Assessing Transparency in eGovernment Electronic Processes

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ABSTRACT Context. The electronic government has become a trend for transforming public management to comply with the performance of an efficient, modern state. The processes for public procurement and personnel recruitment represent an essential fraction of a country's public spending. Objective. Maturity models are tools for assessing different management dimensions resulting in some level of organizational maturity on an ordinal scale which can show null, partial, or total progress towards the desired state. This paper presents an e-government maturity model for public procurement and personnel recruitment processes, based on a literature review to determine the current state of research in the field. Methodology. We have used a known procedural model from Becker to support the design of the proposed model. Later on, we have tested it with government buyers and personnel recruiters. Findings. These initial results show that users understand the questionnaires designed for the study, and their answers allow us to obtain deep validation. A tool with these characteristics can be handy for measuring the degree of transparency in public entities, thus reducing corruption levels in their processes. Conclusion. This proposal describes the complexity of variables that influence the transparency of a socio-technical process in public tenders. We describe five levels of transparency for software procurement through development projects. These classifications enable the maturity levels of the transparency of electronic procedures used by government agencies to be measured in different dimensions. Implications. One of the crucial challenges to increasing a government's transparency is defining a regulatory or legal framework that regulates its processes and allows the levels of transparency or corruption to be measured in its different departments. Thus instruments and metrics play a crucial role in monitoring the expected change. With direct application in the industry, a model is an essential step for fundamental transparency in electronic governments.

INDEX TERMS Maturity models, transparency, procurement, public tenders, e-government.

I. INTRODUCTION

Corruption has been defined by Transparency International [1] as the abuse of entrusted power for private gain. Corruption is a phenomenon that permeates different levels of government and associated processes, leading countries to suffer adverse effects such as deterioration of citizen trust [2], reduced economic growth [3], instability in politics [4], etc. Transparency has been indicated as the "antidote" to corruption [5].

When we talk of transparency, we refer to information that historically has not been available to the public.

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To achieve transparency, the information must be accessible, relevant, of good quality, and reliable, principally in decision-making [6]. Thus governments consider transparency an essential mechanism of public enforceability and responsibility towards society [7]. Transparency is therefore part of accountability, joining other mechanisms intended to provide a response to the expectations of legal entities, citizens, top executives, or organization members.

Accountability is a characteristic of representative governments, enabling electors to verify that their elected representatives comply with their declared goals [8], [9]. It is thus a means for scrutinizing, evaluating, and even sanctioning elected authorities [10]. Verification through transparent procedures is a tool for accountability at the organizational,

rather than the individual level [11]. Accountability requires coordinated activities relating to participation, openness, and frequent, symmetrical, proactive, synergistic, long-term interactions. These features are therefore to be expected in transparent procedures.

In this context, countries' governments have established the concept of transparency in the various processes that they carry out [5]. Transparency is understood as a concept that encompasses several ideas to curb corruption, among them the establishment of simple decision-making processes, appropriate behavior of officials, public disclosure, integrity, responsibility, and even democratic values [12].

To ensure the transparency and efficacy of these processes, multiple challenges must be overcome, such as: incorporating technological processes, promoting legal frameworks, defining a set of good practices, developing an organizational structure that supports the processes, etc. [13], [14]. One of the crucial challenges to increasing the transparency of a government is to define a regulatory or legal framework that regulates its processes, and allows the levels of transparency or corruption to be measured in its different departments. Thus instruments and metrics play a crucial role in monitoring the expected change.

There are three processes of particular interest due to the significant amount of money that they involve: goods procurement processes, services procurement processes and personnel recruitment processes. Regrettably, there are ample reports of corruption in public procurement in both developed and developing countries [15], [16]. At the same time, corruption, mainly in the form of nepotism, is a recognized problem in the public sector, affecting public procurement and personnel recruitment [17].

IT-based process management in the public sector [18] can decrease levels of corruption in all areas of government by enhancing the effectiveness of government administration, improving the quality of public services, and increasing the transparency of government processes. These initiatives help to improve citizens' perception of and confidence in their government [19]–[21]. In many countries, these initiatives have been transformed into laws for the public sector, making use of Information Technologies as a support mechanism for their implementation [21]. Many governments encourage the use of ICT to promote efficiency and transparency [22]; however evidence suggests that incorporating technology alone is not enough to produce this change. Several other issues need to be addressed progressively and stably, acting at a cultural level [23], [24].

Maturity models are a standard management tool in IT-related topics where cultural change is the goal. They allow progress in multiple dimensions with a common reference. They differ from standard certifications principally in that they propose different maturity stages and a path for progress that is more sophisticated than mere compliance or non-compliance. From a communication perspective, it is assumed that harmful practices and corruption are a problem involving the collective, and not only specific persons whose intention is to preserve a corrupted or inefficient organization [25].

The design of diagnostic instruments based on maturity models is a line of research widely studied in the literature; however, the generation of a new maturity model in a less studied area presents particular challenges. The scientific importance of this proposal is that it proposes a maturity model in a little-explored context, based on applying a proven methodology, adapting existing models, and combining the various approaches found in the literature on public procurement transparency in electronic government. In this work, we follow Becker's methodology for maturity models [26], as well as other related multidimensional maturity proposals based on this methodology, such as Valdez-de-Leon's proposal for telecommunications service providers [27].

This work proposes the design of a maturity model for public procurement processes. The proposal covers goods procurement processes, services procurement processes, and personnel recruitment processes, in such a way as to provide a transparent frame of reference against which government institutions can measure their status in the development, assimilation, implementation, and execution of public processes.

Recent work has developed an initial version of a transparency maturity model in the context of software development tenders from public organizations, which is a particular kind of public procurement [28].

Identifying the dimensions of the process, its traceability from the conceptual framework to the appraisal instruments, and the methodological support for formulating the model, make it a reference for formulating other e-government maturity models with a more comprehensive scope. The present research proposes to extend the formulation pattern used in [28] to public procurement of goods and services in general, and personnel recruitment.

Our motivation is to contribute to the field of government transparency, particularly with respect to the acquisition of goods and services, as well as personnel recruitment, where we evidence research opportunities. The novelty of this research lies in the development of a maturity model, based on a proven methodology, in an area in which no such model has previously been applied. In this way we hope to contribute to expanding research in the area, and to provide the community with tools to control the unwanted effects of corruption in public management.

