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MODELS AND TOOLS FOR VALUE SYSTEMS ANALYSIS IN COLLABORATIVE ENVIRONMENTS

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Dissertation to obtain the degree of Doctor in Electrical and Computer Engineering, specialization of Collaborative Networks.

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LISBOA

Março 2011

“Models and Tools for Value Systems Analysis in Collaborative Environments”

Acknowledgments

Thank you to my PhD advisor, Professor Camarinha Matos, for the values of accuracy and knowledge transmitted.

Thank you to my research colleagues, João, António, Tiago, Inês and Filipa, for sharing knowledge and joy which is so essential for a good research environment.

Thank you to the *Uninova, Instítuto Politécnico de Setúbal* and *Fundação de Ciência e Tecnologia*, which valuate the scientific training, and provided me the resources needed to undertake my PhD work.

Thank you to my parents for giving me an upbringing guided by the values of optimism and perseverance, which were essential at moments of frustration and failure.

Thank you to my husband and my three children for being my most valuable things that give me the strength to continue to progress.

Abstract

Participation in collaborative networks is vital for small and medium-sized enterprises to survive in the current market, bringing them several benefits. However, participation in collaborative networks also involves risks and often consortia fail due to internal conflicts. Conflicts can be originated by different prioritization of values and different perceptions of outcomes. The perception of outcomes is, to some extent, subjective given that it depends on the preferences of the subject and how exchanges are evaluated. Therefore, the establishment of a common Value System or the effort to align the Value Systems of network members can play an important role in the collaboration sustainability. Although the topic of values and values alignment has been studied within the scope of various scientific disciplines, there is still no common understanding on these concepts and the literature does not include any suitable models to formally represent and analyze Value Systems within the scope of collaborative networks.

This thesis proposes a set of models and formal mechanisms for specifying and analyzing Value Systems in collaborative networks. The development of models and methods followed a hybrid approach, where qualitative and quantitative techniques are used in order to represent and analyze the Value System. A web application was designed and a prototype developed in order to show that the models and methods proposed can be implemented by a computer program and can be integrated into a single framework in order to support Value Systems management within the scope of collaborative networks.

The application of a multifaceted and systematic validation strategy, supported by the "Square Validation Framework" brought together a set of preliminary results that attest the theoretical and practical relevance of the proposed approach and allow us to conclude that: (i) it is possible to define and analyze Value Systems in collaborative networks, considering the economic and sociologic approach, in an integrated and unambiguous way, (ii) the potential impacts between Value Systems in collaborative environments can be inferred if the typical influences among core values are known and the preferences of the actors, regarding those values, are identified; (iii) the identification and assessment of Value Systems misalignments would be improved if qualitative and quantitative assessment methods integrating the notion of shared-values, potential for conflict and positive impacts were developed.

Key-words: value systems, collaborative networks, causal maps, graph theory

Sumário

A adopção de um modelo de negócios baseado em redes colaborativas representa uma mais-valia para as pequenas e médias empresas no contexto actual de mercado. No entanto estudos empíricos mostram que muitas iniciativas de colaboração inter-organizacionais falham devido a conflitos internos. Estes conflitos são originados, inúmeras vezes, pela existência de diferentes percepções sobre a utilidade e importância das coisas. Portanto, a identificação dos principais elementos que influenciam os valores, no contexto de uma rede colaborativa, e as diversas perspectivas para os avaliar, são um aspecto importante numa gestão sustentável. É também frequentemente defendido que o alinhamento entre parceiros organizacionais é um elemento chave para o sucesso do trabalho colaborativo. Assim sendo, a capacidade de aferir rapidamente um alinhamento de valores entre parceiros, representa um factor importante para o aumento de parcerias sustentáveis.

Esta tese propõe um conjunto de modelos e mecanismos formais para especificar e analisar Sistemas de Valores em redes colaborativas. O desenvolvimento dos modelos e métodos propostos segue uma abordagem híbrida, técnicas qualitativas e quantitativas são utilizadas de forma a contemplar os conceitos envolvidos e a suportar distintas formas de análise. Com o objectivo de mostrar que os modelos e métodos propostos são computacionalmente implementáveis e que podem ser integrados de forma a suportarem a gestão de Sistemas de Valores em redes colaborativas, uma aplicação Web é proposta, sendo desenvolvido um protótipo da mesma.

A adopção de uma estratégia de validação sistemática e multifacetada inclui entre outros: a validação dos indicadores propostos utilizando casos reais de parcerias entre organizações; a realização de experiências que evidenciaram a adequabilidade dos modelos propostos, assim como a realização de testes de usabilidade dos modelos e métodos de avaliação. Tudo isto, permite reunir um conjunto de resultados preliminares que atestam a relevância teórica e prática da abordagem adoptada e que suportam as seguintes conclusões: (i) é possível implementar um modelo que integre a representação das noções de valor propostas pela Sociologia e Economia; (ii) os impactos potenciais entre sistemas de valores numa rede colaborativa podem ser aferidos, se a influência entre *valores essenciais* for conhecida assim como o grau de importância de cada um destes; (iii) a identificação e avaliação dos desalinhamentos entre Sistemas de Valores no âmbito das redes colaborativas pode ser melhorada se for implementada uma abordagem que integre múltiplas perspectivas sobre o conceito de alinhamento.

Palavras-chave: sistema de valores, redes colaborativas, mapas causais, teoria dos grafos.

Table of Contents

List of Figures

List of Tables

Acronyms

CN	Collaborative Network
CVS	Core Value System
V-AligN	Value Systems Alignment Analysis for Collaborative Networks
VBE	Virtual Organizations Breeding Environment
VO	Virtual Organization
VS	Value System

1

Introduction

The purpose of this chapter is to introduce this dissertation, briefly explaining why it is so important to develop models and mechanisms to analyze Value Systems in the context of collaborative networks. The research questions and hypothesis are presented. It follows the discussion of the research method adopted to find a solution to the proposed challenges. Furthermore, the main findings and the processes adopted to validate them are briefly described, based on the Constructive Research method. Finally, the chapter presents an overview of the subsequent chapters.

1.1. Problem Domain, Motivation

Business environments have been facing dramatic challenges in recent years, which, combined with the new possibilities provided by advances in information and communication technologies, are leading to the emergence of a large variety of collaborative networks. Literature in recent decades has pointed out that the participation in a collaborative process brings benefits to the entities involved (Porter, 1980; Carlton and Perloff, 2000; Chituc and Nof, 2007). These benefits include not only an increase in "survival capability" in a context of market turbulence, but also the possibility to better achieve common goals (Fujii et al., 2000; Huang and Wu, 2003). However, empirical studies also show that many inter-organizational collaboration initiatives fail (Kelly et al., 2002; Bamford et al., 2004). In fact, a number of requirements are needed to create successful collaborative coalitions, including: sharing of goals among members, having reached a level of mutual trust, having created some common infrastructures and having agreed, totally or partially, on some practices and values (Martins et al., 2004; Afsarmanesh and Camarinha-Matos, 2005; Bititci et al., 2007).

In Psychology and Sociology, values have typically been conceptualized as shared beliefs about desired behaviors and end-states (Rokeach, 1973). These shared beliefs address goal pursuit processes and outcomes. Moreover, Merton (1957) advocates that the cultural objectives of an organizational unit are the "Things worth striving for" - the things that are valued. Value has also been defined as "relative worth, utility, or importance: degree of excellence" (Webster, 1989). This definition highlights the fact that an object's value depends on the referential that is used in the evaluation. Depending on the referential, the same object

may be valued differently. Thus, inside an organization, cultural and social values are used as the referential for evaluations. In the case of partnerships, if organizations have different values, they will have a different perception of outcomes, which might lead to non-collaborative behavior and inter-organizational conflicts. Cases of inter-organizational failures due to the fact of conflicting values and cultural issues are documented in (Findlay-Brooks et al., 2007; Stott, 2007). Therefore, the identification of the main elements that generate value in the network, and the diverse perspectives to evaluate them are important aspects in the collaborative network operation. Moreover, studies (Materu et al., 2000; Wondolleck and Yaffee, 2000; Mattessich et al., 2001; Zhang et al., 2008) show that joint setting of priorities enhances the performance of the collaboration. However, this collaborative act implies that organizations have the means to explicitly define their values, priorities and evaluation policies. Furthermore, several authors (Nonaka, 1991; Sveiby, 1997; Sullivan, 2000; Allee, 2008) defend the importance of managing intangible issues, such as social capital and cultural capital for the sustainability of organizations.

It is often stated that the alignment among the members involved in collaborative processes is a pre-requisite for successfully co-working. However, the concept of "values alignment" is difficult to define. Nevertheless, it can be intuitively understood that when the core values of one member are incompatible with the core values of another, there is a misalignment and the potential for conflict is high (Jehn et al., 1993; Adkins et al., 1996; Kehoe and Ponting, 2003). Reciprocally, when the core values of a member are compatible with the core values of another member, there is an alignment and the potential for emergence of conflicts is lower. The existence of a total alignment does not imply the total elimination of conflicts, but an assessment of the level of alignment enables the causes for conflicts are better understood and thus mechanisms may be designed for the progressive resolution of problems. Consequently, the level of alignment might work as a predictive indicator of the capacity that a coalition has for reaching agreements when conflicts arise during a collaborative process. In this sense, the ability to quickly identify partners with a strong values alignment can represent an important boost for successful coalition formation.

In engineering, models are the starting point to analyze, design and build. In this case, the development of models to represent values, priorities and evaluation mechanisms in the context of partnerships will be the starting point to analyze "values alignment" among potential partners, and to design methods and tools to support "values alignment" management in collaborative contexts.

Values, priorities and evaluation mechanisms have been studied in the context of Value Systems in distinct scientific disciplines, but there is not yet a common conceptualization about a Value System. Moreover, no existing models in the literature seem to be able to address the representation of a Value System for collaborative environments in order to

support the managing of values, priorities and evaluation mechanisms in an integrated manner. Aspects of a different nature must be considered for the specification and analysis of Value Systems in collaborative environments; hence they can hardly be covered by a single modeling approach. For that reason, the development of a hybrid approach, where qualitative and quantitative techniques are used may bring advantages. The selection of one approach depends in part on the characteristics of the information and knowledge available. When detailed and precise data is available, quantitative techniques can be easily applied, which have the advantage of producing precise results and models. However, when conducting organizational studies we usually have to deal with qualitative information, such as: sign of impacts and effects, ranges and directions of variable changes (Lang, 2000; Ragin, 2000). Nonetheless, this kind of qualitative information is often sufficient to satisfactorily explain and predict organizational behavior. In many situations most of the knowledge at hand is of a qualitative nature rather than exact numerical values (Lang, 2000; Luna-Reyes and Andersen, 2003), thus, in these cases, it is preferable to adopt a qualitative approach . Therefore, it could be expected that the development of Value System models that support not just a quantitative analysis, but also a qualitative one, would provide more effective mechanisms to support decision makers in partnerships management.

