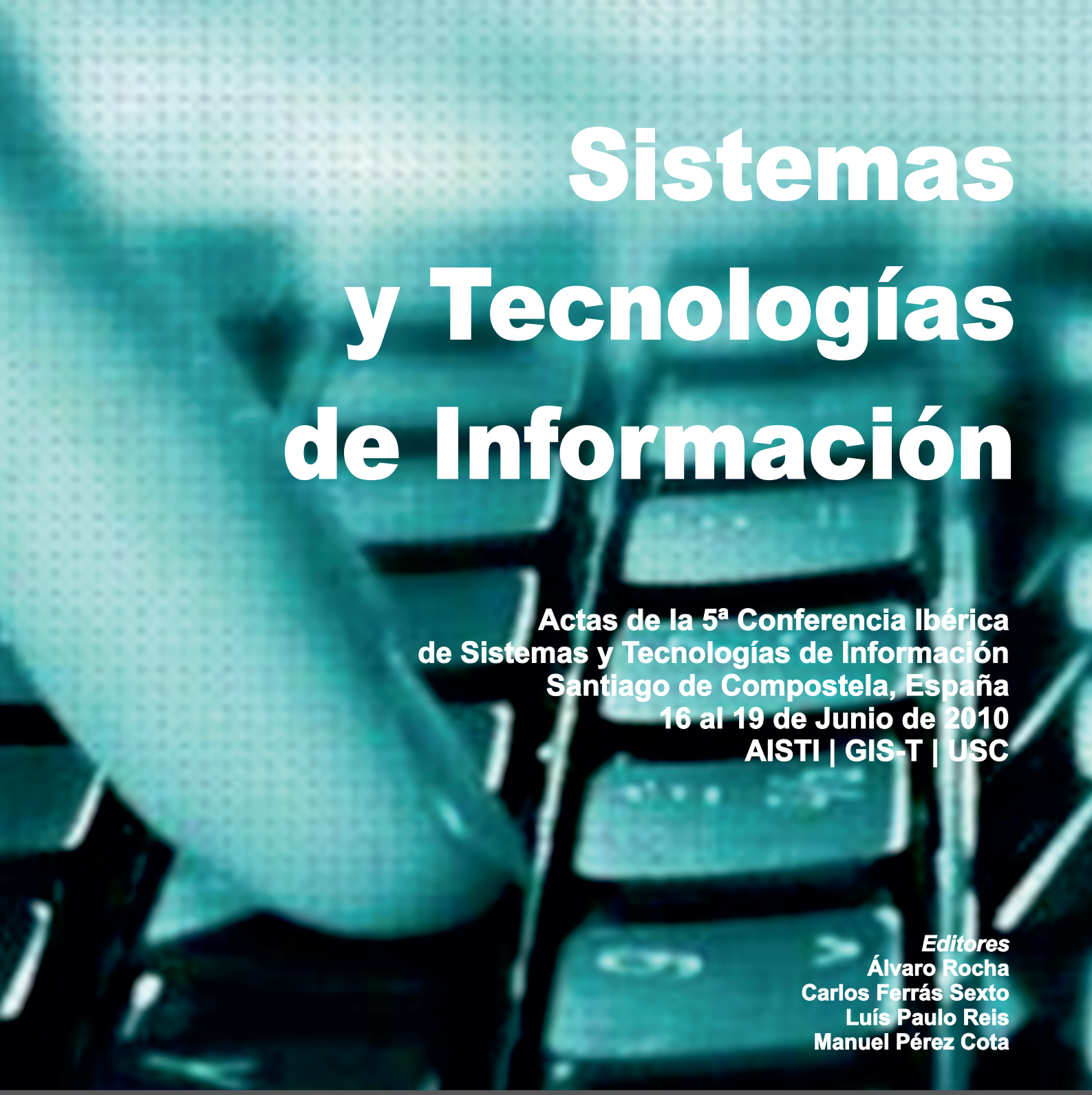

Sistemas y Tecnologías de Información

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Santiago de Compostela, España
16 al 19 de Junio de 2010
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Prefacio

Este libro contiene los artículos aceptados para presentar y discutir en la 5ª Conferencia Ibérica de Sistemas y Tecnologías de la Información (CISTI'2010), organizada por el GIS-T (Grupo de Investigación Sociedade Tecnoloxias e Territorio), USC (Universidade de Santiago de Compostela) y AISTI (Asociación Ibérica de Sistemas y Tecnologías de la Información), entre el 16 y el 19 de junio de 2010, en Santiago de Compostela.

