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SimplexIS: Evaluating the Impact of e-Gov Simplification Measures in the Information System Architecure

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***Abstract*—**Nowadays increasingly the population makes use of Information Technology (IT). As such, in recent year the Portuguese government increased its focus on using the IT for improving people's life and began to develop a set of measures to enable the modernization of the Public Administration, and so reducing the gap between Public Administration and citizens.Thus the Portuguese Government launched the Simplex Program. However these SIMPLEX eGov measures, which have been implemented over the years, present a serious challenge: how to forecast its impact on existing Information Systems Architecture (ISA). Thus, this research is focus in addressing the problem of automating the evaluation of the actual impact of implementation an eGovSimplification and Modernization measures in the Information Systems Architecture. To realize the evaluation we proposes a Framework, which is supported by some key concepts as: Quality Factors, ISA modeling, Multicriteria Approach, Polarity Profile and Quality Metrics

***Keywords*—**Information System Architecture, Evaluation, eGov Simplification measure, Multicriteria Evaluation

I. Introduction

NOWADAYS more people makes use of Information Technology (IT), with objective to enhancing the effectiveness and efficiency in solving their tasks. As such, in recent year the Portuguese government, like other countries, increased its focus on using the IT for improving people's life and began to develop a set of measures to enable the modernization of the Public Administration, and so reducing the gap between Public Administration and citizens.

Thus the Portuguese Government launched the Simplex Program[1] (Portuguese e-government program). The main objectives of this Program is to change and reengineering the process, to reduce bureaucracy of the Public Administration, to simplify and reduce repetitive procedures in order to make life easier for citizens and business in their relationship with the Public Administration

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However these SIMPLEX eGov measures, which have been implemented over the years, present a serious problem: they don't forecast the existence of an Information Systems Architecture's evaluation that shows the impact of these same measures on the Information System Architecture (ISA).

Therefore, it can´t be determined the real impact that the implementation of a SIMPLEX measure brings to the global Public Administration (PA) ISA Reference, in other words without an assessment at the ISA level it isn´t clear if the introducing a new eGovSimplification and Modernization measurewill contribute to the Public Administration achieve its objectives or whether it willcontribute for to moving away from their goals.

Nowadays is hard to evaluate an Information Systems Architecture on a clear and concise way and, consequently, it's also difficult to computerize that same evaluation. We verified that currently still don't exist a defined methodology to evaluate SIMPLEX impact in the ISA, in architectural phase.

Thus, this research is focus in addressing the problem of evaluating the actual impact of implementing an eGov measure in the Information Systems Architecture in an automated form;considering Reference Architectures, a set of Norms, Best Practices and Qualities that must be considered.

Information System Architecture evaluation is a fresh topic, when compared with other more mature areas, (as Software Architecture Evaluation [2]), demanding research in order to generalize its use by the industry.

For this research a scientific work with rigor and validity is required to define and follow a research methodology. So we opted for the choice of a broad method based on the induction principle and the choice of a quantitative approach to the implementation of Action-Research. In choose Action-Research should be noted the similarity with this research: collecting data, constructed hypothesis, (proposed Framework to ISA Evaluation) and corresponding validation (with applying SimplexIS). The applicability of the methodology was developed with base on several case studies.

This document is divided into the following sections:

Framework for evaluating a SIMPLEX measure, where is presented the evaluation Framework and the associated concepts with ISA modeling;

- SimplexIS described the application that allows the ISA evaluation to a automated way;
- Conclusions that resuming the main contributions of this research.

II. Framework for Evaluating a Simplex Measure

The choice of a methodology to evaluate the ISA of a SIMPLEX measure was a key, to realize this evaluation on a clear and concise way. Thus to evaluate the ISA it was defined on a Framework that allows an assessment as to their ISA qualities. This Framework arises from the extension of the Framework to evaluate data models presented by Moody and Shanks [3]. The evaluation of the quality of an ISA and other data models is a discipline, which just began to emerge. Quantitative measurement of quality is almost non-existent [4]. In the recent past some models for assessing architectures qualities have emerged in the literature, however most of these models suggest criteria that may be used to evaluate the quality of data models. Nevertheless quality criteria isn't enough on its own to ensure quality in practice, because different people will generally have different interpretations of what they mean. According to Zultner[5], is necessary to define the measurable criteria for assessing quality, thus reducing the subjectivity and bias in the evaluation process. To reduce the subjectivity and bias was necessary to introduce a set of quality metric to evaluate the quality factors of an ISA. This approach will be presented in more detail below.

The framework proposed is summarized by the conceptual model presented below,[6].

