Business Intelligence to improve the quality of Local Government Services

Case-Study in a Local Government Town Hall

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Abstract: The use of business intelligence (BI) systems by organizations is increasingly considered as an asset, which goal is to provide access to information in a timely manner in order to support the decision-making process. However, in specific cases such as local government organizations, there are very specific challenges. Some of them like privacy rights and applicable law compliance must be carefully observed, making the necessary adaptations of these BI solutions. The developed solution brings some important contributions and represents some advances in the eGovernment context applied to local governments where the information is normally used/stored are not normalized and pre-defined. Being this a big barrier to development of this type of solutions, the developed architecture is prepared to improve the data quality and avoid this type of mistakes. This paper presents an architecture of a BI platform on a local government organization, geared towards the improvement of citizen offered services quality and efficiency maximization, thus contributing for cost reduction to the taxpayer.

1 INTRODUCTION

Young Modern Governments and developed countries, need an agile and flexible Public Administration (PA) capable of facilitating the lives of citizens by establishing a swift decision-making process to address citizens questions in a timely manner. This process should increase public confidence in interaction with the PA.

As such, it is increasingly important to develop an innovative government capable of adapting to the information society challenges, and provides quality services according to new paradigms of organization and networking, supported by recent advances in information and communication technologies.

Pursuing this guideline, a new project in the area of Business Intelligence (BI) is being developed in a local government organization – the Guimarães Town Hall. Guimarães is a municipality in northern Portugal and this Town Hall implemented a series of administrative reforms, upgrading, optimizing and gaining efficiency in the services provided to the citizens. In this context, after a first study performed in the Town Hall it was observed that the use of BI can result in a profitable choice for the local government organization. In this particular case BI is used as a tool to lead the Town Hall to efficiency and innovation. By introducing BI, this local government organization, expects an improvement in decision-making process (Vercellis, 2009) and therefore provide a better service to the citizens.

However an important question arises: will it be possible to apply BI in a local government organization, being this an area of activity with such peculiar characteristics and used towards citizens benefit?

This work will try to answer this question by using a real case study and exploring the possibility of developing a BI architecture for a Local Government, which allows to support and improve the Town Hall quality processes. It is expected that this architecture can optimize their citizen's related services interactions and improve the data quality. The designed solution is prepared to:

- automate keys performance indicators (KPI) gathering related tasks that are currently performed manually;
- ensure the existence of near real-time information considered relevant to the decision-making process;
- provide new decision-making process support information currently inexistent.

The main goal of this paper is to present the data warehouse dimensional model, the BI architecture and the SWOT analysis of the solution which it is suitable for most local government organizations, aiming for an improvement of citizens oriented services, using a near real-time data approach.

A brief background and related work is presented on section 2 and in section 3, contextualization of the problem and main concepts are presented. Section 4 briefly describes the BI architecture and data warehouse model. Section 5 presents the expected results from the implementation of the proposed BI architecture and a SWOT analysis of the solution. Section 6 addresses an introspective discussion of this work and finally, section 7 and 8 concludes the paper and presents future work and areas of research derived from these findings.

2 BACKGROUNG

2.1 Business Intelligence

Business Intelligence (BI), is being increasingly used by organizations (Chaudhuri, Umeshwar and Vivek, 2011), in the private sector, allowing executive managers to improve the decision-making processes

In a simplistic view of BI, it combines the operational data of the organization, which is stored in repositories created for that purpose and through the use of analysis, data processing and exploitation tools, to deliver useful information to managers for the decision-making process, (Negash, 2004), (Sharda, 2008) e (Turban, Sharda and Delen, 2010). The importance of BI lies in the combination of the information delivery process, with the ability that people have to identify the real needs of the organization, since without it, the tools by themselves have no value (Loshin, 2012).

2.2 Business Intelligence for Local Government

The use of BI by organizations reveals itself as an added value in the decision-making process, allowing organizations to obtain a differentiation in provided services (Ranjan, 2009). This methodology has been applied in local government, with positive results, in areas with different characteristics of the ones implemented in this project (Smith, 2008) and (Souza and Pereira, 2009).