La Conferencia Ibérica de Sistemas y Tecnologías de la Información (CISTI) es un foro que pretende reunir académicos y profisionales, sobre todo del espacio ibérico, proporcionando el mútuo conocimiento de experiencias e inovaciones, asi como la discusión de los mismos, en el área de los sistemas y tecnologías de la información. Uno de los ojetivos principales es la dinamización de la simbiosis que falta entre la academia, la sociedad y la industria.

De la Comisión Científica de la CISTI forma parte un grupo pluridisciplinar de peritos oriundos o fuertemente relacionados con el área de los STI del espacio ibérico, a los cuales les ha correspondido la responsabilidad de evaluar, en un proceso de revisión « blindado », los trabajos recibidos en cada una de las ediciones de la conferencia.

En la CISTI'2010 fueron recibidos más de trescientos trabajos, en forma de articulos completos, articulos cortos, pósters, artículos para los Workshops especializados y artículos para el Simpósio Doctoral.

Los artículos aceptados para la presentación y discusión durante la conferencia son publicados en libro y en CD con ISBN. Los autores de algunos de los mejores artículos serán invitados para proceder a su publicación en la RISTI (Revista Ibérica de Sistemas y Tecnologías de la Información) y en el libro TICAI (TICs Aplicadas al Aprendizaje de la Ingeniería) en los capítulos en portugués y español del IEEE.

Finalizamos, deijando un agradecimiento a todos que directa o indirectamente colaboraran con la CISTI'2010 (autores, comisiones, patrocinadores, etc.), participando en la consolidación de un foro de sistemas y tecnologías de información que con los años va ganando importancia para el território ibérico y hasta ibero-americano.

Buena lectura!

Santiago de Compostela, junio de 2010
Álvaro Rocha y Carlos Ferrás Sexto

ÍNDICE

Artículos de la Conferencia

Artículos de los Workshops

First European Workshop on Computing and ICT Professionalism (EWCIP)

First Ibero-American Workshop on Data Quality (IAwDQ)

Second Workshop on Intelligent Systems and Applications (WISA)

Managing Data Quality Requirements for Web Portals Development: an Example of Application

César Guerra-García, Ismael Caballero, Mario Piattini
Department of Information Technologies and Systems, UCLM
Cesararturo.guerra@alu.uclm.es, {Ismael.caballero, Mario.piattini}@uclm.es

Abstract — **Nowadays, most organizations and companies support its main process (organizational and business) through Web portals; however, people that use these applications need trust on the data they manage. The analyst should add some kind of mechanisms to ensure an appropriate level of quality in the data. This paper shows an example of application of the DQ-VORD methodology, for managing and integrating data quality (DQ) requirements into software requirement specification, this methodology intends guiding the analysts and developers in the process of eliciting and defining of DQ requirements for Web portals development.**

I. INTRODUCTION

Nowadays, it is broadly recognized that dealing with data quality problems is a task very expensive and time consuming, this problem has generated the research in new information technologies branches that focus exclusively on the assessment of data quality in an organization and cleaning poor quality data [1].

The data quality (DQ) concept is often defined as "fitness for use": the ability of a data collection to meet user requirements for a task at hand [2]. This generality in the definition involves two main implications: on a hand the multidimensional concept of data quality, and on other one, it is precise to take into account the subjective nature of the concept of quality itself (everyone of the users performing a task or functionality can have a different sight if a set of data has quality).

Due to these implications, the analyst has to correctly specify the DQ requirements generated from the different information needs of each of the distinct users. So, in order to make the Information System fully capable of managing the different environment of using the data, it is necessary to consider the different views of each user (users' viewpoints) to elicit and integrate somehow the DQ requirements of each of them.