Our work is structured as follows: In Section 2, we describe the public electronic procedures process. In Section 3, we report related work. In Section 4, we present the methodology used to create our proposal. In Section 5, we describe the design of the maturity model, its dimensions, and a questionnaire to be used to apply the proposed model. In Section 6, we discuss the research and its limitations. In Section 7, we present our conclusions and future work.

II. PUBLIC ELECTRONIC PROCEDURES

We use the term electronic procedures to define goods procurement processes, services procurement processes and personnel recruitment processes, as described below.

A. GOODS PROCUREMENT PROCESS

This is an administrative procedure of a competitive nature through which a government entity makes a public call to acquire goods or an asset (see Figure 1).
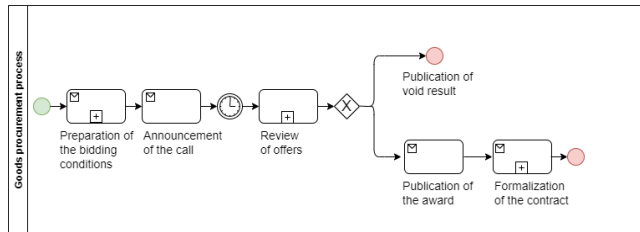

FIGURE 1. Goods procurement process.

The process orders the interested parties to formulate proposals, from which the client will select and accept the most appropriate [29], [30] based on different criteria. The process includes the following steps:

- Preparation of the bidding conditions: definition of the evaluation criteria and selection system. At this stage, the terms, the price range, and the characteristics of the asset required are specified.
- Announcement of the call: the public tender will appear in a technological platform to solicit offers from suppliers registered in the platform.
- Review of offers: in this stage, the client reviews all the offers. Generally, each government entity has internal procedures for classifying the scores of the tenders.
- Publication of the award or void bid result: the name of the provider awarded the proposal is published in the technological platform; in some cases, the process is declared void when no provider meets the client's specific needs.
- Formalization of the contract: the client has regular formal contact. It sends an email to the supplier to manage the purchase.

B. SERVICES PROCUREMENT PROCESS

We have differentiated the purchase of a service or consultancy from the purchase of an asset, since it is the subject
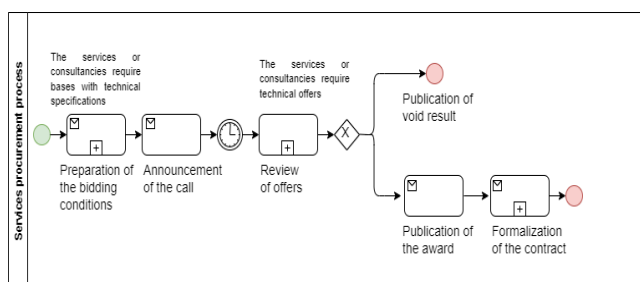

FIGURE 2. Services procurement process.

of more specific requirements. Service or consultancy procurement often starts with the generation of a technical specification, which also involves specialized human resources. On the other hand, planning of the offers entails a more significant effort to comply with the technical specifications (see Figure 2).
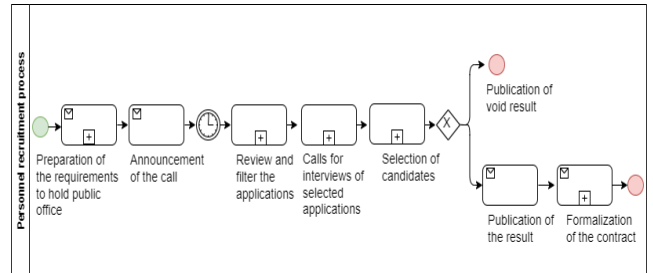

FIGURE 3. Personnel recruitment process.

C. PERSONNEL RECRUITMENT PROCESS

The recruitment process in the public sector takes place when a government entity publicly invites people to apply for a position (see Figure 3). The recruitment process includes:

- Preparation of the requirements to hold public office: the study requirement is specified and the required function is described, as well as the desired competencies for the position.

- Announcement of the call: the call is generally published on a government technology platform.

- Review and filter the applications: at this stage, all applications are reviewed and classified, and the applicants who meet the published requirements are selected for processing.

- Calls for interviews of selected applicants: the different types of interviews are carried out and the applicants with the highest scores are short-listed.

- Selection of candidates: based on the previous stage, a candidate is selected to fill the position.

- Publication of the appointment or void result: the selected candidate is announced. Sometimes the contest may be declared void.

- Formalization of the contract: the selected candidate starts the recruitment process with the government entity.

These electronic processes lack transparency, which is contradictory considering that transparency is an important element of the quality of calls for tenders by electronic platforms [31], [32]; it is also a business balance indicator, and one of the values most appreciated by citizens [33]. Transparency is a crucial indicator for possible providers, who must choose what public calls for tenders to bid for; and for governments, which must confirm to their citizens that rational decisions are taken under its authority. Nevertheless, current transparency parameters cannot address all the situations encountered in a public call for tenders, and there is no transparency benchmarking for public calls for tenders [34].

Achieving transparency in these processes requires an effort that goes beyond Active Transparency (it is the

obligation of State agencies to publish useful, timely and relevant information on their web pages). In particular, it requires an organizational culture in which transparency is a fundamental pillar [35]. This in turn requires a diagnostic methodology for organizational maturity which will allow improvement plans to be developed to meet each problem.
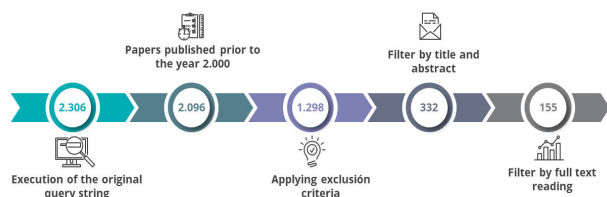

FIGURE 4. Number of papers after application of filters.

III. RELATED WORKS

This section contains related works, identified by systematic mapping of the literature [36]. Systematic mapping produced an overview of the works related to maturity models and government procurement by electronic means.

A. LITERATURE REVIEW

Systematic mapping offers us an overview of a research area by means of classification [36], [37]. It is a method used particularly to answer, methodically, one or more research questions. We followed the protocol for conducting systematic mappings defined by [38].

General guidelines: at this stage of the research, we propose a maturity model designed to measure the level of transparency in government electronic purchasing processes. This proposal is expected to increase the transparency of public bidding in government agencies, as well as disseminating and identifying best practices in government electronic procurement processes.