1.2. Research Questions and Hypotheses

The above section presented an overview of the problem this thesis addresses. It was emphasized that in spite of the fact that several partnerships fail due to values misalignment, there are no formal models and methods available to support partnership managers in the analysis of Value Systems in a collaboration process. Therefore, this research aims to contribute with a conceptual analysis framework that supports the qualitative and quantitative analysis of Value Systems alignment in collaborative network environments.

Main Research Question
What would be an adequate modeling framework to effectively support the specification and analysis of Value Systems in collaborative environments?

The following related questions define the main research objectives of this research:

Research Question 1
What would be an adequate conceptual model to specify and analyze Value Systems in collaborative network contexts?

Research Question 2

What would be an adequate conceptual modeling framework to support the analysis of the interactions between Value Systems?

Research Question 3

Which methods are suitable to assess Value Systems alignment in collaborative network contexts?

For each research question one or more hypotheses were formulated. Each hypothesis statement points to a possible solution for the respective research question. The following chapters will present evidence to prove each of the following statements.

For research question 1

Hypothesis 1 - The specification and analysis of Value Systems in collaborative networks, considering the economic and sociological approach can be carried out in an integrated way, if the concepts of values, priorities, and evaluation mechanisms are formally specified in a single model.

For research question 2:

Hypothesis 2 a) - The potential impacts between Value Systems in collaborative environments can be inferred, if the typical influences among core values are known and the preferences of the actors, regarding those values, are identified.

Hypothesis 2 b) - The perception about the interactions among Value Systems in collaborative environments can be (is) improved, if the relations among core values, organizations and networks can be represented using a graphical notation.

For research question 3:

Hypothesis 3 - The identification and assessment of Value System (mis)alignments in the context of collaborative networks will be improved (faster, easier and more precise) if assessment methods are designed to properly capture and integrate the notions of shared values, potential for conflict and positive impact.

1.3. Research Context: ECOLEAD Project

This research work started during the ECOLEAD project. ECOLEAD was an Integrated Project funded by the European Commission under the 6th Framework Program, which aimed to create the necessary foundations and mechanisms for establishing an advanced collaborative and network based industry society in Europe (Camarinha-Matos and Afsarmanesh, 2005b). The project was a 4-year initiative involving 28 partners of different nature and from 14 countries across Europe and Latin America.

The underlying rationale of ECOLEAD was that the efficient launching and operation of virtual organizations require organizational preparedness, both in terms of virtual organizations environment and involved entities. The core research of ECOLEAD addressed three main areas (as seen in Figure 1.1), namely Virtual Organizations Breeding Environments (VBE), Virtual Organizations (VO) and Professional Virtual Communities (PVC). These areas were complemented by research on horizontal ICT support infrastructures and theoretical foundation.

To sum up:

The VO Breeding Environments area aimed to provide a substantial contribution to the VBE concept in terms of understanding and formalization of operating principles, the infrastructures and services to support the VBE life cycle.

The Dynamic of VOs area aimed to contribute to VO management. VO management challenges come from the temporary nature of VOs and the need to react quickly to changes, usually inside turbulent markets. These challenges are also related to the entities involved in the VOs, such as their strategic objectives, commitments, and business cultures.

The Professional Virtual Communities area aimed to leverage the human centered management and exploitation of knowledge and value creation in these types of communities, and to ensure the members' motivation, commitment and welfare.

The Theoretical Foundation area aimed to provide the basis for technology independent understanding of the area and its phenomena, including: (i) to establish a formal modeling foundation for collaborative networks; (ii) to elaborate reference models for collaborative networks; (iii) to develop soft models for collaborative organizations; and (iv) to establish a basis for combination of models.

The ICT horizontal infrastructure area aimed to develop flexible, generic, easy to use and affordable ICT infrastructures (ICT-I) that enhance the development of the collaborative networked organizations paradigm. These common ICT infrastructures include: (i) ICT-I reference framework; (ii) ICT-I Business models, (iii) Security framework, (iv) ICT SOA-oriented infrastructure for collaboration.

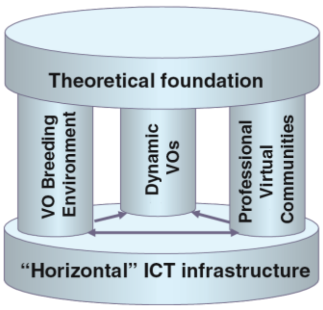

Figure 1.1. The ECOLEAD project (Camarinha-Matos and Afsarmanesh, 2005b)

The ECOLEAD project contributed to the work developed within the scope of this thesis in distinct ways:

- It provided a direct access to know-how on collaborative networks, which was developed inside the project.
- It provided a contact channel to experts on collaborative networks.
- It provided a contact channel to real networks of organizations, since the following networks, ISOIN, CeBeNetworks, ORONA, Swiss Microtech, JSP, Edinform, Supply Network Shannon, and Virtual Fabrik belonged to the consortium.
- It allowed the implementation of experiments using various soft engineering modeling techniques. These experiments covered relevant entities and concepts for collaborative networked organization management, such as: Value System modeling, readiness assessment, trust management, partner selection (Camarinha-Matos and Afsarmanesh, 2008a).
- It provided, from the European Commission reviewers, the useful feedback about the soft modeling experiments in values alignment assessment.

1.4. The Adopted Research Method

Research in engineering and information systems is often applied research, and its objective is to produce results that are applicable in the real world (Galliers and Land, 1987), which requires a different research approach from what is traditional within the natural sciences. Research can be divided into descriptive and prescriptive research. Natural science is mostly descriptive, i.e. an effort to understand the object of study, and design science is prescriptive (or normative), i.e. attempts to improve performance (March and Smith, 1995). The constructive research method (Kasanen et al., 1993) is an approach that is gaining ground within the scope of applied research. This approach is prescriptive and is based on the building of one or more artifacts (such as: models, diagrams, frameworks) that solve a domain problem, in order to create knowledge on how the problem can be solved, and how the solution is new or better than previous ones. The usability of the artifacts can be demonstrated through the actual implementation of the solution.

As an interpretive approach, the constructive research method is usually associated with case studies and qualitative methods, but quantitative methods are also commonly used (Kasanen et al. 1993). According to Kasanen et al. (1993) and March and Smith (1995) natural science deals with explaining natural phenomena, and answering questions like how and why, while design science, on the other hand, attempts to create artificial artifacts that serve human purposes. These artifacts have to be evaluated in order to draw conclusions about the success

of the artifacts in line with the different devised measures. Following the constructive approach, a concept already recognized by scientific community can be applied to solve a specific problem, usually through the development of an artifact (see Figure 1.2). Although March and Smith (1995) consider the building and evaluative activities of design science as separate activities, claiming that "The research contribution lies in the novelty of the artifact and in the persuasiveness of the claims that it is effective. Actual performance evaluation is not required at this stage" (March and Smith, 1995), it is, however, a requirement in the constructive approach to show the worth of the construct.

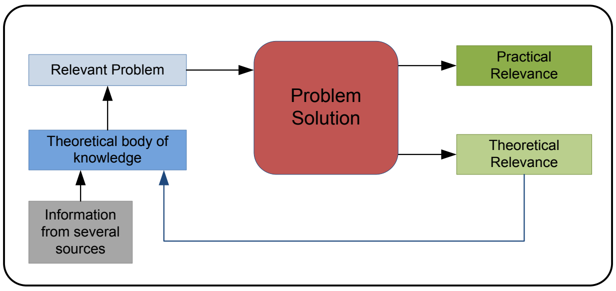

Figure 1.2. Constructive Research method

The main research work in this thesis positions itself in design science, and will thus use the constructive research approach. In fact, the constructive research process can be viewed as an instantiation of the traditional research process, since it follows its main steps, as it can be observed in the Figure 1.3.

	TRADITIONAL SCIENTIFIC RESEARCH PROCESS	CONSTRUCTIVE RESEARCH PROCESS
1	Define Research Question/ Problem	Define Relevant Problem
2	Background/ Observation	Theoretical Body of Knowledge/ Information from Several Sources
3	Formulate hypothesis	Design and implementation of problem solution (an artifact or set of artifacts)
4	Design Experiment	
5	Test Hypothesis	
6	Analyse Results	Show practical and theoretical relevance
7	Publish findings	

Figure 1.3. Traditional scientific research process versus Constructive Research process

Although the constructive research method does not formally specify the definition of scientific hypotheses, this activity is implied, since the design and implementation of a solution requires prior identification of a set of promising solutions followed by the selection of one of them. Thus, hypotheses will reflect the design options, and consequently will guide the research.

For a better understanding of how the research method is applied, a brief description of the instantiation of each element is presented below. This description will also provide an overview of the main findings and of the adopted validation process.

Relevant Problem: In spite of the fact that several partnerships failed due to value misalignment, there are no formal models and methods available to support partnership managers in the analysis of Value Systems within the scope of the collaboration process.

Theoretical body of knowledge: This thesis is based on a growing body of knowledge on distinct scientific topics, namely:

- Collaborative Networks (Molina and Flores, 1999; Wiendahl and Lutz, 2002; Rezgui et al., 2004; Camarinha-Matos and Abreu, 2005; Flores, 2006; Camarinha-Matos and Afsarmanesh, 2008a; Oliveira et al., 2008).
- Value Systems and Value Networks (Wiener, 1988; Zammuto and Krakower, 1991; Gordijn et al., 2000; Sullivan, 2000; Allee, 2002; Goguen, 2003; Liu and Hsieh, 2005; Rekom et al., 2006).
- Graph theory and social networks analysis (Tichy et al., 1979; Freeman et al., 1992; Wasserman and Faust., 1994).
- Causal maps (Greenland and Brumback, 2002) (Eden, 1992b; Eden, 1992a).
- Qualitative reasoning (Kosko, 1986; Montibeller and Belton, 2009).

Problem Solution: The problem solution comprises a set of artifacts that helps solve the previously defined problem. This solution is framed by the set of hypotheses specified in section 1.2 and consists of three components: (i) models, (ii) methods, and (iii) tools. These three components when combined try to give an appropriate answer to the three research questions formulated above.

- <u>Models</u> to represent Value Systems for collaborative environments. A formal conceptual model to represent Value Systems for collaborative networks is proposed. This conceptual model aims to support the economic and sociological view on Value concept. This conceptual model is formalized using a mathematical formalism. Additionally, a conceptual analysis framework is proposed, based on graph theory and causal maps. The combination of graphs and causal maps allow us to visually represent the Value Systems in the context of collaborative networks, and the set of proposed maps are the basis for the development of analysis methods. These two solution components aim to prove hypothesis 1 and hypothesis 2b), specified above.

- Methods (quantitative and qualitative) to assess the alignment level between Value Systems. Two approaches are explored: a quantitative one, and a qualitative one. Both approaches have their strengths and weaknesses, and the selection of one of them depends essentially on the available input data type and on the specific purpose of the analysis. The proposed quantitative approach is essentially based on the matrix representation explored in graph theory. The causal reasoning theory is adopted as the basis for the development of qualitative methods to assess Value Systems alignment. This solution component aims to prove hypothesis 2a) and hypothesis 3 specified above.
- A software Tool to support the Value Systems management and to assist the analysis process for collaborative networks. A *Thin Web Client* architecture is proposed to provide remote access to the application, due to the fact that users are usually dispersed in a network context. A data model to support the Value System Management and a knowledge base to support the inference process are also implemented. This component solution aims to demonstrate how the models and proposed methods can be integrated in order to provide a practical contribution to solve the main problem addressed by this research.

