal[a]**	**County / State / Federal[b]**	**Total**
Clerical Staff	14.3% (2)	35.7% (5)	50.0% (7)	2.8% (14)
Buyer / Contracting Specialist	25.7 (9)	45.7 (16)	28.6 (10)	7.1% (35)
Purchasing Agent	8.2 (5)	54.1 (33)	37.7 (23)	12.4% (61)
Purchasing Manager	24.7 (42)	40.0 (68)	35.3 (60)	34.6% (170)
Chief / Director / Head	37.3 (79)	29.2 (62)	33.5 (71)	43.1% (212)
Total	27.8% (137)	37.4% (184)	34.8% (171)	100% (492)

[a] Includes townships
[b] Includes regional governments and provinces

Table 2. Procurement Role as a Function of Procurement Reach

Procurement Role	Education or Spec'l District	City / Municipal[a]	County / State / Federal[b]	Total
Central Contracting / Decentralized Buying	30.4% (42)	29.2% (54)	29.4% (50)	29.6% (146)
Decentralized with Central Review	17.4 (24)	28.6 (53)	17.1 (29)	21.5% (106)
Centralized with Delegated Authority	37.0 (51)	33.0 (61)	37.6 (64)	35.7% (176)
Centralized	15.2 (21)	9.2 (17)	15.9 (27)	13.2% (65)
Total	28.0% (138)	37.5% (185)	34.5% (170)	100% (493)

[a] Includes townships
[b] Includes regional governments and provinces

This paper utilizes several different ways to investigate the capabilities and integration levels of e-procurement tools across different procurement organizational roles and entities. To begin, a baseline analysis was conducted that looked at whether or not agencies had thirteen of the most common e-procurement tool capabilities, and the results are reported in Table 3. The table organizes the e-procurement tools in terms of declining availability across all agencies – from those e-tools most available to those least offered, and it can be seen some tool capabilities are much more accessible than others. Notice the last column which reports the usable Ns for each respective tool. Because respondents cannot be

ethically forced to answer every question, there are varying levels of response rates across the tools with an average of 164 responses per e-tool. Nonetheless, the data lend themselves to relatively high confidence that they are conducive to proper analysis due to the stability of the reported proportions shown across similar questions within the dataset.

The percentages and Ns tell an interesting data story from the vantage point of each tool. Looking at requisitioning as an example, while 12.6% (N=22) of the 174 agencies do not have the e-tool, 152 of 174 (or 87.4%) have the requisition tool capability. Conversely, the least accessible e-tool is that for reverse auctions which is offered within only about one-in-five (21.3% | N=33) agencies. So in the simplest way of assessing the range of capabilities across agencies, nearly nine-in-ten agencies have the option to utilize electronic requisitioning while only one-in-five have that opportunity in the case for reverse auctions.[7] This is important in evaluating each agency relative to one another, and this is done through statistical typicality mapping.

Statistical Typicality Mapping (STM)

Before conducting the mapping exercise, process benchmarking is to be distinguished from the purposes herein. Often with the aim of developing or increasing some aspect of performance, benchmarking involves a comparison of business processes and performance metrics against best practices in an industry, government, organization, or within a peer group selected for the purposes of comparison along specified evaluation criteria. However this is not the purpose of the current exercise which is to ascertain predictable or standard e-procurement functionality for public procurement agencies and if so, map what it is. Typicality can be measured in numerous ways, but the idea is to rely on relevant statistics to make the case for a typical e-procurement toolset across a few contemporary procurement settings. This process is explained when appropriate throughout the rest of the paper, and it is referred to as statistical typicality mapping or STM for short. The first avenue of

[7] Although technically nonequivalent, subsequent discussions assume that having the capability means that the agencies also use the e-tool.

exploration involves using the independent variables to establish the extent to which agencies use any of the thirteen e-procurement tools, and this is also reported in Table 3.