The second step of systematic mapping, according to [36], is the approach to the research question(s) (RQ); we propose three questions:

RQ-1: Of the selected studies, how many propose maturity models (or theoretical proposals)? How many propose the use of maturity models in the study?

RQ-2: How many studies using maturity models address transparency?

RQ-3: How many studies using maturity models address electronic procurement by governments?

Generating a search string: in order to generate a search chain, the keywords of the research questions were identified, together with the objectives, and then concatenated with logical connectors. This search string was applied in search engines and was also validated by the researchers. The resulting string was: (''Maturity'' AND ''Electronic procedures'') OR (''Maturity AND e-procedures'') OR (''Maturity '' AND ''Electronic procurement'') OR (''Maturity'' AND ''e-procurement'') OR (''Maturity'' AND ''electronic government'') OR (''Maturity'' AND ''e-government'') OR (''Maturity'' AND ''Open government'') OR (''Maturity''

AND ''Business process'') OR (''Maturity'' AND ''acquisition'') OR (''Maturity'' AND ''purchase'') OR (''Maturity'' AND ''Service'') OR (''Maturity'' AND ''hiring'') OR (''Maturity'' AND ''recruitment'') OR (''Maturity'' AND ''e-recruitment'') OR (''Maturity'' AND ''transparency'') OR (''Maturity'' AND ''e-service'').

Data extraction: for the data search and extraction process, we included databases and websites with access to digital libraries. These would contain search engines allowing searches using search chains to download a large number of related works. The selected data sources were Google Scholar, IEEE XPLORE, ACM, SPRINGERLINK and SCOPUS.

Inclusion and exclusion criteria: the search parameter used was the option to select publications for which at least one of the key words was found within the title, excluding patents and citations.

Inclusion criteria:

- Studies from the year 2000 onwards.
- Studies that address maturity models and any government electronic procurement procedure.

Exclusion criteria:

- Studies prior to 2000.
- Studies without an author.
- Documents that do not include maturity models.
- Duplicate studies in different databases.
- Studies whose title is not related to the research object.
- Documents that do not come from traceable journals or procedures.

Search execution: the query string was applied in the selected sources, and an initial number of 2,306 works was obtained. The information was extracted using export tools from each of the digital libraries. Documents published before the year 2000 were removed, leaving 2,096 works. We then applied the exclusion criteria for double-indexed works, reducing the number of results to 1,298. The next stage was reading of the titles and abstracts; the most relevant papers were selected, totaling 332 documents. Finally, these works were read in full text to assess their relevance for mapping, giving a final total of 155 documents (see summary in Figure 4).

Classification scheme: publications were classified in three dimensions: time, category, and type of proposal. The temporal dimension classified the works into bands by year of publication, within the period 2000-2021.

The categories into which the publications were classified were e-government, e-procurement, e-service, business, open government, transparency, innovation and information technology; despite the possibility that some works could be classified in more than one category, the categories were constructed from the combination of characteristics, as has been seen in similar works.

The works found were classified into three types:

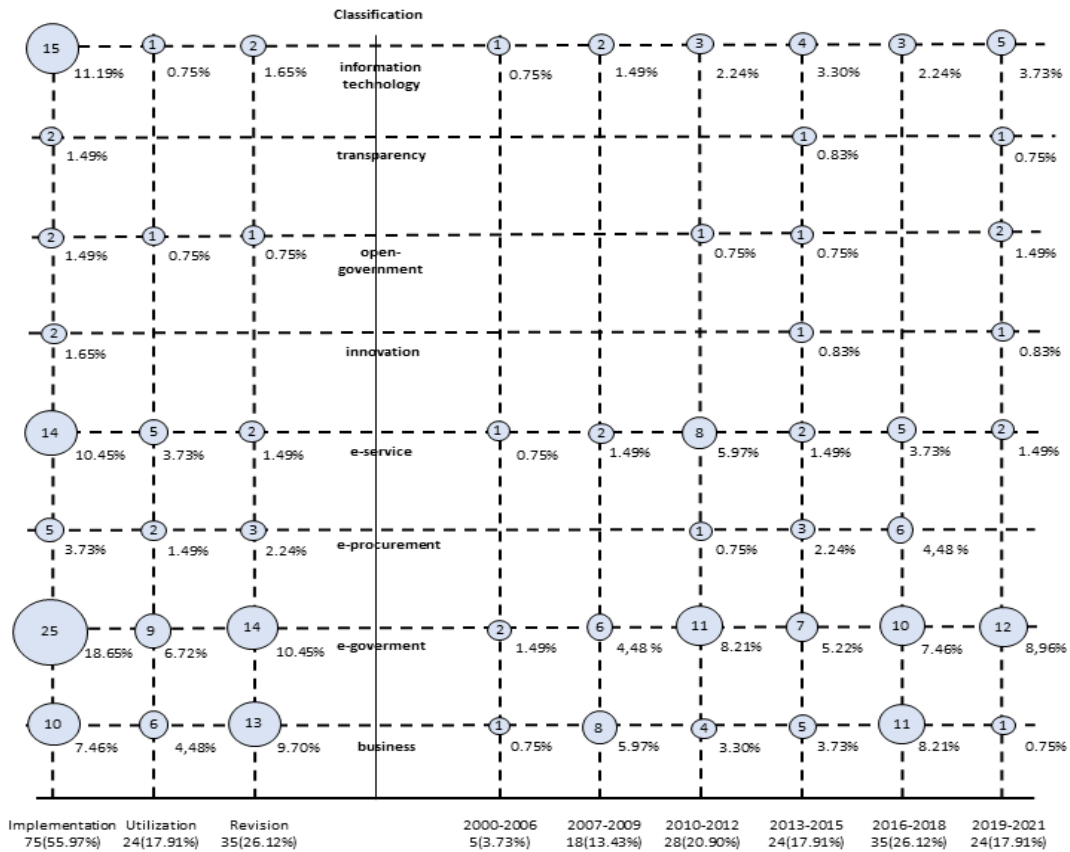i) Review: comparisons between maturity models or literature reviews of the field.

