Eliciting Business Rules Through ISO 9000 Documentation: A Domain Oriented Conceptual Model

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Abstract

Although business rules have been largely used in database modeling, very little can be found in requirements engineering literature. Many articles have been written about the use of business rules but only a few on how to elicit them. This article focuses on business rules as prescribed procedures that should be followed to achieve the business's goals. Companies that are according to ISO 9000 standards have to maintain a set of documents describing the quality system that include policies, procedures and instructions to assure the final product's conformance with ISO 9000 requirements. Partly for this reason, it is contended here that ISO 9000 standards and associated documents can be of a great help for business rules elicitation. This article aims at filling an important gap in business rules research. It details a conceptual model to elicit business rules using ISO 9000 documentation.

Key words: ISO 9000, Business Rules, Requirements Elicitation, Requirements Baseline

Resumo

Apesar de serem largamente utilizadas para a modelagem de bancos de dados, regras de negócios não são normalmente encontradas na literatura sobre engenharia de requisitos. Vários artigos têm sido escritos sobre o uso de regras de negócios mas apenas poucos abordam como elicitá-las. Este artigo enfoca as regras de negócios como procedimentos estabelecidos que devem ser seguidos para se atingir as metas os objetivo do negócio. Empresas que são certificadas pelas normas ISO 9000 precisam manter um conjunto de documentos que descrevem o sistema da qualidade, o qual inclui políticas, procedimentos e instruções de trabalho para assegurar a conformidade do produto final com os requisitos ditados pelas normas ISO 9000. Parcialmente por esta razão, é estabelecido aqui que as normas ISO 9000 e os documentos dela decorrentes podem ser de grande ajuda na elicitação de regras de negócios. Este artigo pretende preencher uma importante lacuna na pesquisa de regras de negócios, detalhando um modelo conceitual para elicitar regras de negócios através da documentação produzida em empresas certificadas pela ISO 9000.

Palavras-Chave: ISO 9000, Regras de Negócios, Elicitação de Requisitos, Baseline de Requisitos

1 - Introduction

Business rules, in the computer science literature, are usually referred to as a means to elicit data base needs with respect to events/actions referring to data entity [Kappel 95] [Dias 91] [Daya 88] [Halle 96] [Halle 97]. We take a broader view. For us, business rules are prescribed policies, guides or procedures that should be followed to achieve the business's goals.

The above mentioned articles, including most of those that addresses the issue, don't cover an important aspect of the problem, which is how to elicit business rules, where one can find them and what techniques should be used.

This article aims at filling this important gap by detailing a partly tested conceptual model to elicit business rules, an idea that has not as yet been explored, according to our literature review. An essential characteristic of this model is the use of ISO 9000 documentation. This article follows-up one a previous

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worked on the use of ISO 9000 documentation to elicit business rules [Cysneiros 98].

We believe, in accordance with Hoydalsvik [Hoydalsvik 93], that one of the main motivations for capturing business rules during the requirements elicitation is to make it easier to maintain the computer system, since it thus becomes easier to make the necessary changes to the system when the business rules change

Many techniques have been proposed to describe business organizations. There are techniques to design how the information flows, to describe the sequence of actions an organization follows, the hierarchy, and so on. In some ways, all these descriptions refer to business rules, but they don't cover an important aspect, the set of rules establishing how the business works [GUIDE 96].

According to the Brazilian Quality Committee [CB-25 97], in October 1997, more than 140.000 companies, worldwide, had been certified. It is relevant that ISO 9000 certification is not restricted any more to large companies. Medium and small businesses, from small bakeries to large industrial organizations, are also being certified. Figure 1 illustrates the steady growth in number of ISO 9000 certified companies, in Brazil. Recently a small school in Rio de Janeiro got the ISO 9002 seal.

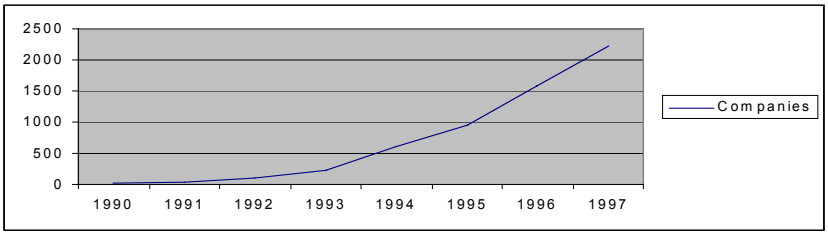

Figure 1 - Number of ISO 9000 certified companies in Brazil

This positive trend regarding ISO certification creates, in our opinion, an opportunity for making use of ISO documentation for business rules elicitation. Indeed, our main hypothesis is that by using the ISO 9000 required documents for business rules elicitation, one can significantly improve software requirements elicitation in organizations.

This hypothesis was inspired by the idea that since the Quality Manual used for ISO certification is the guide defining what will be done and how it will be done, as Corrigan [Corrigan 94] puts it, it could also be an important source for eliciting software requirements.