The requirement analysis stage is considered by all software engineering approaches as a key step in the development of successful software systems [3-5]. Empirical data demonstrates that efforts invested in a detailed requirements analysis reduce considerably the major drawbacks in later phases of the software development [6].

Increasingly Internet users utilize Web portals to obtain information for making their work and to help with their decision making. These users need to ensure that data obtained is appropriate for their needs. Likewise, organizations that provide Web portals must offer data that meet user requirements, so that they can help users to achieve their goals [7].

In the DQ literature, to the best of our knowledge, the management of DQ requirements from the various perspectives corresponding to different point of views of users has been scarcely considered within the Web portals development field [8]. Anyway, one of the most interesting proposal is DQ_VORD published in [9]. In this paper, an example of application of this methodology is presented in order to illustrate and clarify how each one of the stages of the methodology for managing and integrating DQ requirements in the Web portal development process could be used.

The paper is organized as follows: Section 2 briefly summarizes the DQ-VORD methodology. Section 3 presents a working example in which the methodology is applied obtaining the different output products. Finally in section 4, we outline a few conclusions and future work.

II. DQ-VORD: A METHODOLOGY FOR THE ELICITATION OF DQ REQUIREMENTS FOR WEB PORTALS DEVELOPMENT

In this section, we briefly introduce the DQ-VORD methodology proposed in [9]. The descriptions of the main stages of DQ-VORD methodology, as well as its subactivities, input and output products, and techniques/tools related will be shown next.

1. **IWPV. Identification of the Web Portal Viewpoints.** This stage is aimed at discovering the different viewpoints that will use the functionalities of the Web portal, besides the identification of the Web portal functionalities together with the DQ dimensions associated (see table I).

TABLE I. ARTEFACTS AND SUBACTIVITIES FOR THE IWPV.

IWPV.1. Identification of the Web Portal Functionalities (IWPF) to be implemented, it implies to identify the specific functionalities that are provided to each viewpoint.	
Input Product	-List of identified viewpoints being able to propose software requirements for the system. -List of all Web Portal functionalities [10].
Output Product	-List of chosen functionalities for satisfying requirements of each viewpoint.
Tools and techniques	-Interviews -Study of documentation -Questionnaire -Brainstorming

IWPV.2. Identification of the Data Quality Dimensions (*IDQD*), it implies to identify the different DQ dimensions related to each one of the functionalities described for each viewpoint, taking as base the matrix of relationship between DQ dimensions and Web portal functionalities described in [9].	
Input Product	-List of viewpoints identified being able to propose DQ requirement for the system. -List of chosen functionalities for satisfying requirements of each viewpoint. -Matrix of relationship (DQ dimensions and Web portal functionalities).
Output Product	-List of DQ dimensions associated to the different functionalities. -Document of System Requirements Specification.
Tools and techniques	-Interviews -Work sessions -Brainstorming

2. ***VS. Viewpoints Structuring*.** This stage is aimed at grouping the viewpoints related in a suitable hierarchy. Firstly, the main functionalities are located at the top levels of the hierarchy, once done that, these functionalities are inherited to the viewpoints of low level; besides, the DQ dimensions are also hierarchized in the same way (see table II).

TABLE II. ARTEFACTS AND SUBACTIVITY FOR THE VS.

VS.1. Classification of Data Quality Dimensions (*CDQD*), it consists of classifying the DQ dimensions according to the hierarchy, in base at the priority level that the Web Portal functionalities have.	
Input Product	-List of viewpoints identified in the system. -List of DQ dimensions associated to the different functionalities.
Output Product	-List of classification of DQ dimensions.
Tools and techniques	-Work sessions -Judgment of experts

***3. DV. Documentation of the Viewpoints*.** Its main aim is to refine the description of the viewpoints and the functionalities identified, adding the DQ dimensions (see table III).

TABLE III. ARTEFACTS AND SUBACTIVITY FOR THE DV.