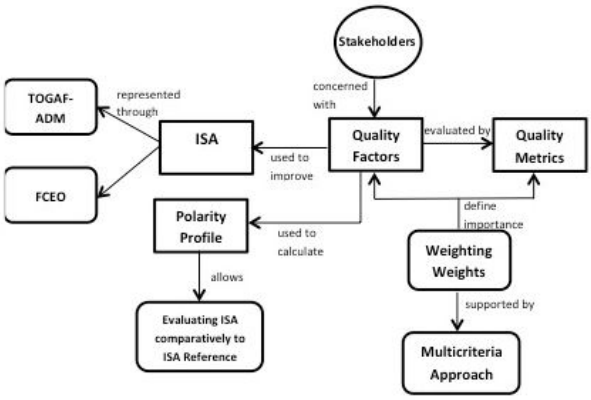

Fig. 1 Framework for evaluating ISA of a SIMPLEX measure

A. Stakeholders

Stakeholders are people who are involved in building the Information System of SIMPLEX measure, and therefore have an interest in its quality [4].

B. Quality Factors

Quality factors have been used in literature since the early hierarchical quality models [7].According to [4], the quality factors can be defined as the properties of a data model that contribute to its quality. The popularity is recognized in the fact that the International Standard ISO 9126[1]is based on them. This standard recommends that the number of key factors should be kept between three and eight.

In this research a total, six Quality Factors are defined. These are Functionality, Reliability, Efficiency, Maintenance, Portability and Alignment. These quality factors are the result of the proposed to extension the software quality model, described in standard ISO 9126 and presented by Vasconcelos, [8], in order to meet the needs of ISA evaluation, in terms of their qualities.

- Functionality - capacity of a set of information systems to providing services that meet the objectives and business strategies.
- Reliability - set of attributes that bear on the capability of information systems to maintain its level of performance under stated conditions for a stated period of time.
- Efficiency - set of attributes that bear on the relationship between the level of performance of the information systems and the amount of resources used, under stated conditions.
- Maintenance - set of attributes that bear on the effort needed to make specified modifications in information systems.
- Portability - set of attributes that bear on the ability of information systems to be changed from one environment.
- Alignment - capacity of ISA components operating in accordance with the requirements/resources that are required/available in other architectural level in order to contribute for the improvement of organizational performance over the time.

These quality factors are evaluated trough a set of quality metrics, which are described in the section below.

C. Quality Metrics

As discussed by [9], metrics are quantitative interpretation of the observable architecture's attributes. These are the ways of evaluate particular quality factors. There may be multiple quality metrics for each quality factor.

The table below presents a resume of some key metrics used in this work, to evaluate the existing qualities factors. The implementation of these metrics results from the adaptation/extension of some existing metrics [4], [8], [10], and in other cases the creation of new quality metrics in order to meet the needs of ISA evaluated through of their quality factors.

[1] ISO 9126 is the software product evaluation standard from the International Organization for Standardization.

TABLE I
QUALITY METRICS RESUME

Quality Factor	Quality Metrics	Architectural Level
Functionality	Different Implementations of Information Entity Factor	Informational
	Distinct Technology of IS Services Factor	Application, Technology
	Security Components between IT Blocks Factor	Technology
	Number of Information Entities Factor	Informational
	Number of core entity specialization in Informational Architecture Factor	Informational
	Number of Informational Architecture Entities for registry interactions events between citizens or organizations with PA	Informational
	Accessibility Web services Factor	Application
	Interoperability Platform Utilization Factor	Application
Reliability	Technology Redundancy Factor	Technology
Efficiency	Service Cyclomatic Complexity Factor	Application
Maintenance	Lack of COhesion in «IS Block»	Application, Informational
	Operation Number in IS <<Block>>	Application
	Response to a Service Factor	Application
Alignment	Number of Application by Informational Entity	Application, Informational
	Low Level Information Entity – IT Block Data Type Mismatch Factor	Application
Portability	Operating System Possible Factor	Technology

In the next table we present an example for a quality metric. Each metric is defined according to the:

- *Name* is the name of quality metric;
- *ID* is a metric identifier;
- *Computing Formula* is a representation of calculation method of the metric value;
- *Architectural Level* describes the architectural levels that may be affected for the metric;
- *Range Value* is a possible range value for the metric;
- *Description* is a short description of the reasons for the quality metric.