A bibliographic survey was first carried out to verify whether some evidence for our hypothesis could be found in the literature. Initially, we looked for elements towards an answer to the question on how a method could be developed for business rules elicitation based upon ISO 9000 knowledge. Very few elements were found [GUIDE 96] [Herbst 96] [Rosca 97], however, that considered business rules in a broader way. Indeed, most of the literature on business rules is concerned with their impacts on data modeling. One exception is Fiorini and Macedo-Soares [Fiorini 96] who propose a method to elicit business processes in companies that pursue total quality and to integrate these processes with requirements elicitation.

Further investigations were carried out in the business administration literature. In Matos [Matos 88], we thus learnt that many companies are actually giving training to their employees on what rules are being applied to the business. Harrington [Harrington 96], as well as Macedo-Soares and Chamone [Macedo-Soares 94] implicitly touch upon the question of business rules when discussing the principles and key practices of total quality strategies, notably that of business process management. While not explicitly addressing the question, Corrigan [Corrigan 94], Hayes [Hayes 96], Hilary [Hilary 96], Hockman et al. [Kumberly 94], Macedo-Soares and Lucas [Macedo-Soares 96], and Struebing [Struebing 96] provide pertinent observations for its treatment in their analyses or comparisons of ISO 9000 and Total Quality Management (TQM).

Both the above mentioned literature review and a recent experience in helping a company with ISO 9000 certification by one of the authors were used to develop a tentative model for business rules elicitation based on ISO 9000 documents. It thus became evident that the latter could play a central role in defining what Leite [Leite 93] calls Universe of Discourse (UofD):

> *"Universe of Discourse is the general context where the software should be developed and operated. The UofD includes all the sources of information and all known people related to the software. These people are also known as the actors in this UofD."*

Our definition of business rules is consistent with Leite's one [Leite 98]:

> *"Business rules are statements about the enterprise's way of doing business. They reflect business policies.*

Organizations have policies in order to satisfy the business objectives, satisfy customers, make good use of resources, and conform to laws or general business conventions. Business rules become requirements, that is, they may be implemented in a software system as a means of a requirement of this software system."

Nevertheless, unlike the idea presented by Leite [Leite 98], this work views business rules as a set of rules that concerns not only business polices, but also cross-functional rules and tasks definitions. Doing so, we will be capturing a large amount of different kinds of business rules that will further dictates requirements, both functional and non-functional.

This work proposes a conceptual model to eliciting business rules, with some heuristics of where and how to search the ISO 9000 documentation for those rules. We try to show where in the documentation one can find business rules related to acquisition of incoming products as well as many other as those related to storing, packing and shipping.

We present our proposal by first introducing ISO 9000 (Section 2), then explaining the core of our proposal (Section 3). Sections 4 details the conceptual model with different approaches to different areas of the company. It includes an example drawn from our initial case study. We conclude by showing how we view our contribution in terms of achieving better quality software systems, by reusing the information contained in ISO 9000 documents.

2 - Introduction to ISO 9000

According to ISO 9000 standards [ISO 94], a product is the result of an activity or process, and can be part, or an association of one or more of the following abstract classes:

1. Hardware - Equipment, components, objects, part of pieces, similar products;
2. Software - Methods, documents, information, procedures, instructions, and projects;
3. Processed Materials - Characteristics of incoming product transformation into continuing process, both physical, chemical and biological;
4. Services - A class of products that are consumed while being produced; in a certain sense they can be considered intangible.

At this point, it is important to make clear what we understand by the following expressions:
✓**Quality System -** The organizational structure, responsibilities, procedures, processes and resources for implementing quality management;
✓ **Quality Manual -** A document stating the quality policy and describing the quality system;
✓ **Quality Policy -** The overall intentions and direction of an organization concerning quality, as formally expressed by upper management;
✓ **Requirements for Quality -** An expression of the needs or their translation into a set of quantitatively or qualitatively stated requirements for the characteristics of an entity to enable its realization and examination;
✓ **Nonconformity -** The non-fulfillment of intended usage requirements.

From the model for the ISO 9001/9002 standards [ISO 94] it becomes clear that, for ISO 9000 purposes, the supplier is the organization providing a product to a customer. ISO 9000 standards call the company being certified as a supplier; its suppliers are called sub-suppliers.

One of the main objectives of implementing a quality system is to achieve customer satisfaction by ensuring the continued repeatability of a set of product and service characteristics that have been explicitly or implicitly agreed upon by a customer and a supplier [Sakofsky 94]. This requires controlling what is done and, consequently, implies that everyone knows *what* is done and *how* it is done [Corrigan 94].

One can clearly see how important it is to document all processes to assure the customers' requirements are met, by performing controls, when one pursues such an objective. In this connection, it is relevant that one of the ISO 9000 requirements (4.5 - Document Control) states:

"... there must be established and maintained procedures to control documents and data that relate to the requirements of the international standard. These documents shall be reviewed and approved for adequacy by authorized personnel before issue. This control shall ensure that: a) the pertinent issues of appropriated documents are available at all locations where operations essential to the effective functioning of the quality system are performed; b) obsolete documents are promptly removed from points of issue or use."