DV.1. Documentation of the Data Quality Dimensions (*DDQD*), it consists of documenting or modeling if possible, the DQ dimensions identified (e.g. through use cases diagram).	
Input Product	-List of classification of data quality dimensions. -Document of System Requirements Specification.
Output Product	-Document of System Requirements Specification augmented with DQ Requirements Specification.
Tools and techniques	-Tools like Word processors -Judgment of experts and work sessions -Modeling tools for UML

4. ***LVS. Layout of the Viewpoints of the System.*** It encompasses identifying the main objects in an object oriented design using the information of the functionality encapsulated in the viewpoints (see table IV).

TABLE IV. ARTEFACTS AND SUBACTIVITIES FOR THE LVS.

LVS.1. Modeling of the data quality dimensions (*MDQD*), it consists of modeling the different DQ dimensions in a data model and later on, in a process model.	
Input Product	-Document of System Requirements Specification augmented with DQ Software Requirements Specification.
Output Product	-Document of high level design with awareness of data quality (data model and process).
Tools and techniques	-Object oriented modeling tools (Rational Rose, Visual Paradigm, Poseidon, ArgoUML).
LVS.2. Validation of Model (*VM*), it consists of validating the complete model with the stakeholders.	
Input Product	-Document of System Requirements Specification augmented with DQ Software Requirements Specification. -Document of high level design with awareness of data quality.
Output Product	-Final Document approved of "System Requirements Specification augmented with DQ Software Requirements Specification". -Final Document approved of "High level design with awareness of data quality".
Tools and techniques	-Work sessions -Interpersonal negotiation techniques

III. EXAMPLE OF APPLICATION

A. Problem statement

In table V typical problem statement for developing a Web portal is showed. We are going to explain how to apply the DQ-VORD methodology to capture the software requirements for this example.

TABLE V. EXAMPLE OF PROBLEM STATEMENT.

As part of the Information Technology Department at Acme, Inc., we are asked to develop new corporate Web portal that implements some characteristics and functionalities like: empowering the corporative image, list the availability of products, enable specific searching on catalogues, as well as the incorporation of a communication mechanism that allows to someone (**potential client**) to request a product. Besides, as one of the main characteristics, the web portal must provide **Administrator** with a specific set of functionalities for calculating payroll of organization's employees. A broader description of the subsystem for calculating payroll through web portal is mentioned below: One of the core functionalities of the portal is to implement a set of functionalities to perform the calculation of payroll for all employees. The company needs a new system that enables **employees** to record their time card information electronically and automatically generate paychecks based on the number of hours worked and total amount of sales (for **commissioned employees**). The new Web portal will allow employees to enter timecard information, enter purchase orders, change employee preferences (such as payment method), and create different reports. For the sake of security and auditing, employees can only access, and edit their own time cards and purchase orders. Employees prior to using the system must be authenticated. The system will retain information on all employees of the company (around 8,000 employees). The system must pay each employee the correct amount, on time, by the specified method (the possible payment methods are described later). Some employees work by hours, and they are paid an hourly rate. They submit timecards that record the date and number of hours worked for a particular charge number. If someone works for more than 8 hours, the company pays the employee 1.5 times his or her normal rate for each extra hour. Hourly workers are paid every Friday. Some employees are paid a flat salary. However, they should submit timecards that record the date and hours worked. This is the way in which the system can keep track of the hours worked against particular charge numbers. They are paid on the last working day of the month. One of the most demanded/required features of the new system is employee reporting. **Employees** will be able to query the system for number of hours worked, totals of all hours billed to a project (i.e., charge number), total pay received year-to-date, remaining vacation time, etc. Employees can choose their method of payment. They can have their paychecks mailed to the postal address of their choice, or they can request direct transfer into a bank account of their choosing. The employees may also choose to pick their paychecks up at the office. The **Department chiefs** will be able to do some functions related exclusively with the employees of his/her own department like: maintain the employee information and execute a query of employees. Besides, the chief will maintain all the information related to each one of the products assigned to his/her department. The Web portal **Administrator** is required to maintain all employee information with the system. The Administrator is responsible for adding new employees, deleting employees and changing all employee information such as name, address, and payment classification (hourly, salaried, commissioned), as well as running administrative reports. The Administrator will run automatically payroll every Friday and on the last working day of the month.

