

Information Technology Standards - a Way to Bring Quality and Performance in the Software Products Field

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Abstract—Project scope, budget and schedule are easily to maintain when working organized and based on standards, keeping at least the same *quality* target as the initial purpose. Standards create concepts and use them to simplify, organize, manage and make the delivery process more efficient by reducing costs and increasing scope and *quality*. In two words, the standards mean *quality* and *efficiency*; they create more performant and predictable software products, offering at the same time a tool for consistency, coherency, integrity, confidence and faster communication. Therefore, in this paper, we will proceed to the analysis, presentation and comparison of the current most important Information Technology standards, in the fields of *Information Technology Governance*, *Enterprise Application Integration*, *Geographic Information Systems*, *e-government*, *information systems testing* and *information security*.

Keywords—e-government, Enterprise Application Integration, Geographical Information Systems, information security, information systems performance, Information Technology Governance, Information Technology standards, testing standards.

I. INTRODUCTION

SIMPLY stated, the *quality* is very important. It contributes to the *performance* of the information systems.

Today most companies developing software products focus on quantity and not *quality*. This thing gives rise to a series of problems of the information systems used in companies or in state institutions. Usually, if an important error is not discovered during *testing phase*, the major risk is to be reproduced when the project is already implemented in production, bringing about substantial losses for the company or the institution the system belongs to, because “the continued growth in the use of information technologies for business purposes makes business organizations increasingly

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dependent on their information systems”[1]. On the other hand, the use of the mechanisms, methods, and models pertaining to the *Information Technology (IT) Governance*, *Information Technology (IT) security*, *Enterprise Application Integration (EAI)* fields or the use of the *information systems*, in the lack of some standards applied to the initial development, may lead to a “real failure” at the end of the project. That is why the use of some standards in the Information Technology (IT), regardless of the field in which the system is developed is absolutely necessary in order to obtain, in the end, a *quality* product.

Standards create concepts and use them to simplify, organize, manage and make the delivery process more efficient by reducing costs and increasing scope and *quality*.

II. CLOSER TO... THE PERFORMANCE OF THE INFORMATION SYSTEMS

Due to the companies’ need to gain *performance*, to be “on top” or at least to set such an objective, the application of some standards – be *IT Governance* compliant and the integration of some “special” information systems specific to a particular economic sector, such as *Geographic Information Systems (GIS)*, *e-government* or *Enterprise Application Integration (EAI)* – has become a prerequisite in achieving success.

A. IT Governance Standards

The application of standards in the field of IT is closely linked to the concept of IT Governance. „IT Governance is a subset discipline of Corporate Governance focused on information technology (IT) systems and their *performance* and risk management.”[2]. In time, the concept of IT Governance has been assigned different definitions. Thus, the University of Tasmania defines IT Governance in the following way: „IT Governance is the strategic alignment of IT with the business such that maximum business value is achieved through the development and maintenance of effective IT control and accountability, *performance* management and risk management.”[3], and the International Committee for Information Technology Standards (INCITS), CGIT1 Corporate Governance of IT has defined the concept of IT Governance on its site like this: “Governance of IT incorporates the mechanisms, methods, and models which

ensure the conformance of IT to underlying and required policies, regulations, laws, and ethical guidelines.”[4].

“The primary goals of IT Governance are to assure that the investments in IT generate business value, and to mitigate the risks that are associated with IT.”[5] Therefore, the working principles (described by the IT Governance Institute (ITGI)) are easily to be inferred giving birth to the IT Governance concept:

- Ensuring IT is aligned with the business;
- Ensuring IT delivers value to the business;
- Ensuring IT manages risk;
- Ensuring IT manages *performance*;
- Ensuring IT manages resources.

Under the above mentioned circumstances, it is obvious that the principles stated couldn't be put into practice without the help of some standards. At present, there is only one standard AS8015 in this field. AS8015 was proposed in 2005 by the de Australian Standard for Corporate Governance of Information and Communication Technology and adopted as ISO/IEC 38500 in May 2008.

ISO/IEC 38500:2008, Corporate governance of information technology can be applied to organizations irrespective of their size, including governmental administrations and non-profit organizations. „The framework comprises definitions, principles and a model. It sets out six principles for good corporate governance of IT that express preferred behavior to guide decision making: responsibility, strategy, acquisition, *performance*, conformance, human behavior. The purpose of the standard is to promote effective, efficient, and acceptable use of IT in all organizations by:

- assuring stakeholders that, if the standard is followed, they can have confidence in the organization's corporate governance of IT;
- informing and guiding directors in governing the use of IT in their organization;
- providing a basis for objective evaluation of the corporate governance of IT.”[6]

It is important to mention the fact that this standard is a guideline for good practices in the field of IT Governance but it does not state exactly how they should be implemented.

Except for the ISO/IEC 38500:2008 standard, there are also a number of good practices and methodologies which complete the ISO/IEC 38500:2008 standard and which can be consulted and followed by managers. Here are some of these practices and methodologies: “CobiT, ITIL, ISO 27001/27002, ISO 20000, Prince2, PMBOK, TOGAF, IT balanced scorecards, the Zachman Enterprise Architecture, IT portfolio management, IT dashboards”[7].

B. Standards for EAI

Integration of information, applications and business processes has become the number one IT investment priority for large enterprises.

By definition, EAI refers to “*the process of integrating multiple applications that were independently developed, may use incompatible technology, and remain independently*

managed” (Integration Consortium). Within its two basic components, Business Process Integration (BPI) and Enterprise Information Integration (EII), EAI it's the most commonly and efficient approach in complex software development and “a strong and important issue when discussing about information systems efficiency”[8].

“EAI encompasses methodologies such as object-oriented programming, distributed programming, cross-platform program communication using message brokers with Common Object Request Broker Architecture, the modification of enterprise resource planning (ERP) to fit new objectives, enterprise-wide content and data distribution using common databases and data standards implemented with the Extensible Markup Language (XML), middleware, message queuing, and other approaches.”[9]

Using standards in EAI solutions is the very first debated approach when talking about software integration. As disparate and disconnected information systems are heterogeneous and must inter-operate as a whole complete, coherent and integrated solution, EAI methods, techniques and standards should guideline the performance and efficiency of the integration process.

EAI standards offer tools and methods for planning and control, aimed at modernizing, consolidating, and coordinating the computer applications in an enterprise.

Standards usage consists of rules and policies to ensure that risks are managed, duplication is avoided, processes are managed and discoverable, standards are followed and changes to the system are appropriately controlled.