This requirement implies that every change in the process has to be documented, approved and available at all locations *before it is implemented*.

Another ISO 9000 requirement (4.2 - Quality System) states:

"... there must exist a documented quality system to ensure that a product conforms to specified requirements. This shall include: a) preparation of documented quality system procedures and instructions in accordance with the requirements of the ISO 9000 International Standard; b) the effective implementation of the documented quality system and instructions."

Put differently, 'the company must follow process documentation at every step of production as well as document the production process as it is enacted'.

There is no rigid format for the Quality Manual, but it is usually divided in sections following the ISO standards. This accounts for a manual with at least four sections, where section 4 is divided into 21 sub-sections, one for each requirement of the ISO standard. When referring to section 4.3, for example, we will be referring to the section in the Quality Manual that specifies the requirement contract review.

Section 1 should refer to the scope of the quality system, Section 2 to important references on the manual and Section 3 to the necessary definitions for understanding the Quality Manual.

The ISO standard establishes the following two requirements for the Quality Manual:

- specify the structure of the quality system's documentation;
- include or refer to procedures that indicate how requirements for the quality system can be met.

The documents required by the ISO 9000 standard are usually built on a three-tier set of documents (see figure 2) [Corrigan 94] and can be described as follows:

1 - Quality Manual (QM) - It is the strategic level document. It defines "What has to be done" to assure that the specified requirements are met.
2 - Quality Control Procedures (QCP) - This document refines directives found in the Quality Manual pointing out "how the quality objectives can be achieved".
3 - Standard Operational Procedures (SOP) - This document registers the documented procedures meeting the applicable requirements of the quality system. Operational procedures can be included or referenced in the Quality Manual.

In order to satisfy ISO's requirements for a good documentation system, the documents have to be linked, e.g., if Section 4.3 of the QCP details Section 4.3 of the Quality Manual, the last one must mention it. Likely, if Section 6 of the SOP for the client's attendance procedure is detailing Section 4.3 of the QCP, the last one must mention it. Therefore, it is possible to visualize ISO's documentation hierarquie.

For practical purposes, when we use the expression "Quality Manual", we should be referring to any or all of the three documents

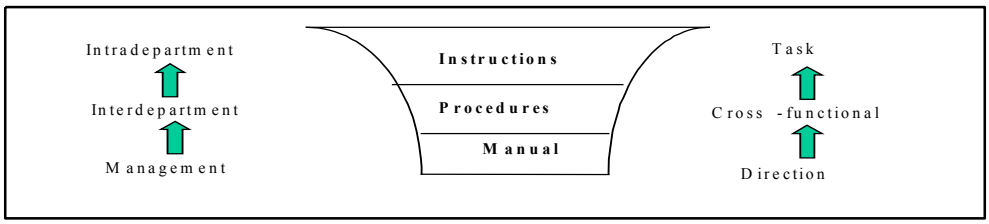

Figure 2 – ISO 9000 Documentation System

We will now detail *some* of the most important sections of the Quality Manual and provide some relevant examples of their business rules:

Section 1 of the Quality Manual is only a presentation of the Quality Manual and is usually very short. The most important information given here is the distribution list, which establishes who is to receive the copies of the Quality Manual.

Section 3 describes the Business's Profile and contains a global scenario of business goals. It usually indicates the products or services offered by the company as well as its market profile.

Section 4 is subdivided in 21 subsections. Some quality systems include one or two extra requirements, for example, legal requirements. As mentioned before, there is no fixed format for the Quality Manual, but usually the subsections are organized according to the following format: 4.1, 4.2,..., 4.21. Some of them are described bellow.

Section 4.1, Management Responsibility, defines the quality system, the organizational structure, the responsibilities and authorities, as well as the management review. The latter process is meant to appraise the effectiveness of the quality system and should therefore be directly correlated to business health.

Section 4.2 and 4.5 were described earlier in this section.

Section 4.3, Contract Review, presents the procedures to assure that the contract established with the client is correct and that it can be carried out by the company in the specified space of time.

Section 4.4, Design Control, only applies to companies being certified according to ISO 9001 standards. It refers to the necessary procedures to control and verify the design of the project.

Section 4.6, Purchasing, details the purchasing process which must include descriptions of the procedures for verification, storage and maintenance of purchaser supplied products to be used in any step of the product's production process.

Section 4.7, Product Supplied by the Client, refers to the process that specifies how products, supplied by the customer, will be identified, verified and stored.

Section 4.8, Product Identification and Traceability, imposes complete traceability to incoming products, sub-products produced during the process, as well as the final product itself.

Section 4.9, Process Control, is where the company (the supplier) identifies and plans the production.

Section 4.10, Inspection and Testing, defines the process to assure that products are not used or processed until they have been inspected for conformance to specified requirements.

Section 4.14, Corrective Action refers to the necessity of establishing procedures to deal with non-conformities, and correcting the process so that the identified non-conformities do not reoccur.