Theoretical and Practical Relevance: The demonstration of the Theoretical and Practical Relevance of the artifacts is sustained by the *Validation Square Framework* (Pedersen et al., 2000). The theoretical relevance of the proposed models and methods is argued through explanation and discussion of the contribution these artifacts make to the following bodies of knowledge: Collaborative Networks, Value Systems and Causal Maps. Within the scope of Collaborative Networks and Value Systems, to what extent the proposed models are suitably adapted to reality is discussed, in the sense that they allow us to represent Value Systems in collaborative network contexts. The scientific contribution is also validated by the scientific community through several publications of distinct forms, namely: journal articles, international conference papers, technical reports and book chapters. The practical relevance of the proposed models, methods and tools is demonstrated through the collection of evidence that shows that the proposed artifacts can be applied in real contexts, bringing new information to support decision-makers.

- A set of illustrative cases show how the models and methods can be applied to provide a better representation and assessment of Value Systems.
- A case-study inside ECOLEAD shows how the set of artifacts can be applied in an integrated way.

- A survey of potential users was carried out in order to validate the user performance of the proposed analysis framework.

A software application was designed and a prototype developed in order to show that the models and methods can be integrated into a unique system, which can be used in practice to support Value Systems management within the scope of collaborative networks.

1.5. Thesis Structure

This dissertation addresses the models, methods and tools that are proposed to support the analysis of the Value Systems in collaborative networks. The basic structure of the thesis follows the main components of the research method adopted (see section 1.4), as illustrated in Figure 1.4.

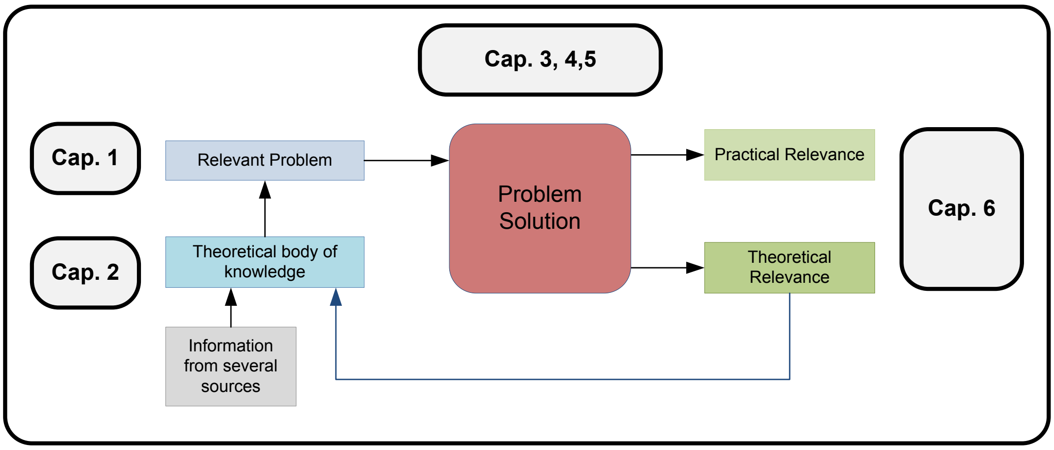

Figure 1.4. Overview of thesis structure

The Problem Solution component is presented in Chapters 3, 4 and 5, as sketched in the diagram of Figure 1.5. The validation is discussed essentially in Chapter 6; however, in early chapters (3, 4 and 5) some artifacts being used as validation elements are presented.

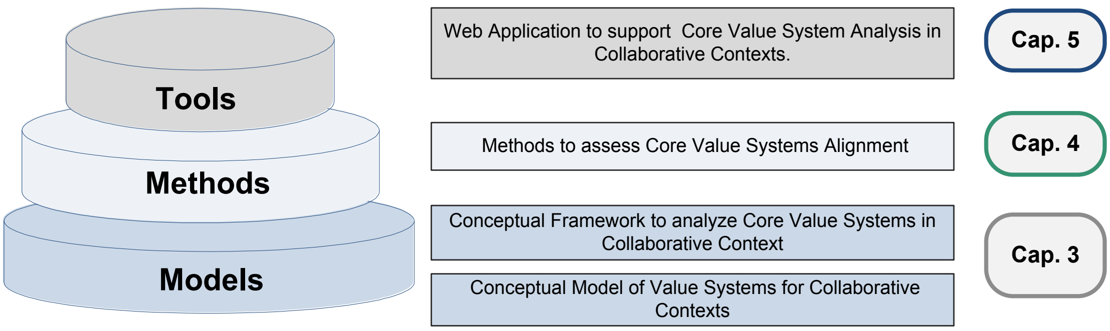

Figure 1.5. Problem Solution presentation and thesis structure

A brief description of the content of the following chapters is presented in order to give an overview of the thesis document.

Chapter 2 - Background and Literature Review: This chapter introduces the concepts needed to better sustain the challenges of this research work. An overview of the main concepts about collaborative networks is introduced, followed by a brief discussion on the modeling approaches to support the representation and analysis of the behavioral and social aspects of Collaborative Networks. In order to discuss the Value System modeling issues, distinct conceptualizations about Value Systems are presented, and some approaches already explored to model them are also briefly described. Given that the analysis of Value Systems is one of the concerns of this thesis, some existing analysis frameworks are discussed, as well as their contributions to the research of Value System analysis in the context of collaborative networks. Finally, an overview of the main open issues found is presented.

Chapter 3 - Conceptual Model of Value System for Collaborative Networks: This chapter presents a conceptual Value System model for collaborative contexts, and a Framework to analyze them. First of all the main elements of a Value System are identified and characterized. Starting from a formal definition of value and evaluation, and preferences, a formal conceptual model of Value System is defined. In order to support the analysis of the alignment between network members' preferences, a specialization of the Value System model - the Core Value System model - is formally introduced. Then, the conceptual analysis framework that was developed in order to analyze the inter-relation between Core Value Systems in a collaborative context is described.

Chapter 4 - Some Methods to Analyze Value Systems in Collaborative Networks: This chapter presents the methods to analyze Value Systems and to assess the alignment level between them. First of all, the chapter discusses the criteria used to compare Value Systems. Then, it presents the two approaches to assess Value Systems alignment, namely, a quantitative approach based on the matrix representation explored in graph theory, and a qualitative approach based on the Causal Reasoning theory.

Chapter 5 - Tool for Analysis of Core Value Systems in Collaborative Networks: This chapter presents the software system designed to support the implementation of the models and the methods proposed in Chapter 3 and Chapter 4. First, the requirement analysis and specifications are presented. The system design specification is then briefly presented and discussed, followed by a description of the strategy adopted to verify the system.

Chapter 6 - Validation and Discussion: This chapter is devoted to the thesis validation. First, it introduces the rationale of the validation process and clarifies the difficulties of performing validation in a work involving organizations in a collaborative context. It describes the validation strategy adopted in the context of the constructive research method. The artifacts that are used in the validation process are presented and discussed.

Chapter 7 - Conclusions and Future work: This chapter presents a summary of the findings and concludes the thesis. The chapter finishes with discussion of further research challenges found during this thesis, and outlines a number of open issues established for future work.

2

Background and Literature Review

This chapter introduces the concepts needed to better sustain the challenges of this research. An overview of the main concepts about collaborative networks is introduced, followed by a brief discussion of the modeling approaches to support the representation and analysis of the behavioral and social aspects of Collaborative Networks. In order to discuss the Value Systems modeling issues, distinct conceptualizations about Value Systems are presented, and some approaches already explored to model them are also briefly described. As the analysis of Value Systems is one of the concerns of this thesis, some existing analysis frameworks are discussed, as well as the contributions they make to the research of Value System analysis in the context of collaborative networks. Finally, an overview of the main open issues found is presented.

2.1. Collaborative Networks

The section aims to give an overview of the basic concepts, terminology and trends concerning Collaborative Networks that delineate the development of this research work, rather than a general literature review about Collaborative Networks. Since part of this research was developed within ECOLEAD project, most of the concepts and terminology adopted concerning collaborative networks have been developed within the scope of this project.

2.1.1 Analysis and Characterization of Collaborative Networks

The notion of a collaborative network is a generic term that embraces a large set of particular cases of collaboration, and has been developed essentially in the last two decades. Industrial clusters, extended enterprises, virtual enterprises and supply chains have been studied as examples of networks of organizations. In literature, diverse taxonomies can be found to classify them (Flores, 2006). For instance, Westkamper and Tutsch (1998) tried to classify these forms of networks according to the duration of collaboration and the relation of dependence and power established among network members, as illustrated in Figure 2.1.

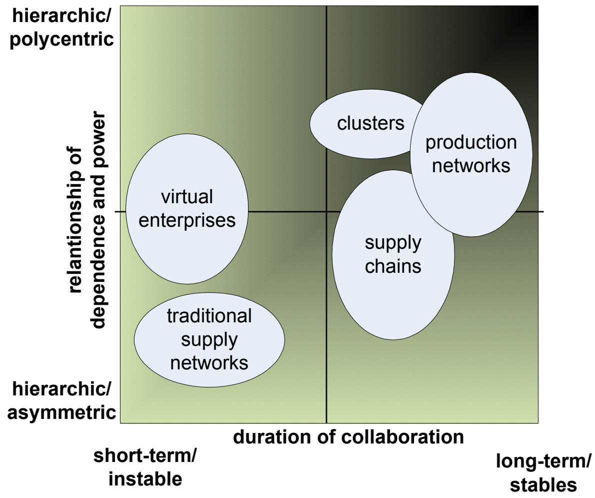

Figure 2.1. Networks classification from Westkamper and Tutsch (1998)

Rupp (2002) proposed that networks could be classified according to their topology. The following three types of topologies were identified:

- Supply chain topology - the partners' interaction pattern mainly follows a chain.
- Star topology - all partners interact with one central hub or strategic centre.
- Peer-to-peer topology - shows high peer-to-peer interaction among all nodes.

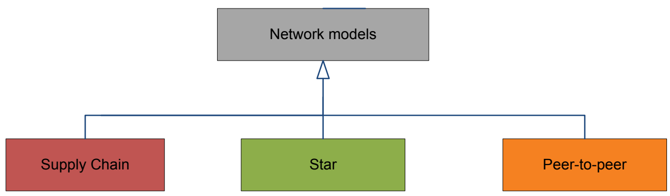

Figure 2.2. Network taxonomy according to its topology (Rupp, 2002)

A completely different approach from Rupp's is the one proposed by Flores (Flores, 2006). Her taxonomy is specific for networking models for innovation. She proposes classifying networks into two types: (i) Intra-Inter Company – the firm as an individual entity or part of a network; (ii) National/Regional – collaboration as a part of a spatial context. Each type is sub-divided into specific networking models, as represented in the diagram of Figure 2.3.