There are relatively few case studies in literature regarding practical applications of a BI technology in government at its several levels, despite the benefits of BI results within the private sector.

Coman (Coman, 2009) presents a framework for a BI implementation for E-Government initiatives. From his paper it is possible to deduce some issues from BI implementations in government related scenarios. There is also some technical work by Microstrategy (Microstrategy, 2007) discussing the advantages of BI solutions, when adopted by the government. Also, within the context of this work - BI in the local-government - Adelakun, (Adelakun, 2012), presented a holistic view of a BI solution implementation within town-halls in Sweden. Adelakun study, contributes to a better understanding of the benefits for local government when adopting a BI solution. He stated that benefits can be achieved in short terms, but the value only appears in the mid-term to long-term.

After analyzed the related work it is important to mention that it is possible identify the advantages and related problems originated by a BI implementation in government. Also worthy of mention, is the lack of practical achievement of the proposed BI architectures in some cases, or the lack of details in others. At the same, time the number of solutions specific to local government are also too reduced. Although there are most solution to this area, the approach presented in this paper appears to be the first which propose a BI architecture that can be applied to a local government organization, improving its Quality Assurance System, meeting its singular business objectives and their restrictions.

2.3 Data Warehousing

Databases used to store a large number of different data sources, current and historical, directed to the subject, a dimensional or standardized, allowing selective analysis of data in order to assist managers in organizational decision making (Inmon, 2005), (Kimball, 2005), (Santos and Ramos, 2006), (Rainardi, 2007), (Turban, Sharda and Delen, 2010).

The development of the data warehouse was started with the "Top-Down" implementation approach. (Sen, 2005) and (Inmon, 2005).

3 CONTEXTUALIZATION

The county of Guimarães is located in the district of Braga in Portugal. It is a highly industrialized country. The city of Guimarães is known for its history and its Historical Centre, classified as Human Heritage by UNESCO.

The society is constantly changing, so one of the concerns of the Town Hall is to provide the best services to its citizens. In this way, the Town Hall has implemented a quality assurance system whose main goals are to provide the best service at the lowest cost to the taxpayer citizen.

With the purpose of providing the best services at the lowest cost to the taxpayer citizen, the Town Hall joined a central government program, known as "Simplex Autárquico". Simplex Autárquico is a program that includes measures of administrative and legislative simplification, in order to simplify the interaction of citizens and companies with the local government. This derived initiative from the wider central government program namely "Simplex". The introduction of this program was an important trigger to the development of this BI solution.

3.1 "Simplex" and "Simplex Autárquico"

The "Simplex" arises from the need of the central government to respond to pressures for change to make public services more effective and efficient. This program has as main objective improving the lives of citizens and companies who interact with the public sector (OECD, 2008).

This program is based on five main objectives (Marques, 2010):
1. To make them simpler services;
2. To bring the services closer to citizens;
3. Services tailored to the citizen,;
4. Services assessment in order to identify the most needed services;
5. Do more with less resource, the need for interoperability of services within the PA.

However, the report of the Organization for Economic Cooperation and Development (OECD) (OECD, 2008), states that in order to maximize the visibility of the Simplex in Central Government, this shall be applied in local and regional government. In this sense came the "Simplex Autárquico", targeting the same objectives as the Simplex, spanning administrative reform at the local level (GESMA, 2008).

For the "Simplex Autárquico", standards are grouped into three measurement groups: Inter-sectorial measures (IS); Intercity measures (IM); City measures (GMR).

The Guimarães Town Hall, which is an integral part of public administration, in order to optimize services for the benefit of its citizens, joined the program "Simplex Autárquico", having implemented some measures, such as: Creation of a common database of knowledge, enabling rapid access to information; Providing online services; Implementing single points of contact. From this point onwards, for sake of simplicity the local government "Simplex" implementation - "Simplex Autárquico" - will be referred to as SIMPLEX.