It is important to emphasize that the ISO standards we are proposing to use are not related to ISO 9000-3 [ISO 91] which are the guidelines for the application of ISO 9001 for the development, supply and maintenance of software. Indeed, ISO 9000-3 is not focused on the elicitation process.

Finally, it is important to stress that, although ISO 9000 may be a way of achieving Total Quality (TQ) and part of a TQ strategy, ISO standards and TQM should not be confounded [Hilary 96] [Hayes 96] [Macedo-Soares 94].

3 - Integrating Business Rules into the Requirements Baseline

An important assumption of our research is that requirements are not static in time. They thus necessarily change during the software life cycle [Leite 95]. This means that the requirements found during the requirements definition, continue to evolve as the software is being developed. As such, the software engineer must pay attention to the possible changes and evolution of requirements. The requirements baseline is structured as follows [Leite 98]:

- a business rules view (proposed here)
- a lexicon model view;
- a basic model view;
- a scenarios model view;
- a hypertext view;
- a configuration view.

Our proposal is to integrate business rules into the baseline to provide a global description of the governing rules of the macrosystem, and to help in the communication process with the client/customer.

Figure 3 portrays the overall strategy. First, the software engineer must define the Universe of Discourse (UofD) (see "DEFINE UofD" on Figure 3), by carrying out interviews and reading manuals, books, legislation, Quality Manual, etc. [Leite 93].

At this initial step, a first reading of the Quality Manual is important to give the software engineer an understanding of the application domain. A first definition of UofD may be drafted at this point. The engineer can elicit business rules at the boundaries of the UofD.

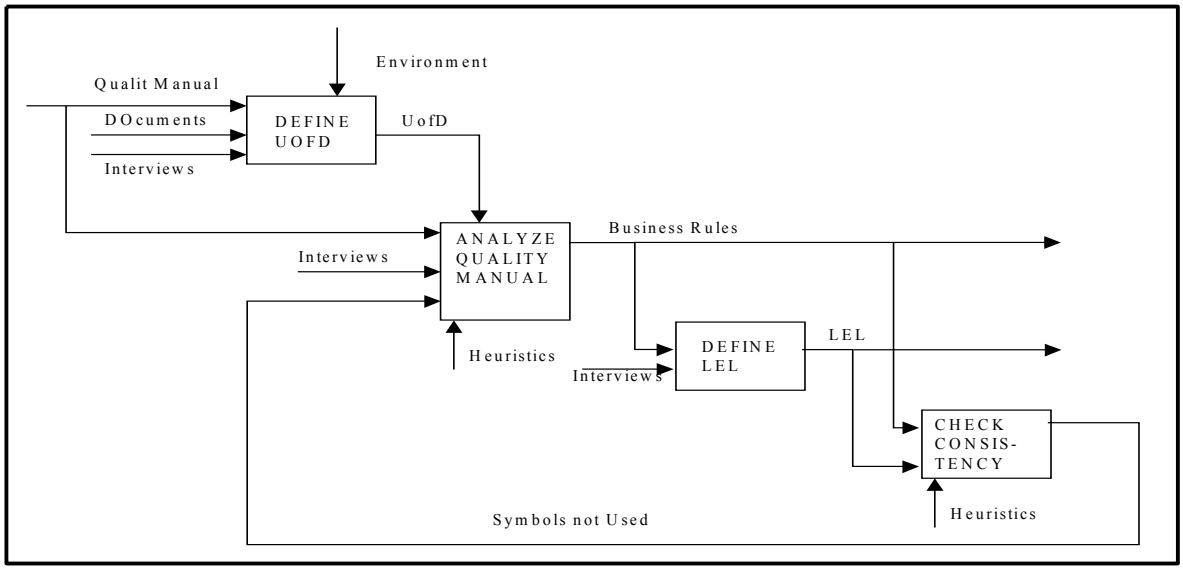

Figure 3 - SADT model for integrating Business Rules in Requirements Baseline

The "ANALYZE QUALITY MANUAL" process, corresponding to step three, aims at eliciting the business rules by way of the manuals. The heuristics, appearing as a mechanism in the SADT of Figure 3, are detailed in Section 4.

After business rules are defined, it is time to define the symbols of the LEL contained inside these rules. The objective of an LEL is to register the vocabulary of a given UofD. It is based upon the following simple idea: understand the problem's language without worrying about understanding the problem [Leite 94]. The main objective of the LEL is to register signs (words or phrases) peculiar to a specific field of application. Adding new symbols to the LEL during business rules elicitation helps to better understand the expressions found in the ISO 9000 documentation.

The LEL is a meta-model designed to help the elicitation of the language used in the macrosystem. This model is based on the idea that a circular description of language terms improves the comprehension of the environment. Each sign is described by natural language sentences for its notions and behavioral responses. In the description of each sign, a high level of circularity is maintained, since each sentence uses signs also described in that LEL. The notions must try to elicit the symbol's meaning and its fundamental relations with other entries. The behavioral response must specify the connotation of the symbol in UofD (See example in Figure 9).