Classification

	Implementation	Utilization	Revision		2000-2006	2007-2009	2010-2012	2013-2015	2016-2018	2019-2021
information technology	15 (11.19%)	1 (0.75%)	2 (1.65%)		1 (0.75%)	2 (1.49%)	3 (2.24%)	4 (3.30%)	3 (2.24%)	5 (3.73%)
transparency	2 (1.49%)							1 (0.83%)		1 (0.75%)
open-government	2 (1.49%)	1 (0.75%)	1 (0.75%)				1 (0.75%)	1 (0.75%)		2 (1.49%)
innovation	2 (1.65%)							1 (0.83%)		1 (0.83%)
e-service	14 (10.45%)	5 (3.73%)	2 (1.49%)		1 (0.75%)	2 (1.49%)	8 (5.97%)	2 (1.49%)	5 (3.73%)	2 (1.49%)
e-procurement	5 (3.73%)	2 (1.49%)	3 (2.24%)				1 (0.75%)	3 (2.24%)	6 (4,48 %)	
e-goverment	25 (18.65%)	9 (6.72%)	14 (10.45%)		2 (1.49%)	6 (4,48 %)	11 (8.21%)	7 (5.22%)	10 (7.46%)	12 (8,96%)
business	10 (7.46%)	6 (4,48%)	13 (9.70%)		1 (0.75%)	8 (5.97%)	4 (3.30%)	5 (3.73%)	11 (8.21%)	1 (0.75%)

Implementation	Utilization	Revision		2000-2006	2007-2009	2010-2012	2013-2015	2016-2018	2019-2021
75(55.97%)	24(17.91%)	35(26.12%)		5(3.73%)	18(13.43%)	28(20.90%)	24(17.91%)	35(26.12%)	24(17.91%)

FIGURE 5. Representation of the systematic mapping.

ii) Use: works that apply maturity models to organizations and evaluate their results.

iii) Implementation: works that propose a maturity model for a specific context.

Map construction: the final product of the systematic mapping stage was a map to facilitate representation and analysis. Figure 5 (left) shows the works classified into: implementation, use and review. The right-hand side of the figure shows the rankings of the publications by year range.

Seventy-five papers, published between 2000 and 2021, were identified that proposed a model for implementation. Over the same period, 24 documents were identified that proposed maturity models and applied them to organizations to assess their results and performance.

With the search and selection procedures described above, only two works were identified that proposed a maturity model to address transparency and accountability.

It was observed that the largest proportion of efforts – 46 articles (34%) – were directed towards formulating and implementing maturity models for: e-government (25), open government (2), e-services (14) and e-procurement (5). Given that the importance of transparency to governments is recognized, as is that of e-procurement, why are there so few articles that address transparency? For example, only 2 articles

(1.49%) study how to identify and evaluate key elements of transparency. In the first [48], the authors propose the Open Government Maturity Model (OGMM) based on field studies with U.S. federal healthcare administration agencies. This model was developed specifically to assess and guide open government initiatives that focus on transparent, interactive, participatory, collaborative public engagement – largely enabled by emerging technologies such as social media. We have reviewed and considered elements from some of these proposals in the development strategy for our model.

In the second article [28], the authors propose a maturity model as a tool for measuring the transparency of software development bids solicited by government agencies. They use a procedural model to support the design of maturity models in four dimensions: Institutionalization, Software acquisition, Communication, and Accountability. A five-step model is defined and tested with real government buyers. The model is supported by an assessment tool that helps guide the next steps in software procurement transparency.

Of these two articles we have focused on [28], in which the methodology of [26] is adapted to measure transparency in public software tenders. The authors describe the complexity of the variables that influence the transparency of a socio-technical process, such as the acquisition of a software

product through a development project; this process produced a similar result to that studied in the present paper.

IV. METHODOLOGY

Like [28], we follow Becker's recommendations for defining Maturity Models [26]. This approach defines how Maturity Models are motivated, produced, and evaluated through two main phases: Generation and Transfer. For the present proposal, we will focus mainly on the first of these.

This Generation phase has four sub-phases: (i) Problem definition, to determine the scope of the domain of the maturity model; (ii) Comparison of existing maturity models, in which we analyze existing models to propose a new model; (iii) Determination of a development strategy, in which we suggest a design strategy that combines extracts from a set of maturity models into a new model; and (iv) Iterative maturity model development, where we submit the proposal for internal and external evaluations [28].
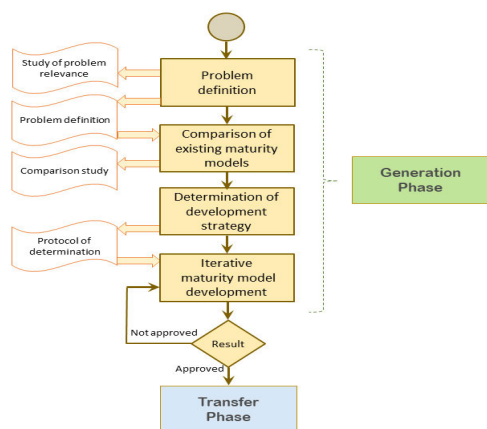

FIGURE 6. Stages adopted from the methodology for developing maturity models.

In Figure 6, we summarize the phases of this procedure as proposed by Becker [26]. In addition to the initial design, we have added notes on transferred sub-phases. The following sections detail the development within each of these sub-phases.

A. SUB-PHASE I: PROBLEM DEFINITION

Becker [26] states that in this sub-phase, establishing relevance also requires exact definition of the problem. In this context, we address the difficulties of State institutions in complying with transparency standards in the bidding processes for goods and services. Achieving transparency in these processes requires an effort beyond Active Transparency (State agencies' obligation to publish useful, timely, and relevant information in their web pages) [40]. In particular, it requires the generation of an organizational culture in which transparency is a fundamental pillar.

This requires a diagnostic methodology for organizational maturity that allows improvement plans to be generated according to the problem.

This opportunity becomes more relevant if we add that the economic and social benefits of a public acquisition or a personnel contract for the public sector can be seriously threatened by various factors, such as: (i) ignorance of the technical area soliciting goods, services or employees; (ii) corruption, which has a negative impact by artificially raising the final price; (iii) self-exclusion of competitive suppliers when they believe that tenders are agreed in advance; (iv) formalization bids, i.e. tender processes to formalize the contracting of services that have already been provided, by honest providers, but outside of a formal procedure, reinforcing the belief that the formal system is merely a bureaucratic adjustment procedure [2], [41].