B. Application of the DQ-VORD methodology

Once described the problem statement, we can begin with the application of the methodology as follows:

1. IWPV. Identification of the Web Portal Viewpoints. The viewpoints identified are: (a) Administrator, (b) Client, (c) Employee, (d) User, (e) Department Chief, (f) Commissioned Employee.

IWPV.1. Identification of the Web Portal Functionalities (IWPF) to be implemented. The output product of this stage taking as base the table I consists in a list of requirements and functionalities identified (see table VI).

TABLE VI. IDENTIFICATION OF THE WEB PORTAL FUNCTIONALITIES (IWPF).

Viewpoint	**Functional Requirement**	**Web functionality described by [10]**
Administra-tor	FR1. Run the Administrative report	Administration
	FR2. Maintain the employee information	Administration
	FR3.Run the payroll	Administration
	FR4. Login into the system	Security
Client	FR5. Search of products	Search capabilities
	FR6. Request a product	Process and actions
	FR4. Login into the system	Security
Employee	FR4. Login into the system	Security
	FR7. Choose payment method	Administration
	FR8. Run an employee report	Security
	FR9. Maintain timecard	Process and actions
User	FR5. Search of products	Search capabilities
Department Chief	FR2. Maintain the employee information	Administration
	FR8. Run an employee report	Security
	FR4. Login into the system	Security
	FR10. Maintain the product information	Content Management
Commissioned Employee	FR11. Maintain the purchase orders	Process and actions

IWPV.2. Identification of the Data Quality Dimensions (*IDQD*). The main output product of this stage is a list of DQ dimensions identified for each one of the web functionalities (see table VII).

TABLE VII. TABLE 1. IDENTIFICATION OF DQ DIMENSIONS.

Web functionality	**DQ dimensions related**
Administration	Consistency, Accessibility, Compliance, Efficiency, Precision, Understandability, Portability, Recoverability.
Security	Accuracy, Completeness, Consistency, Currentness, Accessibility, Confidentiality, Traceability, Understandability.
Process and actions	Accuracy, Completeness, Consistency, Credibility, Currentness, Accessibility, Compliance, Efficiency, Understandability.
Search capabilities	Accuracy, Completeness, Consistency, Credibility, Currentness, Efficiency, Traceability, Understandability, Availability.
Content Management	Accuracy, Completeness, Consistency, Credibility, Currentness, Accessibility, Compliance, Confidentiality, Efficiency, Traceability, Understandability, Portability

2. VS. Viewpoints Structuring. The level of importance of each requirement proposed, taking account in this example the number of times each requirement is related to each viewpoint, it is as follow: (1) *Login into the system, (2) Maintain the employee information, (3) Run a employee report, (4) Search of products, (5) Run the payroll, (6) Choose payment method, (7) Maintain timecard, (8) Maintain the purchase orders, (9) Request a product, (10) Maintain the product information, (11) Run the Administrative report*.

Taking as basis the importance level of each requirement (above mention), we can hierarchize the viewpoints in the next order:

1. Department chief.
2. Administrator.
3. Employee.
4. Client.
5. Commissioned Employee (*it inherits the functionalities of the viewpoint "Employee"*).
6. User.

VS.1. Classification of Data Quality Dimensions (*CDQD*). The output product of this stage taking as base **Erro! Fonte de referência não encontrada.**, is a prioritized list of the DQ dimensions identified: 1. Accuracy, 2. Completeness, 3. Consistency, 4. Currentness, 5. Accessibility, 6. Confidentiality, 7. Traceability, 8. Understandability, 9. Compliance, 10. Efficiency, 11. Precision, 12. Portability, 13. Recoverability, 14. Credibility, 15. Availability.

3. DV. Documentation of the Viewpoints. We use the following templates to conveniently document the different viewpoints and requirements. The results are gathered in Tables VII to XIII (due to pages restriction of the paper, we only describe some of them). This documentation is a key part of a *System Requirement Specification document augmented with DQ Requirements Specification*.