EAI projects are complex and, given the complexity of the integration process and disparate integration activities, EAI solutions are delivered late and over budget, the most of the cases. Hence, the interest in predictability and working procedures and guidelines is furthermore growing.

Another reason to use standard approaches with EAI solutions is the continuous change in software integration projects requirements. Change requirements management will give predictability and re-assignment of priorities according to business needs and will allow a smaller delay and less negative impact on the overall project state.

Time management is a key factor when choosing between EAI solutions; in many cases, the best opportunity to integrate business processes for an enterprise, will be to redesign heterogeneous software applications in order to obtain a fully complete and viable software solution – but the timesheet won't meet business requirements, even if the software solution might be perfectly designed. That means time is also very important, as well as budget constraints.

EAI projects are expensive and time consuming, but they're more efficient than classical solutions of legacy applications refactoring, in both terms of budget and time.

The dynamism of EAI solutions lead to ongoing concern about methodologies, guidelines and rules that must be applied in the process of software integration. EAI standards serve as a project management tool meant to assure planning, monitoring and control in all project phases.

“Within the EAI field, the paradox is that EAI standards themselves are not universal.”[9] They differ from project to project, according to business rules and business processes, depending on project dynamics and deliverables, taking into account financial constraints and resource allocation. As there is always a constant change within EAI projects, the nature of EAI is dynamic and requires dynamic project managers to manage their implementations.

Related to this issue, it is very important to stress here the need of advanced knowledge and business know-how in EAI domain, in both procedural and technical aspects.

For emerging requirements, EAI solutions should be designed flexible and modular, and their implementations should be automate and allow future changes.

EAI standards cope with EAI best practices in defining and controlling the best integration implementation, as EAI standards encompass both business and procedural issues, and technical aspects.

Among the most acknowledged EAI best practices, there are also:

- Failure mechanisms implementations;
- Performance tracking;
- Integration testing plans;
- Building templates for business processes;
- Workflow automation;
- Flexible and modular design;
- Scalable distributed software architecture.

Standards in EAI solutions can be described as the use of proprietary and organization-specific standards for business data and documents, multiple business partners each with their own set of standards, alack of universally adopted standards, and new emerging interoperability standards such as XML and web services.

“In order to design large scale Service Oriented Architecture, EAI solutions need to implement the following architectural standards and design patterns, as Service Oriented Architecture can support a large variety of design patterns including: asynchronous messaging, conversation patterns, orchestration pattern, process/workflow patterns, endpoint patterns and security patterns. The design concept of Service Oriented Architecture for successful enterprise application integration supports interoperability and allow ‘on –the- fly’ information exchange among different systems in a loosely coupled environment that follow standard communication protocols.”[10]

Besides high level standards and process driven methodologies, EAI solutions use standards also in middleware infrastructure and communication protocols that form a linkage to physical system components. Middleware provides critical link between diverse resources and applications that follow standard protocols for interoperability and communication. In other words, middleware is enabling technology for interoperability by adhering to services in distributed environment that have standard protocols. The term middleware attributes to software

technology that solves heterogeneity and distribution problems and coins distributed services that have standard programming interfaces and protocols.

As in any other industry, standards in information technology area contribute to support products reliability, enrichment and development of capabilities, besides project management tools as policies, rules, work procedures and software development methods and methodologies.

Taking into consideration all those aspects in EAI implementations, using standards, rules, work procedures, architectural principles, implementation methodologies and flexible design approaches guideline the EAI project owner to success and the EAI solution customer to performance and efficiency. In short, enterprise integration uses integration-capable technologies and standards to maximize business value.

Organizations are built on various platforms, database management systems and heterogeneous operating systems, but they call for communication and exchange of data among each other. In this context, the main objective of any EAI solution is to provide an effective solution of integration of existing applications to increase the revenue and overall productivity within EAI implementations.

As a conclusion, informally speaking, we could affirm that EAI standards successfully contribute to “raising standards” in integration implementations.

C. Standardization in GIS

Geographical Information Systems are another type of information systems which could be integrated into an organization’s software infrastructure.

The most known standardization organization on the GIS field is the Open Geospatial Consortium (OGC). This is a not for profit organization who’s mission is to develop publicly available interface standards [14]. The second important standardization organization is ISO Technical Committee of Geographic Information/Geomatics ISO/TC 211. Other organizations working on international and GIS standards include: American National Standards Institute (ANSI), Digital Geographic Information Working Group (DGIWG), European Committee for Standardization (CEN), Federal Geographic Data Committee (FGDC), Global Spatial Data Infrastructure (GSDI), International Hydrographic Organization (IHO), Location Interoperability Forum (LIF), Web Services Interoperability Organization (WS-I), World Wide Web Consortium (W3C).

OGC’s standards are implemented in software by both GIS vendors and GIS open source community in their applications. The standards provide an open set of common abstractions for describing, managing, rendering, and manipulating geometric and geographic objects within an application programming environment, expressing geographical features, requesting geo-registered map images from one or more distributed geospatial databases.

Due to the complexity of GIS software, there are a lot of defined standards in this field, but they can be mainly

categorized as:

- geospatial data standards;
- metadata standards;
- database standards;
- Web services standards.

The GIS systems work mainly with geospatial data and, in order to store this kind of information in one single column and to be able to work with it, one spatially-enabled database must have defined a special geometry object with several mandatory attributes and methods defined in the OGC standard “GO-1 Application objects”. The main methods defined by OGC for the geometry object are:

- GetCoordinateReferenceSystem(),
- GetBoundry(),
- GetDistance(),
- GetCentroid().

A spatial database must have also defined a “coordinate system” object, whose methods are defined in the same OGC standard, [15]. The database systems who provide extensions to support the management and analysis of spatial data in a relational database system have implemented the specifications from international standard ISO/IEC 13249 SQL/MM, discussed in details in paper [16].

The most used OGC’s standards regarding the methods to store and visualize geospatial data (vector or raster data) are: Geography Markup Language (GML), Keyhole Markup Language (KML), Style Layer Descriptor (SLD), Scalable Vector Graphics (SVG), Joint Photographic Experts Group (JPEG), GeoTIFF (Geo Tagged Image File Format). A comparison of these standards is shown in table I. GML is a standard for storing the geospatial vector data and it is used most of the times together with SVG or SLD which define how to visualize the data. KML is a standard which defines both how to store and how to display geospatial data. GeoTIFF and JPEG are standards describing how to store raster data, the main difference between them is that GeoTIFF does not need an auxiliary file for georeference, the information is simply stored in the header of the file.