B. SUB-PHASE II: COMPARISON OF EXISTING MODELS

In this sub-phase we study related concepts, just as we described related works in the previous section. As we have said, the aim of maturity models is to provide a ready reference for measuring the performance of organizations in certain sections [42]. Some disciplines use the term 'maturity models' for classification schemes. Various authors use these models to diagnose and define measures of progress [43]–[47].

C. SUB-PHASE III: DETERMINATION OF DEVELOPMENT STRATEGY

Strategies are defined by composing a new model, improving an existing one, or merging different strategies.

Different models involve different issues. Basing attempts to improve on a single model implies missing important features of other designs. Our approach will be to consolidate various models into our new model.

The Open Government Maturity Model (OGMM) [48] was developed to evaluate principles of open government. We adopted a few ideas to contribute to our model, such as (i) transparency, (ii) data management practices, and (iii) citizen-government modes of interaction [28]. Nevertheless, we chose a slightly different path in our approach. Transparency is a significant factor in our proposal, however we adopted the transparency perspective discussed in Meijer [49], in which a synergistic connection between transparency and participation is claimed, using mutual reinforcing patterns.

We took as our starting point tenders for purchases, consultancies and services, basing our proposal on the characteristics that define budgets, bid deadlines, and criteria for evaluating the request. Additionally, we used a multi-methodological procedure guideline as the basis for an ontological approach to maturity models for transparency in public tenders.

D. SUB-PHASE IV: ITERATIVE MATURITY MODEL DEVELOPMENT

This stage represents the operational and continuous improvement capacity offered by maturity models. We divide this initiative into four stages.

Level design: the scope of the application is limited to assets or services to be procured for a specific government entity. It is understood that a government entity is a division of the State with a person in charge. Given that the entity performs a job proper to the State, independent strategic planning makes sense. Given the above, depending on the target area, this model is adapted to particular needs.

Particular approach: the model consists of measurements of transparency in six dimensions: Institutionalization, Goods procurement process, Services or consultancies procurement process, Personnel recruitment process, Communication, and Accountability.

Design of the model: every maturity model that has reached a certain level of consolidation undergoes an audit process [50], which includes questionnaires and evidence collection.

Test the results: for each dimension we generate a set of questions, each question being related to a level of maturity. In this way, we can classify each response and determine the maturity level of the dimension. Each time the maturity model is applied, the entity obtains a rating, revealing its gaps and how it has improved. For this iteration, we validated the usefulness of the current questionnaire by applying it to government agency officials.

V. MATURITY MODEL DESIGN

We propose a maturity model for tenders for procurement of assets, procurement of services or consultancies, and personnel recruitment, as required by a specific government agency. We understand that a government agency is a division of the State. It is responsible for a specific State role that requires independent strategic planning – for example, a hospital, a school, a municipality, a university or a branch of the armed forces. Tender procurement in such agencies is centralized, and the maturity model can therefore be applied to a government agency with a single procurement process.

The model consists of measurements of transparency in the same six dimensions: Institutionalization, Goods procurement process, Services or consultancies procurement process, Personnel recruitment process, Communication, and Accountability. The model is defined with five levels, as shown in Figure 7. We describe each of the levels for each dimension in Table 1.

To evaluate the procurement process for the proposed transparency framework, we need a method to match different
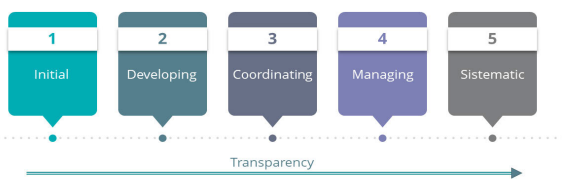

FIGURE 7. Maturity model levels for government electronic processes.

TABLE 1. Definition of levels.

Level 1 (Initial)	Level 2 (Developing)	Level 3 (Coordinating)	Level 4 (Managing)	Level 5 (Systematic)
Institutionalization				
Only discourse	Explicit vision aligned with the discourse	Speech and plan aligned with national guidelines.	There is a procedure to update the strategy that includes maintaining consistency with national guidelines.	Vision is refined (detailed), and there is evidence that the strategy is periodically updated following the defined procedure.
Goods procurement process				
There is a generic process for acquisitions	Stages of the acquisition process are distinguished in detail.	The process is documented and is required of officials by regulation; its application is monitored.	It is quantifiable with metrics formalized in the process. The process is controlled and there is evidence that it has been corrected according to the results of the control.	Corrections to the process are based on the historical results of the metrics defined, and are planned and performed periodically.
Services procurement process				
The search for the service is made official; the organization has a general idea of the guidelines.	Elements are integrated that allow detailed stages of the service acquisition process to be established.	The process that has been carried out is documented, formalizing items that are relevant when submitting a tender.	The organization monitors the bidding process and this is where decisions can be made regarding the information as it is updated.	The process is institutionalized; the organization pursues continuous improvement of the service bidding process.
Personnel recruitment process				
The personnel recruitment process is carried out with minimal information that does not allow monitoring of the process in question.	Elements are integrated that allow stages of the application process for the position to be specified.	The documentation of the process is established and minimum guidelines are indicated.	There is organization and planning of the process. The initiative is formalized and there are personnel in charge of managing the bidding process.	Applications are updated. The application stages are reviewed constantly.
Communication				
Internal: it is one-way and informal. External: it is unidirectional, informal and sometimes reactive.	Internal: the process is disseminated through formal channels. External: it is formal.	Internal: it is planned. External: it is planned and includes bidirectional elements.	Internal: it is evaluated. External: it is interactive and evaluated.	Internal: systematic and corrected. External: systematic and corrected.
Accountability				
It is informative. There is one-way communication regarding the delivery of information on the administrative and technical bases of the procurement process. Other items are kept private.	There is interaction between questions and answers around the procurement process and the justification of the award is reactively informed. Private items are added.	Information and justification practices are consolidated, in greater depth than in the previous levels, decisions and actions around the procurement process.	Proactive in reporting budgets, questions, answers, and supplier evaluation of the procurement process. Evaluation and sanction mechanisms are communicated to interested parties.	It is proactive towards the public in terms of informing conditions, budgets, award minutes, list of suppliers, mechanisms for evaluating the procurement process.

observable organizational elements to one of these five maturity levels [28]. We used the organizational ontology described by Rao [51], which provides basic organizational elements such as formalized practices, objects or resources, and tasks. These elements form part of a basic understanding of members of an organization and may form part of a questionnaire for members of the organization or auditors [28]. In Figure 8, we illustrate how these elements indicate the level of each dimension.
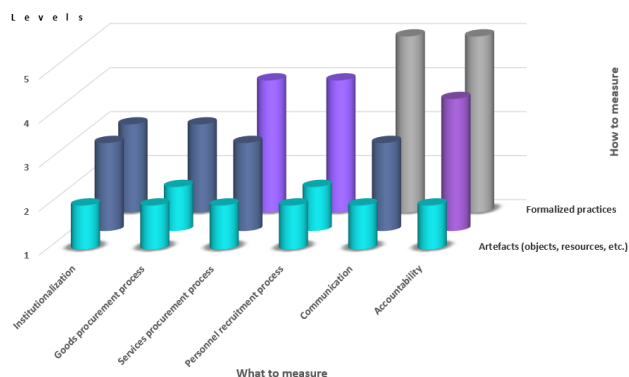

FIGURE 8. Model implementation.