TABLE VIII. SPECIFICATION OF VIEWPOINT "ADMINISTRATOR".

Reference	Administrator
Focus	Viewpoint of the Web portal Administrator, person in charge mainly of the management and control functionalities of the company.
Attributes	None specific.
Use cases	The use cases related can be seen in the Figure 1.
Requirements	Run the Administrative report, Maintain the employee information, Run the payroll, Login to the system.
Web functionalities	Mainly associated with the Web functionalities: Administration and Security.
Exceptions	None.
History	No alterations.

TABLE IX. SPECIFICATION OF VIEWPOINT "EMPLOYEE".

Reference	Employee
Focus	Viewpoint of the Employee, he performs the basic functionalities into the Web portal.
Attributes	Name, Address, Telephone, kind of employee, payment method.
Use cases	The use cases related can be seen in the Figure 1.
Requirements	Login to the system, Choose payment method, Run an employee report, Maintain timecard.
Web functionalities	Mainly associated with the Web functionalities: Security, Administration, Process and actions.
Exceptions	None.
History	No alterations.

TABLE X. SPECIFICATION OF VIEWPOINT "COMMISSIONED EMPLOYEE".

Reference	Commissioned Employee
Focus	Viewpoint of the Commissioned Employee, it inherits the Web functionalities associated to the viewpoint *Employee*, besides to do one of main functionalities of the company "*Maintain the purchase orders*".
Attributes	Same attributes that *Employee* viewpoint.
Use cases	The use cases related can be seen in the Figure 1.
Requirements	Maintain the purchase orders, Login to the system, Choose payment method, Run an employee report, Maintain timecard.
Web functionalities	Process and actions, Security, Administration.
Exceptions	None.
History	No alterations.

TABLE XI. REQUIREMENT "MAINTAIN THE EMPLOYEE INFORMATION".

Reference	Maintain the employee information
Description	To management and maintain the information of every one of the Employees.
Data	Employee name, address and payment classification.
Viewpoints	Administrator and Department Chief.
Non-functional requirements	None.
DQ requirements	Consistency, Accessibility, Compliance, Efficiency, Precision, Understandability, Portability, Recoverability.

TABLE XII. REQUIREMENT "MAINTAIN THE PURCHASE ORDERS".

Reference	Maintain the purchase order
Description	Maintaining the information of every purchase order of each one of the sold out products by specific employees.
Data	Date, purchase total, percentage of commission.
Viewpoints	Commissioned Employee.
Non-functional requirements	None.
DQ requirements	Accuracy, Completeness, Consistency, Credibility, Currentness, Accessibility, Compliance, Efficiency, Understandability.

TABLE XIII. REQUIREMENT "RUN AN EMPLOYEE REPORT".

Reference	Run an employee report
Description	It is responsible for running a report with all the information of every Employee, this information should be only seen by each specific Employee and the Department Chief.
Data	Quantity of worked hours, quantity of billed hours and payment total.
Viewpoints	Employee, Department Chief.
Non-functional requirements	None.
DQ requirements	Accuracy, Completeness, Consistency, Currentness, Accessibility, Confidentiality, Traceability, Understandability.

DV.1. Documentation of the Data Quality Dimensions (*DDQD*). As part of the output product of this stage based on the **Erro! Fonte de referência não encontrada.**, and with the goal of documenting and modeling in a more clear and specific way the DQ dimensions, we apply in this point the UML profile proposed in [11], this profile will permit us incorporating and modeling DQ requirements (*DQ dimensions*) associated to the different functionalities that the system will provide, taking as basis this profile we can model an "*Information case diagram*" [11], which is much more explicit as the one shown in figure 2.

In this "*Information case diagram*" we can see the use cases previously referred: *FR2. Maintain the employee information*", *FR8. Run an employee report* and *FR11. Maintain purchase order*; however, these use cases can be modeled now like "*Information cases" (IC)*, which maintain a relation of type "*include*" with the use cases stereotyped like "*DQDim*", it means that data managed for each one of *Information cases* should satisfy the DQ dimensions specified. Thus, the developer will have to consider the DQ dimensions at the moment of implementing the different functionalities of the application.

