A MODEL TO MEASURE E-PROCUREMENT IMPACTS ON ORGANIZATIONAL PERFORMANCE

Francesco Gardenal, Andrea D'Angelo and Valerio Manzo*

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 4 years, the case study is herewith exposed. The model can be applied in different context, therefore method and practical recommendations are also provided.

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INTRODUCTION

During the first decade of the new millennium public procurement greatly benefited from the diffusion of e-procurement. Specific sets of technologies and organizational solutions have been introduced worldwide, particularly granting Public Authorities the possibility to manage tendering procedures and auctions online.

Similarly as what have already been witnessed in the private sector, the initial implementation of public e-procurement solutions has been saluted with a great hype. The benefits generated by e-procurement have actually been vary, depending on the implementation context, however e-procurement value impact, when applied intelligently, is indisputable (Aberdeen group, 2005).

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

It has been highlighted that 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), to completely automate certain procurement activities (Smith and Flanegin, 2004; Aisbett, Lasch and Pires, 2005).

The technology maturity curve (i.e. Hype cycle, Gartner, 1995) suggests that a very significant peak of expectations is usually seen for a short time after the initial implementation. Positive organizational impacts could happen in the short term, justifying the hype. This model highlights that long lasting benefits are achieved only when the technology reach the "plateau of productivity", with 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 monitoring performance (Bakos, 1991; Croom, 2001; Essig and Arnold, 2001; Rasheed and Geiger, 2001).

Performance benefits are encouraged and strengthened by moving towards a systemic usage of this technological innovation, with a continuous flux of electronic purchasing activities affecting important volumes of expenditure (Ramayah, Zbib, Jantan and Koh, 2006). Therefore, it is expected to witness a slow increase in the harnessed performance benefits, which are growing accordingly to the users' experience.

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 Davenport and Andersen have been particularly considered to develop the procurement performance measurement approach adopted in Lombardia. 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. Moreover, being the performance scores available online to every user, this model contributed to raise awareness on e-procurement potential and stimulated a positive competitiveness among Contracting Authorities.

Region Lombardia 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 are still very high in most Contracting Authorities.

Being able to precisely measure results in a comprehensive way is a positive mean to foster voluntary commitment and accountability towards the final goal of optimizing public expenditure with e-procurement. Therefore, using this measurement framework can be more effective in overcoming resistances to change and boost

productivity, rather than imposing the compulsory use of e-procurement systems by legal means.

MODEL TO MEASURE E-PROCUREMENT IMPACTS ON ORGANIZATIONAL PERFORMANCE

Considering B2B electronic procurement, there has been some studies on the impact of e-Procurement, measurement of 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 e-procurement performance measuring, while proposing a suitable, practical and customizable model to study the impacts of these new 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. Fig. 1). Each impact dimension is explored below, providing details of the set of indicators used to score the related performances.

Fig. 1 – Public e-procurement impact dimensions
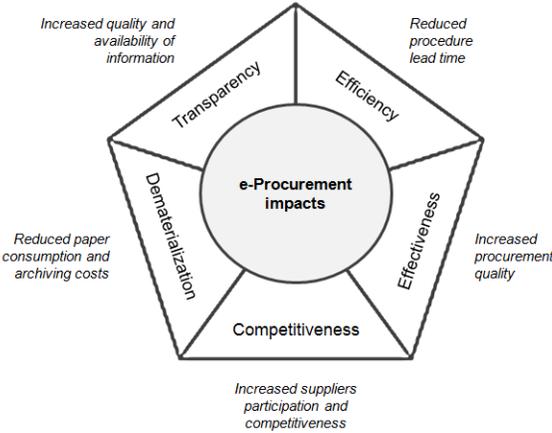
Efficiency

Efficiency measures the usage of resources during a process. E-procurement impacts this dimension allowing employees to achieve (at least) the same results of a traditional "paper-based" procedure, but using less time, thanks to the automation of certain activities. Thus, the reduction of the overall elapsed time employed to complete the tendering process is the main driver to measure efficiency.

Efficiency measurement framework	
Reduction of the effort and time required	1. Elapsed time reduction per procedure phase

Effectiveness

To measure effectiveness means comparing goals with results. Among the goals of Contracting Authorities, it's important to achieve good prices, while granting the respect of qualitative standards. 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 should allow increased discounts, because it makes possible to access larger markets and to use advanced instruments for negotiations, such as e-auctions. Being able to achieve goals minimizing the effort required by HR is another driver of effectiveness. Furthermore, minimizing disputes and appeals from the suppliers is crucial, 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.