3.2 "SIMPLEX" and e-government

According to OECD (OECD, 2008), "Simplex" and e-government (Bélanger & Carter 2012) initiatives share common goals. Both want to make life easier for citizens and companies in their interaction with the local government through the use of information technologies in order to increase the efficiency and effectiveness of government services.

3.3 Organization Complexity

This structure consists of seven departments and twenty-four divisions, each one with specific tasks.

Being a large organization, there is the need to restring the focus on the specific division covered on the project development. The quality assurance process is implemented in almost all the Town Hall departments and divisions. The main focus of the project is on the "Divisão de Modernização Administrativa e Qualidade" (DAMQ) – stands for division of administrative modernization and quality assurance – under dependency of the "Departamento de Administração Geral" (DAG) – stands for general administration department. The main goals of the DAMQ are (Portugal, 2013):
- Promote, improve and ensuring the maintenance of a Quality Assurance System (QAS) in accordance with European standards;
- ensure the efficiency and effectiveness of services provided by the Town Hall;
- prepare decision-making on relevant aspects;
- keep the administration informed about the relevance and efficiency of the QAS;
- promote the assessment of user satisfaction;
- gather and normalize the information that should be available to the citizens;

- manage the single point of contact (physical or virtual) for the citizens;

In short, the DAMQ main focus and their activities revolve around the citizen.

4 BUSINESS INTELLIGENCE ARCHITECTURE FOR LOCAL GOVERNMENT

This architecture focuses on all activities related to the Town Hall - citizen interaction and all the services involved in this interaction, supporting the single point of contact and all the back office activities. Thus, this platform improves the monitoring of citizens requests and information, necessary to support the decision-making process. Enabling a more efficient control over the quality assurance system (QAS) implemented in the Town Hall. With the implementation of this BI architecture, an increase of the performance of the Town Hall services is to be expected in the near future. Since the information will be subject to knowledge discovery that was not available before.

4.1 Data Acquisition

As a result of the SIMPLEX program, the Town Hall implemented the so-called "Balcão Único" which is no more than a Single Point of Contact (SPC), a place that integrates various services of the Town Hall in a single place. SPC and the information obtainable in their workflow are the main data source of the BI platform. In this SPC, the citizen can get all the required information about any service, or perform any type of request.

In the implementation of the SPC, it was necessary for the Town Hall to adopt a software solution that enables an integrated management of services offered to citizens.

This application allows the flow of information across all the departments and their respective divisions, making the management of all citizens' requests swifter. When a citizen goes to the SPC to make a request (claims, participations, requests for certificates, among others) the request is created on the application by the public servant.

Accordingly to the type of classification assigned to the request, it will follow a predetermined information workflow.

These workflows are previously created/ configured in the application itself. Within each workflow there are multiple nodes that identify the points where the requests must pass. Within each department/division there are specific workflows. Each new request from the citizen is inserted in a given workflow, and dispatched to the proper responsible department (as configured on the workflow) for resolution.

The workflows created in the process management computer application, tend to recreate the real, tangible, flow of information.

As a downside, the computer application does not address all the needs of the organization, reflecting some shortcomings common in all the Town Halls, such as:
- general overview of all requests;
- identify execution times of requests workflows;
- make average execution time of requests;
- make statistical analyses;
- identifies slower requests and bottlenecks.

A review in-place, of associated tasks executed within the scope of the requests workflow, has showed that certain tasks are still performed manually, recurring to computer spreadsheets. Production of statistical indicators relevant for the decision-making process are not based on information obtained in real-time, but produced manually on large time frames that hinders the ability to use those indicators in a timely fashion to correct deviations to the workflow.

This type-working provide a high number of wrong values and the insertion of many not pre-defined values. This situation is common in this context and it was one of the main barriers to the development of the proposed architecture. With this BI architecture the information acquisition for the Extraction, Transformation and Loading (ETL) process, will be done in real-time through views of the operational database. This task will overcome the need of manual registration of indicators.