	SLD	GML	KML	SVG	GeoTIFF	JPEG
OGC open standard	√	√	√	√	√	√
XML type file	√	√	√	√		
Stores geospatial 2D vector data		√	√			
Stores geospatial 3D vector data		√				
Stores geospatial raster data					√	√
Describe how to display geospatial data on the map	√		√	√		
Describe how to navigate on the map			√			

Table I - Comparison between main OGC’s standards regarding geospatial data.

Other very important standards in GIS world are the Well Known Binary (WKB) and Well Known Text (WKT) representations for geometries, which are described in the international standard ISO 19125-1, “Geographic information-Simple feature access”. The Well-known Binary Representation for Geometry (WKBGeometry) provides a

portable representation of a geometric object as a contiguous stream of bytes [17]. It permits geometric object to be exchanged between an SQL/CLI client and an SQL-implementation in binary form. Well-known text (WKT) is a text markup language for representing vector geometry objects on a map, spatial reference systems of spatial objects and transformations between spatial reference systems. Geometric objects that can be represented with WKT are: points, lines, polygons, TINs and polyhedrons [18]. Examples of WKT representations of some vector geospatial features are shown in below table:

Geometry type	WKT representation
Point	Point (10 10)
LineString	LineString ((10 10, 20 20, 30 40))
Polygon	Polygon (((10 10, 10 20, 20 20, 20 15, 10 10)))
Multipoint	MultiPoint (((10 10),(20 20)))
Multiline	MultiLineString((10 10, 20 20), (15 15, 30 15))
Multipolygon	MultiPolygon(((10 10, 10 20, 20 20, 20 15, 10 10)), ((60 60, 70 70, 80 60, 60 60)))

Table II - WKT representations

The WKT representation is also a standard to describe, as a text, the information about the geospatial data’s projection system or spatial reference system (SRS). The projection system must be specified in the geospatial data source (file or database), because it is very important especially when the data from different sources is used together. One can overlay on a map only layers in the same projection (or spatial reference system) [19]. For example, the WKT representation of the world’s most used SRS: WGS84 (World Geodetic System of 1984):

```
GEOGCS["WGS84",DATUM["WGS_1984",SPHEROID["WGS84",
6378137,298.257223563,AUTHORITY["EPSG","7030"]],TOWGS84[0,0,0,0,0,0],AUTHORITY["EPSG","6326"]],PRIMEM["Greenwich",0,AUTHORITY["EPSG","8901"]],UNIT["degree",0.01745329251994328,AUTHORITY["EPSG","9122"]],AUTHORITY["EPSG","4326"]]
```

A non OGC geospatial data related standard is the ESRI Shapefile. A shapefile stores a nontopological geometry and attribute information for the spatial features in a data set. The Geometry for a feature is stored as a shape comprising a set of vector coordinates. The ESRI shapefile is a proprietary format from a commercial vendor, ESRI, but, the format specifications are publicly open so other software can also generate and read them.

The geospatial data related standards are necessary because this kind of data can be provided by the vendors in “different formats, different *quality*, different scale, and different coordinate systems, but in the end they must be used all together in the framework of one information system” [20].

Several formal approaches in order to formally specify the content and the spatial integrity constraints of a geographic database were encountered apart from the well known UML or GML standards, such as GeoUML [21], a conceptual model which includes the “General Feature Model” (ISO 19109) and

a specialization of the “Spatial Schema” (ISO 19107), performed according to the standard “Rules for Application Schema” (ISO 19109) or IN-TERLIS2, which can serve as a national example implemented in Switzerland. The GeoUML model contains the following components:

- a set of predefined UML classes for the representation of the spatial component of geographical information;
- a constraint template for the specification of spatial integrity constraints based on a reference set of topological relations called “topological constraints”;
- a constraint template for the specification of spatial integrity constraints among objects with common structure (aggregate, complex, subcomplex and primitive represented in the geometric classes GM_Aggregate, GM_Complex and GM_Primitive of the spatial schema);
- a set of predefined schema skeletons representing widely used structures in the description of geographical information like: segmented attributes, layers, partitions [22].

OGC has standardized not only the access to the geospatial data but also to the metadata repository through the definition of the catalogue services (Fig. 1).

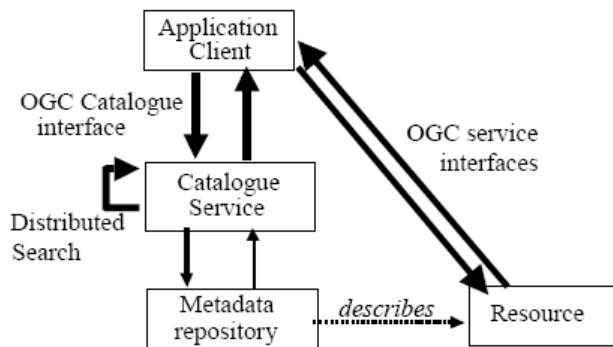


Fig. 1 - OGC's standards regarding the application's interfaces with data and metadata

“Metadata adds informative and *quality* aspects to the data. There has been a wide range of metadata standards proposed.”[23]

The OGC Catalogue Services specification requires abstract query of a small number of metadata elements (such as the bounding box of a geospatial feature or its spatial reference system) for cross-collection, cross-discipline search [24]. According to this standard, the Catalogue Service class can be associated with the:

- OGC_Service class, which provides the `getCapabilities` operation that retrieves catalogue service metadata;
- Discovery class, which provides four operations for client discovery of resources registered in a catalogue;
- Session class, which provides four operations for interactive sessions between a server and a client;
- Manager class, which provides two operations for inserting, updating, and deleting the metadata by which resources are registered in a catalogue;
- Brokered Access class, which provides the “order”

operation for ordering an identified resource that is registered in a catalogue but is not directly accessible to the client.

ISO 19115 also has become an international metadata standard for geographic information.

