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A MODEL TO MEASURE E-PROCUREMENT IMPACTS ON ORGANIZATIONAL PERFORMANCE

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ABSTRACT. This paper presents a model for Public Contracting Authorities to quantify procurement performance benefits that can be achieved by adopting e-procurement. It has been found that e-procurement could generate positive impacts, especially on the efficiency, effectiveness, dematerialization, competitiveness and transparency impact dimensions. Adopting e-procurement in the public sector is far more than just a technological challenge; it embodies a large scale change management effort to create a more efficient procurement culture. Using the performance measurement approach herewith presented helps to tackle this challenge, stimulating the effective use of e-procurement solutions. Measuring how e-procurement is contributing to optimize public expenditure by increasing organizational performances; can help to overcome the resistance to change. Plus, this model can be used to strengthen stakeholder accountability of both Contracting Authorities and public e-procurement service providers. The model has been consistently tested over the last four years with satisfactory results confirming the hypothesis; the case study is herewith exposed. The model can be applied in different context, therefore method and practical recommendations are also provided.

INTRODUCTION

During the first decade of the new millennium public procurement greatly benefited from the diffusion of e-procurement. Specific sets of

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technologies and organizational solutions have been introduced worldwide, particularly granting public authorities the possibility to manage tendering procedures and auctions online.

Similarly to what has already been witnessed in the private sector, the initial implementation of public e-procurement solutions has been saluted with great enthusiasm. The benefits generated by e-procurement have varied, depending on the implementation context, however e-procurement's value impact, when applied intelligently, is indisputable (Aberdeen Group, 2005).

Literature and specific research contributions on e-procurement and the implementation of these instruments, especially those focusing on Public Services, began to develop recently. The first papers dedicated to these issues date back to the end of the 90s. Since then authors have continuously stressed the importance of employing information technology (IT) in procurement activities handling the benefits.

Most importantly, e-procurement has to be evaluated in its complexity, which encompasses numerous goals: to rationalize expenditure, to reduce "administrative confusion" and costs, to foster operational efficiency (Croom, 2000), to strengthen organizations' network vision and technological collaboration with business partners (Gamble, 1999; Greenemeier, 2000; Murray, 2001), and to completely automate certain procurement activities (Smith & Flanegin, 2004; Aisbett, Lasch & Pires, 2005).

The Gartner technology maturity model, i.e. "hype cycle," (Gartner, 1995) suggests that a very significant peak of positive expectations toward a new technology is usually seen for a short time after the initial implementation. Although positive organizational impacts could happen in the short term (justifying the "hype"), this model highlights that long lasting benefits are achieved only when the new technology reaches the "plateau of productivity", with an experienced user and well established processes in support.

Therefore, in order to achieve value-generating goals, the implementation of e-procurement has to be carried out alongside a change management effort to re-engineer the procurement processes, which has to emphasize the importance of optimizing the overall performance of the procurement process (Bakos, 1991; Croom, 2001; Essig & Arnold, 2001; Rasheed & Geiger, 2001).

Performance benefits are encouraged and strengthened by moving towards a systemic usage of this technological innovation, with a continuous flux of electronic procurement activities affecting important volumes of expenditure (Ramayah, Zbib, Jantan & Koh, 2006). Thus, it is expected to witness a slow increase in the harnessed performance benefits, which are growing accordingly to the users' experience. Nevertheless, carrying out 100% of the procurement activities online does not automatically mean to maximize e-procurement performance benefits, which have to be disclosed by chief procurement officers through active management techniques, such as using the measurement framework herewith presented.

The pros and cons of IT-based innovations in complex organizations have encouraged a plethora of studies that investigated these impacts under a variety of points of view. The contributions of T. H. Davenport about the specific effects of IT on organizational processes (Davenport, 1994) and K. V. Andersen (2005), regarding the direct effects of technology over organizational capabilities and interactions have been particularly considered to develop the procurement performance measurement approach presented in the following chapters and used in Region Lombardia (Italy). The theoretical background of the model has been thoroughly explored in a previous paper from the author (Gardenal, 2010).

Since 2008, Region Lombardia has been using this model to evaluate the organizational impacts generated by the use of e-procurement, using the results to promote the diffusion and suggest further developments of its e-procurement services. Aggregate performance scores, such as "Paper saved by contracting authorities in 2012, using e-procurement instead of traditional paper-based procedure", have been published on the web and made available to every stakeholder. Therefore, the use of this measurement framework is greatly contributing to raising awareness on e-procurement potential.

Region Lombardia's experience suggests that the importance of measuring performances in the public sector has proven to be crucial. Indeed, in order to reach the aforementioned plateau of productivity, thus generating value on a continuous basis, it is necessary to overcome the resistances to change, which still remains very high in most contracting authorities (CA).

Being able to precisely measure results in a comprehensive way is a positive method to foster voluntary commitment and accountability towards the final goal of optimizing public expenditure with e-procurement. Therefore, using this measurement framework could be more effective in overcoming resistances to change and boosting productivity, rather than imposing the compulsory use of e-procurement systems by legal means.