A. A VALIDATION SURVEY

The survey was created from the maturity model of electronic procedures which proposes five levels: initial, developing, coordinated, managed and systematic. For each dimension, we generated a set of questions. Each question is related to a level of maturity. In this way, we can classify the answers and determine the level of maturity of each dimension. The questionnaire consisted of 73 questions, distributed as follows:

All the questions in the questionnaire are closed, with two possible answer types: i) Yes, and ii) No. The questionnaire is attached at Appendix 1.

To demonstrate the relationship between the questions and the maturity levels described in Table 1, we will explain an example for Dimension 4: Personnel recruitment process. The questions formulated for each level of this dimension are cited below.

Question 1 is related to Level 1, whose definition is: "The personnel recruitment process is carried out with minimal information that does not allow monitoring of the process in question". This means that there are indications that the

TABLE 2. Distribution of the questions.

Dimensions	Level 1	Level 2	Level 3	Level 4	Level 5	**Total**
D1: Institutionalization	1	2	1	2	2	**8**
D2: Goods procurement process	1	1	2	2	1	**7**
D3: Services procurement process	1	1	2	2	1	**7**
D4: Personnel recruitment process	1	1	2	2	1	**7**
D5: Communication Internal	1	1	1	1	1	**5**
D5: Communication External	2	1	2	2	1	**8**
D6: Accountability	3	6	6	8	8	**31**

government entity, through an executive, has recognized that transparency in electronic procedures is important and needs to be addressed explicitly, i.e. it is not enough to declare transparency in all acquisitions; however, there is no evidence of an action plan aimed at promoting transparency in procurement. Considering this definition, our proposed question to determine Level 1 is: Q1: Have minimum guidelines been proposed for the personnel recruitment process? (Definition of Level 1, Initial).

Question 2 is related to Level 2, whose definition is "Elements are integrated that allow stages of the application process for the position to be specified". In other words, at this level certain guidelines are required for the recruitment of personnel such as the minimum experience and knowledge required to fill the position, the mission that the appointee will carry out in the institution, or the application history; however this is not made explicit in the application process. For this level our proposal was: Q2: Is there a defined process for personnel recruitment? (Definition of Level 2, Developing).

Questions 3a and 3b are related to Level 3, whose definition is "The documentation of the process is established and minimum guidelines are indicated". These questions enquire whether the organization provides the minimum guidelines for applications to be made for the position to be filled. There is a strategy, and adequate personnel to start this process. The progress of each applicant is evaluated until the optimum is reached, in addition to documenting the process to keep a record and make future improvements. We have decided to include two questions for this level, because the definition of a Coordinating level implies the existence of a person to act as coordinator:

- Q3a: Are there strategies for assessing the progress of each applicant in the recruitment process?
- Q3b: Does any staff member monitor the application stages?

The definition of Level 4 is: "There is organization and planning of the process. The initiative is formalized and there are personnel in charge of managing the bidding process". This definition suggests organization and planning of the application process for the position; thus the requested data should be clear and descriptive, and explicitly express the requirements of the position and the experience necessary. This initiative is institutionalized and there is a group of people in charge of managing each personnel recruitment process. Two questions were therefore defined for this level also, because a Managing level should have documentation and assigned personnel:

- Q4a: Is detailed documentation kept of the personnel recruitment process?
- Q4b: Is any staff member assigned to carry out this activity?

Level 5 is defined as: "Applications are updated. The application stages are reviewed constantly". This definition states que the importance of transparency in the personnel recruit process is relevant for the organization since the application process is visible to all applicants, the job

description gives clear information on what is expected of the applicant and/or person selected. There is constant periodic review of the application stages and their closure, as well as the challenges and guidelines of the position. We have defined only one question, since according to our criteria it corresponds to a Systematic level, that is, of review and analysis.

Q5: Is there constant review and analysis of the recruitment process (related to job profile and documentation) to improve the stages of application? (Definition of Level 5, Systematic).

To classify the levels of a survey, we established the requirement that the answer to all the questions at the level assessed should be "Yes"; and that the answer to all questions at previous level(s) must also be "Yes".

The resulting questionnaire was sent to officials at government agencies who were asked to respond to our on-line survey. Initially 22 officials from 20 government agencies responded, all of whom had experience in procurement tenders. The results generated by 82% of the participants showed that their agencies were classified as Level 1 in our maturity model; 14% classified as Level 2, and only 1 (4%) as Level 3. The types of institutions surveyed are shown above in figure 9 and the Development Area of the respondents within their institutions is shown below in Figure 10.

B. GENERAL ANALYSIS BY DIMENSION

In general terms, the questions addressed in the Institutionalization dimension of all the institutions explored whether there are indications that the government entity, through an officer, has recognized the importance of transparency in electronic procedures: 65% answered "Yes" and only 35% answered "No".

In the Goods procurement dimension, the questions addressed aspects related with the existence of a procurement procedure within the organization: 76% of those surveyed answered "Yes" and only 24% answered "No".

In the Service acquisition dimension, the question addressed aspects related with the existence of a defined procedure for the acquisition of services within the organization: 73% answered "Yes" and only 27% answered "No".

For the personnel recruitment dimension, the questions addressed aspects related with the existence of procedures for this process: 69% responded "Yes" and only 31% responded "No".