In order to create the statistical typicality mapping models (STM models), it is useful to identify the *ex ante* criteria for inclusion of the tools in any of the typicality models subsequently identified in this paper, and a consistent yet conservative methodology is adopted throughout the paper. To be included in a typicality model, the criterion requires at least 50%+1 of the agencies have the respective e-tool capability. This criterion is consistent with the conceptual notion of typicality – a converging tendency toward accessibility of the tool across organizations, and it is the basis for inclusion of tools in the STM models to be subsequently discussed.[8]

Table 3. Availability of Thirteen E-procurement Tools

E-procurement Tools	Availability of Tool		
	No	Yes	Nª
Requisitioning (catalog services / shopping cart)	12.6% (22)	87.4% (152)	174
Online supplier registration	35.5 (59)	64.5 (107)	166
Central contract repository	39.9 (67)	60.1 (101) ^{X3s}	168
Notifications	42.8 (71)	57.2 (95) ^{X3m}	166
Spend analytics	54.0% (88)	46.0% (75)^{X1}	163
eSourcing	61.3 (100)	38.7 (63)^{X2}	163
Marketplace (including catalog services)	64.0 (105)	36.0 (59)	164
Contract life-cycle management suite	67.1 (110)	32.9 (54)	164

[8] Note that this is not the median which is a threshold at 50% (as opposed to 50%+1).

Supplier performance and risk management tools	73.3 (121)	26.7 (44)	165
Collaboration tools	73.6 (117)	26.4 (42)	159
eInvoicing	74.1 (120)	25.9 (42)	162
Forward auctions	75.6 (121)	24.4 (39)	160
Reverse auctions	78.7 (122)	21.3 (33)	155
Averages	**57.9% (94)**	**42.1% (70)**	**164**

[a] Ns reported are for all agency-respondents concerning tool
$X1$ Signifies majority use of tool for only first level of procurement reach
$X2$ Signifies majority use of tool for centralized procurement roles
$X3s$ Signifies majority use of tool for medium and large agencies only (not small)
$X3m$ Signifies majority use of tool for small and large agencies only (not medium)

The first STM model is the baseline statistical typicality mapping model ($STM_{Baseline}$), and it consists of only those agencies available to an overall majority or better of agencies. From Table 3, it can be seen that the $STM_{Baseline}$ model consists of the first four tools listed in the left column: {Requisitioning, Online supplier registration, Central contract repository, and Notifications}. This suggests the expectation that on average, if one had to predict which e-procurement tools were being used across a randomly drawn sample of 100 procurement agencies, without knowing any information about the sample elements such as their reach, procurement role, etc., the best prediction that would result in the fewest errors would be this $STM_{Baseline}$ toolset.

Notice the calculation strategy for defining this baseline model: simple majority-agency clustering by e-tool capability or not. However if one had information on other agency characteristics, one might make better predictions over those same 100 randomly chosen agencies. Thus a different strategy can employ a further degree of stratification beyond the baseline model contingent on procurement reach, role, or size (the independent variables). Results of this

modeling strategy are reported in the table as superscripts in the "Yes" column. From this information, three additional STM models are derived and compared to the $STM_{Baseline}$ model which has no independent variables.

STM_{Reach} Model

The STM_{Reach} model is based upon stratifying tool capability according to procurement reach, and this information shows that although the spend analytics tool is *not* used by a majority of agencies in the baseline model, the spend analytics tool would only be included in the STM_{Reach} model for procurement reach level 1 (education or special districts) because not shown in the table is the fact that 56.5% (N=26) of level 1 procurement agencies have the spend analytics tool capability. Compare this to the medium reach agencies (48.4% | N=31) or entities with the broadest procurement reach (level 3), the latter which shows the spend analytics e-tool available to only 34.0% (N=18) of these agencies. Thus the tool would be dropped for this group because it is not typical e.g. it is not used by a majority of agencies. Thus the STM_{Reach} model toolset consists of the following elements for reach level 1: {Requisitioning, Online supplier registration, Central contract repository, Notifications, and Spend analytics} but for reach levels 2 and 3, it is simply the $STM_{Baseline}$ model.

STM_{Role} Model

Table 3 also reports data associated with the creation of the STM_{Role} model by utilizing information on the role of procurement (its relative level of centralization), and calculations show that only for the centralized procurement role would the eSourcing tool be added to the $STM_{Baseline}$ toolset, because 52.4% (N=11) of these agencies use the tool.[9] Thus only for centralized roles, the STM_{Role} model is {Requisitioning, Online supplier registration, Central contract repository, Notifications, and eSourcing}. For the other three

[9] For the eSourcing tool, the following usage by the remaining procurement roles is: decentralized with central review (44.9% | N=22); centralized contracting/decentralized buying from established contracts (31.3% | N=10); and centralized with delegated authority (32.8% | N=20).

procurement roles, again the agency typicality toolset reverts back to the $STM_{Baseline}$ model.