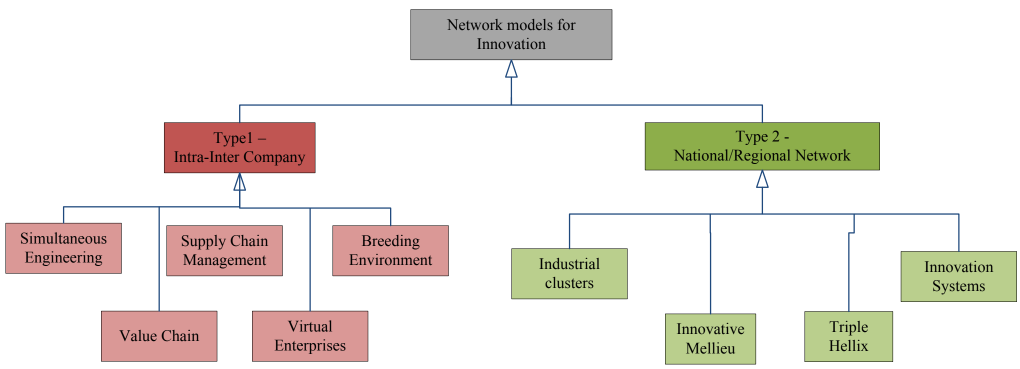

Figure 2.3. Taxonomy for networking models for Innovation (Flores, 2006).

The collaborative network (CN) term was introduced for the first time by Camarinha-Matos and Afsarmanesh (2005a), who established that a *collaborative network is a network consisting of a variety of entities that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but who collaborate to better achieve a common or compatible goal, thus jointly generating value, and whose interactions are supported by computers*. They have carried out extensive work on collaborative networks (Camarinha-Matos and Afsarmanesh, 1999; Camarinha-Matos and Afsarmanesh, 2003; Camarinha-Matos and Afsarmanesh 2004; Afsarmanesh and Camarinha-Matos, 2005; Camarinha-Matos and Afsarmanesh, 2006; Afsarmanesh et al., 2008b; Afsarmanesh et al., 2009), proposing a more comprehensive taxonomy to classify collaborative networks, which is summarized in Figure 2.4.

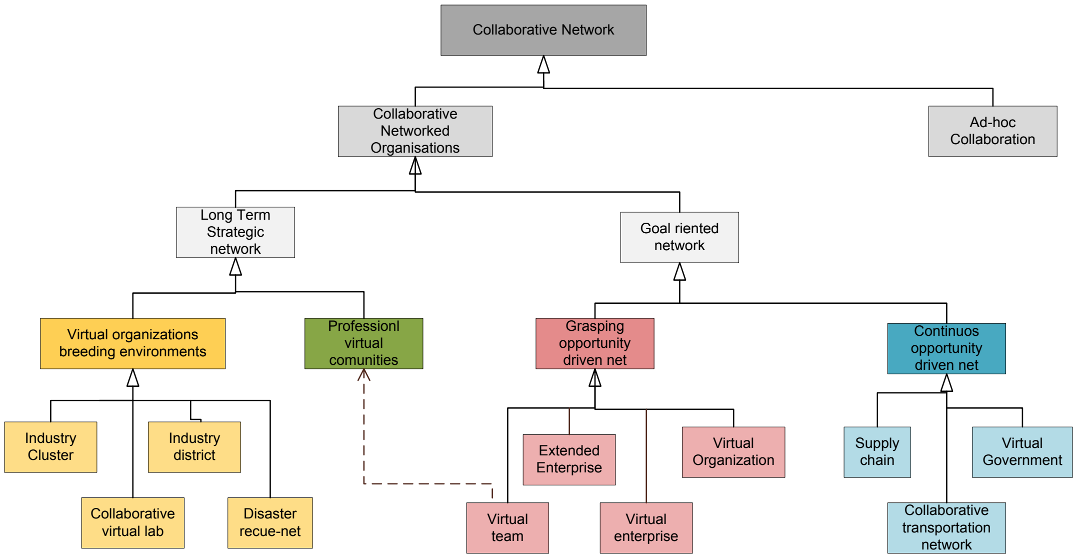

Figure 2.4. ECOLEAD taxonomy for collaborative networks (Camarinha-Matos and Afsarmanesh, 2005a)

This taxonomy subdivides the CNs into collaborative networked organizations (CNOs) and Ad-hoc collaboration. CNOs are networks that *imply some kind of organization in the activities of their constituents, identifying roles for the participants*, *and some governance rules* (Afsarmanesh et al., 2008b); Ad-hoc collaboration processes are more spontaneous forms of collaboration, such as the ones that emerge in virtual communities that are not business oriented. CNOs are classified into two main groups, the ones that are goal oriented networks and the ones that are long-term strategic networks. The long-term strategic networks are created with the main purpose of engaging and supporting collaboration opportunities. These networks are formed by individuals or organizations where a set of basic infra-structures is developed, and a set of common operating principles is established. The goal-oriented networks, on the other hand, are of a temporary nature and formed to achieve a specific collaboration opportunity.

This taxonomy specifies two classes of Long-Term Strategic Networks, the Virtual Organization Breeding Environments (VBE) and the Professional Virtual Communities (PVC). A VBE is defined as: *an association of organizations and their related supporting institutions, adhering to a basic long-term cooperation agreement, and adoption of common operating principles and infrastructures, with the main goal of increasing both their chances and their preparedness towards collaboration in potential Virtual Organizations* (Afsarmanesh and Camarinha-Matos, 2005). Also, according to these researchers, a PVC *is an alliance of professional individuals that aims to be prepared for collaboration under a business perspective, and provide an environment to facilitate the agile and fluid formation of Virtual Teams (VT) to respond to business opportunities*. VTs are temporary coalitions of experts that share resources and expertise in order to accomplish a specific task, and whose interactions are supported by computer networks, while VOs are considered to be *a set of collaborating independent organizations, which to the outside word provide a set of services and functionality as if they were one organization, supported by computer networks* (Camarinha-Matos et al., 2006). In this approach there is a correspondence between PVCs and VBEs and between VOs and VTs. While VBEs and VOs are networks composed of organizations, PVCs and VTs comprise of individuals.

During its lifetime, a collaborative network goes through different stages, and each stage has a set of partial goals to be achieved and a set of specific tasks to be executed. There is however no one single model for a network life-cycle. Some of the models found in the literature review are summarized in Table 2.1.

Table 2.1. Network life-cycle models (adapted from (Zaidat et al., 2005))

<table>
<tr><th>Sources</th><th>(Hoffmann and Schlosser, 2001)</th><th>UCANet project (2002)</th><th>(Strader et al., 1998)</th><th>(Loeser, 1999)</th><th>(Camarinha-Matos and Afsarmanesh, 1998)</th></tr>
<tr><td rowspan="6">Phases (Stages)</td><td>Strategic analysis</td><td rowspan="3">Partners search and constitution</td><td>Identification</td><td>Initiation</td><td rowspan="3">Creation</td></tr>
<tr><td>Search of partner</td><td rowspan="2">Formation</td><td>Configuration</td></tr>
<tr><td>Designing the partnership</td><td>Design</td></tr>
<tr><td rowspan="2">Implementation and management</td><td rowspan="2">Operation</td><td rowspan="2">Operation</td><td rowspan="2">Operation</td><td>Operation</td></tr>
<tr><td>Evolution</td></tr>
<tr><td>Termination</td><td>Reorganization</td><td>Termination</td><td>Disbandment</td><td>Dissolution or Metamorphosis</td></tr>
</table>

As this dissertation will be focused on the collaborative networks of organizations, either VBEs or VOs, it is relevant to understand the singularities of each life-cycle phase in order to develop the operating principles, infrastructures and services to support each CN type. From

these five models, the one proposed by Camarinha-Matos and Afsarmanesh is the only one that details the main tasks to be executed at each stage, differently according to each distinct collaborative network type. Namely, they detailed the different stages of the VBE's and the VO's life cycles, as the steps involved in VBE management are somewhat different from the steps involved in the management of the VO. These differences are due to the fact that VBE and VO have distinct business goals. While a VBE is a long-term cooperative association that does not intend to respond to a specific business opportunity, but to prepare its members in order to be ready to collaborate, a VO is a short-term association that is created to respond to a specific business opportunity.

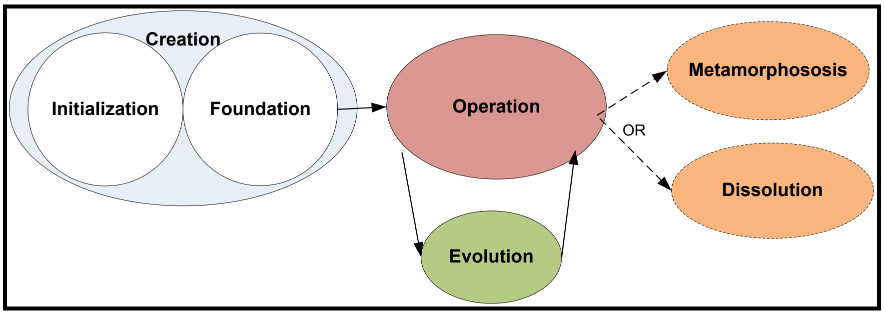

Figure 2.5. VBE life-cycle

The creation phase of the VBE (Afsarmanesh and Camarinha-Matos, 2005) consists of two sub-phases: (i) Initiation and the recruiting sub-phase, where a common ICT infrastructure is implemented, while potential organizations to join the VBE are recruited; (ii) Foundation sub-phase where support systems are set up and founding members are registered, and the set of governance principles and rules that will guide the VBE life cycle are defined, as well as the ontology to be adopted.

The VBE operation and evolution phase comprises essentially the assisting of VO creation and support activities such as management of competencies and assets, registration of new members, management of ontologies for the domain/sector, assessment of the collaboration processes, guaranteeing that principles and rules are understood and shared by all VBE members, and acquisition and management of common knowledge and assets. The VBE metamorphosis phase occurs when the VBE has a relevant transformation. In this case the new organizational structure is designed, the information is reorganized and the knowledge collected during the VBE operation is analyzed according to the new organizational context.

The VO formation process can take place in two different ways (as illustrated in Figure 2.6):

- **Direct way**: when a business opportunity is identified, the members that are to form the VO are selected from the "open universe" of organizations (case 2 in Figure 2.6).

- **Indirect way**: when a business opportunity is identified during the Operation phase of the VBE the members that form the VO are selected from among the VBE members (case 1b in Figure 2.6). The VBE members have been previously selected from the "open universe" of organizations (case 1a in Figure 2.6).