Regarding spatial databases, the OGC standard “OpenGIS® Implementation Standard for Geographic information - Simple feature access - Part 2: SQL option” defines the schema for the feature tables using predefined data types as shown in below figure:

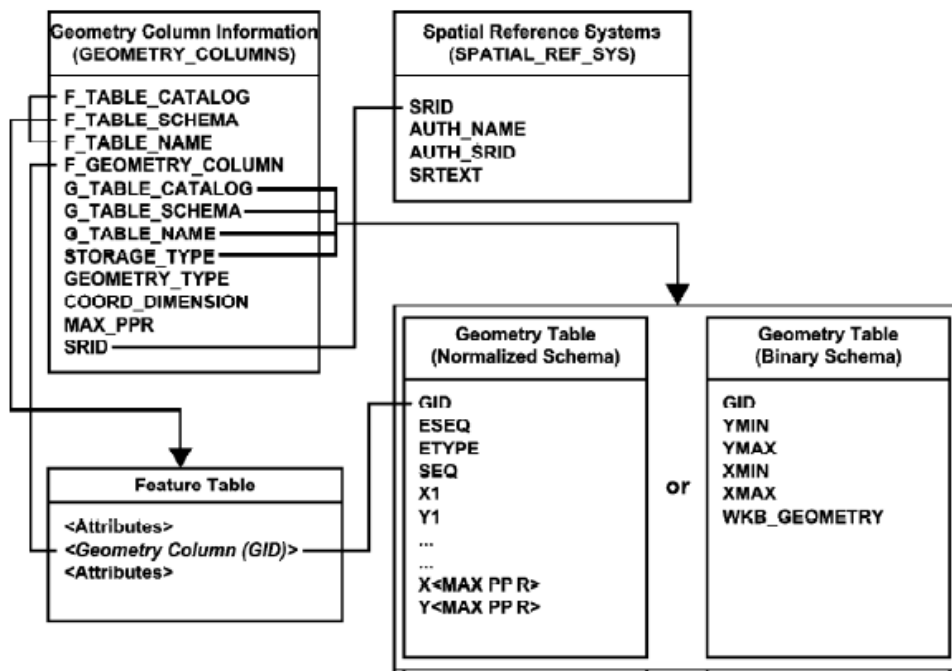


Fig 2 - Schema for feature tables using predefined data types; source: [25]

Regarding the mechanism of rendering the geospatial data from a data store into a map, OGC has defined the international standard for Web Mapping Services (WMS). In reference work [26], it is specified that the OGC's services are based on a set of standards that are popularly called RESTful web services. This means that all the queries are going to be simple HTTP GET requests, the service will be called using an URL prefix to which additional parameters are appended in order to construct a valid operation request. The reference standard defines three operations for a WMS: mandatory GetCapabilities and GetMap, and optional GetFeatureInfo. A GetCapability operation is a XML document showing what the server offers. Upon receiving a GetMap request, a WMS shall either satisfy the request, returning a map, or issue a service exception.

GeoServer, the most well known open source WMS, OGC compliant, offers support for both HTTP GET and POST methods. The Geoserver's REST architecture is shown in Fig. 3.

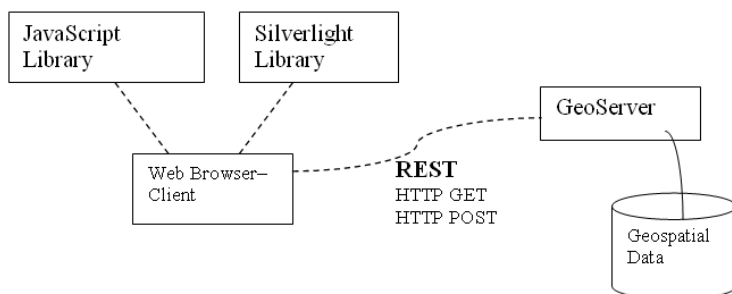


Fig. 3 - GeoServer REST access

The OGC's defined data services are: Web Feature Services (WFS) and Web Coverage Services (WCS). WFS provide feature data in vector format encoded in Geographic Markup Language (GML) and WCS provides coverage data in raster format [27].

The geographic services taxonomy is shown in the international standard "OpenGIS Abstract Specification Topic 12: OpenGIS Service Architecture" [29] as follows:

- Geographic human interaction services;
- Geographic model/information management services;
- Geographic workflow/task management services;
- Geographic processing services (spatial, thematic, temporal, metadata);
- Geographic communication services;
- Geographic system management services.

D. Standards for e-government systems

„In the <<information technology and Internet era>> the fact that e-Government systems do not live up to the expectations (except for very few European countries including Denmark, Iceland and Norway) it is a real paradox. Citizens were asked for their reasons for not using online government services. The most mentioned obstacle was the lack of personal contact followed by concerns about *data protection and security*. They have also mentioned: the complexity of online applications and their availability.”[30]

The field of e-government information systems is very new and difficult to implement so that, on the one hand, it may be in accordance with the population's needs and expectations and, on the other hand, with the IT Governance standards of security or even to be in full accordance with a public administration's flow of activities. So, ever since the e-

government concept “was born” no personalized standards of this concept have yet been crystallized. That is why, at present, the “classic” standards specific to any economic information system are applied to the e-government information systems.

However, at national level, in countries such as: Germany, Northern Ireland, UK, The United States, Macao, Hong Kong, Singapore, India, New Zealand, Tasmania and the list can go on, or even at the EU level, the need to create some standards applicable in the development and use of the e-government information systems started to be felt. These standards have been developed, mainly, by following the best practices both internally and internationally. We shall go on to present some examples of states which have adopted home standards for the e-government information systems:

- *Northern Ireland*: here The Enterprise Design Authority, is the body which is in charge with developing standards on the technical side of e-government. „e-Government technical standards are the policies and frameworks that facilitate interoperability between systems in the public sector.”[31].
- *Germany*: The document *Standards and Architectures for e-Government Applications (SAGA)* was created In Germany by the Federal Ministry of the Interior together with the German Federal Office for Information Security and it has reached the 5.0 version at present. This document “behaves” as a standard at national level because it comprises: recommendations, architectures, infrastructure, specifications and technologies as to the e-government type information systems. This document „is a guideline that serves as an orientation aid when it comes to developing concepts for technical architectures and general technical concepts for individual IT applications.”[32]
- *Macao*: At present in Macao there is an ongoing project called „Standards and Best Practices for e-Government in Macao”, whose main aim is to define „a set of management and technical standards and practices for the development, implementation and operations of e-Government services offered by Macao Government, integrated and adhering to international good practices.”[33]
- *India*: „The Government of India has launched the National e-Governance Plan (NeGP) with the intent to support the growth of e-governance within the country. To ensure Interoperability among e-Governance applications, Government of India has setup an Institutional mechanism for formulation of Standards through collaborative efforts of stakeholders like Department of Information Technology(DIT), National Informatics Centre (NIC), Standardization Testing and Quality Certification(STQC), other Government departments, Academia, Technology Experts, Domain Experts, Industry, BIS, NGOs etc. In this process there is a provision of formal Public review also.”[34] So far the following standards/guidelines have been approved to be followed in developing and implementing e-government information systems, according to the site „e-Governance Standards”, [34]:

- a) Guidelines for Usage of Digital Signatures in e-Governance;
- b) Biometric Standards;
- c) Policy on Open Standards for e-Governance;
- d) Quality Assurance Framework (QAF);
- e) Conformity Assessment Requirements (CARE);
- f) Guidelines for Indian Government Web Sites;
- g) Information Security Standards Framework and Guidelines;
- h) Interoperability Guidelines for Digital Signature Certificate issued under Information Technology Act;
- i) Metadata and Data standards for person Identification and Land region codification;
- j) Character Encoding Standard document;
- k) Font Standard.