STM_{Size} Model

Similar to the STM_{Role} model, it can be seen from Table 3 that if one had additional agency information, the STM_{Size} toolset would differ based on procurement agency size. Here the model gets a little tricky in that although there are no *additional* tools beyond the $STM_{Baseline}$ model and its four elements, there are actually fewer tools than the $STM_{Baseline}$ depending on the procurement agency size. Consider that for large agencies only, the STM_{Size} = $STM_{Baseline}$. However for small agencies, the toolset consists of only three e-tools {Requisitioning, Online supplier registration, and Notifications} while for the medium-size agencies, there are also only three elements that include {Requisitioning, Online supplier registration, and Central contract repository}.[10] A comparison of the toolsets is reported in Table 4. In sum, there is sufficient stability surrounding the $STM_{Baseline}$ toolset to warrant its use as a baseline but obviously not as a benchmark. Nonetheless, the variation in the typicality toolsets based on these three independent variables suggests more consideration within the literature, especially in terms of better understanding of the one-size-fits-all nature of maturity models.

Consider that maturity models tend to be based on linear functionality, and the purpose of identifying maturity levels often lays in their application of attempting to benchmark organizations in order to measure the gap between current procurement process status and those determined to be best-in-breed. However the findings here invite caution in this regard. For instance, the simplest formulation of typicality as laid out here suggests that the linear benchmarking application of identifying maturity levels may be misplaced. The variables identified here indicate the need to identify the scope of governments; account for substantively different organizational roles for procurement agencies; and consider the potential for differential agency size, because there is suggestive evidence that all of these

[10] For small agencies, the Central contract repository is available to only 46.8% (N=29) of agencies while for the medium agencies, the Notifications e-tool is accessible by only 47.7% (21).

variables reflect practical yet subjective purposes within which procurement operates and functions. Of course, the findings here are likely an artifact of the *ex ante* majority criterion imposed on measuring typicality, especially as it relates to maturity models, and this is worthy of discussion. Unfortunately, to the authors' knowledge, this has not yet occurred in the literature, and this paper represents a start in that direction. However so far, the paper has focused on e-procurement capabilities while neglecting levels of integration – the subject of the next section.

Table 4. Comparison of Four STM Models ($STM_{Baseline}$=1st Four Tools)

	STM_{Reach}			STM_{Role}[a]				STM_{Size}		
E-procurement Tools	1	2	3	A	B	C	D	Sm	Md	Lg
Requisitioning[b]	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Online supplier registration	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Central contract repository	✔	✔	✔	✔	✔	✔	✔		✔	✔
Notifications	✔	✔	✔	✔	✔	✔	✔	✔		✔
Spend analytics	✔									
eSourcing							✔			
Total Tools in Model	5	4	4	4	4	4	5	3	3	4

a The four different categories for STM_{Role} are: A = Decentralized with central review; B = Centralized contracting/decentralized buying from established contracts; C = Centralized with delegated authority; and D= Centralized

b Includes catalog services / shopping cart

E-procurement Integration

As in the case of e-tool capabilities, there are numerous ways to investigate the level of integration – both methodologically and the independent variables that might be considered relevant – but given space limitations, this paper considers only the impact of procurement reach on integration. Table 5 reports the percentage of e-tools that are fully or partially integrated as a function of procurement reach, and the tools are listed in order of percent of full or partial integration of the respective e-tools (as reported in the Total column). The data suggest that at least for some tools, the level of e-procurement integration can be different across procurement reach. Consider the spend analytics tool. It shows that two-thirds of education or special districts have this tool either fully or partially integrated while a minority (46.4%) of those classified as level 3 procurement reach have their spend analytics integrated. Indeed with the exception of forward auctions, across the gamut of e-tools, level 1 reach (education or special districts) consistently shows that a greater proportion of these agencies are integrated than the other levels of procurement reach. Moreover, as described in Table 3 previously, even though the forward auctions capability is available to only about one-in-four agencies (24.4%), those agencies comprising level 3 procurement reach are definitely more likely to have this tool integrated than others.