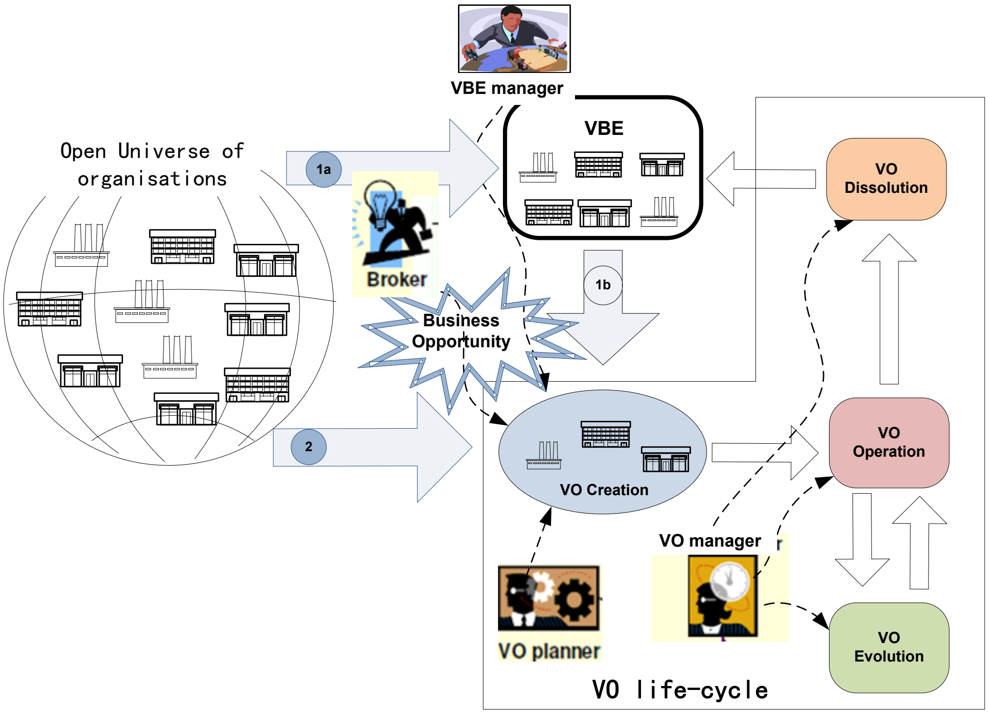

Figure 2.6. Roles in VO life cycle

Therefore, if the VO is created in the indirect way, the VBE takes a central role in the VO creation process, and major roles can be played by a large number of VBE actors (Afsarmanesh and Camarinha-Matos, 2005), these main roles are (see Figure 2.6)

- ***VBE Member -*** this is the basic role played by those organizations that participate in the VBE activities.
- ***VBE Manager*** *(or VBE administrator)* - performed by the organization responsible for the VBE operation and evolution, promotion of cooperation among the VBE members, daily management of the VBE general processes (e.g. assignment/reassignment of rights to different actors in the VBE, based on their responsibilities, conflict resolution, preparation of VBE assets, and drawing up common VBE policies etc.).
- ***Opportunity Broker*** or simply ***Broker*** - performed by a VBE actor who identifies and acquires new collaboration opportunities (of business nature or others), by marketing VBE competencies and assets and negotiating with potential customers.
- ***VO Planner*** or (business integrator) - performed by a VBE actor who identifies the necessary competencies and capacities, selects an appropriate set of partners,

and structures the new VO. In many cases the roles of *Opportunity Broker* and *VO Planner* are performed by the same actor.

- ***VO Manager*** *(or* VO coordinator) - performed by a VBE actor who will coordinate a VO during its life cycle in order to fulfill the goals set for the collaboration opportunity that triggered the VO.

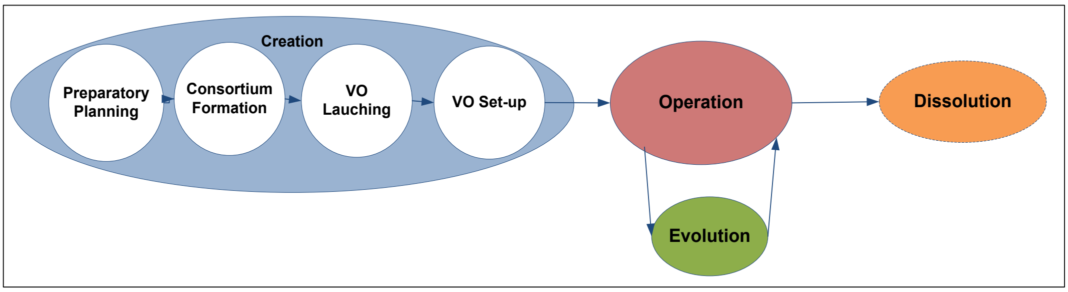

Figure 2.7. VO life-cycle phases

The life cycle of the VO, similarly to the VBE's life cycle, consists of four main stages: Creation; Operation, Evolution and Dissolution (see Figure 2.7).

If VO creation process is indirect and the contract for a new collaboration opportunity is already ''guaranteed'', the VO creation process is conducted essentially by the VO planner and includes the following sub-phases (Camarinha-Matos et al., 2005): (i) the preparatory planning phase begins with the identification and characterization of the collaboration opportunity, followed by the rough VO planning where a draft structure of the potential VO are determined; (ii) the consortia is formed based on the prior characterization and rough plan and mainly includes: (a) the search for partners and suggestions, where the partners are identified and selected; (b) the negotiation that comprises the steps needed to reach an agreement about the balance between the needs and the offers; and VO composition in which the organizational structure and assignment roles of VO members are defined; (iii) the VO launching phase begins with the detailed VO planning, the main activities of which are refining the initial VO plan and the specification of its governance principles; this is followed by the contracting phase that involves the final formulation and modeling of contracts and agreements as well as the contract signing; and (iv) the VO setup phase is the last phase of the VO creation process, and its main goal is to put the VO into operation. This phase includes the following main tasks: configuration of ICT infrastructures, instantiation and orchestration of the collaboration spaces, setting up of VO governance principles, assignment and set up of resources.

The activities of the VO operation phase depend on the business core of the VO, but are essentially the execution of the activities planned in the VO launch phase. The activities of VO operation management essentially comprise activities of monitoring and control of the VO performance as a whole. During the VO evolution phase rescheduling of activities, reassigning

milestones and reallocating budget might occur, in order to meet the changed VO conditions. When the VO dissolution phase arrives, one of the fundamental activities is to save useful experience of the VO to be used in the VBE and future VOs. Thus, the data to be stored is selected and the information is packaged and transferred for storage in the VBE. Regarding VO's inheritance is fundamental to define responsibilities and liabilities.

From this short description of the main activities that comprise each stage of the VO and VBE life cycles, we can recognize that in order to create sustainable and "efficient" CNs a huge set of structural, functional and behavioral issues has to be managed in an integrated way. Moreover, in our opinion the identification of the social and behavioral aspects (tangibles and intangibles) that influence the behavior of the CN, as well as how these aspects are related to the functional and structural aspects of CNs, is a key condition to improve the sustainability and performance of CNs.

2.1.2 Modeling Collaborative Networks

2.1.2.1 ARCON Reference Model

As it was suggested above, the CN life-cycle management has to deal with a set of distinct items that should be represented in a comprehensive and systematic way, in order to help us deal with the complexity inherent to this kind of system. A modeling framework called ARCON (Afsarmanesh et al., 2008a) has been proposed to support the complexity involving the representation of CNs. The modeling framework divides this complexity into three perspectives (see Figure 2.8), in order to cover all relevant aspects of the Collaborative Networks (CNs), in terms of life-cycle stages and environment characteristics.

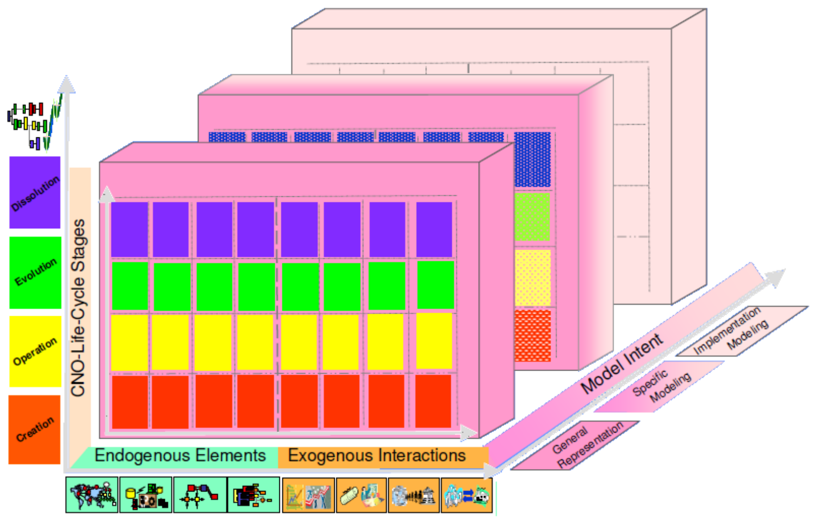

Figure 2.8. ARCON modeling framework (Afsarmanesh et al., 2008a)

- Vertical perspective: Life-cycle stages - This perspective captures the diversity and evolution of CNs during their entire life cycle. It follows the life-cycle model proposed by the authors (see Figure 2.5).
- Horizontal perspective: CN environment characteristics - This perspective includes two subspaces: the internal characteristics as well as the external characteristics that are related to the logical surrounding of the CNs.
    - Endogenous Elements (Endo-E) subspace represents the CN *from the inside*, four dimensions are proposed: (i) the structural dimension addresses the structure or composition of the CN's constituting elements, as well as the roles performed by those elements; (ii) the componential dimension focuses on the individual tangible/intangible elements in the CN's network, e.g. the resource composition, such as human elements, software and hardware resources, information and knowledge; (iii) the functional dimension addresses the "basic functions / operations" available in the network, and time-sequenced flows of executable operations related to the different phases of the CN life cycle; (iv) the behavioral dimension addresses the principles, policies, and governance rules that drive or constrain the behavior of the CN and its members over time.
    - Exogenous Interactions (Exo-I) subspace represents the CN as seen from the outside, with a focus on the interactions between the CN and this environment, four dimensions are defined: (i) the market dimension covers the issues related to interactions with "customers" and "competitors", such as: purpose/mission of the CN, its value proposition, joint identity; (ii) the support dimension covers the issues related to support services provided by third party institutions, such as certification services, auditing, insurance services, training, accounting, external coaching, etc.; (iii) the society dimension covers the issues related to interactions between the CN and society; (iv) The constituency dimension focuses on the interaction with the universe of potential new members of the CN, covering issues such as sustainability of the network, attraction factors, rules of adhesion and specific "marketing" policies for members etc.
- Diagonal perspective: Modeling intention - This perspective is related to different intents for the modeling of CNs. Three layers are considered: (i) The general representation layer that includes the most general concepts and related relations, common to all CNs regardless of the application domain; (ii) The specific modeling layer that includes more detailed models focused on different classes of CNs; and (iii) the implementation modeling layer that includes models of specific CNs.