A MODEL TO MEASURE E-PROCUREMENT IMPACTS ON ORGANIZATIONAL PERFORMANCE

Considering B2B electronic procurement, there have been some studies on the impact of e-Procurement, measurement of the benefits of e-Procurement, value of e-Procurement, and adoption of e-Procurement models, but limited empirical research has been conducted on e-Procurement implementation, benefits and value in the public sector (Vaidya et al., 2004, 2004b; Gardenal, 2010). Public e-procurement diffusion and performances have been measured and evaluated in existing studies mostly in terms of economic volumes exchanged per year through web platforms (E-procurement Observatory, Politecnico Milano, 2006-2011).

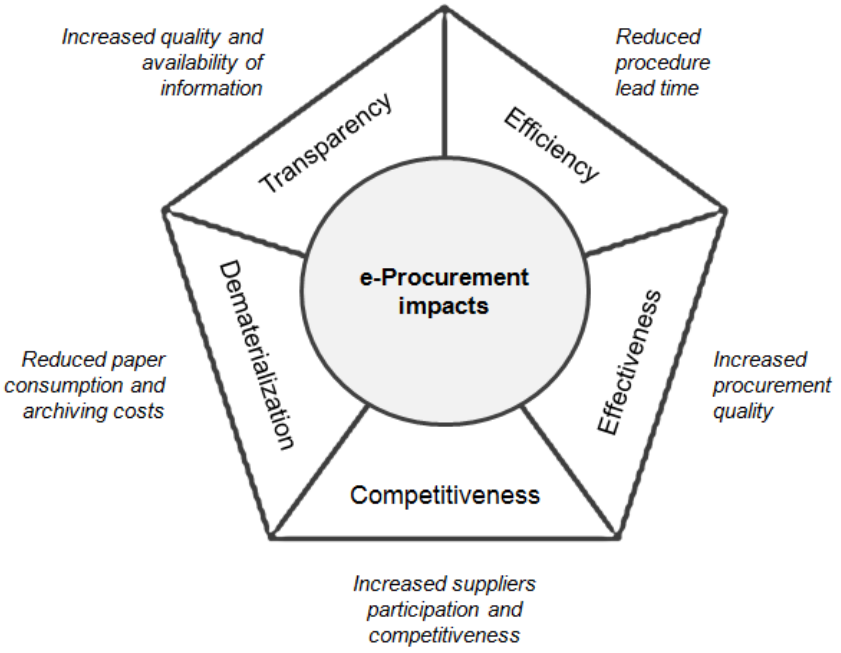
This paper aims to contribute to the theoretical corpus on public procurement performance measuring by proposing a practical and customizable model to study the impacts of e-procurement technologies. Particularly, the model applies to the e-tendering phase of the procurement process, from the publishing of the tender documents to the award of the procedure.

The measurement framework is based on five impact dimensions, each consisting of a set of indicators. The impact dimensions represent the organizational areas which could benefit the most from the introduction of e-procurement: efficiency, effectiveness, competitiveness, dematerialization and transparency (cf. Figure 1). Each impact dimension is explored below, providing details of the set of indicators used to score the related performances.

Efficiency

Efficiency measures the usage of resources during a process. E-procurement impacts this dimension allowing employees to achieve

FIGURE 1
Public e-Procurement Impact Dimensions



(at least) the same results of a traditional "paper-based" procedure, but use less time, thanks to the automation of certain activities. Thus, the reduction of the overall elapsed time employed to complete a tendering procedure (i.e. from publishing of the tender notice up to the contract awarding phase) is the main driver to measure efficiency. The overall elapsed time can be split, considering the duration of every specific phase of a tendering procedure.[1]

TABLE 1
Efficiency Measurement Framework: Key Performance Indicators (KPI)

Goal: to reduce procedure lead time	1. Elapsed time (overall tendering procedure)
	2. Elapsed time (per procedure phase)

Effectiveness

To measure effectiveness means comparing goals with results. Among the goals of contracting authorities, it's important to achieve competitive prices in comparison to actual market standards and historic prices paid by the CA, while granting the respect of qualitative standards.[2] Therefore, average discount on the reserve price is a good proxy to evaluate performance in this dimension, given that e-tenders should at least grant compliance with qualitative standards. E-procurement is expected to allow increased discounts, because it makes it possible to access larger markets and to use advanced instruments for negotiations, such as e-auctions. Consequently, being able to achieve the same goals, minimizing the effort required by human resources (HR) is another driver of effectiveness. Another way to measure effectiveness is the reduction of disputes and appeals from the suppliers, as they could be depending on an inaccurate tender strategy definition. E-procurement should free up more time to contracting authorities' personnel; this time could be used to study a more precise documentation and strategy, thus limiting the possibility of disputes.

TABLE 2
Effectiveness Measurement Framework - KPI

Goal: to increase procurement quality	1. HR employed per procedure (considering employees, officers, managers)
	2. Discount on the reserve price
	3. Appeals / disputes with suppliers per period

Competitiveness

As government spending represents 50,5% of GDP (in the EU27 area 2010Q3; Eurostat, 2011) and given the economic crisis which is facing the euro-zone, it is becoming more and more important to stimulate the highest levels of market competition, with the final goals of creating more opportunities for economic operators (lowering the barriers to entry public procurement procedures) and obtaining for CAs the most favorable prices for and the highest quality available in the market of procured goods/services.

E-procurement solutions could contribute promoting competitiveness, ensuring higher levels of suppliers' participation in tendering procedures and using advanced negotiation instruments (i.e. e-auctions). Quality standards may be ensured by using the "most economically advantageous offer"[3] (MEAT) tender evaluation criterion; e-procurement solutions allow for an easier configuration of complex tendering procedures where scoring of MEAT evaluation criteria is partly or totally automatic.