In terms of maturity models, these finding beg the question: why do governments with smaller reach tend to have a greater percentage of their e-procurement tools integrated than other governments? Again, it may just be an artifact of the methodology used to elaborate the differences, but surely this warrants further investigation. Perhaps these findings are merely due to the specific entities where the respondents worked (otherwise known as sampling error), but if this is the case, there is no way to know without further study. At the very least, if these results are an artifact of sampling error, the fact is that these specific cases and their integration levels manifest some obvious conundrums for maturity as it is presented in the literature. Indeed, why is integration of the requisitioning tool fairly similar across procurement reach while for the other tools, integration levels appear to be substantively different? Although there is no obvious

answer, one possibility may lie in how the tool became available, and it is to this the analysis now turns.

Table 5. Percentage of E-tools Fully or Partially Integrated as a Function of Procurement Reach

	Procurement Reach			
E-procurement Tool	Education or Spec'l District	City / Municipal[a]	County / State / Federal[b]	Total
Requisitioning[c]	91.1% (41)	86.9% (53)	83.6% (46)	87.0% (161)
Spend analytics	67.7 (21)	57.9 (22)	46.4 (13)	57.7% (97)
Central contract repository	60.6 (20)	50.0 (22)	55.6 (20)	54.9% (113)
eInvoicing	64.7 (11)	41.4 (12)	50.0 (11)	50.0% (68)
Marketplace[d]	66.7 (16)	34.5 (10)	46.4 (13)	48.1% (81)
Contract life-cycle mgt	63.2 (12)	32.1 (9)	38.1 (8)	42.6% (68)
Notifications	53.6 (15)	31.0 (13)	41.0 (16)	40.4% (109)
Online supplier registration	59.5 (22)	23.3 (10)	39.0 (16)	39.7% (121)
eSourcing	48.1 (13)	20.7 (6)	46.4 (13)	38.1% (84)
Supplier performance/risk mgt	42.1 (8)	34.5 (10)	23.8 (5)	33.3% (69)
Collaboration tools	50.0 (7)	20.8 (5)	21.1 (4)	28.1% (57)
Reverse auctions	25.0 (3)	13.0 (3)	18.8 (3)	17.6% (51)
Forward auctions	8.3 (1)	11.5 (3)	31.6 (6)	17.5% (57)

[a] Includes townships
[b] Includes regional governments and provinces
[c] Includes catalog services / shopping cart
[d] Includes catalog services

Table 6 reports the percentages of agencies that have each e-tool configured within enterprise resource planning (ERP) software or other financial solution, in contrast to those agencies that have the tool capability provided because it was either built in-house or

configured from a commercial-off-the-shelf (COTS) software[11] – and this information is broken out again as a function of procurement reach. There are several points to make about the data across procurement reach. First, procurement reach level 2 appears slightly more likely to use the requisitioning tool as part of an ERP solution than the others, while it is less likely to have its eSourcing tool configured that way compared to the others. Second, in addition, for the reach level 3 agencies, they appear to be slightly more likely to have both their supplier performance / risk management and procurement marketplace e-tools as part of a core ERP or financial solution than the other reach levels. Nonetheless, the ERP configuration for these two e-tools would not be considered to be typical since they are not arranged that way in a majority of reach level 3 agencies. Third, while there is some use of auctions within ERP by procurement reach levels 2 and 3, there are no level 1 agencies that utilize any auctions as an ERP solution. Moreover, of the 138 respondents submitting information on these two tools, only 6 (4.3%) have a built in-house or COTS forward auction tool, and 6.5% (N=9) have a reverse auction capability (again as a built in-house or COTS).

Table 6 also reveals other information relevant to maturity models, and that involves the overall integration levels as measured and reported in the last column (labeled Percent ERP). First, it is noteworthy that there are only three tools (Requisitioning, eInvoicing, and Spend analytics) where a majority of agencies have these as part of an ERP or financial solution. Recall that operationalization and theoretical expectations for e-tools deployed as part of an ERP or financial solution suggests greater overall integration across the entity and enterprise, and the fact that only three tools are integrated by a majority of agencies in this way certainly suggests a lack of coordinated incorporation of the remaining ten tools. Recall from Table 5 that most of the e-tools are not either fully or partially integrated, and this might be due to the fact that most of the tools were built in-house or were part of COTS software. Both of these possibilities make it understandable given the widely-known lack of

[11] The COTS contains two potentialities – it is either installed locally, or the COTS is cloud-based (software as a service).

standardization of operating systems as well as common ICT resource constraints that are needed to be overcome in order to appropriately assimilate these functionalities. However, it is difficult to rectify even these possibilities with the fact that the other ten tools are so relatively low in terms of this level of integrated functionality. It is apparent from the data that the vast majority of government entities do not digitally coordinate their buying functionalities with their financial software.