4.2 Requirements Engineering

To identify the requirements for this BI architecture, the Requirements Engineering (RE) activity was used, since it is crucial to the success of project development of information systems (Sommerville, 2006). Requirements engineering is defined, not only as an initial activity of a project which is conducted the survey of requirements from users for the product to be developed, but also includes management of the negotiating process, with the objective that the requirements obtained, satisfy organizational objectives, ensuring business

alignment (Berry and Lawrence, 1998) and (Sommerville and Kotonya, 1998).

The RE was accomplished according to Somerville process (Somerville, 2005). By using this process, knowledge from the stakeholders was acquired, in order to develop a more broad architecture capable of serving a wide range of Town Halls. This RE process resulted in a set of requirements that the platform should provide. They obey certain characteristics to ensure their quality, according to BABOK (IIBA, 2009).
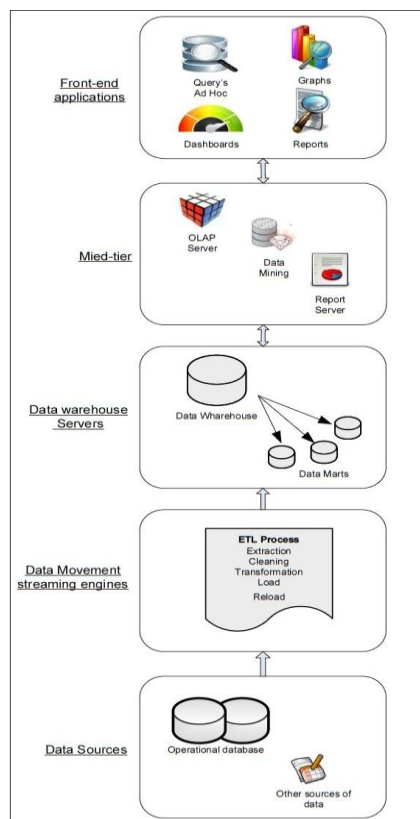
4.3 Architecture

Figure 1: Proposed Architecture for Business Intelligence platform for the local government

In order to develop a broad architecture that satisfy not only the needs of this local government, but allow its adjustment to other local governments, the developed architecture incorporates the different concepts presented by Chaudhuri, Dayal and Narasayya (2011), where it is possible to simply identify the layers that makes the BI architecture under implementation in the Town Hall. This architecture is presented above, in Figure 3.

4.3.1 Architecture Features

Being this a broad architecture it is expected to contain set of non-functional requirements. This is important because it defines the effectiveness of the BI solution on accomplishing the task it is supposed to do. Non-functional requirements represent additional features that define the overall qualities to be implemented in the development of the BI solution. During the architecture development the following overall requirements were taken into account: information availability; information security; information reliability; interoperability; portability; adaptability; real-time.

4.3.2 Architecture break-down

The layered architecture approach makes it easier to identify and interpret the phases for implementation, required for the development of Business Intelligence (BI) platform technologies. This architecture consists of five layers which present different characteristics from each other, such as:

- **"Data Sources"** –For the development of this architecture, views from the operational databases and worksheets produced in control points is used.
- **"Data Movement streaming engines"** –In this process, commonly known as Extract, Transform and Load (ETL), the Microsoft technology tool is used.
- **"Data Warehouse Servers"** –This repository is supported by Microsoft technology.
- **"Mied-tier"** –For this layer of the architecture, the Microsoft technology tools is used.
- **"Front-end applications"** –The front-end applications are being developed taking in account some feature: usability, user-friendly, Human-Computer Interaction (HCI) and best coding practices.