The LEL definition will be carried out using the business rules found to extract the symbols of LEL that can be found inside these rules (See " DEFINE LEL" on Figure 3). Notions and Behavioral response might not be found nearby the place where the business rule is. If this is the case, it will be necessary to see in section 4.1 who is(are) the actor(s) responsible for the section where the business rule was found and carry out a set of interviews to determine the respective notions and behavioral responses. Even when it is possible to identify some notions and behavioral responses related to the symbol of the LEL that are being defined, one should validate them using the actors involved. A good approach to find the notions and behavioral responses inside the ISO 9000 documentation is to search all the documents for the symbol of the LEL being described.

The objective of the "CHECK CONSISTENCY" process, corresponding to step four, is to provide the necessary feedback to the two previous processes. At this stage, the software engineer must look for new LEL symbols contained in the business rules, their notions and behavioral responses, and integrate them into the

LEL. This process also accounts for checking whether there are missing rules, based on LEL symbols not referred to in any rule. If there is any symbol not present in the business rules, the software engineer must look for it in the Quality Manual to be absolutely sure that there are no business rules related to this symbol.

This process will continue until no new LEL's symbols are found in step three.

4 – Conceptual Model for searching ISO 9000's documentation

4.1 – The Proposed Conceptual Model

The quality leader is usually the best source from whom one can find information about how ISO 9000's documentation is structured in an organization. If the organization does not have a quality leader, the software engineer must look for the Management Representative who is responsible for maintaining the quality system. Section 4.1 states who plays this role.

Reading the Quality Manual will often prompt the software engineer to read the Quality Control Procedures manuals, and many times, also, the Operational Procedures manuals.

The more relevant parts of a Quality Manual and the respective rules that can be found inside these are briefly described below. We also present some of the sections of the Quality Manual where one can find business rules, together with some information on what one can expect to find in each section.

Figure 4 shows a conceptual model, inspired by Fiorini's work [Fiorini 96] for searching ISO's 9000 documentation with a view to eliciting business rules. Figure 5 details how to know about the processes of the organization. These conceptual models can be understood as a path to understand the organization and to find its business rules.

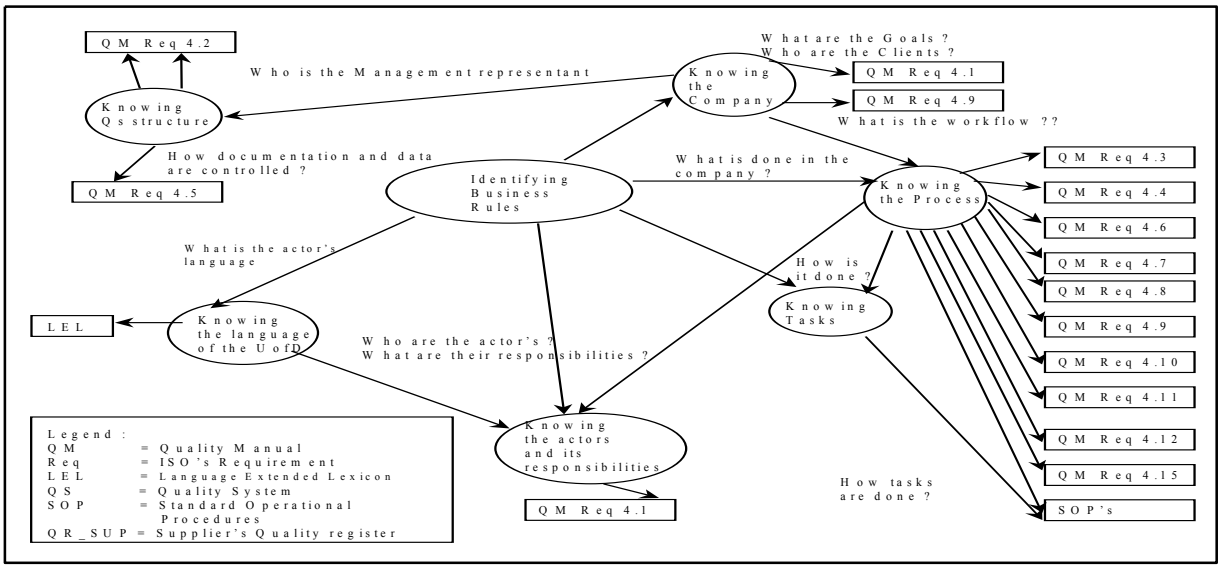

Figure 4 – A general Conceptual Model for Searching ISO's Documentation with a View to eliciting Business Rules

We will now state some heuristics that can be derived from the conceptual model shown in Figures 4 and 5. Every time we refer to "product" we will be also referring to "services". This heuristics are particular to each business area. Every time we refer to Section 4.x, we are referring to a specific section of the Quality Manual as explained in Section 2 of this article.