TABLE II
DESCRIPTION METRIC EXAMPLE

Name	Distinct Technology of IS Services Factor
ID	MFu2
Computing Formula	The Distinct Technology of IS Services Factor are available is calculated by accounting for each <<*ISServie*>>the number of <<*ITServices*>> associated. $MFu2 = \frac{\#<<ISService>>}{\sum_{i} \#<<ITService>>_i}$ • #<<ISSercice>>is the number of <<ISSerice>>presents in ISA • #<<ITService>>- is the number of <<*ITService*>>that implementing the <<*ISService*>>$_i$
Architectural Level	Application, Technology
Value Range	[0;1[
Description	Interoperability and portability of IS, represented by ISA, increases trough the number of technologies that is available in a same interface. The calculation of this metric can be viewed as the technologies average in which each applicational interface is available.

D. Weights

According to Moody [4],a weight defines the relative importance of different quality factors in a problem situation. These are used to make trade-offs between different quality factors.

In this research we defined for each quality factor and quality metric a weight with value range between 0-5 to according their importance. The weight is defined through the M-Macbeth Approach, [11]. The use of this technique allows that the attribution of each weight can be made in a less subjective way, since the attributions of weights aren't only dependent of human action.

E. Multicriteria Evaluating

The role of multicriteria evaluation approach is to minimize the difficulties that human decision makers have to manage complex data in a consistent way, [11]. The multicriteria evaluation technique allows distinguishing the weights of each option. To apply this evaluation technique in our research we use the M-Macbeth Software. The M-Macbeth Software, among other characteristics, allows the calculation weights to metrics and quality factors. The figure below shows an example of using this software during the research.

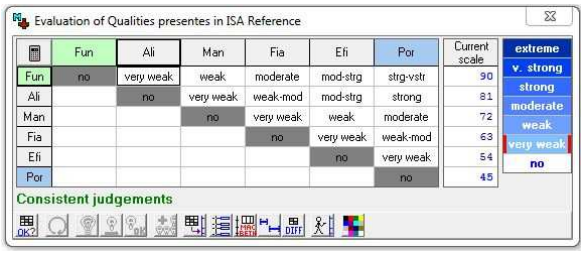

Fig. 2 Using M-Macbeth

The use of this evaluation technique presents numerous advantages where such as:

- Minimizes the difficulties of decision-makers;
- Reduction of subjectivity;
- Increases consistency of results;
- Management of complex problems involving qualitative value scores and weights in a facilitated form.

F. ISA and Representation Frameworks (FCEO and TOGAF-ADM)

According [12], ISA was defined as the representation of the Information System (IS) components, their relations, principles and guidelines in order to support the business. In this work we adopted the model presented by [13], which divides ISA into three layers: Informational Architecture, Applicational Architecture and Technology Architecture. This architecture model is a key tool to help in corporate governance because it allows to know the alignment or non-alignment between the organization strategy, your business and the technologies that supports it. So, given the constant evolution in technology and administrative simplification, in Public Administration often using the IT, the use of ISA is very necessary so that there will be a greater alignment between PA, your business and used IT to support the business.

As such, to a substantial improvement in the implementation the quality of SIMPLEX measures it is required that these measures using the ISA, thus allowing a better representation and evolution.

As earlier mentioned the main objective of this research is to evaluate the actual impact of the implementing of SIMPLEX measures in the ISA in an automated way; considering a Reference Architecture, Norms and Qualities that they must attend.

To reach such end it will be necessary to introduce a *metamodel* for describing the SIMPLEX measure in terms of Information Systems Architecture; this is a critical step for the alignment between information system and business.

In order to be able realize the automated evaluation of the Information System Architecture (that isthe main goal of this research), we need to analyzed a set of tools and Frameworks in order to identify the most appropriate to the observed problem. In first phase, we analyzed the possible utilization to the CEO Framework (CEO Framework is UML profile to modeling ISA, view [8], for further detail) that modeling profile to ISA. This Framework showed that is excellent for this purpose, however it doesn´t exist,modeling tools that support it. To overcome, this difficulty we created a new UML profilefor Enterprise Architect [14], tool, in order to support the use of CEO Framework to ISA modeling.

In the next picture you can see a small example with the new UML profile.