- *New Zealand*: “The New Zealand Government Web Standards (the “Web Standards”) set the accessibility and policy-compliance standards for public sector web sites in New Zealand. The major focus is enhancing online access through accessibility. Accessible web sites are equally usable for all users, irrespective of physical or technological impediments.”[35] According to the site “New Zealand Government, Web Standards”, [36], the standards adopted are compulsory for any official website of: The Public Service departments, the New Zealand Police, the New Zealand Defence Force, the Parliamentary Counsel Office, the New Zealand Security Intelligence Service.

- *Tasmania*: “The authority which approves the standards and guidelines for use in Tasmanian Government is primarily the Inter Agency Steering Committee, with some being approved by Cabinet.”[37] The actual documents approved by this authority are: “a list of policies, frameworks, standards and guidelines developed by the Office of eGovernment in the areas of information management, information systems, and project management.”[37]

And yet what is the situation in *Romania*? If we proceed to a thorough analysis of the Romanian public administration sites, we can easily find out that, at least at the user interface level, there is no standard. Romania is facing such a situation, despite the fact that after 2000, the Government has issued a number of laws requiring the public institutions to make use of the information systems in their current activities. As to the interconnection of the E-government systems with the National Electronic System, the full documentation can be found on the website <http://www.e-guvernare.ro>.

III. WHEN THE PERFORMANCE IS SEEN AS... QUALITY AND SECURITY...

In our days, we have to learn that for an IT project, it is not enough to satisfy only the requested requirements, but more claimed functionalities with a higher *quality* level. Knowing this, using *testing standards* is a must, especially since the considerations of validity and reliability typically are viewed as essential elements for determining the *quality* of any project. On the other hand, we can not talk about *performance* of information systems without *security*. But, security in the

field of IT was and still is a controversial and current problem, because “cyber crime as well as threats [...] is costing organizations billions of dollars each year.”[38]

A. Testing Standards

Testing is maybe one of the most important and complex phase from an IT project development. Although “a standardized system is more likely to be perceived as disruptive”[39], professional and practitioner associations frequently have placed this concern (testing phase of an IT project) within broader contexts when developing standards and making overall judgments about the *quality* of any standardized test as a whole within a given context. “Generally, standards provide widely recognized frameworks and guidelines that companies can use to develop their own environmental management systems.”[40]

In this context, software and software-based systems testing is a technical discipline of systems engineering. The purpose of software and software-based systems testing is to help the development organization build *quality* into the software and system during the life cycle processes and to validate that the *quality* was achieved. The test process determines whether the products of a given life cycle activity conform to the requirements of that activity, and whether the product satisfies its intended use and user needs. This determination can include inspection, demonstration, analysis, and testing of software and software-based system products. Test activities are performed in parallel with software and system development, not just at the conclusion of the development effort.

The test activities provide objective data and conclusions about software and system *quality*. This feedback can include anomaly identification, performance measurement, and identification of potential *quality* improvements for expected operating conditions across the full spectrum of the software-based systems and their interfaces. Early feedback allows the development organization to modify the products in a timely fashion and thereby reduce overall project and schedule impacts. Without a proactive approach, anomalies and associated changes are typically delayed to later in the schedule, resulting in greater costs and schedule delays.[41]

One of the challenges facing software testers is an agreed set of document standards and templates for testing. Also known as the “IEEE 829 Standard for Software Test Documentation”, is an IEEE standard that specifies an internationally recognized set of standards for test planning documentation. It state that: “*Test processes determine whether the development products of a given activity conform to the requirements of that activity and whether the system and/or software satisfies its intended use and user needs. Testing process tasks are specified for different integrity levels.[...]The documentation elements for each type of test documentation can then be selected.[...]This standard applies to software-based systems being developed, maintained, or reused (legacy, commercial off-the-shelf, Non-Developmental Items)*”[41].

According to this IEEE standard, for test activity, one of the most important document is Master Test Plan (MTP). The purpose of the Master Test Plan (MTP) is to provide an overall test planning and test management document for multiple levels of test (either within one project or across multiple projects). In view of the software requirements and the project's (umbrella) *quality* assurance planning, master test planning as an activity comprises selecting the constituent parts of the project's test effort; setting the objectives for each part; setting the division of labor (time, resources) and the interrelationships between the parts; identifying the risks, assumptions, and standards of workmanship to be considered and accounted for by the parts; defining the test effort's controls; and confirming the applicable objectives set by *quality* assurance planning. It identifies the integrity level schema and the integrity level selected, the number of levels of test, the overall tasks to be performed, and the documentation requirements.

To respect the standards, MTP have to contain the following section:

- *MTP Section 1*: Introduction. Introduce the following subordinate sections. This section identifies the document and places it in context of the project-specific lifecycle. It is in this section that the entire test effort is described, including the test organization, the test schedule, and the integrity schema. A summary of required resources, responsibilities, and tools and techniques may also be included in this section.
 - *MTP Section 1.1*: Document identifier. Uniquely identify a version of the document by including information such as the date of issue, the issuing organization, the author(s), the approval signatures (possibly electronic), and the status/version (e.g., draft, reviewed, corrected, or final). Identifying information may also include the reviewers and pertinent managers. This information is commonly put on an early page in the document, such as the cover page or the pages immediately following it. Some organizations put this information at the end of the document. This information may also be kept in a place other than in the text of the document (e.g., in the configuration management system or in the header or footer of the document).
 - *MTP Section 1.2*: Scope. Describe the purpose, goals, and scope of the system/software test effort. Include a description of any tailoring of this standard that has been implemented. Identify the project(s) for which the Plan is being written and the specific processes and products covered by the test effort. Describe the inclusions, exclusions, and assumptions/limitations. It is important to define clearly the limits of the test effort for any test plan. This is most clearly done by specifying what is being included (inclusions) and equally important, what is being excluded (exclusions) from the test effort. For example, only the current new version of a product might be included and prior versions might be excluded from a specific test effort. In addition, there may be gray areas

for the test effort (assumptions and/or limitations) where management discretion or technical assumptions are being used to direct or influence the test effort. For example, system subcomponents purchased from other suppliers might be assumed to have been tested by their originators, and thus, their testing in this effort would be limited to only test the features used as subcomponents in the new system. [41]

It is implied that the test tasks will reflect the overall test approach and the development methodology. If the development is based on a “waterfall” methodology, then each level of the test will be executed only one time. However, if the development is based on an iterative methodology, then there will be multiple iterations of each level of test. For example, component testing may be taking place on the most recent iteration at the same time that acceptance testing is taking place on products that were developed during an earlier iteration.