TABLE 3
Competitiveness measurement framework - KPI

Goal: to increase suppliers' participation	1. Suppliers' participation per procedure
	2. Use of economically most advantageous offer
	3. Use of auction / e-auction

Dematerialization

The volume of consumed paper (measured as the number of A4 sheets) is rarely considered relevant when evaluating a procurement procedure. Nevertheless, an enormous volume of documents and bundles pile up in most contracting authority offices. Thus, archiving costs are constantly increasing.

Using e-procurement as an operational standard could completely cut down paper usage. This is supposed to happen thanks to the substitutive document retention in e-procurement platforms, the use of digital signatures, the use of certified emails and other technologies. Dematerialization has an environmental value, represented by the reduction of paper usage (which could also be represented with "saved trees"), and a financial value, represented by the reduction of archiving costs.

TABLE 4
Dematerialization Measurement Framework - KPI

Goal: to reduce paper consumption and archiving costs	1. A4 pages produced / printed per procedure
	2. Archiving costs per procedure

Transparency

Administrative transparency consists of ensuring the highest circulation of information, both inside and outside a public authority. E-procurement could improve transparency, for example, automating the online publishing of tender documentation and the outcomes of procedures (winning suppliers, ranking, clarification requests, etc.).

To carry out technical/qualitative evaluations using tabular format requires contracting authorities to increase the organizational effort in the tendering strategy definition phase, but represents another important transparency index. This evaluation technique implies an automatically assignation of a specific score to every possible technical alternative, instead of using scoring ranges with discretionary evaluation. It is the most transparent evaluation system because suppliers know exactly their technical scores, as they are not depending on discretionary evaluation made by procurement officers. Using e-procurement platforms allows an easier use of this technique, as scoring is automatically done by the system.

TABLE 5
Transparency Measurement Framework - KPI

Goal: to increase quality and availability of information	1. Online availability of 100% of tender documentation
	2. Technical evaluation in tabular format

METHOD: PRACTICAL USE OF THE MODEL

The first part of this paper concentrated on the theoretical background for performance analysis of public procurement, especially how e-procurement systems can affect performance scores. What happens when it comes to the real use of such a model? Which are the key questions which use of this model can answer? Which compromises should the analyst accept? How can the model be used for multi-dimensional measuring needs, ensuring the provision of the required outputs? This section of this article aims to answer these questions by using the last test of the model which was carried out between July 2011 and January 2012, among the users of

Sintel, the e-procurement platform of Region Lombardia - Regional Procurement Agency.

The E-Procurement Performance Measurement Model (named for an ease of reference EPPMM) had been built with the key objective of providing reliable results in a complex environment, which involves:

- numerous and heterogeneous contracting authorities and procurement habits;
- a potentially disruptive level of resistance to change by employees and low to medium level public managers, for whom the e-procurement initiative can represent a mere complication of daily tasks;
- a large number of issues to be tackled, with the need to carry out complex drill-down analysis, while sticking to a simple and ready-to-use methodology.

Thus, EPPMM had been built around four key features: *reliability*, s*implicity*, *flexibility* and *specificity* (i.e. high level of detail, for example considering how procurement performances may vary according to the procedure type or the awarding criteria).

Analyzing the impact of any technological innovation requires delving into details of complex organizational processes, thus measurement frameworks tend to be case-specific biased. Although results may accurately fit in the native scenario, potential spillovers from duplication and synergies could be limited, due to technicalities which make models practically not replicable. To avoid this risk, a simple and adaptable methodology had been the core of EPPMM, nevertheless allowing further tuning and customizations.

In order to ensure the four key features of the model (i.e. reliability, simplicity, flexibility and specificity) are respected, a 5-step methodology has been developed:

1. Create the “baseline” scenario (first survey),
2. Update the dataset (following surveys or business intelligence integration),
3. Follow- up,
4. Data analysis, and
5. Reporting.

Step 1 of the methodology will be carried out only once, when first implementing EPPMM, thus a 4-step methodology will be the base of the process for the majority of its uses.

Creation of the "Baseline" Scenario (First Survey)

The model is based on a very simple syntax: it is developed as a gap analysis tool which allows the analyst to compare the situation in the current period t_0 with respect to a previous one, t_{-1}. The latter represents the baseline scenario, where the dimensions of the model are measured prior to the implementation of e-procurement. Additionally, the model can be used to compare the situation in t_0 with a hypothetical desirable future scenario t_{+1}, thus entailing a dynamic component of analysis.

Defining an accurate baseline scenario is the foundation of EPPMM and represents the first step of the proposed methodology. The tool used to gather information is a survey, which will elicit some important requirements in order to build a baseline scenario that is a good proxy of reality. General guidelines follow.

- The survey must be short (i.e. a maximum of 25-30 questions), easy to understand and very specific with regard to the final goals of data collection.
- Questions should be quantitative and, to the extent possible, limit the possible answers providing ad-hoc ranges (derived by a general analysis of the topic and from the experience of the surveyor).
- A limited number of qualitative questions can be introduced in the questionnaire (at the end of its sections) to test coherence; answers are not used for the elaboration of information but they serve the purpose of testing the intrinsic validity of answers. The elaboration and interpretation of these parameters is a sensitive issue, as answers could be subjective; the suggestion is therefore to use them as ex-post verification for the amelioration of future survey design.
- In relation to the expected variability of answers and to the technical issues tackled (according to the interest of the analyst to understand in a deeper way certain impact dimensions), the questions can have a very general level of detail (i.e. analysis of a generic type of e-tendering procedure); a medium level of detail

(e.g. require a comparison between under and over EU threshold e-tendering procedures) and a high level of detail (e.g. require a comparison between the various adjudication methods allowed by the e-tendering platform or specific phases of the procedures).