Effectiveness measurement framework		
Reduction of prices paid and disputes	1.	Reduction of HR effort (considering employees, officers, managers)
	2.	Average discount increase on the reserve price
	3.	Reduction of appeals and disputes with suppliers

Dematerialization

A4 sheets consumed are rarely considered relevant when evaluating a procurement procedure. Nevertheless, an enormous volume of documents and bundles pile up in most Contracting Authorities offices. Thus, archiving costs are constantly increasing. Using e-procurement as an operational standard could trigger a dramatic turnaround in 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.

Dematerialization measurement framework		
Reduced paper usage; reduced archiving costs	1.	Reduction of consumed A4 pages
	2.	Reduction of archiving costs

Transparency

Administrative transparency consists in 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 (where a specific score is given to every technical alternative, instead of scoring ranges with discretionary evaluation) requires Contracting Authorities to increase the organizational effort, but represents a crucial transparency index.

Transparency measurement framework	
Quality and availability of information; non-discriminatory technical evaluation	1. Increase of tendering procedures whose documentation is fully available online
	2. Increase of tendering procedures that use technical evaluation in tabular format

Competitiveness

As government spending represent 50,5% of GDP (in the EU27 area 2010Q3; Eurostat, 2011) and given the unfavorable economic conjuncture it is becoming more and more important for Contracting Authorities to stimulate the highest levels of market competition. 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).

Competitiveness measurement framework	
Increased suppliers' participation; auctioning	1. Increased number of suppliers participating to a tendering procedure
	2. Increased tendering procedures that use e-auctions

METHOD - PRACTICAL USE OF THE MODEL

The first two chapters of this paper concentrated on the theoretical background constituting the ground for analysis of performance in the public sector, more specifically for the procurement infrastructure.

But, what happens when it comes to the real use of such a model? Which are the key questions to which such a model should answer? Which compromises should the analyst accept? How can the model cope with multi-dimensional measuring needs, ensuring the provision of the required outputs?

This chapter has the objective to answer these questions, on the base of the last test of the model which has been 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) has 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 enter into details, while sticking to a simple and ready-to-use methodology.

Thus, EPPMM has been built around four key features: *reliability*, *simplicity*, *flexibility* and *specificity* (i.e. high level of detail).

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 be accurately fitting 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 has 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. Creation of the "baseline" scenario (first survey);

2. Update the dataset (following surveys or business intelligence integration);

3. Follow- up;

4. Data analysis;

5. Reporting.

Point 1. of the methodology will be carried out only once, when first implementing EPPMM, thus a 4-step methodology will be at the base of the process for the large 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 have to respond to 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. max 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) as a mean to test coherence; answers will not be used for the elaboration of information but they will 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 surveys design.

- In relation to the expected variability of answer 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 on 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 will be run in t_0 to gather information about both t_0 and a situation in the past (t_{-1}). t_{-1} identifies a past situation in which there is no public e-procurement infrastructure established. t_0 identifies the current situation, with an e-tendering solution implemented.

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 chapter 2).

The baseline scenario will be 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 or in the social paradigm. The only requirement to change a baseline will be 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 chapter.

The analyst will have the possibility to 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 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 in the model data from Contracting Authorities ERP systems, which possess the ability to 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

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 the use a survey tool for data collection are to receive a low answer rate and/or to have a large number of uncompleted questionnaires.

To avoid this problem, the solution proposed is easy and practical. The analyst should identify a representative sample of key respondents which can guarantee the maximum coverage of the whole population. Various statistical techniques are available to this aim, but against 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 experience of the analyst have to drive the choice of the most representative institutions among which 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 ampler 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 will consist in an e-mail and telephone control, done to explain the purpose of the analysis, reinforce the importance and added value of this 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 will be 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 will be required 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.

- *Classify 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 will be 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 medium term, the constant use of EPPMM allows the construction of a "cockpit" from which the analyst, Contracting Authorities and other stakeholders could 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 towards e-procurement potential, increase budget control and accountability of public management.

Particular emphasis has to be put on the impact of increased information for CAs managers. The involvement of these subjects in the process is fundamental, and is often their attitude that stands below to the success or failure of the e-procurement initiative. Increased information over the results of the initiative can be a great stimulus for them in the easiest way: 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 are fundamental to overcome the resistance to change.