2.1.2.2 Modeling Approaches

The ARCON Modeling Framework underlines the importance of representing social and behavioral issues, such as: principles, policies, and governance rules, mission, values, when modeling CNs. However, this framework does not propose any specific modeling approach or modeling language to represent each of the aspects covered by the ARCON framework. Preliminary work has already been carried out on the instantiation of the ARCON modeling framework (Romero et al., 2008), as well as work on modeling some of the aspects covered by ARCON, such as: competency modeling (Ermilova and Afsarmanesh, 2007; Ermilova and Afsarmanesh, 2008; Rosas et al., 2009), trust models (Msanjila and Afsarmanesh, 2007), business process models for CNs (Rajsiri et al., 2008), negotiation models (Oliveira et al., 2008), benefit models (Camarinha-Matos and Abreu, 2005).

Modeling is considered a key activity in understanding, designing and implementing artifacts and systems, and is at the heart of any scientific and engineering process. As such, there is a huge number of distinct modeling approaches and tools that come from distinct disciplines and research fields that have some potential to be applied in collaborative networks modeling (a survey of modeling approaches and tools which can potentially be applied in collaborative networks can be found in (Camarinha-Matos and Afsarmanesh, 2008b)). This large number of possibilities makes the selection of a specific modeling approach a challenge. Therefore, although it is out of the scope of this work to discuss this issue in depth, a brief discussion of our understanding of the area follows in order to delineate the work presented in next chapters.

We believe the modeling act is a way to deal with the complexity of a phenomena or an object, and when we are modeling, we are, in fact, representing/describing a set of elements that characterize the domain problem. The resulting model aims to facilitate the analysis process or to guide the design of a solution. However, just as philosophical theories (such as Plato's theory, or Aristotle's theory, or Kant's theory) are a form of interpreting the world, distinct modeling approaches also imply distinct forms of interpretation of the domain problem. For instance, when we select multi-agent systems as the paradigm for modeling the domain problem, we are considering that the domain can be represented by a set of autonomous and distributed entities. If we use Organizational Semiotics, we are describing the information of the domain as being a composition of signals. And when we use the Object Oriented Paradigm, we are describing the system in terms of objects and their interactions. These three examples of modeling constructs do not have any specific mode of representation associated to them. However, models have to use some kind of notation to be represented. Although a model can be represented using just natural language, or using a drawing, usually models are expressed using a specific modeling language. Modeling languages are used to

express information, knowledge or systems in a structure that is defined by a consistent set of rules. It is this set of rules that allows the interpretation of the meaning of components in structures. Unified Modeling Language (UML), First Order language, Z notation, and OWL are examples of distinct modeling languages. The modeling languages can be classified into graphical and textual categories. Graphical modeling languages use a diagramming technique with named symbols that represent concepts, and lines that connect the symbols and represent relations, and various other graphical notations to represent constraints. Textual modeling languages typically use standardized keywords accompanied by parameters to make interpretable expressions. UML is a graphical language, while OWL and Predicate logic languages are examples of textual languages. Another group of modeling approaches is characterized to have a reasoning mechanism associated to them, such as: Social Network Analysis, Bayesian Networks, Fuzzy Logic, Graphic Theory and Qualitative Reasoning.

Table 2.2 gives a brief description of some modeling approaches from distinct areas that can potentially be applied to model the cognitive and behavioral aspects of CNs.

Table 2.2 . Examples of modeling approaches

Modeling Approach	Description	Areas of Application
Multi-agent systems	In the Multi-agent Systems paradigm the systems are deemed to be made up of many autonomous and distributed agents. It is applied essentially to model distributed and autonomous Systems.	Artificial Intelligence.
Semiotics	Organizational Semiotics focuses on the concept of signs as a basis to specify information. It is applied essentially to model knowledge and information.	Computer Science, Social Sciences.
Fuzzy logic	Fuzzy Logic is derived from fuzzy set theory. In Fuzzy logic reasoning mechanisms are based on "degrees of truth" rather than the usual "true or false" (1 or 0). It is used to model fuzzy data, feedback control systems, and inference system.	Control Engineering, Artificial Intelligence.
Belief Networks	A belief network represents the believed relations within a set of variables which are relevant to the problem. It is commonly represented as a graph, in which vertices represent variables, and the edges represent the conditional dependencies in the model. The reasoning rules apply the Bayesian probability theory.	Artificial Intelligence.
Qualitative Modeling & Causal Modeling	Qualitative reasoning is an approach used to perform analysis of variables with incomplete or with the lack of quantitative data. It can create representations for continuous aspects of the world, such as space, time, and quantity, which support reasoning with very little information. One approach for qualitative reasoning is causal reasoning.	Physics, Social Sciences, Business.
Graph Theory	Offers an abstract representation for the network in terms of a set of linked nodes. The relations can be described based on algebraic notation. It provides a means for quantifying some structural properties and allows optimization.	Electrical Engineering, Artificial Intelligence.

(continue Table 2.2)

Modeling Approach	Description	Areas of Application
Social Network Analysis	Social networks analysis is one of the known applications of graph theory where the nodes are the individual actors (persons, groups, organizations or groups of organizations) within the networks, and ties are the relations between the actors.	Social Network Analysis
Petri Nets	A Petri net is one of several mathematical modeling languages for the description of distributed systems. It is a directed bipartite graph, in which the nodes represent transitions and places.	Electrical Engineering, Real Time Systems. Software Engineering
IDEF	IDEFØ is a method designed to model the decisions, actions, and activities of an organization or system. IDEFØ has an associated graphical language and is a standard for functional modeling.	Computer Sciences, Management Engineering.
Predicate Logic	The formal language used to represent Predicate Logic Systems. Predicate Logic is the branch of logic that deals with quantified statements such as "there exists an x such that..." or "for any x, it is the case that…" where x is a member of the domain of discourse.	In almost all Engineering Fields.
Deontic Logic	Deontic logic is the study of the logical relations among propositions that assert that certain actions or states of affairs are morally obligatory, morally permissible, morally right or morally wrong.	Artificial Intelligence.
UML	A graphical language that essentially supports the object oriented paradigm. Allows modeling human-human and human-machine interactions. Also allows the decomposition and logical structuring of activities on an elementary level.	Software Engineering, Organizational Engineering.

The selection of a specific modeling approach to represent and analyze a specific aspect of CNs depends on multiple factors and is not a straightforward process. We almost always have to combine two or more modeling approaches to support the modeling needs. In conclusion, it is useful to have some guidelines that help us in the selection process.

Within the scope of the business modeling process, Curtis (1992) has argued that a set of characteristics should be taken in account when we select a modeling technique. These characteristics are:

- **Granularity and Precision** - Granularity refers to the level of detail necessary to represent the subject. Some subjects may require different levels of granularity. Precision refers to the level of accuracy necessary to represent the subject. Usually formal languages provide more accurate models.
- **Fitness and Prescriptiveness** - Fitness refers to the ability of the model to faithfully describe the object in accordance with its purpose. For instance, if we want to model a norm, we need to have a modeling language that supports the modeling of permissions and obligations. Prescriptiveness (or scriptiveness) refers to the degree to which the model can be faithfully (without ambiguities) followed. Example: if the resulting model can be translated automatically to a computer program, then the model has a good level of prescriptiveness.

- **Formality** – It refers to the level of formalism required to represent the elements, and depends on the requirements of precision and the goal of the model. For instance, to be translated into a computer language a model needs a higher degree of formalism than a model that just has to be interpreted by humans.

In this work, we will use this approach, suggested by Curtis, to assess if the selected modeling techniques are adequate.

Within the scope of the ECOLEAD project several experiments have been carried out to develop innovative approaches to deal with some complex issues concerning cognitive and behavioral aspects of collaborative networks, like: Trust Assessment (Msanjila and Afsarmanesh, 2007; Schmidt et al., 2007); Competency assessment (Rosas et al., 2009), VO / VT Partner's selection (Dingwei et al., 2002; Jarimo and Salo, 2008), VO coordinator selection (Pereira-Klen et al., 2008). These experiments have applied some soft modeling methods (Causal Models, Fuzzy Logic, Belief Networks, Qualitative models, etc), since they seem to be more suitable to represent and analyze the CN aspects of a socio-organizational and anthropocentric nature. Behaviors, perceptions of value and importance / priority of things, emotions, preferences, working habits, ethical values, level of trust and competences are examples of these kinds of issues that should be considered when conducting CN management.

However, the experiments carried out have indicated that the specification and analysis of the processes that deal with these issues such as: trust assessment, partner selection, conflict resolution, preparedness assessment, can hardly be comprehensively covered by a single model or modeling approach. For that reason, the development of a multi-approach, where diverse modeling approaches are used and integrated has begun to be explored in diverse studies within the scope of modeling CNs (Abreu and Camarinha-Matos, 2008; Msanjila and Afsarmanesh, 2008; Pereira-Klen et al., 2008). Nevertheless, in most cases the integration of these hybrid solutions in services is still in an experimental phase. Some examples of common modeling approaches used to model cognitive and behavioral aspects of collaborative networks are summarized in Table 2.3.

Table 2.3. Modeling approaches (examples) to model behavioral and social aspects of CNs

Modeling Approach	CN Modeling Aspect	Authors/ project
Multi-agent systems	The behavioral and social dimension (in terms of values and norms) of networks.	(Filipe, 2003)[a]
		(Antunes and Coelho, 1999)[b]
	Trust assessment	(Schmidt et al., 2007)
Organizational Semiotics	The behavioral and social dimension (in terms of values and norms) of networks.	(Filipe, 2003) Note: The same as in [a].
Fuzzy logic	Trust Assessment	(Mun et al., 2009) (Schmidt et al., 2007) (Liu and Ding, 2008)
	Partner Selection	(Jarimo and Pulkkinen, 2005)
Belief Networks	Partner selection: assessment of preparedness to collaborate.	(Rosas and Camarinha-Matos, 2008) [c]
	Cooperative learning process: analyze the individual aspects of the student, as affective states, personality and acceptance, and group aspects, as cohesion.	(Boff et al., 2006)
Social Network Analysis	Collaboration Benefits	(Abreu and Camarinha-Matos, 2008) [d]
Qualitative Models	Trust Assessment	(Msanjila and Afsarmanesh, 2008)
Predicate Logic (Language)	To formally define concepts related to social and behavioral aspects, such as: (1) soft competences, (2) trust, (3) preparedness for collaboration and character, (4) values and priorities, and (5) benefits.	(Rosas et al., 2009) (Msanjila and Afsarmanesh, 2007) (Rosas and Camarinha-Matos, 2008) Note: The same as in [c]. (Antunes and Coelho, 1999) Note: The same as in [b]. (Abreu and Camarinha-Matos, 2008) Note: The same as in [d].
Deontic Logic	The norms defined to operate inside networks	(Filipe, 2003) Note: The same as in [a].

2.2. Value and Value Systems

Using the different notions of value as the starting point, some contributions on Value System conceptualization are discussed. Afterwards, some modeling approaches already explored to model Value Systems are analyzed, which is followed by a discussion of the main Value System analysis frameworks and values alignment assessment developed in the context of single organizations.