4.3.3 Data warehouse model

To fulfil the final set of requirements, a multidimensional model of the data warehouse was created (Figure 4). This model is composed of the fact table FACT_REQUEST, and eight dimension tables. The model allows the induction of several indicators (e.g. number of requests, average time, classifier type) grouped by type of request and type of movement, workflow, region, time, citizen, department and user.
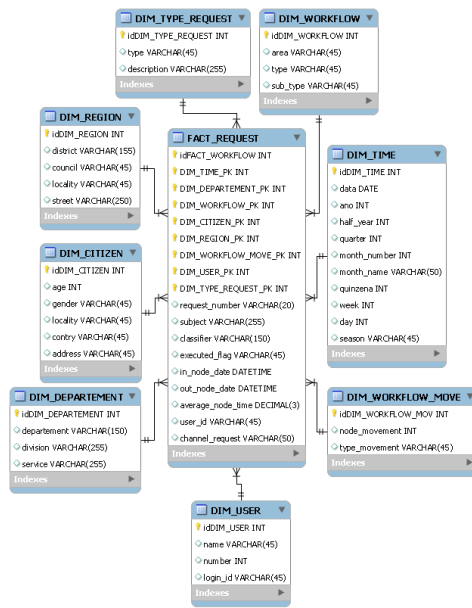
Figure 2: Data warehouse model for Business Intelligence platform for the local government.

One of the main concerns, during DW development, was to follow a design where the local government organization informational needs would be fulfilled by increasing for example the data quality. To accomplish this there are several approaches such as: goal-oriented, data-oriented and user-oriented. These can be used separately or combined (Inmon, 2005), (Niedrite, Solodovnikova, et al, 2007).

The selected approach was goal-oriented, which in conjunction with Requirements Engineering (RE) techniques, allowed to elucidate the organizational goals that became the local government organization KPI's which allowed us to ascertain the DW performance (Niedrite, Solodovnikova, et al, 2007).

5 RESULTS

5.1 Business Indicators

At the moment is being concluded the last phase: implementation and monitoring. With this Business Intelligence (BI) implementation, through the use of a more broad architecture, it is possible to meet the following business requirements, considered transversal to all local government institutions: statistical indicators; average response times; prediction of the average response time; measurement of the citizens level of satisfaction; management of key business indicators.

It presents a set of Key Performance Indicators (KPI) which allow the organization to obtain the following information:

- total requests received;
- quantities by type of requests;
- average time resolution of requests;
- detection of temporal deviations on requests;
- prediction of time for requests resolution;
- identify patterns on type of requests entry;
- identify potential bottlenecks on workflows;
- identify communication channel most used;
- busiest periods of time at the physical SPC.

All these analysed KPIs have temporal analysis options along several dimensions, such as year, month, day, semester, among others. At the moment these KPIs is under development and was pre-validated by the town hall.

5.2 Strengths, Weaknesses, Opportunities and Threats

The analysis of strengths, weaknesses, opportunities and threats (SWOT) is used to ascertain the company's strategic position (Hill & Westbrook, 1997). It is one of the most known management tools for the strategic analysis of the internal and external factors favorable or unfavorable for the organization (Piercy & Giles 1989), that provides information relevant for the decision-making process (Kajanus et al. 2004), also allowing for a good starting point to check for strategic business alignment of the organization.

With this analysis as can be observed in table 3, above it was possible to identify the internal strengths and weaknesses, as well as the external threats and opportunities, resulting from the implementation of this BI solution at the Town Hall.

Table 1: SWOT analysis

Internal Factors	
Strengths	▪ Increases efficiency of services ▪ Increases quality of services ▪ Improve performance off attendance ▪ Reduces costs of information analysis ▪ Increases quality in decision-making ▪ Faster access to data ▪ Data availability readiness ▪ Reporting (ad-hoc reporting) ▪ Integration of different systems ▪ Monitoring and compliance to standards and rules ▪ User defined parameters for analysis ▪ Intuitive platform with easy access
Weaknesses	▪ Access to information (legal constraints) ▪ Sensitivity data nature (legal constraints)

	• BI project complexity • Fragmented data source existing • Change of organizational culture • Data security • User resistance to the change • IT departments knowledge
External Factors	
Opportunities	• Increasing urbanization of the people; • Population increasingly technological. • Needs of organization cost reduction • Improve the quality of decision making • Improve efficiency in service delivery • Improve citizens satisfaction
Threats	• Suspicion of citizens relating to information processing. • Policy issues (legal constraints) • Security issues • Technological complexity • Technological skill and expertise • Autonomy of the organization (monetary) • Information and data quality