KSFs and replicability of the model

The Key Success Factors are hereby defined as the distinctive features of the EPPMM. At the beginning of this chapter we presented four KSF: reliability, simplicity, flexibility and specificity. Nonetheless, we also introduced a fifth one when 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 high level of adaptability and tailoring possible. Measurement of performance in public sector is gaining more and more importance nowadays in every country of the world, and in particular in countries where the level of 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 i) public expenditure is very high

(especially in some strategic industries as export-intensive ones), ii) a centralized public procurement system has been created in the last years to rationalize public expenditure (in the specific case, trough the creation of the Central Supply and Tenders Board, CSTB†), and iii) 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 programme has a strong medium and long-term policy perspective: in the words of the UN Escap on the Pacific region (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; 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 source for policy making in this field to local governments as well as 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

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† **Country Public Procurement Profile Survey (with E-Government Procurement Overview)**, Asian Development Bank (2011) http://adbprocurementforum.net/?page_id=1547

‡ ST/ESCAP/2406, available online at http://www.unescap.org/publications/detail.asp?id=1157

countries, to leverage its socio-economic spillover and increase accountability, performance and awareness.

Also, the flexibility of the model allows to its use with a broad range of reference target: from a single organization to whole processes (for example the whole procurement cycle), 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 has been presented in 2009, since then the model has been used continuously in Region Lombardia, with an ongoing tuning activity that 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 in the previous chapters, has been conducted on Lombardia Public Healthcare Service, during fall 2008, by the means of questionnaires and interview.

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. Fig. 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.

Fig. 2 - Scope of the 2011 analysis
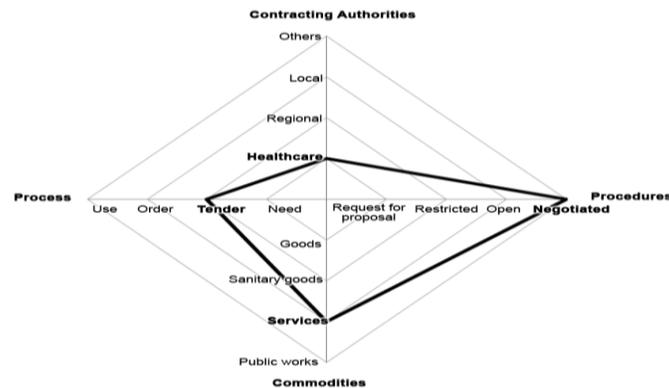
Lombardia Region context

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 procedures, with on average ~20-25% e-tenders on total procedures carried out per year. Two Authorities used e-procurement for about 100% of their procurement needs. This represents the avant-garde at Italian level, where on average still less than 1% of total tendering procedures are e-tenders.

Healthcare Authorities represent the sector that affect the most of Lombardia 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 comprehending certified private structures.

Crucial to the successful spreading of e-procurement, a precise political will stimulating e-procurement exists 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 MBOs related to the effective use of e-procurement. Furthermore, the healthcare authorities are very involved in innovation themes, both regarding the 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 the business intelligence. Information already available have been used to double-check the quality of the output information.

The distribution of surveyed / answering Contracting Authorities is shown in the following Tab. 1.

Tab. 1

Contracting   Authorities   within   scope   of   analysi

Authorities	Answering	Surveyed	Answering / Surveyed	Total	Surveyed / Total
Healtcare	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%

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 chapter 3, comparing the current situation t_0 with the baseline (when e-procurement was not used) and an hypothetical future situation t_n, when every kind of procedure will be carried out online.

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.

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

The final scores of the indicators (cf. chapter 2) are exposed below in Tab. 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.

Tab. 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 treshold)	Working days	84	55	**-35%**
	Elapsed time per procedure (above EU treshold)	Working days	145	107	**-26%**
Effectiveness	HR employed per procedure (below EU treshold)	FTE	11,4	9,3	**-18%**
	HR employed per procedure (above EU treshold)	FTE	22,5	17,4	**-23%**
	Discount on the reserve price (below EU treshold)	€	11,2%	13,2%	**+18%**
	Discount on the reserve price (above EU treshold)	€	8,3%	9,0%	**+8%**
	Appeals / disputes per period	Appeals	2,6	0,3	**-88%**
Competitiveness	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%**
Dematerialization	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% of tender documentation	N. tenders	58%	71%	**+22%**
	Technical evaluation in tabular format	N. tenders	44%	16%	**-64%**

For each KPI a number of drill-down analysis 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. Fig. 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.