1. **Knowing the Company :** One can learn about how the company functions and what are its goals by first reading Section 4.1. In section 4.9, one can learn about the whole company' process. Here, usually some kind of workflow, describing a general view of the company's process, can be found.
2. **Knowing the main actors :** The main actors playing roles in the UofD can be found in Section 4.1, where one can find a table specifying what are the actors responsible for each of the ISO 9000 requirements.
3. **Relationship with the Client :** To know how the company interacts with the client, one may read Section 4.3 to know how a formal contract is established with the client, and what will be used to evaluate whether the contract was performed satisfactorily. Section 4.7 establishes what are the products delivered by the

client, and if necessary, the controls that must be performed to ensure conformance with the quality system. Section 4.19 must also be checked, as long as many Call Centers are treated in this section.

4. **Warehouse / Purchasing :** To understand how the purchasing works and what are the warehouses policies, one might read several sections of the Quality Manual. First of all section 4.6 establishes all the processes for purchasing products, including what, when and how it will be done. Here it is also possible to know how suppliers will be evaluated and categorized in order to keep only the ones who match the company's policies. Section 4.10 will establish the procedures for Inspection and tests that must be performed when the Warehouse receive any incoming product to assure the desired quality of these products. Sections 4.11, 4.12, 4.13 and 4.15 will also be somehow related to processes that must be performed in the warehouse to assure the quality of the incoming product, as: Avoid to have products inside the warehouse which are not in conformance with the standards (4.13), How to store the incoming products to assure its conformance (4.15), and so on.
5. **Product Delivering :** We here understand product delivering as the process of receiving the final product, storing it for a while, packing it and finally shipping it. Section 4.15 is the place where to search for business rules related to this area.
6. **Finances :** It is not necessary to have finance processes established in ISO documentation, unless they directly interfere with the final product or with the client. Information about any finance process must be centered in Section 4.3 where everything related to the contract established with the client must be stated. Section 4.19, associated services, might also have some process related to charging clients. Section 4.1 may sometimes mention rules about finance goals, for example: "The company must have at least a cash reserve equivalent to one-month 's sales revenue" .
7. **Production :** To understand how the products are produced, one will have to read many different sections. Figure 6 gives a good view of the necessary process to understand how the products are made and its policies. Section 4.4 establishes how a new type of product is developed. Section 4.9 will represent all the productive cycle that occurs in the company. Section 4.10 will state all the inspections and tests that must be performed from the moment the product starts to be manufactured until it is finished. Section 4.12 states all kinds of identifications that a product may have while it is being manufactured to assure its conformance to standards. Section 4.11 refers to all the controls that have to be performed in any equipment related to manufacturing. Section 4.13 will have all the procedures necessary to control any product, anytime during the manufacturing process, that is not in conformance with the requirements of the quality system. Section 4.8 plays an important role in ISO 9000 standards and must be carefully examined. This section establishes the identification process that must be carried out during the product's manufacturing to assure complete traceability of the product. ISO 9000 requires tracing every step that happened during a product manufacturing. Section 4.15 will focus on the way that the product must be handled and stored during the production cycle, as well as how and where it should be placed/delivered when it is finished.

In addition to the conceptual model, the following general heuristics were created to help the software engineer in the process of eliciting business rules:

1. Check every point in the Quality Manual that makes any mention to external clients, such as: customers, suppliers, and sub-supplier;
2. Pay attention to any information or incoming product being processed in any form. It will probably be part of a productive process and will be written somewhere in the Quality Manual. Also, there is a good chance it may reflect a business rule;
3. Check for points in the Quality Manual defining behaviors or process quality. They can point out business rules that will express non-functional requirements;
4. Once finished the search for business rules in the Quality Manual, eliminate redundancies and check for possible rules linked by functionality;
5. Check for policies (rules) expressed in the Quality Manual. It is common to find expressions like: "Company's policy for purchase is ...";
6. Check for the Keywords as : "Must/Must not" , "Can not" , "Greater/Lower/Taller/Thinner and adjectives in general";
7. Check for the following sentence structure:
   - IF + phrase + then/implies + phrase
   - When + phrase + then/implies + phrase

- Subject + will + verbal phrase
- Verbs like : do, process, check, manipulate, attend, generate, provide, ask, input, enter, have, manage, inform, evaluate, analyze, develop, be, store, pack, ship, select, require,

8. Repeat the search process until no further rules can be found. Each time the search is carried out, more is learnt about the business, and the capability to elicit rules that were not observed earlier is increased