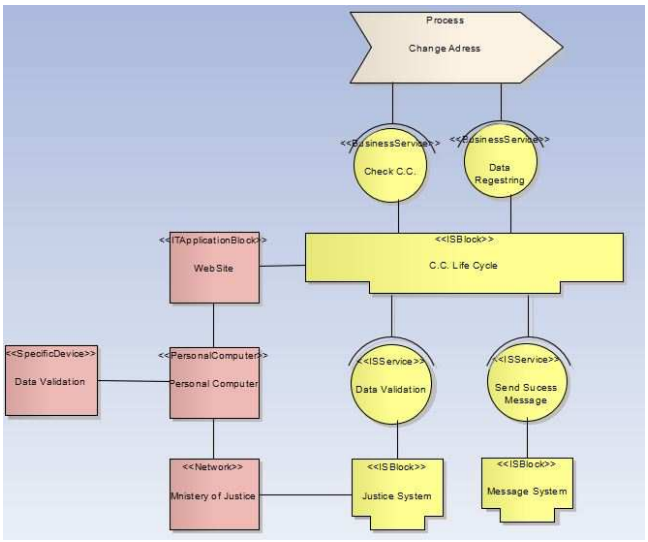

Fig. 3 Example of using new UML Profile

The choice of the Enterprise Architect tool was derived from the possibility of creating news Add-Ins and ability to extensibility, can meet the needs of this research. One of this needsis using the ADM methodology (constituent part of TOGAF Framework), [15]. The ADM methodology serves that *metamodel* to describe and represent the ISA of SIMPLEX measure, in other words is this *metamodel* to representation a SIMPLEX measure. However, we verified a need to introduce a set of changes and adaptations to the ADM methodology to meet the needs before the observed problems

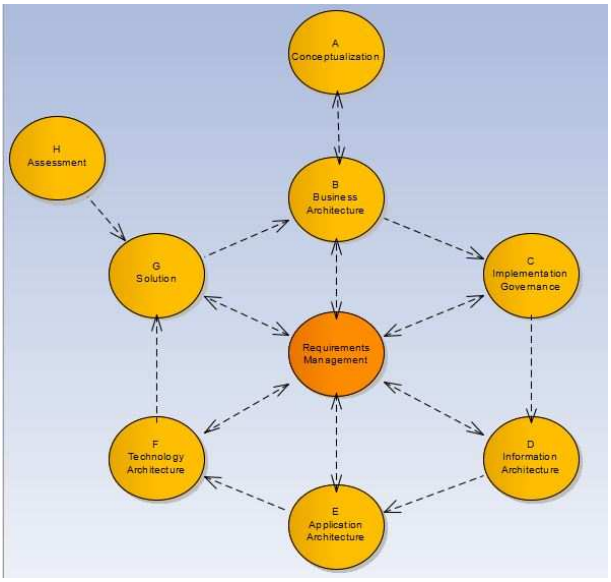

Fig. 4 Example TOGAF-ADM adaptation in EA

The set of changes and adaptations is possible because the ADM methodology is a generic methodology for architecture development, however in many times is necessary to modify or extend the methodology to meet a specific need. Thus, one of the tasks before proceeding to the use the ADM will be review application components. The main objective of using the ADM methodology is to support the Information System Architecture development. We still verify that, the CEO Framework and ADM methodology are supported by the Enterprise Architect tool, so we only need to introduce a set of extension to meet the changes and adaptions. Thus we analyzed the possibility of combining the proprieties of CEO Framework as modeling language with the ADM as a methodology for development and support Information System Architecture, so that the two methods complement each other.

In order to cover fully the evaluation issue it is still necessary to introduce an Add-In for Enterprise Architect to support the calculation of the metrics value in order to produce results that can be compared with a set of Reference Architectures, Standards and Guidelines that meet the SIMPLEX measure development must obey. This issue will be detailed later, in this article (see section III SIMPLEXIS).

G.Polarity Profile

In order to make the evaluation of an ISA based on quality factors it is necessary to define the required objectives for each quality factor, thereby establishing a comparison relationship between the qualities of an ISA Reference and ISA of a SIMPLEX measure.

The chosen solution is to use a Polarity Profile, [16]. For each criteria, there are a range of values. The required quality criteria is defined as a single value on a horizontal line. The actual quality achieved is also defined as a single value on the same line. The advantage of using a Polarity Profile is that its format can be easily understood by anyone, [17]. Further, it is easy to determine whether or not a criterion has been over-engineered, since its actual quality value will be further advanced along the line than it's required quality value. According to [17], each organization will use different metrics and metric approaches to measure different quality attributes. In order to identify the required quality for each criterion in the Polarity Profile, the properties of that criterion need to be measured using metrics. The same metrics should be used to identify the actual quality for that criterion.

In sub-section *C. (Quality Metrics)* are already defined metrics that are used during this research in the evaluation of the quality factors. Figure above shows an example of the Polarity Profile.