The test approach identifies what will be tested and in what order for the entire gamut of testing levels (component, component integration, system, and acceptance). The test approach identifies the rationale for testing or not testing, and it identifies the rationale for the selected order of testing. The test approach describes the relationship to the development methodology. The test approach may identify the types of testing done at the different levels. For example, “thread testing” may be executed at a system level, whereas “requirements testing” may take place at the component integration as well as at a systems integration level.

The documentation (LTP, LTD, LTC, LTPr, LTR, and LITSR) required is dependent on the selection of the test approach(es). [41]

- *MTP Section 1.3: References.* List all of the applicable reference documents. The references are separated into “external” references that are imposed external to the project and “internal” references that are imposed from within to the project. This may also be at the end of the document.
- *MTP Section 1.4: System overview and key features.* Describe the mission or business purpose of the system or software product under test (or reference where the information can be found, e.g., in a system definition document, such as a Concept of Operations). Describe the key features of the system or software under test [or reference where the information can be found, e.g., in a requirements document or COTS documentation].
- *MTP Section 1.5: Test overview.* Describe the test organization, test schedule, integrity level scheme, test resources, responsibilities, tools, techniques, and methods necessary to perform the testing.
 - *MTP Section 1.5.1: Organization.* Describe the relationship of the test processes to other processes such as development, project management, *quality* assurance, and configuration management. Include the lines of communication within the testing

organization(s), the authority for resolving issues raised by the testing tasks, and the authority for approving test products and processes. This may include (but should not be limited to) a visual representation, e.g., an organization chart. [41]

- *MTP Section 1.5.2: Master test schedule.* Describe the test activities within the project life cycle and milestones. Summarize the overall schedule of the testing tasks, identifying where task results feed back to the development, organizational, and supporting processes (e.g., *quality* assurance and configuration management). Describe the task iteration policy for the re-execution of test tasks and any dependencies.
- *MTP Section 1.5.3: Integrity level scheme.* Describe the identified integrity level scheme for the software-based system or software product, and the mapping of the selected scheme to the integrity level scheme used in this standard. If the selected integrity level scheme is the example presented in this standard, it may be referenced and does not need to be repeated in the MTP. The MTP documents the assignment of integrity levels to individual components (e.g., requirements, functions, software modules, subsystems, non-functional characteristics, or other partitions), where there are differing integrity levels assigned within the system. At the beginning of each process, the assignment of integrity levels is reassessed with respect to changes that may need to be made in the integrity levels as a result of architecture selection, design choices, code construction, or other development activities.
- *MTP Section 1.5.4: Resources summary.* Summarize the test resources, including staffing, facilities, tools, and special procedural requirements (e.g., security, access rights, and documentation control).
- *MTP Section 1.5.5: Responsibilities.* Provide an overview of the organizational content topic(s) and responsibilities for testing tasks. Identify organizational components and their primary (they are the task leader) and secondary (they are not the leader, but providing support) test-related responsibilities.
- *MTP Section 1.5.6: Tools, techniques, methods, and metrics.* Describe documents, hardware and software, test tools, techniques, methods, and test environment to be used in the test process. Describe the techniques that will be used to identify and capture reusable testware. Include information regarding acquisition, training, support, and qualification for each tool, technology, and method.

Document the metrics to be used by the test effort, and describe how these metrics support the test objectives. Metrics appropriate to the Level Test Plans (e.g., component, component integration, system, and acceptance) may be included in those documents (see Annex E). [41]

- *MTP Section 2*: Details of the Master Test Plan. Introduce the following subordinate sections. This section describes the test processes, test documentation requirements, and test reporting requirements for the entire test effort.
 - *MTP Section 2.1*: Test processes including definition of test levels. Identify test activities and tasks to be performed for each of the test processes described in Clause 5 of this standard (or the alternative test processes defined by the user of this standard), and document those test activities and tasks. Provide an overview of the test activities and tasks for all development life cycle processes. Identify the number and sequence of levels of test. There may be a different number of levels than the example used in this standard (component, component integration, system, and acceptance). Integration is often accomplished through a series of test levels, for both component integration and systems integration. Examples of possible additional test levels include security, usability, performance, stress, recovery, and regression. Small systems may have fewer levels of test, e.g., combining system and acceptance. If the test processes are already defined by an organization's standards, a reference to those standards could be substituted for the contents of this subclause.
 - *MTP Section 2.1.1 through 2.1.6*: "Life cycle" processes. Describe how all requirements of the standard are satisfied (e.g., by cross referencing to this standard) if the life cycle used in the MTP differs from the life cycle model in this standard. Testing requires advance planning that spans several development activities.

Address the following eight topics for each test activity:

 - a) *Test tasks*: Identify the test tasks to be performed. Optional test tasks may be performed to augment the test effort to satisfy project needs. The standard allows for optional test tasks to be used as appropriate, or additional test tasks not identified by this standard. [41]

Some test tasks are applicable to more than one integrity level. The degree of intensity and rigor in performing and documenting the task should be commensurate with the integrity level. As the integrity level increases or decreases, so do the required scope, intensity, and degree of rigor associated with the test task.
 - b) *Methods*: Describe the methods and procedures for each test task, including tools. Define the criteria for evaluating the test task results.
 - c) *Inputs*: Identify the required inputs for the test task. Specify the source of each input. For any test activity and task, any of the inputs or outputs of the preceding activities and tasks may be used.
 - d) *Outputs*: Identify the required outputs from the test task. The outputs of the management of test and of the test tasks will become inputs to subsequent processes and activities, as appropriate.
 - e) *Schedule*: Describe the schedule for the test tasks. Establish specific milestones for initiating and completing each task, for the receipt of each input, and for the delivery of each output.
 - f) *Resources*: Identify the resources for the performance of the test tasks. Specify resources by category (e.g., staffing, tools, equipment, facilities, travel budget, and training).
 - g) *Risks and Assumptions*: Identify the risks (e.g., schedule, resources, technical approach, or for going into production) and assumptions associated with the test tasks. Provide recommendations to eliminate, reduce, or mitigate risks.
 - h) *Roles and responsibilities*: Identify for each test task the organizational elements that have the primary and secondary responsibilities for the execution of the task, and the nature of the roles they will play.
- *MTP Section 2.2*: Test documentation requirements. Define the purpose, format, and content of all other testing documents that are to be used (in addition to those that are defined in MTP Section 2.4). A description of these documents may be found in Clause 9 through Clause 16. If the test effort uses test documentation or test levels different from those in this standard (i.e., component, component integration, system, and acceptance), this section needs to map the documentation and process requirements to the test documentation contents defined in this standard.
- *MTP Section 2.3*: Test administration requirements. Describe the anomaly resolution and reporting processes, task iteration policy, deviation policy, control procedures and standards, practices, and conventions. These activities are needed to administer the tests during execution. [41]
 - *MTP Section 2.3.1*: Anomaly resolution and reporting. Describe the method of reporting and resolving anomalies, including the standards for reporting an anomaly, the Anomaly Report distribution list, and the authority and time line for resolving anomalies. This section of the plan defines the anomaly criticality levels. Classification for software anomalies may be found in IEEE Std 1044TM-1993 [B13].
 - *MTP Section 2.3.2*: Task iteration policy. Describe the criteria used to determine the extent to which a testing task is repeated when its input is changed or task procedure is changed (e.g., reexecuting tests after anomalies have been fixed). These criteria may include assessments of change, integrity level, and effects on budget, schedule, and *quality*.
 - *MTP Section 2.3.3*: Deviation policy. Describe the procedures and criteria used to deviate from the MTP and level test documentation after they are developed. The information required for deviations includes task identification, rationale, and effect on