6 DISCUSSION

The initial results of this project point towards the existence of benefits resulting from the implementation of a BI solution within the local government, more specifically and as addressed in this, the Town Hall. Despite the use of BI tools within the government being somewhat recent, and some barriers to the implementation were identified on the SWOT analysis (such as Policy issues, quality of the data our technologically issues), results from these early BI deployments clearly demonstrate that the benefits clearly outweigh the drawbacks.

IT is not uncommon on local government (like the own studied) that several organizational units are organized in a very strict and bureaucratic fashion. This often results in organizational and informational silos, making the information sharing between horizontal units, hard or even impossible to accomplish. Usually information must go up into the hierarchy and back down to it final destination.

Even for this to happen, there must be clearly identified business process that establish this informational path. One of the benefits of the proposed BI solution is that some, if not most, of the KPI indicators, would be available horizontally across the entire local government organization, never of course, without observing proper access and/or clearance levels, in the case of sensitive KPIs.

As stated before, a great deal of effort has been put to this architecture, in order to avoid confining it to one local government organization (the one where it is being implemented), so that it can be re-used in similar scenarios where most, if not all, of the KPIs are of interest to keep under supervision. Taking the KPIs in account as the main driver for the BI architecture design, the proposed solution aims at the local, rather than the central, Government since, most of the KPI's are explored taking into account the organizational structure already exposed above, where the informational flow, itself, must be controlled and monitored, as the requests travel horizontally through the several organizational units that intervene on the citizen request. Usually in central government, requests from citizens usually travel vertically from superior authorization, and back down to the originating office.

Some preliminary results from the implementation, point towards a simplified and more expedite access to the required information. Also, some KPI indicators that, were hard to get and involved a significant investment in manual labour, can now be accessed in a timely fashion. Some of them were actually impossible to get, and are now possible to observe in near real time.

7 CONCLUSIONS

The use of Business Intelligence (BI) in a local government organization, as is the case of a Town Hall, has clear benefits to the organization. In this paper an architecture for a BI solution was presented, designed to be as broad as possible so it can be reused throughout local government organizations. The own BI solution is being terminated and was developed using a real case. This BI solution is capable of providing useful support to the decision-making processes, since information is taken as one of the most valuable assets to any organization. When used properly, it can help decision makers in their task by providing them with insight for making the right choices leading to a positive impact on a target group of citizens.

In short, this BI solution can provide concrete information regarding the trends and needs of the citizen, allowing for local government organization services optimization and proper knowledge gap discovery if that is the case.The main contribution of this paper is a BI architecture that can be reused throughout local government organizations, in order to improve service quality and benefits to the citizens.

8   FUTURE WORK

The project is under development and expected future work concluding the implementation of the BI solution, based on the presented architecture, includes but is not limited to: Validation of its applicability in the local government institution under study - the Town Hall; analyze what benefits this system introduces in the local government organization and in the life of citizens; identification of a set of indicators considered relevant for future implementations in other local government organizations.

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REFERENCES

Adelakun, Olawale. (2012). "The Role of Business Intelligence in Government: A Case Study of a Swedish Municipality Contact Center."

Bélanger, F. & Carter, L., (2012). Digitizing Government Interactions with Constituents: An Historical Review of E-Government Research in Information Systems. Journal of the Association for Information Systems, 13, pp.363–394.

Berry, Daniel M., and Lawrence Brian, (1998), "Guest Editors' Introduction: Requirements Engineering," IEEE Software, vol. 15, no. 2, pp. 26-29.

Chaudhuri, Surajit, Umeshwar Dayal, and Vivek Narasayya, (2011). "An overview of business intelligence technology." Communications of the ACM 54.8 (2011): 88-98.