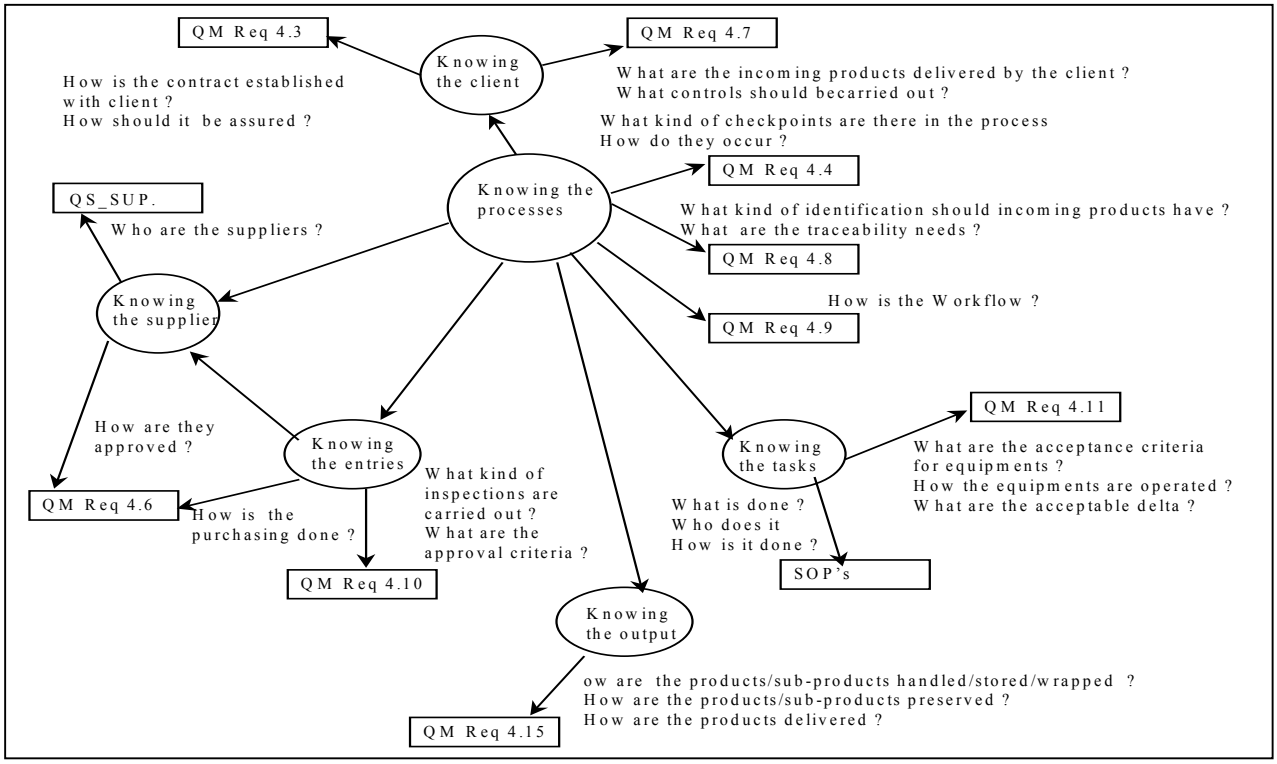

Figure 5 – Detailed conceptual model

4.2 - Checking LEL and Business Rules Consistency

Once the business rules and the LEL have been identified, their consistency must be verified. Towards that end, we propose the following general heuristics:

- *Every important symbol in a business rule has to be represented in LEL.*
- *Every LEL entry should be present in at least one business rule*.

When this check is carried out for the first time, many symbols present in business rules may not be present as yet in a LEL. This is the time to include them in LEL with their respective notions and behavioral responses

As this process becomes a cycle, it is possible that updating a LEL brings new symbols are not yet represented in business rules. This may point to some forgotten business rules.

The software engineer must be sure this symbol is not in LEL with another name. If so, he or she should update the LEL with this alias. If not, the software engineer may go back to analyze the Quality Manuals and search for the business rules related to the symbol.

Figure 8 gives one example of this. **Calibration** is a symbol that is part of the behavioral response of **Analyzer,** which is part of the notions of the symbol **tests, which** are found in business rule 2. **Analyzer** is a symbol that is not present in business rules. This could mean that there are business rules about analyzers and calibrations not found in the analyses of the Quality Manuals.

On the other hand, symbols such as draw sites, samples, patient, as well as some others, have not as yet been represented in LEL and should be included. Notions and behavioral responses of these symbols may still not be completely clear to the software engineer. In this case, another analysis of the manual must be carried out, and, probably, also an interview with the actor responsible for the requirement where the business rule was found.

Analyzer
Notion:
- Equipment used to perform **tests**.

Behavioral response
- Requires **calibration**.

Bar code label
Notion:
- Used to elicit a particular **recipient.**
- A unique number.
- This number is called **sample number**.

Behavioral response:
- Automatically generated by the system during **patient** data input
- Fixed the recipient by the **attendant.**
- Has to be linked to one and only one **patient**.

Kits
Notion:
- Chemicals used in **analyzers** to perform specific **tests**.

Behavioral response
- Each **Kit** has a **serial number.**
- Operator registers **Kit** data and date of opening a **spreadsheet.**

Tests
Notions:
- Are performed by **anal yzers.**
- A set of **tests** grouped in one **test** is called a **profile.**
- Can be performed by one or more **sectors**.

Behavioral Response
- Have **constraint rules** for admission purposes.
- **Reference values** are printed in **patient** report.

