REQUIREMENTS ENGINEERING FOR THE BUSINESS PROCESS RE-ENGINEERING: an Example in the Agro-Food Supply Chain*

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Abstract: Recent researches in Requirements Engineering and Software Engineering suggest that a deep organizational analysis is needed as a preliminary phase of any project that aims at introducing or modifying the use of Information Technologies inside an organization. Accordingly to this view, the social setting is the motivating factor that justify the technological choices. In this paper, we show with an example how balancing social and business issues can be properly addressed and analyzed by means of the Early Requirements Analysis phase of the Tropos methodology. In particular, we refer to an ongoing project with the goal of proposing web based technologies to spread-off information, data and knowledge on the so called *Genetically Modified Organisms*.

1 INTRODUCTION

The debate on modern agrobiotechnologies and, specially, the so called *Genetically Modified Organisms* (GMO) is surely one of the most controversial questions of the last years, involving many levels of interests and actors. Economic, political and scientific significance involves the discussion, since the application of this technology has a deep impact on the "quality of life". Besides, the difficult communication attitude often achieved by the scientific community towards the Society does not help a confident debate, and allows an uncontrolled spread of incorrect information. The question involves a great amount of data and information, to be allocated in an efficient way to allow all the actors involved to choose for themselves. Differences in interests and roles should be regarded as driving forces in the debate. In what we could call a *deliberative democracy*, each part should be provided with the same amount of information, but at the same time should be allowed to express a personal and aware opinion, free from others' influences. This explains the need of rationalizing the way information and data are made available to the different actors participating to the scientific debate on GMOs. To answer to these needs, we are currently working at a project (Osserva3), the aims of which include also to provide an Information Technology and/or Multimedia infrastructure to support knowledge and information sharing and broadcasting for a better informed deliberative democracy on the topic. Thus, we adopt the Tropos methodology for Requirements and Software Engineering (Bresciani et al., 2004) to define the requirements of such a system (Marin et al., 2003).

The Tropos methodology deals with all the phases of system requirement analysis and all the phases of system design and implementation in a uniform and homogeneous way, based on common mentalistic notions as those of *actors*, *goals*, *soft-goals*, *plans*, *resources*, and *intentional dependencies*. Thus, one of the Tropos main advantages is that it allows us to capture not only the *what* or the *how*, but also the *why* a piece of software is developed. The Tropos method-

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ology is based on four phases (Bresciani et al., 2001; Bresciani et al., 2004): *Early Requirements Analysis*, to understand the problem context by studying its organizational setting; *Late Requirements Analysis*, to define the system-to-be, in the context of its organizational environment; *Architectural Design*, to deal with the definition of the system global architecture and the *Detailed Design* phase. In particular, during the Early Requirements Analysis the existing organizational setting is analyzed in terms of *actors*, who play some role in the organization, and of their reciprocal *intentional dependencies*, in the context of the organization. The output of this phase is an organizational model which includes relevant actors and their respective intentional dependencies. *Actors* are characterized by having *goals* that each single actor, in isolation, would be unable —or not as well or as easily— to achieve. Intentional dependencies are used to describe this kind of relationships among actors. *Goals* are the the elements around which the intentional dependencies are established.

In this paper, we will concentrate on the Early Requirements Analysis phase. In particular, we will base our discussion on the assumption that a deep organizational analysis is needed as a preliminary phase of any project that aims at introducing or modifying the use of Information Technologies inside an organization (Bresciani et al., 2004; Donzelli, 2003; Bresciani et al., 2001; Donzelli and Bresciani, 2003). Specifically, in the Osserva3 project we focus on carrying out a clear analysis of the current socio-economical and scientific scenario on biotechnologies, taking into accounts diverse actors, as, e.g., Institutions, Scientists, Industries, Farmers and Breeders, Consumers, Mass Media, Food Retailers, their own interests and their reciprocal intentional dependencies.