- The baseline scenario survey could be run in t_0 asking only information about the current situation (t_0 itself), but in most cases it is run in t_0 to gather information about both t_0 and a situation in the past (t_{-1}). Use of t_{-1} identifies a past situation in which there is no public e-procurement infrastructure established. Use of t_0 identifies the current situation, with an e-tendering solution implemented.

The result of the survey should be a complete set of data to calculate the Δ between t_0 and t_{-1}, allowing calculating of the indicators of the model (as described in the previous section).

The baseline scenario is almost constant for the first years of usage of the model in an organization, but there is no limit to its possible change to make the assessment of performance more challenging or to respond to disruptive innovation in the system. The only requirement to change a baseline is to run a new survey as the one here described, adapted to reflect the new needs of analysis.

Update the Dataset (Following Surveys or Business Intelligence Integration)

When the model has been run for the first time and the baseline scenario has been created, the survey which collects data in a new *t* situation (to be compared again with the baseline scenario) is much simpler than the first survey described in the previous section. The analysts can tailor a couple of new specific questions to the actual research needs, without the need to rerun the full survey. Likely, there won't even be the need to run a human-guided survey. E-procurement solutions can gather automatically updated data on most of the indicators (i.e. time required for a certain phase of the tendering procedure, discounts achieved, suppliers' participation, etc.).

Further information gaps could even be filled by integrating the model data from contracting authorities' enterprise resource planning (ERP) systems, which can manage a vast set of data, generating automatically the required information output. These systems could

be lightly customized with a specific module used to collect some of the data needed for the model.

Follow up

Using the survey tool is necessary, as required information to structure the t_0 scenario lies in the experience of procurement officers only. However, the creation of the survey and its spread among the selected contracting authorities has to be carried on alongside a consistent follow-up. Two of the risks related to the use of a survey tool for data collection are a low answer rate and/or a large number of uncompleted questionnaires.

To avoid this problem, the analyst should identify a representative sample of key respondents that can guarantee maximum coverage of the whole population. Various statistical techniques are available to this aim, but in contrast to the classical approach of a totally randomized sample, the authors think that the random sample should be extracted from a set of pre-identified samples of highly representative clusters. In particular, considering the various types of tenders launched by different contracting authorities, the analyst's experience drives the choice of the most representative institutions among which to run the randomized selection.

The final choice of the number of respondents should be limited to the actual practical capacity of the analyst to perform a correct follow-up exercise. The larger the sample size, the better in statistical terms, but, in the opinion of the authors, a big sample left without a correct follow-up will risk bringing unreliable and biased data.

From a practical perspective, the follow-up should be an e-mail and telephone report, done to explain the purpose of the analysis, and to reinforce the importance and added value of the evaluation, thus ensuring the effective compilation of questionnaires. The objective is to increase the interest and the active participatory approach of institutions: involvement and improved awareness are the key to obtain an excellent output in terms of validity, reliability and completeness.

Contracting authorities will normally need between 20 and 30 days to complete the first analysis (creation of the dataset for baseline definition), while half of this time could be sufficient for subsequent surveys.

Data Analysis

The data analysis is a crucial milestone of the process. An analyst with solid knowledge of statistics is needed to complete this step in a competent and comprehensive way. Nonetheless, apart from the high number of possible considerations which a professional statistician could derive from the analysis of data, the model outcome per-se is easy to be extracted, and in view of an increased usability, a brief list of key actions is hereby provided:

- classification of the data, analyzing its descriptive statistics and acting on outliers, missing values and invalid values;
- minimization of tails and standard deviation;
- definition of Δ and elaboration of final indicators.

The final action of the analysis is the calculation of deltas between t_0 and the baseline scenario, allowing the elaboration of the indicators of the model. A system of weights can then be introduced by the analyst in case of willingness to increase or decrease the impact of one or more of the variables for the elaboration of the final indicator for each dimension.

Reporting

In the meantime, the constant use of EPPMM allows the construction of a "cockpit" from which the analyst, contracting authorities and other stakeholders can directly access updated information, with a simple selection of parameters and a click on "update". Needless to say, the positive impact of such an instrument is likely to be very high, for example, in order to stimulate contracting authorities' procurement performance, raise awareness of policy makers and stakeholder to e-procurement potential, and increase budget control and accountability of public management.

Particular emphasis has to be put on the impact of increased information for CA managers. The involvement of these subjects in the process is fundamental, and often it is their attitude that is responsible for the success or failure of the e-procurement initiative. Increased information about the results of the initiative can be a great stimulus for them: it can demonstrate to their superiors and to policy makers their high performance.

It is therefore important to stress that the correct implementation of the EPPMM, supported by an initial contact with public managers of involved CAs (then strengthened by the comprehensive follow up approach), along with the creation of ready-to-use indicators and their wide diffusion among these actors is fundamental to overcome the resistance to change.