To take just one example, it is surprising that only one-in-three (37.3%) of agencies that have the electronic contract life-cycle management suite capability actually have it integrated as part of an ERP or financial solution. This suggests that governments are not leveraging relevant information as well as they can in helping the decision-making processes associated with procurement and auditing. Accordingly, well-coordinated e-procurement can help reduce inventory levels by gathering and managing supplier data – not just on future contracts but also on those already in progress. For instance, integrated systems can help institutionalize timely payments to those suppliers who deliver while withholding payments to those who are not, and in general, this can incentivize better supplier behavior. Moreover in times of budget cuts and reductions, e-procurement systems that are integrated with financial solutions not only help standardize systems, but they also give more timely data that can be used to help make rapid decisions concerning where to make instantaneous cuts and where more lead times are needed to determine those cuts.

However the two auction tools need further discussion. The fact that so few agencies have these tools available – whether as a stand-alone tool or integrated as part of a financial solution – suggests that potential users in the government space think there is little value to be obtained from them. It also might be that these agencies need to have these auction tools so customized as to preclude the deepest levels of integration e.g. ERP, or it might be that due to regulations or security concerns, public agency use of these tools is prohibited. Another possibility might be that the arms-length nature of auction tools – the use of which functions like a spot market (see Neef 2001), may potentially cause so many political headaches that it is

not worth it to the procurement agencies. Consider that the spot market price is dependent on several factors, one being the suppliers who participate. Suppose that initiation of a reverse auction for sourcing results in a contract price savings of 40%. Although huge savings can be made for the life of that contract, suppliers who lost out on the contract or award may opt out of future reverse auctions which may raise the price for the same good or service in subsequent contracting periods. Thus questions might be raised about why price rises took place, and the loss of potential suppliers may in the extreme cause the buyer to become captive to a sole-source supplier for that contract.

So the relative lack of the two auction capabilities – while in general probably reflecting a lower level of relative maturity – may actually be exhibiting prudence from the procurement agency's point of view. In fact, this example highlights a point made repeatedly throughout this analysis: linear maturity models presume one-size-fits-all characteristics that mask difficulties in their appropriateness and applicability. Recall that this exploratory analysis began with the straightforward hypothesis that three independent variables (X_1 = procurement reach; X_2 = procurement organizational role; and X_3 = procurement agency size) can help one understand the e-procurement capabilities and levels of integration/configuration deployed across government entities (Y). Although not definitive, the results are not disconfirmed by the analysis, and they hold implications for the use and understanding of maturity models.

Table 6. Proportion of Agencies Deploying E-tools as Part of Core ERP or Financial Solution as a Function of Procurement Reach

	Have Tool as Part of Core ERP or Financial Solution			
E-procurement Tool	Education or Spec'l District	City / Municipal[a]	County / State / Federal[b]	Percent ERP (Total N)
Requisitioning[c]	66.7% (28)	82.5% (47)	66.7% (36)	72.5% (153)
eInvoicing	57.1 (8)	52.9 (9)	66.7 (8)	58.1% (43)
Spend analytics	55.2 (16)	56.7 (17)	48.0 (12)	53.6% (84)

Contract life-cycle mgt	31.6 (6)	37.5 (6)	43.8 (7)	37.3% (51)
Central contract repository	32.4 (12)	34.1 (15)	44.7 (17)	37.0% (119)
Supplier perf. / risk mgt	29.4 (5)	31.6 (6)	50.0 (7)	36.0% (50)
Marketplace[d]	20.0 (4)	27.3 (6)	47.4 (9)	31.1% (61)
eSourcing	30.4 (7)	10.0 (2)	40.9 (9)	27.7% (65)
Notifications	26.9 (7)	24.4 (10)	28.2 (11)	26.4% (106)
Online supplier registration	25.0 (9)	17.5 (7)	23.7 (9)	21.9% (114)
Collaboration tools	25.0 (2)	27.3 (3)	14.3 (2)	21.2% (33)
Reverse auctions	0.0 (0)	12.5 (2)	20.0 (2)	11.4% (35)
Forward auctions	0.0 (0)	5.9 (1)	7.1 (1)	5.4% (37)