2 USING TROPOS: A SIMPLE SCENARIO

For the sake of brevity we here consider only a simplified business scenario extracted from our Osserva3 project: the terminal part of the agro-food products delivery chain. The objective is to analyze how the consumer attitudes toward the GMOs products may influence the marketing strategies. Of course, this is only a small and simplified fragment of the analysis developed inside the Osserva3 project (that includes more then 27 actors).

The two main actors (the consumer and the food retailer) are characterized by having a set of goals, and depend each other for achieving some of these goals. E.g., the consumers aim at environment protection, technical development and social equality. This attitude is reasonable, as well as it is reasonable the fact

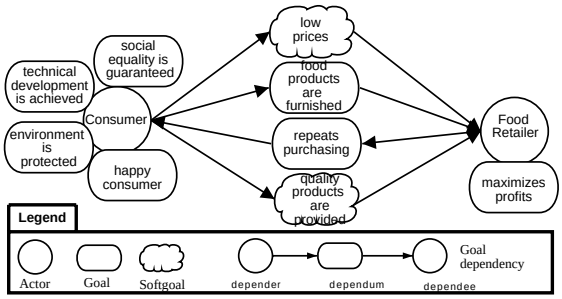

Figure 1: Actor Diagram with goals and intentional dependencies between Consumer and Food Retailer.

that the food retailer aims at obtaining high economical profits. To better understand their motivations, it is important that the two actors are not considered and analyzed in isolation: they depends each others to reach some objectives. The food retailer depends on the consumer to have her as a costumer or, better, to have her keeping on shopping with it. The consumer clearly depends on the food retailer first of all to buy food, but also for its quality level and (possibly) low prices. As well, it is interesting to consider, e.g., the trade-off between quality and prices, a detailed analysis on what kind of quality the consumer may be interested in, the strategies that the food retailer can adopt to better match consumers expectations, and so on. Tropos provides a diagrammatic notation to deal with this kind of analysis: by using diagrams we have a visual tool that allow us to focus different aspects on turn, and to breach the global cognitive effort into smaller chunks of knowledge, that can be more easily understood and analyzed, as shown next.

2.1 Building Tropos Actor Diagrams

First we identify the most relevant actors in the social environment. Initially, we concentrate only on few actors, together with their goals and reciprocal intentional dependencies: the Consumer and the Food Retailer, as shown in the Actor Diagram of Figure 1. Actor Diagrams are used to represent goal dependencies among actors. *Actors* are represented by means of circles, labeled by the actor names. In Figure 1, some of the possible *goals* of the two actors Consumer and Food Retailer are represented. The main Food Retailer goal is maximizes profits. Goals are represented by means of labeled ovals. In the case of maximizes profits the goal appears in the diagram attached to the actor that aims at fulfilling it (Food Retailer). Similarly, the actor Consumer wants to attain the goals social equality is guaranteed, technical development is achieved, and environment is protected, as well as the goal happy consumer. Some other goals in Figure 1 are not directly attached to any actor, but in the middle

of a path of the kind actor1→goal→actor2 (e.g., as in Food Retailer→repeats purchasing→Consumer). The meaning of such a pattern is that actor1 (referred as the *depender*) *depends* on actor2 (referred as the *dependee*) to achieve the goal (referred as the *dependum*), either because she is not able to satisfy it by herself, or not as easily or not as efficiently. In Figure 1, the Consumer depends on Food Retailer for fulfilling the soft-goals[1] low prices, quality products are provided, and the goal food products are furnished. Finally Food Retailer delegates the goal repeats purchasing to the Consumer.