KSFs and replicability of the model

The Key Success Factors (KSFs) are hereby defined as the distinctive features of the EPPMM. At the beginning of this section we presented four KSFs: reliability, simplicity, flexibility and specificity. Nonetheless, we also introduced a fifth one saying that a model as the one here presented has to cope with the risk of case-bias, reducing the risk of its presence to allow a greater possibility of duplication. The fifth KSF is therefore replicability of the model.

The EPPMM has been created as a mean to measure performance of an evolving e-procurement environment (in Lombardia Region, Italy), and has in the replicability and flexibility its distinguishing elements.

It is in fact an easy model, with a simple and reliable methodology, but with a high level of adaptability and tailoring possible. Measurement of performance in the public sector is gaining more and more importance nowadays in every country of the world, and in particular in countries where public expenditure is very high, the measurement of performance in public procurement turns out to be a key element for the correct development of a sustainable strategy for medium and long term growth.

If, for example, we take into account the situation of an emerging economy such as the Papua, New Guinean, we would confront ourselves with an economy where:

- public expenditure is very high (especially in some strategic industries as export-intensive ones);
- a centralized public procurement system has been created in the last years to rationalize public expenditure (in the specific case, through the creation of the Central Supply and Tenders Board, [CSTB]) (Asian Development Bank, 2011); and

- the first e-procurement initiative steps have been undertaken in order to boost transparency and efficiency (see www.cstb.gov.pg website).

It is straightforward to see how in such a situation, the impact of performance measurement of the e-procurement program has a strong medium and long-term policy perspective: in the words of the UN ESCAP (United Nations Economic and Social Commission for Asia and the Pacific) (2006), "E-procurement has the potential to improve efficiency in government administration and promote competition in the business sector. However, there are still a multitude of challenges in introducing and implementing an e-procurement system. Infrastructures are underdeveloped and there is a lack of awareness among national and local government policy-makers and business of the benefits that e-procurement can provide. Before an e-procurement system can achieve maximum potential, a strong infrastructure must be developed; information and communication technology (ICT) services expanded; innovative policies administered to establish a secure online environment; standards developed; and government administrators and in the private sector human resources must be trained".

Investing in all the above-mentioned sectors without prior confirmation of the benefits achieved by the current pilot projects would be not only unfeasible, but also senseless. The use of the model presented in this paper in such a context allows a better identification of results achieved, areas where investment is necessary and ones where investment would not be beneficial; moreover it would increase employees' awareness on their daily activities and performances, improve awareness and accountability and provide reliable sources for policy-making in this field to local governments as well as to international donors.

This example shows therefore how the KSFs of our model are important also in perspective of measurement of performance as a mean of prioritization of e-procurement reform in developing countries, to leverage socio-economic spillover and increase accountability, performance and awareness. Also, the flexibility of the model allows its use with a broad range of reference targets: from a single organization to whole processes, including its possible application for the study of the impact of technological innovations different from the e-procurement one.

CASE STUDY: EVIDENCES FROM REGION LOMBARDIA

The first tested version of this model was presented in 2009; since then the model has been used continuously in Region Lombardia, with an ongoing tuning activity that has led to the actual version of the measurement framework and data gathering approach, which is herewith presented.

The first survey, based on the measurement framework and method presented above, was conducted on Lombardia Public Healthcare Service, during the fall of 2008, by means of questionnaires and interviews.

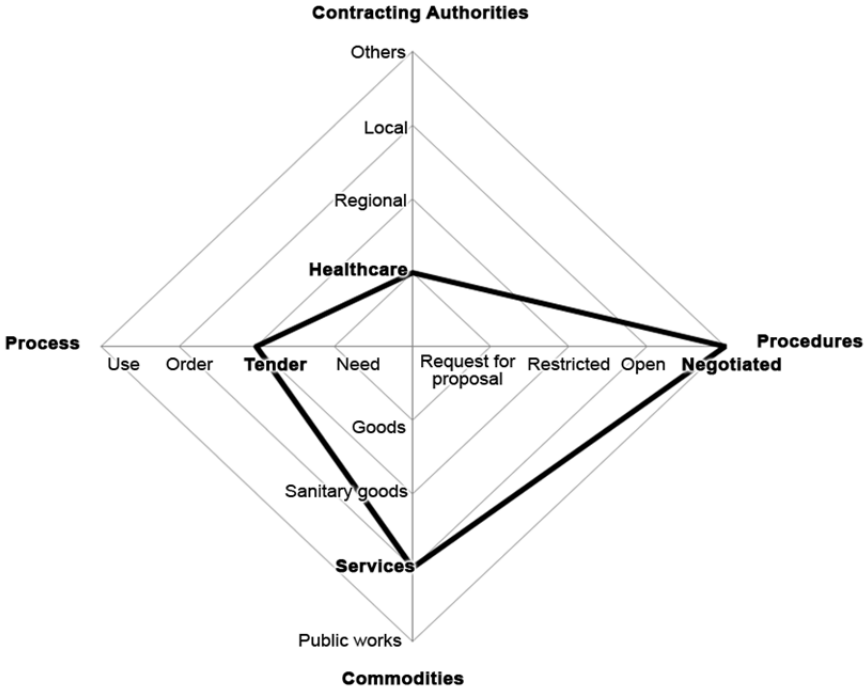
Only requests for proposals for goods and services, below the 2008 EU threshold of € 206.000, have been covered in the 2008 survey. Tendering procedures for public works were not considered, as the number of e-tenders related to works was still very low. Among the procurement cycle, only the purchasing process has been taken into account, thus excluding orders, logistics and consumption. The latest 2011 analysis gathered information from every kind of contracting authorities using e-procurement in Lombardia. Within scope of the analysis is every kind of goods and service procurement, both above and below the EU threshold of € 200.000, public works being the only exception (cf. Figure 2).