[a] Includes townships
[b] Includes regional governments and provinces
[c] Includes catalog services / shopping cart
[d] Includes catalog services

DISCUSSION AND CONCLUSION

To summarize the findings, it is obvious that the complex nature of public systems and the levels of electronic procurement capabilities and integration in the public sector are problematic, and this has been noted before (Leukel & Maniatopoulos, 2005; West, 2005). It is possible that the lack of integration across the thirteen e-tools is the result of ineffective or non-existent consultation with practitioners, and this can be a recipe for failure, especially if they have not participated in the design of the ICT-based e-procurement system which might result in delegitimizing its use (Mota & Filho, 2011; Chang & Wang 2010; also see Bof & Previtali, 2007).

But the data is also consistent with a different conclusion – one that has yet to be acknowledged within the literature, and that is the possibility that given the nature of public procurement and its plethora of often-conflicting goals and public objectives, the "evolution" and "maturity" of e-procurement may be less about transforming processes through e-government initiatives and more about concerns over protecting traditional supplier relationships and fundamental ways of doing business. Indeed, Varney (2011)

discusses at length the fact that mandated integration of procurement platforms across EU countries has been slowed based upon individual government intractability – behavior that is more consistent with protectionism than with an inability to become more "mature."

The findings here are also consistent with well-known problems in integrating and leveraging legacy systems. In fact estimates of how long the agencies have been using procurement software of any type in this dataset is an average of 13 years (N=185) and a median of 11 years, and this is consistent across all three levels of procurement reach. It is well known what helps the development process and the Critical Success Factors of ICT implementation (Ghapanchi et al., 2008; Almarabeh & AbuAli, 2010; Rose & Grant, 2010), but the results associated with the statistical typicality mapping (STM) reveal low levels of e-procurement deployment. Indeed, the $STM_{Baseline}$ toolset consists of only four of the thirteen e-tools: {Requisitioning, Online supplier registration, Central contract repository, and Notifications}. Moreover it is difficult to understand why the Spend analytics tool is only associated with the STM_{Reach} for level 1 and not for any other procurement reach levels or other STM models for that matter. In addition, the fact that the eSourcing tool is only associated with centralized procurement systems in the STM_{Role} mapping exercise offers another mystery in need of further investigation.

The findings concerning the STM_{Size} model are interesting as well. Recall that for small and medium size procurement agencies, there were only three tools in the toolset, and they were not even the same tools. For instance, a majority of small agencies did not have the Central contract repository e-tool yet a majority of medium size agencies had the Central contract repository e-tool. However these medium size agencies did not have the notifications tool available. Furthermore, a majority of large agencies had the baseline 4-element toolset but no additional tools available to a majority of those agencies, and it is this last point that deserves emphasis. Theoretically on its face, it makes sense that if there were going to be agencies that have more tools than the baseline, it would be a majority of larger procurement agencies, but this was not the case. In fact, procurement reach is also conceptually associated with size in

that greater or higher levels of reach are theoretically consistent with more reach and diversity of programs and hypothetically more e-procurement capabilities, yet the opposite is true – the smallest reach has the most e-tool capabilities (five tools as does centralized procurement architectures).

As mentioned previously, the results may be an artifact of the methods or sampling error, but another possibility worthy of future research is that maturity models, at least in the public sector, might be called into question. The fact that across different governmental reach, roles, and size, there is inconsistency in e-procurement capabilities and integration, suggests at least the possibility that linear maturity as it is discussed in the literature may be inappropriately applied to public e-procurement. Considering the low proportion of agencies that have e-tools integrated within an agency's core ERP or financial solution further indicates the anecdotal and idiosyncratic nature of e-procurement and e-government, and it is unlikely that this is due to a lack of market for these tools.

It is obvious that software companies have rushed to provide numerous ICT solutions and there are also plenty of private application service providers (ASP) that could easily support governments of all kinds with appropriate e-procurement tools and applications. However the relative uniformity with which e-procurement has *not* been made available to public procurement practitioners strongly hints at *political* reasons for non-deployment. Consider that suppliers themselves are stakeholders (Joha & Janssen, 2010), and that contract-arrangements can become extremely complicated if governments want to utilize ASPs. Moreover, if governments wanted to merely integrate their procurement systems to what is considered to be an advanced level of maturity, there are politically complicated issues associated with security concerns and with incentives to bring along the supplier base to integrate with the government. Indeed, vendors are quite protective of their proprietary information, and the stated operational efficiencies associated with digital transformation may not be worth it if they thought their comparative informational advantage might be compromised by governments or their ASPs.