2.2.1 Theory of Value

The concept of value of is a very old and complex one, and has evolved since early times. According to Forgati (1996), the first theories about value began with the Aristotelians' philosophers, who introduced the relation between *value* and utility, and the notion of *value in exchange*. Since then, several philosophers, sociologists and economists have discussed the notion of *value*. Although it is out of the scope of this work to discuss value theory, a brief introduction of the main theories about *value* developed during the 20th century are presented, in order to better understand the conceptual model proposed for Value Systems in Chapter 3.

Value, in its plural form, usually refers to beliefs – "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1973b). Theories about *value*s as a shared belief have been developed in the Sociology and Psychology fields. These theories have been applied to other scientific areas, such as Education (Cooley, 1977), Organizational Management (Krishnan, 2005) and Information System Design (Shneiderman, 1998).

Value, in its singular form, can also be used with different meanings. The concept of *value* involved in the mechanism of exchange is defined as: *how much is given in exchange for a product or service*. This concept was first developed in economic theories, where all products and services are assigned a price, which is the reference *value* used for the exchange. This concept is the basis for the Accounting Systems. In sociological studies, Piaget (1965) and Goguen (2003), Homans (1958) developed theories about the dynamics of *value* exchange, where the notion of *value* is extended from the specific *value-price* and *value-cost* association to a wider use, where the term *value* is associated to *"anything that can give rise to an exchange"* (Piaget, 1965). In this sense, *value*s are not only material objects, but may also be actions, ideas, emotions, social habits, etc. According to Piaget, economic *value* is a quantitative *value*, while social interactions essentially comprise qualitative *value* exchanges.

The concept of *value as the utility of a product or service* considers that *value* comes from the qualitative characteristics of a product or service. Value engineering is an area of Economics that develops methods in order to analyze the *value* of a product, depending on its internal qualities (Cheah and Ting, 2005; Jariri and Zegordi, 2008). According to this notion of *value*, the *value* of something depends on its internal qualities and cost.

The philosopher Robert Hartman (1967) developed the Formal Axiology, which is a branch of Axiology (axiology is a general theory/science of human *value*s, their origins, interrelations and dynamics) that attempts to use a mathematical formalism to define *value* by contemplating different perspectives. Hartman introduced the concept of *dimension of value*, defining three basic dimensions for *value*: *systematic value*, e*xtrinsic value* and *intrinsic value*.

- **Systematic value** - The dimension of formal concepts. Ideas of how things should be. This dimension is the dimension of definitions or ideals, goals, structured thinking, policies, procedures, rules and laws.
- **Extrinsic value** - The dimension of abstracting properties, comparing things to each other. This is the dimension of comparisons, relative and practical thinking.
- **Intrinsic value** - The dimension of uniqueness and singularity. This is the dimension of uniqueness, of people or things as they exist in themselves.

In recent years Holbrook (1999), a marketing researcher, starting from the axiology theory created by Hartman, defined three different perspectives to analyze *value*: (i) Intrinsic versus extrinsic; (ii) Self-oriented versus other-oriented; (iii) Active versus reactive. Based on this analysis, Holbrook proposes the following four classes of *value*s:

- **Utilitarian value** – efficiency and excellence. Example: A specific car has a certain *value* that corresponds to its degree of efficiency and excellence.
- **Social value** –Status and Esteem. Example: A certain company is recognized in the community. The company has a great *value* to the community.
- **Emotional value** – the benefit in terms of the emotions it provokes. Example: Friendships have a great *value* for me.
- **Altruistic value** – the sense of being right or good (ethically and spiritually). Example: The *value* of helping the victims of war.

This classification is the basis for a development of studies in consumer theory, in order to conclude what the motivations behind a purchase are.

Another distinct approach to the theory of *value* has been proposed by the socio-psychologist Stamper (1996). He defined *value* as a type of norm. The different types of norms reflect the different aspects that a social system can share, such as perception, interpretation, cognition and behavior.

- **Perceptual norms** are associated with the attitude of acknowledging the existence of something - Ontological attitude.
- **Evaluative norms** are associated with the attitude of being in favor or against something in *value* terms - Axiological attitude.
- **Cognitive norms** are associated with the attitude of adopting a degree of belief or disbelief - Epistemic attitude.
- **Behavioral norms** are associated with the attitude of being disposed to act in some way – Deontic attitude.

Another interesting contribution to the discussion of values and category of values comes from the knowledge management area. The introduction of the concept of knowledge as an asset to an organization has brought new developments in the notion of *value*. The understanding of

intangibles was a step forward made in the 1990s, through the work of Sveiby (1997). He introduced an accounting approach to explore and manage the intangible assets. Philosophically, his concept of *value* is based on the notion of exchange *value*; however, it has the novelty of dealing with elements that were previously exclusively considered on the social and cognitive areas, in the same manner as dealing with the tangible elements. Along the same lines of research, it is important to refer to the work carried out by Verna Allee (2002; 2008) who clearly defines the notion of economic *value* and the notion of organizational values. This author believes that vision, values and mission are the elements that identify an organization, thus, they are considered intangible assets of the organization.

Ray Zammutto (1991), James Collins (1995), Brian Hall (1995), Verna Allee (2002), and Richard Barrett(2006), are examples of researchers that have developed studies in the area of organizational values. While it is generally assumed that personal values generally reflect what we believe in as individuals, and provide a basic foundation for our lives, organizational values are seen as the values related to desirable conduct, or desirable states of existence for the members of organizations or the organization itself.

By examining the contributions made by different researchers on the concept of *value*, it can be concluded that many of the contributions are complementary. Therefore, as a starting point for our work, we do not select a specific author or philosophical movement, but rather a set of ideas around the concept of *value*, which in our view are complementary and cover the complexity of the term. This basic set of concepts is summarized in the Table 2.4.

Table 2.4. Concepts about *value* notion.

Concept	**Description**	**Researchers**	**Area**
Value as shared belief	Value as an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence.	(Rockeach, 1973a)	Philosophy
Personal value	Values that reflect what we believe in as individuals	(Rokeach, 1973a; Schwartz, 1992)	Psychology
Organizational values	Values related to desirable conduct or desirable states of the existence for the organization's members or the organization itself.	(Collins and Porras, 1996) (Hall, 1995) (Barrett, 2006)	Sociology, Knowledge Management
Value as Mechanism of exchange.	How much is given in exchange for a product or service. Economic value: quantitative nature. Social value: qualitative nature.	(Homans, 1958; Piaget, 1965)	Sociology and Psychology

(Continue Table 2.4)

Concept	Description	Researchers	Area
Value as a Norm	Value is considered as an evaluative norm.	(Stamper, 1996)	Socio-psychology
Value as utility	Value comes from the qualitative characteristics of a product or service, and its cost.	(Cheah and Ting, 2005; Jariri and Zegordi, 2008).	Value Engeneering
Dimensions of value	Value can have different dimensions. Example: Systematic Value, Extrinsic Value and Intrinsic Value.	(Hartman, 1967)	Axiology
Classes of Value	Values can be classified into distinct types. Example: Utilitarian Value, Social Value, Emotional Value, Altruist Value.	(Hoolbrook, 1999)	Marketing
Value as an intangible asset	Intangible assets of organizations are considered as capital. Core values are considered capital.	(Sveiby, 1997) (Allee, 2000b) (Sullivan, 2000)	Knowledge management

2.2.2 Identifying Values

As discussed above, the study of personal values is no longer the exclusive preserve of Philosophy and Psychology, and in recent decades it has become a research issue of Organizational Sociology, Marketing and Management. Studies carried out by (Hall, 1995; Collins and Porras, 1998; Williams, 2002; Barrett, 2006), to develop methods to assess employees' personal values, have shown the importance of shared values within organizations. Starting with personal values, a set of values related to desirable conduct for organizations was defined. Like personal values, an organization's values can also be associated with priorities; thus, inside Sociology and Psychology methods have been developed to access *value* priorities of individuals and communities. Several authors in different fields have denominated *core values* as being the set of priority values, namely (Albert and Whetten, 1985; Goguen, 1992; McWhinney, 1998; Egri and Herman, 2000; Myers and Tan, 2003; Rekom et al., 2006).

Several researchers argue that organizational values are part of the social capital of an organization, defining it as *organizational identity* (Hall, 1995; Hebel, 1998; Allee, 2000b). The focus of this thesis is not on the discussion of taxonomies of organizational values, or forms to capture them; however, in order to clarify how values can be classified and identified inside an organization, a brief overview of the main studies developed on this issue in the last years is presented.

In the early 1960s Maslow came up with a hierarchical set of personal values. The proposed classification is based on the idea that there are primary values (food, shelter, security, etc.) that have to be achieved before a person can look at higher values (for instance: justice, peace). Rokeach was one of the first researchers to suggest a taxonomy of personal values. He classified personal values into instrumental values (referring to preferable modes of

behavior) and terminal values (referring to desirable end-states of existence; the goals that a person would like to achieve during his or her lifetime), where instrumental values are defined as the means to reach the terminal values. His taxonomy defines 18 terminal values and 18 instrumental values. Rokeach's work demonstrated the importance of priorities in the evaluation processes. Twenty years after Rokeach, Schwartz presented his theory on the structure of personal values. One significant feature of his approach is that it does not confine its purpose to the mere distinction of personal *value* types, but the theory specifies a set of dynamic relations among personal values by referring to mutual compatibilities and conflicts. Schwartz developed methods to assess values based on a questionnaire, in which users rank values according to their importance. Other techniques to assess organizational and personal values have also been developed (see Table 2.5). For instance, Badovic and Beatty (1973a; 1987) published an empirical study, where a method to identify and assess the shared values within organizations uses three distinct instrumental techniques, namely interviews, document analysis, and questionnaires.

Table 2.5. Methods to assess core values

Methods	Description
Qualitative interviews	Explorative interviews in order to identify the organizational values and their importance
Quantitative questionnaires	Questionnaires with pre-defined questions.
Document analysis	Semantic analysis of the contents of the main documents of an organization, in order to reason about the core values of that organization.
Discourse analysis	Analysis of the informal discourse of individuals.

Another example comes from Benjamin Tonna and Brian Hall (1995), who developed the *Hall-Tonna Inventory*, which includes questionnaires and document analysis. This method consists of a universal list of personal values that are common throughout all languages and races. They developed some measurement methods, in order to measure the value priorities. These tools were developed on the assumption that personal values are embedded in language, thus they implemented essentially two methods: document analysis and a questionnaire. A composite of the measures obtained by the two previous methods will provide a total corporate assessment. A different approach was recently proposed by Rekom and his colleagues (2006), who developed a method to identify the core values held by organizations, based on their employees' daily actions. This method was empirically tested by them in some organizations, and was developed within the scope of Cognitive Sciences, using causal maps.

These and other contributions to organizational and personal values assessment are summarized in Table 2.6.