Figure 8 - Example of LEL entries extracted from business rules

The process of checking LEL and business rules consistency is an interactive process. Up to now, we only have very general heuristics. These will be refined as we conduct more case studies about the method in question

4.3 – An Example Drawn From an Initial Case Study

This section will present an example drawn from an initial case study. We used the Quality System of a clinical analyses laboratory that recently got its ISO 9002 seal. The same company was used before in a case study which we already built the LEL for this domain. Nevertheless, here we used the existing LEL only for purpose of comparison. We applied the conceptual model to search for business rules and after that, we built the LEL from the rules found. The rules were validated with the actors of the UofD and the LEL compared with an existing LEL from a previous case study. We used the syntax proposed in [Cysneiros 98] to represent the business rules, which is:

- Number + "-" + Business rule statement + $_1{}^n${"- Section :" + ISO's requirement}

Some of these rules are presented below.

The following business rules are obtained from Figure 6:
1. The **Draw sites** ask the **client** for a **medical order** with **tests** to be performed. – Section 4.3
2. The **Attendant** will enter all the required information in the system. – Section 4.3
3. The system will automatically generate **bar code labels** to the **samples.** – Section 4.3
4. The system will automatically generate a **protocol**. – Section 4.3
5. The **protocol** must have the **requested tests** and **delivering data.** – Section 4.3

In addition, the following business rules were extracted from figure 7:
6. Traceability of **Kits, reagents and controls** will be assured by using a spreadsheet containing identification of the product and **date of opening**. – Section 4.8.2
7. Each **recipient** must have a **code bar label** with its unique number. – Section 4.8.2
8. The computational system will generate a **sample number** – Section 4.8.2
9. The computational system must provide ways to check where a **sample** is now. – Section 4.8.2

Words boldfaced in the above business rules represent important symbols of the language belonging to the UofD. These symbols were represented in the LEL with its respective notions and behavioral response. Every subject and direct object of business rules were good candidates for becoming LEL's symbols.

Notions and behavioral responses for each symbol were initially searched for in the Quality Manual and its sub-products. The Quality Manual were, in the worst case, useful to point out the actors responsible for that requirement. Every actor of the UofD present in the business rules should be a symbol of the LEL (patient, draw sites, distribution sector), as well as words and expressions peculiar to the domain (kits, reagents, delivering data, tests) found by the process described previously.

4.3. – Contract Review

The Draw sites will ask the client for a medical order with the tests to be realized.
The attendant checks if it is possible to deliver the patient's report in the time required by the client.
The attendant will enter all the required information in the system, which will automatically generate bar code labels for the samples and a protocol.
Once attendance is finished, a protocol is given to the client. The protocol must have the requested tests and delivering data.

Figure 6 - Example of a section 4.3 - Critical Analyses of the contract

4.8.2 - Traceability

4.8.2.1- Incoming Products Traceability

Traceability of Kits, reagents and controls will be assured by using a spreadsheet containing identification of the product and date of opening.
Each recipient must have a code bar label with its unique number. The computational system will generate a sample number for each recipient.
Traceability of samples collected from a client will be achieved by code bar reading every time a sample moves from one place to another. The computational system will provide a way to consult the position of specific samples and the places it has been to.

Figure 7 - Example of traceability requirements in a clinical laboratory

Figure 8 gives an example of LEL extracted from Figures 5 and 6. During a real LEL specification, all symbols arising in notions and behavioral responses were represented as an LEL entry. The final version of the LEL we got here enclosed four symbols which we haven't found in the previous case study using another method.

6 - Conclusion

Many recent works have dealt with business rules but only a few of them addresses the question on how to find them. This article aims at filling this important gap by detailing a partly tested conceptual model to elicit business rules, an idea that has not as yet been explored, according to our literature review. An essential characteristic of this method is the use of ISO 9000 documentation

What we propose is to take ISO 9000's documentation as a starting point for rules' elicitation. We propose a detailed conceptual model focusing different areas of a company in such a way that the software engineer can use them as guidelines to elicit business rules in different areas of the company. Since software quality can only be achieved if the requirements are met, it is very important to have a precise definition of the requirements before engaging in software production. By its very nature, ISO 9000 documentation provides guidelines for defining requirements with the necessary precision.

Since the requirements baseline [Leite 95] [Leite 97] is geared towards natural language sentences, the integration of business rules into the proposed scheme is very simple, using the links established by the common vocabulary, that is the LEL.

Because ISO 9000 requires a quality system to be complete, well documented and always updated, we believe that it is not only a good source for eliciting business rules but it can also provide some reuse on the quality documentation produced by a quality process providing requirements traceability. We take as point of departure the already verified documentation in order to gather significant information about the business, which, in turn, will constitute a major source for eliciting the software requirements of the organization in question. However, as is obvious, our strategy should be complemented with other elicitation strategies to better describe the real requirements of a future system.

Future work will include case studies that should contribute to confirm the existing heuristics, as well as to develop new ones. Since the requirements baseline is based on the links provided by the common vocabulary, the future automation support, under construction, is founded on the concept of hypertext. The evolutionary nature of the requirements baseline matches ISO 9000 policies for maintaining the quality system. This match will also be stressed in future works. Finally, we intend to identify patterns present in the quality manual that should support the development of a tool to support business rules acquisition.

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