The findings here also have policy implications, because the e-government transformational challenges exhibit distinctive and possibly quirky configurations that are not easily amenable to simple classifications required of maturity models. In other words, governments do not appear easily subject to standardization – something that might be required of growth models. Indeed the variation of purposes across governments are likely subject to varying social, political, and cultural contexts (Ali, Weerakkody, & El-Haddadeh, 2009; Homburg, 2009). Moreover, the complicated organizational and functional contexts within which governments operate – across different structures, levels of jurisdictional authority, and functional units, are also complicated by the overlapping nature of service delivery even within the same domains such as health care or more broadly social welfare (see Homburg, 2009; Cordella & Iannacci, 2010).

The analysis presented here seriously calls into question the efficacy of developing and utilizing an e-procurement maturity model, at least in the public sector. On the one hand, the nature of public procurement needs to be considered vis-à-vis its private counterparts but on the other hand, its relation to e-government projects needs to be better clarified. There are doubtless operational efficiencies to be leveraged through the use of e-procurement, but the nature of many (if not most) government requirements and acquisitions is probably of a non-strategic character. As but one example, it is easy to make the case for closer relationships and strategic alliances in the aerospace and defence industries, but it becomes much more difficult to justify creating closer linkages between governments and vendors/suppliers, especially within a regulatory setting that often requires arms-length transactions and indeed bans close relationships for fear of encouraging corruption.

Thus it is might be explainable to see why collaboration e-tool capabilities exist for only one-in-four agencies. However what is a huge conundrum and hurdle for maturity modelling is the fact that only one-in-three agencies have a contract life-cycle suite available for use, because the operational efficiencies are so obvious as to be without argument. Perhaps many or most of the procurement agencies do not rely on contracting for their provision of services, or

maybe it is possible that government contracting in many of the agencies comprising the dataset are done by the end-users and thus are not captured by NIGP membership.[12] Unfortunately the data cannot offer up the answer, but one thing is sure – much more research is needed in this area to better understand both the potential and pitfalls of attempting to fit a universalistic maturity model to such diversity in governments and public objectives.

[12] Looking across the four procurement roles, the procurement architecture that has the highest likelihood of making the contract life-cycle suite available to its agencies is the Decentralized with Central Review where 40.6% (N=13) have it deployed.

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APPENDIX A

1. In what State, Province, or Territory is your entity located?
2. For what type of entity do you work?
3. Which BEST describes your position?
4. Which organizational structure BEST describes your procurement function?
5. Do you work for (indicate type of procurement function)?
6. What is the total number of full-time equivalent (FTE) employees in your
procurement office?
7. What is your # of active contracts (do not include POs in this number)?
8. What is your # of informal 'written' (including email, fax, and on line) request for quotes issued per year?
9. What is your # of formal competitive solicitations (i.e., IFB, RFP) issued per year?
10. What is your # of POs processed per year?
11. What is your # of invoices processed per year?
12. What was your entity's total Operating expenditure on goods and services
(regardless of how procured or paid) in FY 10?
13. What PERCENTAGE of the amounts above were under Procurement's responsibility?
14. What was your entity's total Capital Outlay expenditure in FY 10?
15. What PERCENTAGE of the amounts above were under Procurement's responsibility?
16. Are you using a state furnished system for any of the following functions?
17. Does your entity/agency use any other Procurement software?
18. Please estimate the approximate NUMBER OF YEARS your entity has been
using procurement software of any type?
19. Please indicate how each capability is provided in your current configuration.
20. To what extent are these capabilities integrated with your financial system?

21. How would you rate your satisfaction with the capabilities of your software?
22. What level of benefit have you found in the following aspects of using a procurement software system?
23. What PERCENTAGE of your total system cost is covered by each type of fee?
24. If you use an electronic catalog function for requisitioning, does it provide special attention to green products?
25. Did you enhance or modify your procurement software system to help compliance with federal stimulus reporting requirements?
26. Which commodity coding system do you use with the software?
27. Are you currently planning to implement new or additional procurement software?
28. Are you currently planning to implement procurement software?
29. What PRIMARY reason has prevented you from implementing a procurement software system?
30. How would you rank the following benefits of using procurement software?