Fig. 3 - Average elapsed time per procedure phase (lowest price awarding criteria, below EU threshold)
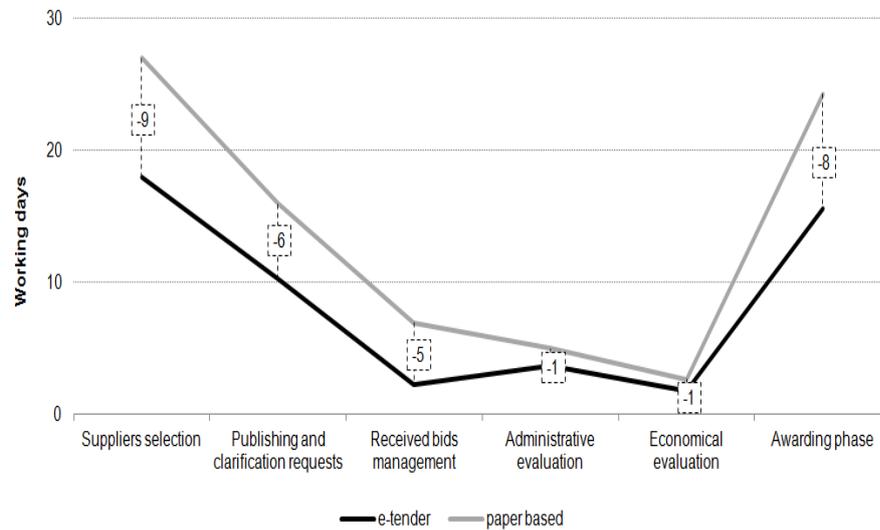
It is remarkable that the most significant efficiency benefits are harnessed in the initial and conclusive phases of the procedure, while the core of the tender is affected less significantly by e-procurement.

Administrative and economical evaluation are the phases that require the most 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.

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 millions 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 was 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 needs.

Tab. 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 seem 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 Authorities. Thus, the cockpit measures e-procurement impacts on the whole Lombardia Healthcare Sector. Nevertheless, as aforementioned, the model can be used referring to a single CA or to any different aggregation of Authorities.

Tab. 4 – Scores of the KPI composing the cockpit (aggregate data)

Impact dimension	KPI	Unit of measure	baseline	t_0	Δ t_0 / baseline	t_n	Δ t_n / baseline
Efficiency	Duration of tenders below EU treshold	Working days	116.914	100.525	-14%	76.480	-35%
Effectiveness	Appeals / disputes	Appeals	149	125	-16%	15	-90%
Competitiveness	Use of auction / e-auction	N. auctions	408	434	+6%	554	+26%
Dematerialization	A4 pages consumed	A4 pages	9.359.325	7.267.028	-22%	2.077.704	-78%
Transparency	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 Fig. 4). Moreover, as described in the previous chapter 3, it can be

integrated with the business intelligence, granting the possibility of automatically update the scores without running new surveys.

Fig. 4 - Cockpit of Key Indicators
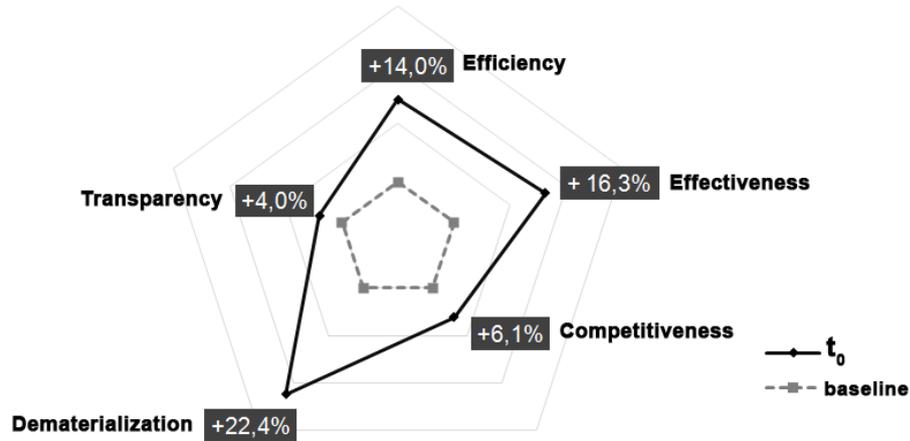
CONCLUSIONS

Limited systematic analysis of the benefits of the adoption of electronic procurement in the public sector exists and, without this, 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 analysis based on the model suggest that e-procurement can actually be an effective mean 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 were 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 had now the ground 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 got enriched by e-procurement and 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 reached mastery of the technological solutions. This means that e-tenders should not be a mere replication of traditional paper-based procurement habits and processes, instead being 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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