Statistical consistency of collected data was reached only for healthcare CAs, which are the most advanced and experienced e-procurement users in Lombardia. Therefore, results refer to healthcare only, while general considerations are provided for new entrant users: regional, local and other contracting authorities.

Lombardia Region Context

Healthcare authorities have been the most active in employing e-procurement, among the public sector in Lombardia. Seven hospitals have been e-procuring since 2003. During 2008, 10 out of 48 healthcare contracting authorities autonomously managed about 10% of their tendering procedures online. In 2011 every healthcare authority used e-procurement for at least 15 tendering procedures, with on average ~20-25% e-tenders of total procedures carried out per year. Two authorities used e-procurement for about 100% of their

FIGURE 2
Scope of the 2011 Analysis



procurement needs. This represents the avant-garde Italian level, where on average still less than 1% of total tendering procedures are e-tenders.

Healthcare authorities represent the sector that affects most of Lombardia's public expenditure, having an aggregate expenditure of more than € 3 billion per year. Lombardia Healthcare Authorities provide sanitary services to 9.5 million people, counting more than 100 hospital facilities and about 50.000 sleeping accommodations, also including certified private structures.

Crucial to the successful spreading of e-procurement, precise political actions stimulating e-procurement have been taken in Lombardia. In fact, since 2007, the Regional Procurement Agency has been established, by the means of a Regional Law. One of the primary goals of this organization is to develop and diffuse the use of

an e-procurement public web platform, “Sintel”. Moreover, Region Lombardia Central Authority set increasingly challenging management by objectives (MBO) systems related to the effective use of e-procurement. Furthermore, the healthcare authorities are very involved in innovation themes, both regarding administrative units and the four sanitary ambits. Indeed, prevention, diagnosis, therapy and rehabilitation are strongly influenced by technology (i.e. electronic clinical records, telemedicine and surveillance, electro medical equipments).

Findings

Information required to describe the baseline scenario and the current t_0 situation have been gathered through a survey, although much of the data were available from previous analysis and from business intelligence. Information already available has been used to double-check the quality of the output information.

The distribution of surveyed / answering contracting authorities is shown in Table 1. As aforementioned, only the data gathered from healthcare authorities have been taken into account for the analysis herewith presented. This data have been analyzed through the method described in the previous section, comparing the current situation t_0 with the baseline (when e-procurement was not used) and a hypothetical future situation t_n, when every kind of procedure will be carried out online.

TABLE 1
Contracting Authorities within Scope of Analysis

Authorities	Answering	Surveyed	Answering / Surveyed	Total	Surveyed / Total
Healthcare	45	45	100%	48	94%
Local	22	26	85%	370	7%
Regional	4	4	100%	35	11%
Other	2	2	100%	12	17%
Total	73	77	95%	465	17%

In order to properly describe each period it is necessary to consolidate information about volumes and types of procedures carried out by contracting authorities within scope.

Table 2 shows the mix of "paper-based" and e-tendering procedures per period.

TABLE 2
"Paper Based" and E-Tendering Procedures Carried out per Period and Procurement Value per Year

	Baseline		t_0		t_n		
EU Threshold	Paper Based	e-Tender	Paper Based	e-Tender	Paper Based	e-Tender	Healthcare Procurement Value per Year
Below	5,100	0	4,179	921	0	5,100	€ 600,213,900
Above	675	0	577	98	0	675	€ 2,239,671,263
Total	100%	0%	82%	18%	0%	100%	€ 2,839,885,163

The final scores of the indicators mentioned above are exposed below in Table 3. The score of each indicator (grey column) is the percentage variation between the result of a paper-based traditional procedure and an e-tender. Results represent the impacts of e-procurement, being calculated as the weighted average of the respondents' data.

For each KPI a number of drill-down analyses may be carried out, in order to provide the analyst more detailed information, for example in order to understand if a correlation exists between the awarding criteria and the achieved discounts on the reserve prices.

Drill down analysis and insights

As an example of a drill-down analysis, the efficiency KPI "elapsed time per procedure" could be split, in order to understand which phases of the procedure are particularly positively affected by e-procurement. Results reported for the efficiency impact dimension are encouraging, as e-tenders seem to last on average a third less than paper- based procedures. A graphical representation of the most affected procedure phases is provided below (cf. Figure 3). The data refer to the procedure type that occurs more often in a year: negotiated procedures below EU threshold, with the lowest price awarding criteria.