In this diagram (see figure 2), the Information case "*Maintain the employee information*" (associated with the Web functionality "*Administration*") manages mainly the following pieces of data: *employee name*, *address* and *payment classification*. It means that these data should be compliant with the DQ dimensions of *Consistency* and *Compliance*. Similarly, the Information case "*Maintain the purchase order*" (associated with the Web functionality "*Process and actions*") will manage the following pieces of data: *date*, *purchase total*, *percentage of commission*. So, these data should be compliant with the DQ dimensions of *Accuracy* and *Completeness*. Finally, the Information case "*Run an employee report*" (related to Web functionality "*Security*") should authenticate the employee and verify that data are available, and in this way permit the access to the next data only to the specific employee and Department chief: *quantity of worked hours, quantity of billed hours and payment total*. This IC should fulfill with the DQ dimensions of *Accessibility* and *Confidentiality*.

LVS.1. Modeling of the data quality dimensions (MDQD). The output product of this stage based on the **Erro! Fonte de referência não encontrada.**, it consists mainly in getting an object-oriented design, it should contain the main classes responsible for providing the functionalities of the Web portal, as well as the classes responsible for implementing the DQ dimensions. These diagrams are part of a document of high-level design with awareness of DQ.

LVS.2. Validation of Model (*VM*). Finally, the main documents obtained once applied the methodology ("*Document of System Requirement Specification with DQ Requirements Specification"* and "*Document of high-level design with awareness of DQ*") should be validated with the client.

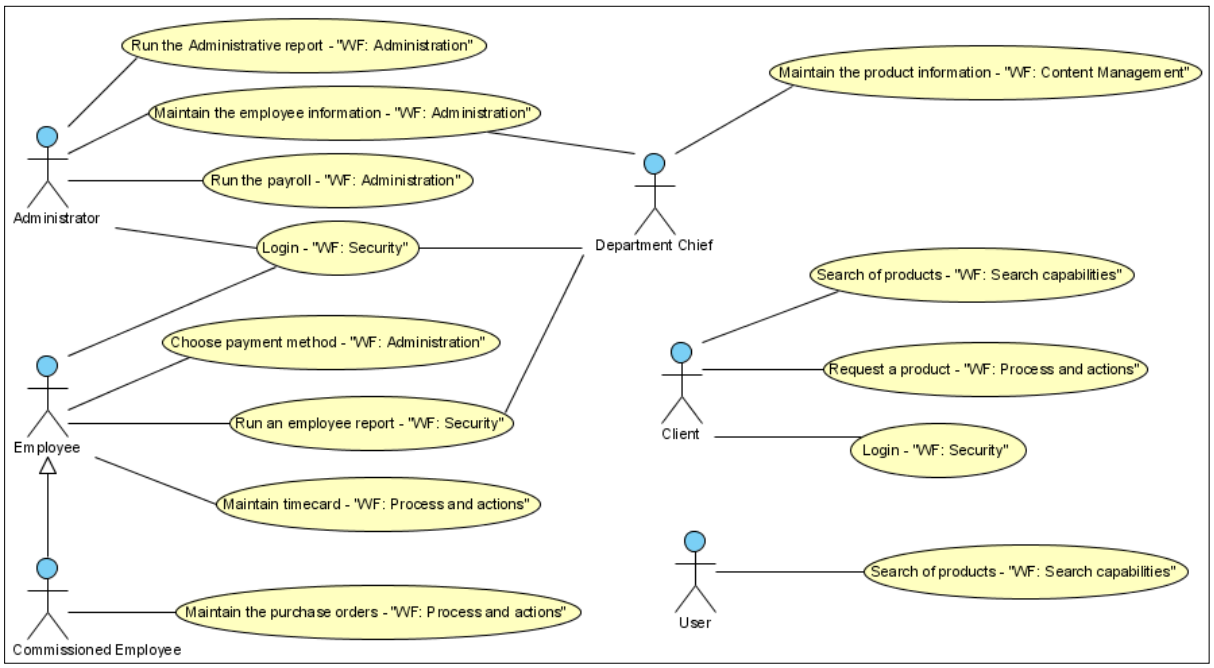

Figure 1. Use case diagram.