Coman, Marius. (2009) "Business Intelligence and E-governance." Lex ET Scientia International Journal (LESIJ) XVI-1: 484-491.

GESMA. (2008) Simplex Autárquico - Quanto Mais Perto Melhor. [Online] Available from: http://www.gsema.gov.pt/index2.php?option=com_docman&task=doc_view&gid=34&Itemid=32; [Accessed: 18th April 2014]

Hill, T. & Westbrook, R., 1997. SWOT analysis: It's time for a product recall. Long Range Planning, 30, 46–52.

IIBA, A, (2009). "guide to the business analysis body of knowledge (BABOK Guide)."International Institute of Business Analysis (IIBA).

Inmon, W. H. (2005). Building the Data Warehouse (Fourth edition). New York: Wiley

Kajanus, M., Kangas, J. & Kurttila, M., 2004. The use of value focused thinking and the A'WOT hybrid method in tourism management. Tourism Management, 25, pp.499–506.

Kimball, Ralph, and Ross, Margy, (2006). The Data Warehouse Toolkit: the complete guide to Dimensional Modeling. John Wiley & Sons, Inc. NY.

Marques, Maria Manuel Leitão. (2010) Simplex'10, - Quanto mais simples melhor. Lisboa, Maio 2010. [online] Available from: http://www.simplex.pt/downloads/programasimplex2010.pdf ; [Accessed: 18th April 2014]

MicroStrategy, Inc (2007), MicroStrategy " Business Intelligence And Government – , viewed 18 July 2014, < http://www.inst-informatica.pt/servicos/informacao-e-documentacao/dossiers-tematicos/>

Negash, Solomon. (2004) "Business Intelligence. "Kennesaw State University, Communications of the Association for Information Systems 13.

Niedrite, Laila, Solodovnikova, Darja ,et al. (2007) "Goal-Driven Design of a data warehouse based business process analysis system." Proceedings of the 6th Conference on 6th WSEAS ICAIKEDB.

OECD (Organisation for Economic Co-operation and Development). (2008). Making Life Easy For Citizens And Businesses In Portugal - Administrative Simplification And E-Government. Paris.

Piercy, N. & Giles, W., 1989. Making SWOT Analysis Work. Marketing Intelligence & Planning, 7, pp.5–7.

Portugal (2013). Despacho nº 16970-A/2013. Diário da Republica nº 253, 3º Supl. da Série II de 2013-12-31.

Rainardi, Vincent. (2007). Building a Data Warehouse: With Examples in SQL Server. Apress; USA

Ranjan, Jayanthi. (2009) "Business intelligence: concepts, components, techniques and benefits." Journal of Theoretical and Applied Information Technology 9.1 (2009): 60-70.

Santos, Maribel Yasmina, and Isabel Ramos. (2006). Business Intelligence: Tecnologias da Informação na Gestão de Conhecimento. FCA.

Sharda, Ramesh, Jay E. Aronson, and David N. King. (2008). Business intelligence: A managerial approach. Upper Saddle River: Pearson Prentice Hall.

Smith, A. D. (2008). Business and e-government intelligence for strategically leveraging information retrieval. Electronic Government, an International Journal. doi:10.1504/EG.2008.016126

Sommerville, Ian and Kotonya, Gerald, (1998), Requirements Engineering: Processes and Techniques. John Wiley & Sons, Inc., New York, NY, USA.

Sommerville, Ian, (2006). Software Engineering, 8th Edition, Addison-Wesley, ISBN10: 0321313798.

Souza, R., & Pereira, A. (2009). A Business Intelligence Methodology for E-government Reverse Auctions. 2009 IEEE CCEC. doi:10.1109/CEC.2009.37

Turban, E., Sharda, R., & Delen, D, (2010). Decision support and business intelligence systems (9 ed.). Upper Saddle River, NJ, USA: Prentice Hall Press.

Vercellis, Carlo, (2009). Front Matter. Business Intelligence: Data Mining and Optimization for Decision Making. Politecnico di Milano, Italy: A John Wiley and Sons, Ltd., Publication.