2.2 Building Tropos Goal Diagrams

After identifying the relevant stakeholders, their goals, and intentional dependencies, the Tropos Early Analysis phase proceeds by decomposing each goal in subgoals by means of techniques of *AND-OR decomposition* and *contributions analysis* (Chung et al., 2000; Mylopoulos et al., 2001; Dardenne et al., 1993). The resulting diagrams are called *Goal Diagrams* (Bresciani et al., 2001). AND-OR decomposition allows for a combination of AND and OR decompositions of a root goal into subgoals, thereby refining a goal structure. In particular, AND-decomposition implies that all subgoals have to be fulfilled for achieving the root goal, while for OR-decomposition the fulfillment of one of them is enough. Contribution analysis allows us to point out goals and soft-goals that can contribute positively or negatively at reaching the goal under analysis. Using these techniques, we can build some diagrams in which we analyze each goal from the actor point of view, to acquire a deeper understanding on *how* and *why* to achieve that goal. The idea is that a goal may be decomposed in one or more subgoals, that could be delegated to other actors or fulfilled in isolation.

Figure 2 shows a Goal Diagram where the goals of the actor Food Retailer are decomposed by means of AND-OR decomposition. In particular, we OR-decompose the goal maximizes profits into the subgoals reduces costs, increases quantity, or increases prices: the satisfaction of (at least) one of the subgoals guarantees also the satisfaction of maximizes profits. Again, the goal reduces costs is further refined into the two subgoals wholesale product prices are reduced and optimizes management. The former is delegated to the actor Agro-food Industry, establishing a new goal dependency between the actor Food Retailer and Agro-food Industry. It is worth noticing that, here, the dependency arrow points directly

[1]A distinction is made in Tropos between goals —aka hard-goals— and soft-goals. While hard-goals define objectives the satisfaction of which can be defined with clear-cut criteria, soft-goal achievement cannot be sharply defined.

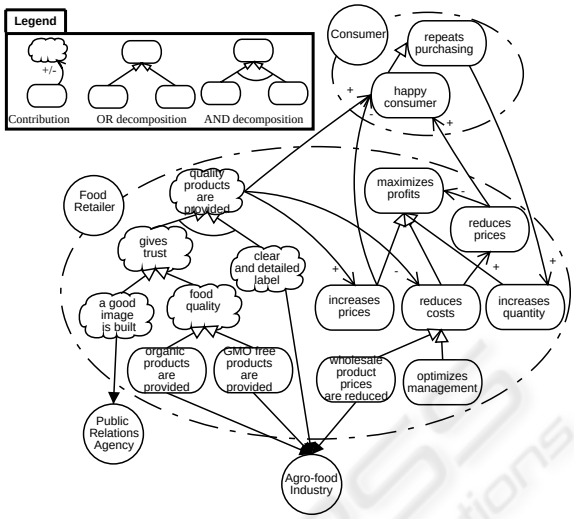

Figure 2: Goal Diagram from the Consumer and Food Retailer point of view.

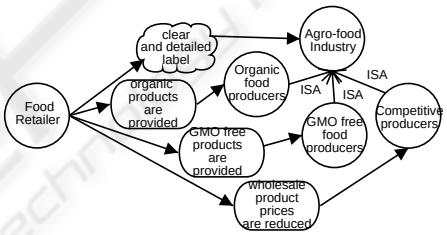

Figure 3: Actor Diagram with the new actors introduced by effect of the goal analysis.

from inside the context of the depender toward the dependee. Thanks to this kind of analysis, we can complete the Actor Diagram depicted in Figure 1 with new details like hard-/soft-goal dependencies, new actors, and so on. The Tropos methodology foresees to incrementally increase the detail level of each diagram, by means of a cyclic process, until a sufficiently detailed model is produced.

The so called *contribution analysis* allows us to highlight hard- and soft-goals which contribute positively or negatively at reaching the goal under analysis. For example, the arrow labeled with a "+" and pointing from the goal reduces costs to the goal reduces prices means that the first goal contributes positively at satisfying the second one. Again, the goal reduces prices contributes partially positively at fulfilling the goal happy consumer and negatively at maximizes profits (note the label "−").