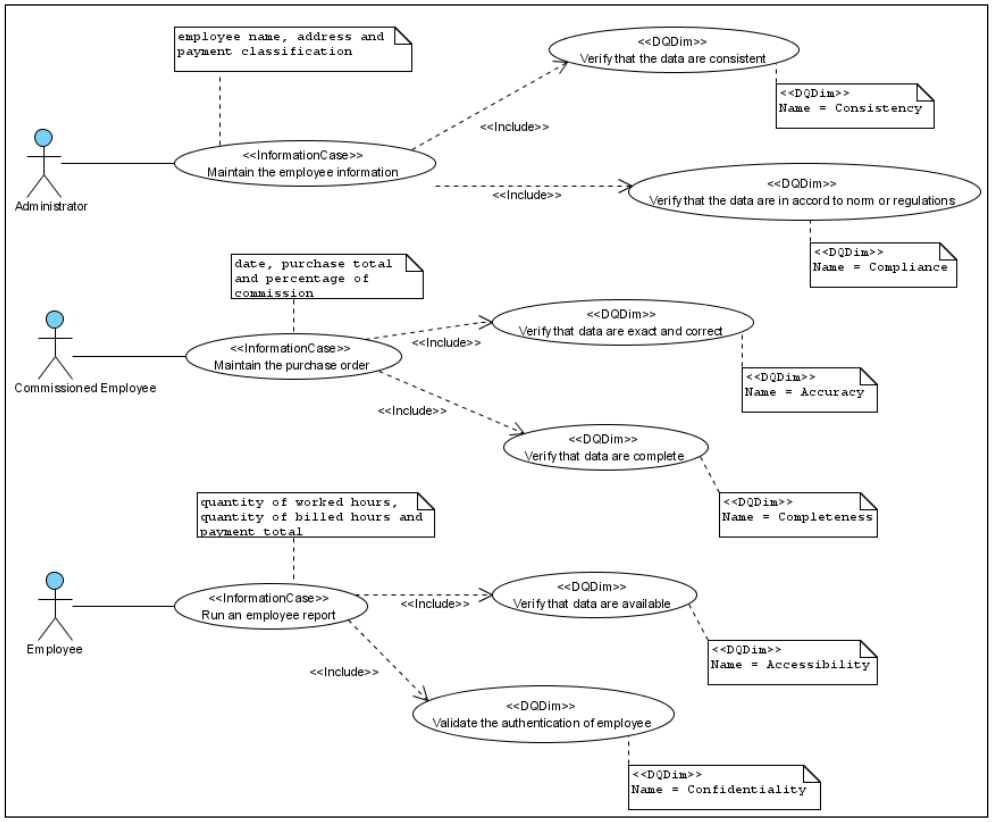

Figure 2. Information case diagram.

IV. CONCLUSIONS

Nowadays, more and more people are using the Internet to access all kind of information, being the Web portals one of the preferred means to get information. However, the users need to be sure that the data obtained from these applications have the adequate level of quality according to their needs. Only a few proposals have been focused on the data quality field in Web. Specifically, there are not proposals focused on the management of specific data quality requirements during the phase of analysis, besides the already mentioned here.

Once applied the DQ-VORD methodology in this example, we have showed a way of eliciting and managing the DQ requirements from the initial stage of development, helping to analyst and developers to become awareness of the DQ requirements that should be taken in mind at the moment of developing the Web portal functionalities. Ensuring in this way, that the data managed by the distinct functionalities and stored into the Web portal, it will have the adequate quality for the task that each users will perform with the system.

Although the methodology was initially conceived and focused to the elicitation and specification of DQ requirements into an environment of Web portal development, DQ-VORD could be applied and generalized to the development of any other type of applications. In this paper, we have shown an example of application of the DQVORD methodology, in order to simplify the process of elicitation and definition of DQ requirements in Web portal development process.

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