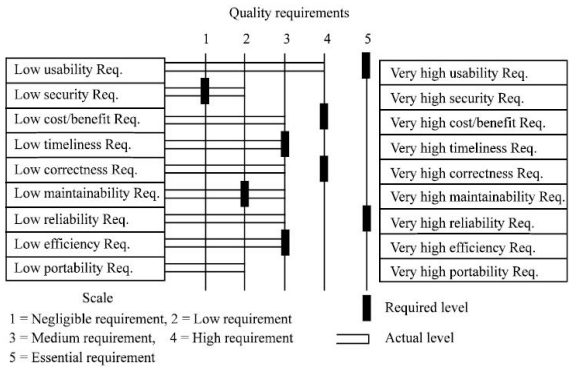

Fig. 5 An example of polarity profile,[16]

Having considered Polarity Profile it might be useful to produce a single value of quality which may be used to indicate the overall quality of a product in terms of its required versus actual values, [16]. This single value shows the overall quality of a product in terms of the percentage of quality requirements met. According same author, the advantage of producing a single quality value for a product, is that it simplifies quality comparisons between architectures.

Formulas to calculate the overall quality value:

- Required Key Quality Factor (KQF)

$$RKQF = \sum_{i=1}^{i=n} KQF_i \tag{1}$$

- Actual Key Quality Factor(KQF)

$$AKQF = \sum_{i=1}^{i=n} KQF_i \tag{2}$$

- Overall quality

$$Q = \frac{AKQF \times 100}{RKQF} \tag{3}$$

III. SIMPLEXIS

Meeting a principal focus of this research, the evaluation in a computed form of SIMPLEX measure in terms of ISA, there was a need of implement a software tool that supports the evaluation. The application design was performed based on the Evaluation Framework presented in the previous section. The figure below shows an example of using the application.

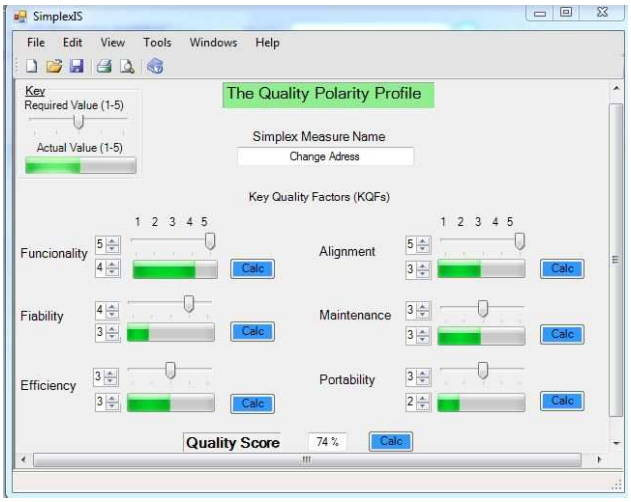

Fig. 6 SimplexIS Application

The application, SimplexIS, is an Add-In for Enterprise Architect (EA) tool. The fact that the SimplexIS is an Add-In for EA, allows us to get all the functionalities that the EA provides for modeling the ISA, particularly the use of the UML profile created for CEO Framework.

In the application screenshot (Fig 6) several concepts described before are used. The required value represents the values of the defined qualities for the ISA Reference to Public Administration; the Actual Values are values that result from the evaluation qualities of ISA that represents a SIMPLEX measure. The Actual Values are obtained through the evaluation of metrics for each quality factor. The Quality Score is the difference between the obtained result to ISA Reference Qualities and actual ISA qualities. Note that metrics and quality factors weights are obtained using the M-Macbeth software as detailed in section II.

To make easy end-users understanding of the tool, the metrics results used to measure the quality were converted into a value that lies in the range 1 to 5, for displaying in the application SimplexIS.

The SimplexIS has been applied to a set of SIMPLEX measures to test validity of the model.

IV. Conclusions

This paper has proposed a comprehensiveFramework to evaluating the impact of eGov Simplification measures in the ISA. The research presented the evaluation based in measurement of a set of qualities that an ISA should have. For weighting the weights of each quality factor and quality metrics we used a multicriteria approach to make the results more reliable. The use of the CEO Framework and TOGAF-ADM contributed a substantial improvement in the ISA representation, thus a greater alignment between IS and business. Using the Polarity Profile allows us to validate the quality factors. In order to allow the evaluation in an automated way was implemented the application SimplexIS, which is based on the key concepts presented in the Evaluation Framework.

Although results from the use of the methodology have been positives, there are a number of areas that require further investigation. The approach has been tested, but its scalability is uncertain and can only become clear after extensive use of the methodology. The quality factors set currently consists of six attributes, but again further this number may change on the evaluation needs depending. Moreover, metrics that evaluation each quality factor, despite their importance to the approach, need greater validation with its application in several case studies.

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