The Communication dimension is divided into "internal" and "external". To the questions enquiring into the existence of internal dissemination or communication media for the transparency of electronic procedures, 48% of those surveyed answered "Yes" and 52% answered "No". In the external division, the questions related to the transparency of electronic procedures towards the public or citizens: a similar result was obtained with 46% answering "Yes" and 54% "No".

Finally, in the Accountability dimension, the questions related to the disclosure of elements of electronic tender procedures: 69% answered "Yes" and only 34% "No".
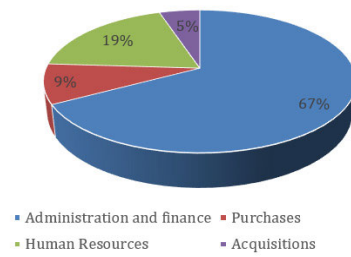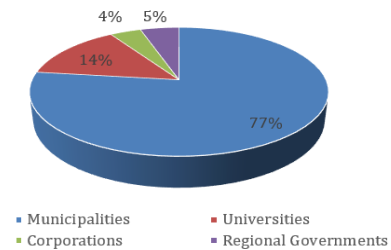
FIGURE 9. Government institutions.

FIGURE 10. Development area of the respondents.

At first glance, the number of "Yes" responses appears to be high; however, as this is a maturity model, i.e. a staggered evaluation, most of the institutions did not give a full set of affirmative answers to achieve any level of maturity.

The first observation arising from analysis of the data was that the Communication dimension, with its internal and external divisions, presented the most critical results: the respondents indicated that they were unaware of transparency procedures in communications connected with procurement tenders. Next, it can be seen that in the three lower levels (Initial, Developing and Coordinating) there were more responses indicating knowledge of activities related to transparency; the opposite occurred in the higher levels (Managing and Systematic), where there are more responses indicating ignorance or non-existence of the aspects explored by the question(s) corresponding to each level.

Each respondent's answers were used to assess the level of discrimination of each question. All questions were answered affirmatively ("Yes") or negatively ("No"), confirming the use of effective discrimination criteria. This shows that the questions used would allow us to effectively identify the various levels.

VI. DISCUSSION AND LIMITATIONS

This article describes the context and the problems faced in assessing transparency in e-government processes, introducing our research proposal. A bibliographic review is presented, through which we determined the state of the art in research into maturity models and transparency in government electronic procurement. We followed the methodology developed by Petersen [38], which proposes applying search chains limited to the research questions posed; for this reason we found very few documents referring to transparency and maturity models.

TABLE 3. Dimension of institutionalization.

	(1) Dimension: Institutionalization
Level 1	Has the head of your unit stated publicly that transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process) is important?
Level 2a	Is there any strategic plan, development plan or other institutional policy document stating that transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process) is important?
Level 2b	Is this strategic plan consistent with the statements of management in terms electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3	Is the strategic plan, development plan or other institutional policy document on transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process) of your unit aligned with the national position?
Level 4a	Is there any kind of norm or procedure defined for the generation of a strategic plan, development plan or other policy document?
Level 4b	Does this norm or procedure comply with national guidelines, and seek to ensure that the resulting plan is aligned with these electronic procedure policies (goods procurement process, services procurement process and personnel recruitment process)?
Level 5a	Is any kind of record kept of updates to the strategic plan, development plan or other institutional policy for transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 5b	Can this record be used to show that the procedure defined has been monitored?

TABLE 4. Dimension of assets procurement process.

	(2) Dimension: Assets procurement process
Level 1	Has any process or suggestion been followed for the procurement of public goods?
Level 2	Are the stages in the public goods procurement process defined?
Level 3 a	Is there any norm that obliges public employees to follow a public goods procurement process?
Level 3 b	Is the process monitored by any authority?
Level 4 a	Is the process controlled by quantifiable indicators, for example number of applicants, number of companies that make enquiries?
Level 4 b	Have corrections been made to the process as a result of the control?
Level 5	Is there planned periodic analysis of the public goods procurement process in which it is improved, based on historical results?

We believe that implementing a maturity model requires a methodological guide; it can be a long and complex process to follow. Generating a maturity model to measure transparency in electronic public procurement processes is a challenging project. According to our review of the technical literature, the measurement of transparency through maturity models

TABLE 5. Dimension of services procurement process.

	(3) Dimension: Services procurement process
Level 1	Is there any process, or have steps been proposed, which must be followed in services procurement by the organization?
Level 2	Have clear stages been defined for applications for service procurement?
Level 3a	Is there a detailed, documented process for the stages of tendering to provide a service?
Level 3b	Does any staff member monitor the application stages?
Level 4a	Is the process controlled by quantifiable indicators, for example number of applicants, number of companies that make enquiries?
Level 4b	Have corrections been made to the process as a result of the needs that arise from the process of tendering to provide a service?
Level 5	Is there planned periodic analysis of the tendering process, and the changes and improvements incorporated?

TABLE 6. Dimension of personnel recruitment process.

	(4) Dimension: Personnel recruitment process
Level 1	Have minimum guidelines been proposed for the personnel recruitment process?
Level 2	Is there a defined process for personnel recruitment?
Level 3a	Are there strategies for assessing the progress of each applicant in the recruitment process?
Level 3b	Does any staff member monitor the application stages?
Level 4a	Is detailed documentation kept of the personnel recruitment process?
Level 4b	Is any staff member assigned to carry out this activity?
Level 5	Is there constant review and analysis of the recruitment process (related to job profile and documentation) to improve the stages of application?

is a little-explored area, the more so when the focus is on measuring transparency in public purchasing and recruiting processes.

While it is true that the design of diagnostic instruments based on maturity models is a line of research widely studied in the literature, the generation of a new maturity model in a less studied area presents particular challenges. As can be seen from the literature review presented in the article, there are practically no works related to the generation of maturity models in the field of transparency in public administration, associated with contracting processes (procurement and recruitment). In this context, the present proposal acquires scientific importance: it proposes a maturity model in a little-explored context, based on a proven methodology, by adapting existing models and combining the various approaches found in the literature on the transparency of public contracting in the context of e-government.

We have applied a proven methodology for maturity model design, following Becker's procedural methodology [26]; and we have also taken as a reference a recent work [28] in which the authors developed an initial version of a transparency

TABLE 7. Dimension of communication.