system/software *quality*. Identify the authorities responsible for approving deviations.

- *MTP Section 2.3.4*: Control procedures. Identify control procedures applied to the test activities. These procedures describe how the software-based system and software products and test results will be configured, protected, and stored. These procedures may describe *quality* assurance, configuration management, data management, or other activities if they are not addressed by other efforts. Describe how the test activities comply with existing security provisions and how the test results are to be protected from unauthorized alterations.
- *MTP Section 2.3.5*: Standards, practices, and conventions. Identify the standards, practices, and conventions that govern the performance of testing tasks including, but not limited to, internal organizational standards, practices, and policies.
- *MTP Section 2.4*: Test reporting requirements. Specify the purpose, content, format, recipients, and timing of all test reports. Test reporting consists of Test Logs (Clause 13), Anomaly Reports (Clause 14), Level Interim Test Status Report(s) (Clause 15), Level Test Report(s) (Clause 16), and the Master Test Report (Clause 17). Test reporting may also include optional reports defined by the user of this standard. The format and grouping of the optional reports are user defined and will vary according to subject matter. [41]
- *MTP Section 3*: General. Introduce the following subordinate sections. This section includes the glossary of terms and acronyms. It also describes the frequency and the process by which the MTP is changed and baselined. It may also contain a change-page containing the history of the changes (date, reason for change, and who initiated the change).
 - *MTP Section 3.1*: Glossary. Provide an alphabetical list of terms that may require definition for the users of the MTP with their corresponding definitions. This includes acronyms. There may also be a reference to a project glossary, possibly posted online.
 - *MTP section 3.2*: Document change procedures and history. Specify the means for identifying, approving, implementing, and recording changes to the MTP. This may be recorded in an overall configuration management system that is documented in a Configuration Management Plan that is referenced here. The change procedures need to include a log of all of the changes that have occurred since the inception of the MTP. This may include a Document ID (every testing document should have a unique ID connected to the system project), version number (sequential starting with first approved version), description of document changes, reason for changes (e.g., audit comments, team review, system changes), name of person making changes, and role of person to document (e.g., document author, project manager, system owner). This information is commonly

put on an early page in the document (after the title page and before Section 1). Some organizations put this information at the end of the document. [41]

As parts of MTP, The IEEE divides test activity in eight defined stages of software testing, each stage potentially producing its own separate type of document.

- *Test Plan*: A detail of how the test will proceed, who will do the testing, what will be tested, in how much time the test will take place, and to what *quality* level the test will be performed.
 - *Test Design Specification*: A detail of the test conditions and the expected outcome. This document also includes details of how a successful test will be recognized.
 - *Test Case Specification*: A detail of the specific data that is necessary to run tests based on the conditions identified in the previous stage.
 - *Test Procedure Specification*: A detail of how the tester will physically run the test, the physical set-up required, and the procedure steps that need to be followed.
 - *Test Item Transmittal Report*: A detail of when specific tested items have been passed from one stage of testing to another.
 - *Test Log*: A detail of what tests cases were run, who ran the tests, in what order they were run, and whether or not individual tests were passed or failed.
 - *Test Incident Report*: A detail of the actual versus expected results of a test, when a test has failed, and anything indicating why the test failed.
 - *Test Summary Report*: A detail of all the important information to come out of the testing procedure, including an assessment of how well the testing was performed, an assessment of the *quality* of the system, any incidents that occurred, and a record of what testing was done and how long it took to be used in future test planning. This final document is used to determine if the software being tested is viable enough to proceed to the next stage of development.
- Given this, one can say that a *standardized test* is a test that is administered and scored in a consistent, or organized, manner. Standardized tests are designed in such a way that the questions, conditions for administering, scoring procedures, and interpretations are consistent and are administered and scored in a predetermined, standard manner [41].
- In addition, we could remind other useful testing standards as: *BS-7925-1 Software Testing – Vocabulary* (This standard gives terms and definitions to aid communication in software testing and related disciplines), *BS-7925-2 Standard for Software Component Testing* (it defines the process for software component testing using specified test case design and measurement techniques. This will enable users of the standard to directly improve the quality of their software testing, and improve the quality of their software products), or *IEEE 1008 Software Unit Testing* (for bidirectional parallel communications between personal computers and printing peripherals).

One of the main advantages of standardized testing is that the results can be empirically documented. Therefore, the test scores can be shown to have a relative degree of validity and reliability, as well as results can be generalized and replicated; another advantage is aggregation. A well designed standardized test provides an assessment of a typology of IT projects and which, when applied, will reflect the project value according to the general standardized quality requirements; but do not forget that a standard applied “cannot measure initiative, creativity, imagination, conceptual thinking, curiosity, effort, [...], nuance...”(as Bill Ayers said).[41]

B. Some Considerations about Information Security Standards

Security in the field of IT was and still is a controversial and current problem. For any company, the dangers and threats concerning the information they possess come both from outside and from inside (the company’s employees).

Following a survey conducted by Earnast & Young company on information security within a Romanian company involved in the field of IT, the findings were difficult to predict: only 53% of the organizations have business continuity plans in case of a possible security attack, while only 41% of the organizations are concerned about internal attacks on their systems, although it is known that currently the highest number of attacks comes from inside the company.