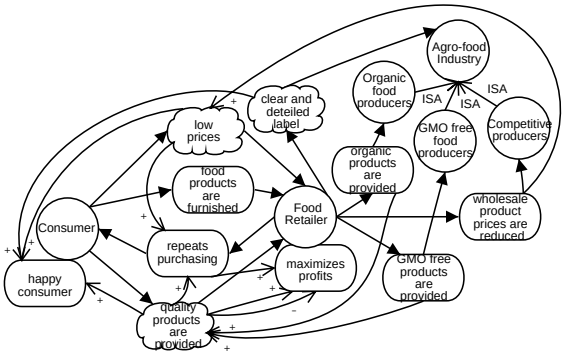

Figure 4: Global Actor Diagram with goal contributions.

3 REVISING ACTOR DIAGRAMS

Accordingly to the Tropos Early Requirements Analysis process, each diagram may evolve incrementally, following an iterative and incremental development. For example, it maybe here interesting considering how the dependencies introduced during Goal Analysis can be further developed in the Actor Diagram again. Let us consider the dependencies among Food Retailer and Agro-food Industry, introduced with Figure 2. A better picture of these dependencies can be given in the Actor Diagram of Figure 3. Here, an extra level of detail is provided, which states that three of the dependencies posed on the Agro-food Industry are indeed to be delegated to more specific kinds of it. Three new actors, Organics food producers, GMO-free food producers, and Competitive producers (see Figure 3) are introduced as specializations (*ISA*) of the actor Agro-food Industry. The three new actors inherit the dependencies and goals of the actor Agro-good Industry, like, e.g., the delegations of the softgoal clear and detailed label. As well, they are the dependees in the specific dependencies for achieving the goals organic products are provided, GMO free are provided, and wholesale product prices are reduced respectively. These last observations let us refocus on the original task: to analyze and understand which possible impact may have the introduction of GMO products in a agro-food products delivery chain. In fact, from the contribution analysis of 2, we can evidence that price competitiveness is in general a factor contrasting with quality. Since quality is often related by many consumers to the absence of *artificial* factors —like chemicals but also GMO— in the products, organics products and GMO-free products are frequently perceived as having a higher quality standard, and this fits the expectations of the average consumer, despite the fact that she has to pay a higher price. Thus, after balancing all the elements in favour and against (that of course do not have all the same weight), we can propose to adopt our analysis to justify market and business choices.[2]

Finally, we briefly introduce an interesting extension for the Analysis process, where contributions with a relevance for different actors are represented in a more organic and compact way. In Figure 4, all the contributions with a relevance for more than one actor, i.e., spanning outside the local contexts of each single actor, are replicated in a global Actor Diagram. The idea is to highlight the impact that the different goal (hard and soft) may have on the dependencies among the actors. In this way we abstract from contextual details —the single, personal point of views— and can present a more *objective* view of the global contributions network. The aim is to ease the task of capturing the dependums that play a crucial global role, so to facilitate the identification and understanding of the most essential goals on which to focus possible choices and decisions.

4 CONCLUSION

Starting from a simplified business scenario in the context of the current debate on the adoption of GMOs for food products, dealing, in particular, with the consequences that possible alternative choices about the option of selling GMO-food may have on the business strategies of the terminal part of the products delivery chain, we introduced in this paper a technique for analyzing business scenarios, also aimed at implementing the Information Systems Requirements Engineering processes. The technique —called Early Requirements Analysis— is part of the Tropos methodology for Requirements and Software Engineering and it is presented here by means of our case-study. As well, we showed how consequences on the business process can be directly derived by means of the analysis proposed by using Early Requirements.

In particular, in the last part of the paper 4, we briefly sketched a compact Actor Diagram view, aimed at summarizing the propagation of contribution analyses—which normally reside only inside the scope of each single actor Goal Diagram across an extended view including all the relevant actors.

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[2]Of course, this is a very simplistic view of the scenario —we are far from proposing, here, any real marketing stategy. Our aim, is just to give an idea of the feasibility of the application of this approach.

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