(5) Dimension: Communication	
Internal communication:	
Level 1	Has transparency been promoted in the goods procurement, services procurement and personnel recruitment processes, even informally (conversation, team meeting)?
Level 2	Is there any means of internal communication to promote actions of transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3	Is there any action plan to promote transparency in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 4	Do any mechanisms exist to assess initiatives for internal communication and promotion of transparency in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 5	If actions are taken for internal promotion of transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process) that are planned and assessed, are these evaluations systematic, and are they used to correct these internal promotion actions?
External communication:	
Level 1a	Is information made public on transparency in the goods procurement, services procurement and personnel recruitment processes (electronic procedures)?
Level 1b	Has there been any public response to accusations of lack of transparency in goods procurement, services procurement and personnel recruitment processes (electronic procedures)?
Level 2	Is there any formal means of public communication to promote transparency actions in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3a	Is there any means of communication to receive or record enquiries or suggestions by the public about transparency actions in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3b	Is there any action plan for public communication on transparency in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 4a	Is there any official means of communication to allow the public to suggest improvements in transparency in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 4b	If there is an action plan for external communications, is there any process for assessing the impact of these actions?
Level 5	If actions are taken for external promotion of transparency in electronic procedures (goods procurement process, services procurement process and personnel recruitment process) that are planned and assessed, are these evaluations systematic, and are they used to correct these external promotion actions?

TABLE 8. Dimension of accountability.

(6) Dimension: Accountability	
Level 1a	Is there any mechanism to inform the public of the technical and administrative bases of electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 1b	Is there any internal mechanism to make public the award status of the tender process or job application?
Level 1c	Is there any internal mechanism to make public the list of tenderers in the process?
Level 2a	Is there any internal mechanism to make public the price ranges of electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 2b	Is there any internal mechanism to make public the exact budget of electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 2c	Is there any mechanism for Q & A responses to tenderers' enquiries in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 2d	Is there any mechanism to satisfy public concerns about the award of tenders in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 2e	Is there any internal mechanism to make public the table of assessments of suppliers or tenderers in the process?
Level 2f	Is there any internal mechanism to make public the list of tenderers in the process?
Level 3a	Is there any response mechanism to advise tenderers who make enquiries as to the exact budget of electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3b	Is there any mechanism for Q & A information in response to tenderers' enquiries in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3c	Is there any mechanism to inform tenderers about the award of tenders in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 3d	Is there any response mechanism to advise tenderers of the table of assessments of suppliers or tenderers to the process?
Level 3e	Is there any response mechanism to advise tenderers who make enquiries of the list of suppliers or tenderers to the process?
Level 3f	Is there any internal mechanism to make public the instruments for appraisal in the tender process (appraisal of public employees)?
Level 4a	Is there any mechanism to inform tenderers about the exact budget of tenders in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 4b	Is there any mechanism to inform tenderers about Q & A information in electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 4c	Is there any response mechanism to inform the public about the award of tenders in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 4d	Is there any response mechanism to inform tenderers who make enquiries of the quality reports on technical documents in the tender process?

maturity model in a specific context, following the steps established by Becker.

There are various threats to the validity of the tool. For example: i) We do not yet know whether question

TABLE 8.

Level 4e	Is there any internal mechanism to inform tenderers about the table of assessments of suppliers or tenderers in the process?
Level 4f	Is there any response mechanism to inform tenderers who make enquiries about reports of sanctions applied to public employees who work in tender processes?
Level 4g	Is there any response mechanism to advise members of the public who make enquiries of the list of suppliers or tenderers to the process?
Level 4h	Is there any mechanism to advise tenderers of the instruments for appraisal in the tender process (appraisal of public employees)?
Level 5a	Is there any mechanism to inform members of the public about the exact budget of tenders in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 5b	Is there any mechanism to inform members of the public about the Q & A relating to electronic tendering procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 5c	Is there any mechanism to inform members of the public about the award of tenders in electronic procedures (goods procurement process, services procurement process and personnel recruitment process)?
Level 5d	Is there any response mechanism to inform members of the public about the quality reports on technical documents in the tender process?
Level 5e	Is there any mechanism to respond to members of the public about the table of assessments of suppliers or tenderers in the process?
Level 5f	Is there any response mechanism to inform members of the public about the quality reports on technical documents in the tender process?
Level 5g	Is there any mechanism to inform members of the public about the list of suppliers or tenderers in the process?
Level 5h	Is there any mechanism to inform members of the public about the instruments for assessing tenders?

interpretation by each respondent is the same; ii) There is no simple way of validating the trustworthiness of the tool, since this would require several respondents with the same profile within the same organization; iii) Finally, the most important validation is triangulation, which involves matching respondents' answers with findings by a professional audit team.

VII. CONCLUSION AND FUTURE WORK

This paper describes the complexity of variables that influence the transparency of a socio-technical process in public tenders. We propose a maturity model that objectively assigns an organization to a given level of transparency. We used the principles described by Becker [26] as a methodological reference for the development of our maturity model.

We used this conceptual framework to prepare a maturity model describing five levels of transparency for software procurement through development projects: (1) Initial, (2) Developing, (3) Coordinating, (4) Managing, (5) Systematic. These classifications enable the maturity levels of the transparency of electronic procedures used by government agencies to be measured in the following dimensions: Institutionalization, Goods procurement process, Services or consultancies procurement process, Personnel recruitment process, Communication, and Accountability. We selected these levels and dimensions to achieve integration and innovation based on an exhaustive review of specialized literature on this topic.

We also prepared the first version of an evaluation tool and tested the discrimination criteria with positive results. However, we need to perform further surveys using this first proposal, and broaden our experience, in order obtain an iterative process that will successfully achieve a consolidated judgment.

Some areas that we have identified for future work to improve the structure of the questionnaire are:

- Estimate the validity of the questionnaire and its metric invariance. This estimation allows the internal structure of the instrument and its possible dimensions to be identified;
- Estimate the reliability and stability of measurement. The reliability of the scale is essential for correct evaluation of the construct measured, as it is a fundamental property of psychometry;
- Estimate the concurrent validity of the instrument with other available measures (for example, results of professional audits).

One of the crucial challenges to increasing a government's transparency is defining a regulatory or legal framework that regulates its processes. Thus instruments and metrics play a vital role in monitoring the expected change. With direct application in the industry, a model is an essential step for fundamental transparency in electronic governments.

APPENDIX A
QUESTIONNAIRE TO MEASURE TRANSPARENCY IN ELECTRONIC PROCEDURES FOR sTATE AGENCIES
See Tables 3–8.

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