As nowadays the information systems are in fact “the heart of a business”, because “organizations are more dependent than ever on the reliable operation of their information systems”[44]. Therefore it is obvious that the need of information security is a very high one. The International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC), which represents a specialized international system for standardization at world level, “adopted” the standards with the best practices and methodologies in the field of information security.

“Information security is the process of protecting information. It protects its availability, privacy and integrity.”[45] Thus, for the companies that need to implement an information security management or to improve the usual security practices, the standard ISO/IEC 17799:2005 was adopted, which is known at present as *ISO/IEC 27002:2005* or *the Code of Practice for Information Security Management*. It “sets out the guidelines and general principles for organizations in order to initiate, implement, maintain and improve the information security management” [47]. The standard *ISO/IEC 27002:2005* establishes the best practices and methodologies in the field of Information Security Management for the following sectors: “security policy; organization of information security; management; physical and environmental security; communicational and operational management; access control; information systems purchase, their development and maintenance; continuous business management” [47]. We have also to add the fact that this standard is concerned only with *information*: electronic files,

paper documents, recordings (video, audio), communications and messages.

Another standard “adopted” by ISO and IEC is the ISO/IEC 27001:2005 standard or *Information technology - Security techniques - Information Security Management Systems (ISMSs) – Requirements*. This standard is also known as BS 7799-2:2002. It “establishes the requirements for an ISMS”[47].

The ISO/IEC 27001:2005 standard belongs to the series of ISO/IEC 27000 standards. “The series provides best practice recommendations on information security management, risks and controls within the context of an overall ISMSs, similar in design to management systems for quality assurance (the ISO 9000 series) and environmental protection (the ISO 14000 series).”[48] Also, this series of standards “is deliberately broad in scope, covering more than just privacy, confidentiality and IT or technical security issues. It is applicable to organizations of all shapes and sizes. All organizations are encouraged to assess their information security risks, then implement appropriate information security controls according to their needs, using the guidance and suggestions where relevant”[48].

IV. CONCLUSION

As nowadays the *information* which is “behind” the information systems in fact stands for *power*, it is normal “to safeguard” it very carefully. Without *information*, it is practically impossible for a company to cope with competition, it is impossible to achieve its set objectives, so “it is absolutely vital that information systems (IS) are properly assured from the very beginning, due to the potential losses faced by organizations that put their trust in all these IS”[49]. Among the features that standards usage offers concerning the software information systems field, the following can be included: increased productivity, allowing developers to reduce the demands and time of writing new code for the integration of two or more software products; ability to access real time information and support, regardless of platform used, including mainframe environments, different operating systems, hardware variety, target users, heterogeneous businesses having each of them distinct specific activities; optimization based on costs, allowing inter-connected enterprises to reduce time spent to unify search operations, reporting, integration between different information systems. Time spent on writing standards and unifying guidelines and rules leads to work *quality*, *performance* and *efficiency*, it allows customers to accelerate business integration processes, and developers to increase productivity. Therefore, the need for applying some standards of good practice and methodology in the field of the information technology is very high.

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- "Ways to Increase the Efficiency of Information Systems", *Proc. of the 10th WSEAS International Conference on Artificial Intelligence, Knowledge Engineering and Databases (AIKED '11, University of Cambridge)*, February 20-22, 2011, Cambridge, UK;
 - "Modern Information Technologies Used in Market Research", *Proc. of the 9th WSEAS International Conference on Computational Intelligence, Man-Machine Systems and Cybernetics (CIMMACS '10)*, December 14-16, 2010, Merida, Venezuela;
 - "Business Intelligence and Data warehouse – Technological Support for Decisional Management in Geographical Information Systems", *Proc. of the 3rd International Conference on Communications and Information Technology (CIT'09)*, December 29-31, 2009, Athens, Greece;
- and 9 articles published in scientific reviews , among witch:
- "Market Research – a significant step in propelling a business or a solution for the e-government systems to the top", *International Journal of Applied Mathematics and Informatics*, issue 2, vol. 5, 2011.
 - "Modern Database Machines", *Journal: Informatics Economics*, no. 2, 2010;
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 - "Modern Information Technologies Used in Market Research", *Proc. of the 9th WSEAS International Conference on Computational Intelligence, Man-Machine Systems and Cybernetics (CIMMACS '10)*, December 14-16, 2010, Merida, Venezuela;
 - "Business Intelligence and Data warehouse – Technological Support for Decisional Management in Geographical Information Systems", *Proc. of the 3rd International Conference on Communications and Information Technology (CIT'09)*, December 29-31, 2009, Athens, Greece;
- and 5 articles published in scientific reviews , among witch:

- "Market Research – a significant step in propelling a business or a solution for the e-government systems to the top", *International Journal of Applied Mathematics and Informatics*, issue 2, vol. 5, 2011.
- "Modern Database Machines", *Journal: Informatics Economics*, no. 2, 2010;
- "Information systems in the knowledge based economy", *Journal: WSEAS TRANSACTIONS on BUSINESS and ECONOMICS*, issue:1, vol. 7, 2010.

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- "Information Systems Integration, a New Trend in Business", *Proc. of the 10th WSEAS International Conference on Applications of Computer Engineering (ACE '11)*, March 24-26, 2011, Meloneras, Gran Canaria, Canary Islands, Spain;
 - "Ways to Increase the Efficiency of Information Systems", *Proc. of the 10th WSEAS International Conference on Artificial Intelligence, Knowledge Engineering and Databases (AIKED '11, University of Cambridge)*, February 20-22, 2011, Cambridge, UK;
 - "Advanced e-Government Information Service Bus (eGov-Bus)", *Proc. of the 9th International Conference on Informatics in Economy*, May 5-7, 2009, Bucharest, Romania,
- and 3 articles published in scientific reviews:
- "Academic Research Information System", *Journal: JAQM (Journal Of Applied Quantitative Methods)*, issue: 1, vol. 3, 2008;
 - "Medical Virtual Public Services", *Journal: Informatics Economics*, no. 1(45), 2008.

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His research activity can be observed in international proceedings (papers ISI proceedings), among which:

- “Ways to Increase the Efficiency of Information Systems”, *Proc. of the 10th WSEAS International Conference on Artificial Intelligence, Knowledge Engineering and Databases (AIKED '11, University of Cambridge)*, February 20-22, 2011, Cambridge, UK;
- “Information Systems Integration, a New Trend in Business”, *Proc. of the 10th WSEAS International Conference on Applications of Computer Engineering (ACE '11)*, March 24-26, 2011, Meloneras, Gran Canaria, Canary Islands, Spain;
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