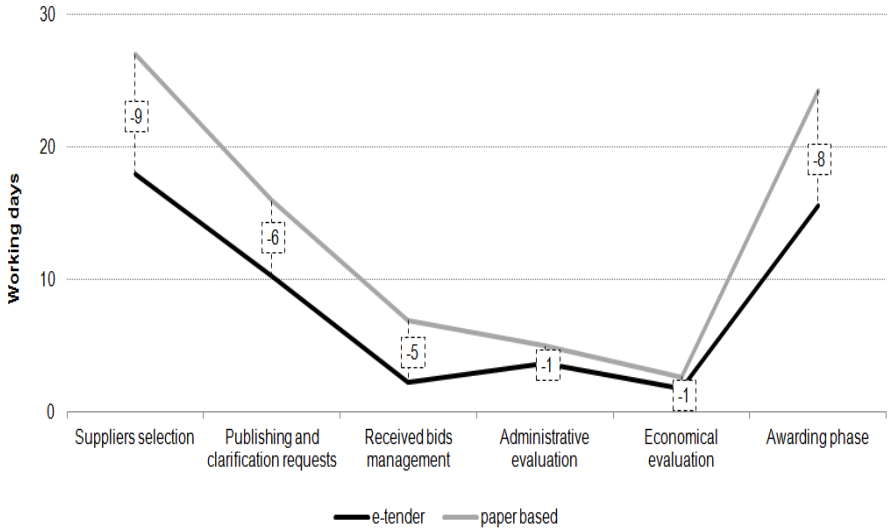
TABLE 3
Average Scores of the KPI Composing the Model

Impact dimension	KPI	Unit of Measure	Paper Based	e-Tender	%Δ
Efficiency	Elapsed time per procedure (below EU threshold)	Working days	84	55	-35%
	Elapsed time per procedure (above EU threshold)	Working days	145	107	-26%
Effectiveness	HR employed per procedure (below EU threshold)	FTE	11.4	9.3	-18%%
	HR employed per procedure (above EU threshold)	FTE	22.5	17.4	-23%
	Discount on the reserve price (below EU threshold)	€	11.2%	13.2%	+18%
	Discount on the reserve price (above EU threshold)	€	8.3%	9.0%	+8%
	Appeal / disputes per period	Appeals	2.6	0.3	-88%
Competitive-ness	Suppliers' participation per procedure	N. bids	3.5	8.9	+154%
	Use of economically most advantageous offer	N. tenders	53%	23%	-57%
	Use of auction / e-auction	N. auctions	7.2%	9.8	+36%
Dematerializi-zation	A4 pages produced / printed per procedure	A4 pages	106	40	-62%
	Archiving costs per procedure	€	€ 21.4	€ 12.0	-44%
Transparency	Online availability of 100%	N. tenders	58%	71%	+22%
	Technical evaluation in tabular format	N. tenders	44%	16%	-64%

It is remarkable that the most significant efficiency benefits are harnessed in the initial and conclusive phases of the procedure, while the core of the tender is affected less significantly by e-procurement.

Administrative and economical evaluations are the phases that require the most of the competencies of procurement personnel; therefore it is difficult to automate evaluation activities. This consideration applies even more to technical evaluation in tenders with economically most advantageous offer- awarding criteria (~2 working days reduction using e-procurement, on a ~60 days phase duration). Nevertheless, as an indirect performance benefit, it is possible to infer that the reduced overall HR effort (~ -20%) may be employed in activities with higher added-value, such as bids evaluation, or tender strategy definition.

FIGURE 3
Average Elapsed Time per Procedure Phase (Lowest Price Awarding Criteria, Below EU Threshold)



Taking into account another perspective of the impacts, particularly encouraging results are shown in the "dematerialization" impact dimension. Lombardia is already saving 22% of the paper consumed every year for healthcare procurement: about 2 million of A4 sheets. This means that carrying out online 10% of the total tendering procedures can roughly save 180 trees of average dimension. The figure could go up to 700 trees saved per year if e-procurement were used for every procedure, without taking into account the paper which is saved by suppliers and every other type of contracting authority. Thus, the "environmental" leverage in promoting e-procurement can definitely be interesting.

KPI Cockpit

After consolidating the results of the analysis, a cockpit was composed, choosing a set of key indicators. Aim of the cockpit is to provide a graphical representation of the e-procurement impacts, granting a simple and effective reporting tool both for single CAs and the analyst's needs.

Table 4 presents the set of key indicators chosen to compose the cockpit; it also shows the results of each indicator for the three considered periods (baseline, t_0, t_n). The hypothetical future period t_n (when all of the procedures will be carried out by electronic means) has been included in the analysis, expecting that the KPI scores will become trends. This seems to be confirmed by the KPI scores time series (2008-2011).

The scores for baseline, t_0 and t_n have been measured at system-level, aggregating the information provided by every single contracting authority. Thus, the cockpit measures e-procurement impacts on the whole Lombardia healthcare sector. Nevertheless, as aforementioned, the model can be used to refer to a single CA or to any different aggregation of authorities.

TABLE 4
Scores of the KPI Composing the Cockpit (Aggregate Data)

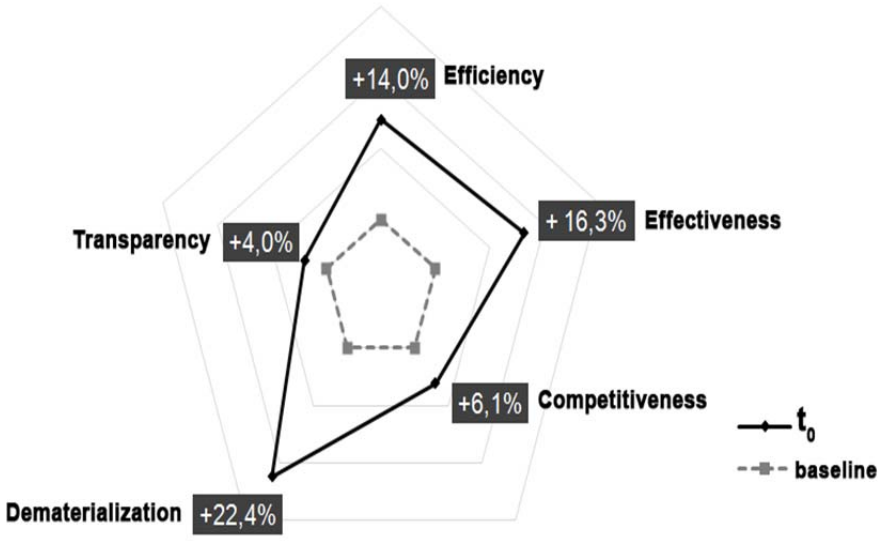
Impact dimension	KPI	Unit of Measure	Baseline	t_0	Δt_0 Base-line	t_n	Δt_0 Base-line
Efficiency	Duration of tenders below EU threshold	Working days	116,914	100,525	-14%	76,480	-35%
Effective-ness	Appeals / disputes	Appeals	149	125	-16%	15	-90%
Competiti-veness	Use of auction / e-auction	N. auctions	408	434	+6%	554	+26%
Dematerial-ization	A4 pages consumed	A4 pages	9,359,325	7,267,028	-22%	2,077,074	-78%
Transpa-rency	Online availability of 100% of tender documentation	N. tenders	3,275	3,410	+4%	4,022	+19%

A cockpit with these characteristics can be easily graphically represented for immediate comprehension (such as in Figure 4). Moreover, as described in the previous section, it can be integrated with the business intelligence, granting the possibility of automatically updating the scores without running new surveys.

CONCLUSIONS

Limited systematic analysis of the benefits of the adoption of electronic procurement in the public sector exists and, without this,

FIGURE 4
Cockpit of Key Indicators



implementing e-procurement as a way to optimize public spending and organizational processes has still to be considered an act of blind faith (Tonkin, 2003; Gardenal, 2010).

This paper proposed a model to measure and continuously control the performances of public procurement organizational units, which are found to be positively correlated to the use of e-procurement. Findings of analyses based on the model suggest that e-procurement can actually be an effective means to optimize procurement activities, considering all of the proposed impact dimensions. Therefore, the use of such a model represents a way to lead a cognizant implementation of these technological solutions, encouraging contracting authorities to move towards an “advanced” and systematic usage of e-procurement.

The case study conducted in Region Lombardia over the last 4 years demonstrates that using e-procurement and measuring the performances can trigger a powerful virtuous circle. When the first analysis was run, the vast majority of CAs involved was just first-time users of e-procurement. Nevertheless, the measurement model showed that significant results had already been achieved at the very

beginning. These encouraging results have stimulated the users to carry out more procedures online in the following years, hence increasing the benefits. The policy makers have now the grounds for specific normative acts to promote the use of e-procurement, giving a top-down enforcement to the virtuous circle. Just as effective is the bottom-up leverage, originating from the final users, which found that their jobs had actually been enriched by e-procurement and that users were willing to use it more.

Empirical evidences clearly suggest that benefits are increasingly significant when e-procurement is established as the standard mean to carry out every kind of procedure and users reach mastery of the technological solutions. This means that e-tenders should not be a mere replication of traditional paper-based procurement habits and processes, but instead be the leverage for a successful change management effort aimed to fully disclose performance benefits and finally empower CA personnel.

Generalizing the discussion, e-procurement can be a stimulus to move from the bureaucratic model of administration (based on standard procedures, committed to respect formal rules), to more effective organizational models, such as the "virtual bureaucracy" (Nohria & Berkley, 1994; Fountain, 2001) in which communication is informal and electronic; employees are cross-functional; jobs are enriched in content and "limited" not only by the expertise of the employees, but also by the extension and sophistication of the mediation offered by technologies.

Therefore, e-procurement and other IT-based innovations have to be building blocks of change processes guided by empowered HR, freed from bureaucratic activities, able to work more effectively, generating added-value, and measuring it.

Nevertheless, even if it has been demonstrated that it has a true capability of changing old ineffective practices, and it has been around for more than a decade, e-procurement has not become an operational standard yet. Using a measurement framework to quantify performance benefits should be the right approach to raise stakeholder awareness, motivate the users and promote the continuous development of IT solutions.

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NOTES

1. Especially through e-procurement platforms it is possible to clearly identify the start and end of each of the tendering procedure phases (as they are generally opened and closed through specific commands such as "open the administrative evaluation phase"), and every phase must not overlap the previous or the subsequent (i.e. under EU and Italian law, it is forbidden to check the economic bids, before finishing to evaluate the technical and administrative ones).
2. Several means to ensure respect of quality standards are in place in Lombardia: standard requisitioning for technical evaluation (based on similar items awarded by national or regional procurement agencies), availability of specific quality certifications per commodity/service group (as a pre-requisite for supplier participation), respect of minimum eco-sustainability criteria (which are set with a Ministerial decree for green public procurement).
3. The most economically advantageous tender (also known as "MEAT") criterion enables the contracting authority to take account of criteria that reflect qualitative, technical and sustainable aspects of the tender submission as well as price when reaching an award decision.

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