Table 2.6. Contributions to instrumental methods for core values identification/assessement

Author	Contribution	Instrumental Methods
	Classification of values into instrumental values and terminal values, where instrumental values are defined as the means to reach the terminal values. 36 values (18 terminal, 18 instrumental) are defined.	Questionnaire
(Rokeach, 1973a; Badovick and Beatty, 1987)	Development of a method comprising an interview, questionnaire and document analysis to measure the shared values within an organization.	Questionnaire, Document Analysis and Interview
(Enz, 1986)	Development of an Organizational Value Scale that intends to measure organizational culture. The measurement is done by filling in a questionnaire, in order to define to what degree a set of values is desirable in an organization.	Questionnaire
(Zammuto and Krakower, 1991)	Development of studies to measure organizational culture in higher Education and public utilities	Questionnaire
(O'Reilly et al., 1991)	Development of the Organizational Culture Profile (OCP), a Q-Sort technique requiring subjects to sort 54 items into nine ordered categories.	Questionnaire
(Schwartz, 1992)	Development of the Schwartz Value Survey- An Online-Tool for intercultural research. By ranking the importance of 57 values, 10 value types on the individual level and 7 cultural value dimensions are displayed.	Questionnaire
(Goguen, 1992)	Introducing a method for using discourse analysis to determine the values of an organization from a collection of stories told by members of the organization among themselves on informal occasions.	Discourse analysis
(Hall, 1995)	Development of the Hall-Tonna Inventory, where a universal list of values, common throughout all languages and races, was specified. Development of some measurement tools, in order to measure values priorities. These tools were developed on the assumption that cultural values are embedded in the language.	Document analysis and Questionnaire
(Cameron and Quinn, 1999)	Development of a Competing Values Framework (CVF) for cultural assessment. Development of The Organization Culture Assessment Instrument (OCAI), which is a questionnaire divided into six categories, in which 100 points are distributed among four sub-items, each representing the four Competing Culture Values.	Questionnaire
(Sarros et al., 2005)	Development of an Organizational Culture assessment. The assessment is based in a questionnaire, where for each organizational culture characteristic the extent to which the organization has this characteristic is defined.	Questionnaire
(Richard Barrett 2006)	Development of Cultural Transformation Tools to map the values of individuals and organizations, and to reason about the alignment between individual values and organizational values. This tool is a software internet based application, where the employees of an organization pick ten values from a list of 90-100 values, previously customized.	Questionnaire
(Rekom et al., 2006)	Development of a cognitive approach proposed by Rekom and his colleagues as a method to identify the core values held by organizations, based on their employees' daily actions.	Interview and Questionnaire
(Bozbura and Beskese, 2007)	Development of methods to assess priorities of cultural organization indicators. The assessment of individual priorities is done by analyzing the answers obtained through a questionnaire.	Questionnaire

2.2.3 Value System Concept and Value System Models

Like the term *value*, the term *Value System* is used in diverse ways and for distinct purposes, often with an unclear meaning. There is no consensus in literature about what a *Value System* is, what elements belong to it, and how these elements can be characterized. A discussion now follows about the distinct conceptualizations of *Value System*, in order to allow a better understanding of the conceptual model proposed in the next chapter.

Sociologists have conceptualized Value System as the ordering and prioritization of the ethical and ideological values that an individual or society holds. Value Systems are applied to a community or society, and may be supported by a legal set of laws and norms. This approach to Value Systems has been adopted by several research areas: education (Cooley, 1977), Organizational Sociology (Hall, 1995; Hebel, 1998; Krishnan, 2005; Barrett, 2006), Information System Design (Shneiderman, 1998) and Artificial Intelligence (Antunes and Coelho, 1999; Filipe and Liu, 2000; Goguen, 2003; Rodrigues et al., 2003).

Goguen (Goguen, 1992; 1994; 1997; 2003) has developed several studies since 1978 about *value* and *Value System* in organizations. These studies introduced a method for using discourse analysis to determine the *Value System* of an organization from a collection of stories told by members of the organization among themselves on informal occasions. The evaluative material collected from the stories is classified and represented using a formal structure called a *Value System* tree. Thus, a *Value System tree* (Goguen, 1994) serves as a formal summary of the interpretation that the analysts gave to the data that was collected. The formal model proposed by Goguen has several limitations: it only considers one type of relation between values (hierarchical relation); it does not make a distinction between *value* and the characteristic that is evaluated; and it does not cover the notion of evaluation.

Some contributions to the study of *Value Systems* come from the Distributed Artificial Intelligence discipline, which offers some theories on *Value Systems* using agents. Antunes and his colleagues (2000) propose an architecture for agents called *BVG* (beliefs, values, goals). This architecture supports the decision-making process and includes goals, candidate actions to be chosen from, beliefs about states of the world, and values about several things, including desirability of those states. Filipe (2003) proposed an approach based on organizational agents, in which it is assumed that an agent is responsible for its values. The agent's preferences with respect to norms are defined in his/her *Value System.* In this approach, an agent may be a member of an organization or an organization itself. This approach to *Value Systems* is a contribution towards a formal model, but it limits the specification of the definition of preferences, and does not include the notion of evaluation, or the notion that objects can have several characteristics to be evaluated.

From another perspective, economists have developed the concept of *Value System* based on the assumption that *value* means how much (usually money) a product or service is worth to someone, relative to other things. This *value* conceptualization theory assumes that *value* is a mechanism of exchange, strictly related to *price* and *cost*. As a result, the notion of *Value System* in Economics is related to the dynamic of *value* creation inside an organization or network of organizations. In Porter's (1980; 1985) perspective a *Value System* can be used as a tool to analyze how a company positions itself relative to other companies. It shows the role of a company in the overall activity of providing a product to a customer, explicitly outlining who the suppliers and what the channels of the given company are.

Following the economic approach on *Value System*, Gordijn and his colleagues (2000) have developed a method and an ontology called *e3-value*, in order to define *value models* that supports e-commerce business. This ontology introduced the concepts of *value object* and *value activity*. It defines an *actor* as an independent entity that adds *value* to the system with the performance of *value activities*. An actor is an economic or legal entity that is engaged in business transactions and exchanges *value objects*. A *value object* is defined as a service, a thing, or a consumer experience that is of *value* to one or more actors. Each *value object* has one or more valuation properties that are characterized by a name and a unit that indicates the scale of evaluation. The *e3-value* model is essentially focused on the economic *value* of objects and on activities and actors that create economic *value* (Gordijn et al., 2000), but does not cover the notion of "shared values", or priorities.

Verna Allee (2000a; 2000b; 2002; 2008) has further extended this concept of *Value System* in order to support a wider notion of *value* under which the term is associated to "anything that can give rise to an exchange", developing the Value Network model. This notion of *Value System* is supported by a notion of *value* that has already been systematized by Piaget (1965), who defended that values are not only material objects, but may also be actions, ideas, emotions, and social habits. Allee's work and the work generally developed within the scope of Intellectual Capital Management (Nonaka, 1991; Sveiby, 1997; Sullivan, 2000), contribute to the convergence of the economic and social approach to *Value System* conceptualization. Another two groups of researchers, Rodrigues and Luck (2005) and Dimuro and his colleagues (2005), have conducted their work on *Value Systems* also based on Piaget's theories on values exchange (Piaget, 1965). Their work concerns the dynamics of values in interactions, and they both essentially focus on the representation of *value* exchange mechanisms. However, they do not use the concept of evaluation mechanism as a basic element to specify *value* transaction between actors.

In conclusion, Table 2.7 summarizes the main Value System Models discussed.

Table 2.7. Some preliminary *Value System* models for organizations

Model	Researchers
Value System tree – This is a formal model, which presents the values of an organization in a hierarchical structure.	Goguen (1994; 2003)
BVG (beliefs, values, goals) – This is a formal model for agents. This model supports the decision-making process and includes goals, candidate actions to be chosen from, beliefs about states of the world, and values.	L. Antunes e H. Coelho (1999)
EDA - This is a formal model based on agent theory, where it is assumed that an agent is responsible for its values, and an agent can represent a member of an organization or an organization itself. The Value System model is a component of the EDA model where the agent's preferences with respect to norms are represented.	J. Filipe and K. Liu (2000)
e3-value – This model was developed to support e-commerce business, and is essentially focused on the representation of economic value of objects and on the activities and actors that create economic value.	Gordijn , Kartseva and Tan (Gordijn et al., 2000; Kartseva et al., 2004; Tan et al., 2004)
Value Network – This model represents the value exchanges with each and every member of the business or organizational network. Where value exchanges can be: goods, knowledge or intangible benefits.	(Allee, 2002)
Value Exchange Model – This model is based on Piaget's theories on value exchange and is concerned with the dynamics of value interactions among agents (these agents can be people or organizations).	Rodrigues and Luck (2003)

2.2.4 Value System Modeling

From the review of literature on *Value System* modeling, we have observed that distinct methods have been used to model Value Systems. We also noticed that several researchers have not used any specific notation to represent their model, and just use textual description or their own graphical schemas. We also observe that almost all of the researchers who use a standardized modeling language or method use mathematical formalisms such as deontic logic, first order logic or algebraic theory. Hartman (1967), in his work on Formal Axiology, proposed a formal representation for value and for *Value Systems* based on algebraic theory. Some semiotic studies also introduced a formal way to represent *Value Systems* also based on formal mathematic languages (Goguen, 2003). The approach based on agents suggested by Filipe (2000), where he attempts to model the *Value System* of an agent (its axiological component), proposes the use of default modal logic (Reiter, 1980). Another cognitive approach was developed by Rekom (2006), who chooses causal maps to represent the cognitive structure of core values.

The table below summarizes the modeling techniques selected by the different researchers studied (see Table 2.2 for a short description of the main modeling approaches).

Table 2.8. Value System models and modeling approaches

Value System/ Values Models	Researchers	Modeling Method/ Modeling Language
Hartman Value Model	Hartman (1967)	Algebraic Theory
Value System Tree	Goguen (1994; 2003)	Algebraic Theory /Semeiotic
BGV	L. Antunes e H. Coelho (1999)	Predicate Logic
EDA	J. Filipe and K. Liu (2000)	Deontic Logic for model norms
e3-value	Gordjnic et al. (2000)	UML
Exchange Social Values Mode	Dimuro et al. (2005)	Intervals Mathematics Theory (Moore, 1966)
Values Model	Rekom (2006)	Causal maps (Qualitative modeling)

2.2.5 Values Alignment

2.2.5.1 The Concept of Values Alignment

Values alignment in an organizational context is a topic that has been studied essentially by social researchers. Alignment is a very broad concept involving consistency, fit, and similar ideas. In the literature review on values alignment, different concepts were found in reference to this term, namely:

- The consistency between the personal exposed values and personal lived values. This alignment criteria is usually called *individual alignment* (Schein, 1996; Harshman and Harshman, 1999), or *personal alignment* (Barrett, 2006).
- The consistency between the existing organizational values and desired organizational values (Badovick and Beatty, 1987; Colins and Chippendale, 1995).
- The compatibility between the set of values of one individual and another individual (Meglino and Ravlin, 1998). The idea of shared values as criteria of alignment is commonly accepted by social researchers (Badovick and Beatty, 1987).
- The alignment between members' values and an organization's values (Colins and Chippendale, 1995; Hultman and Gellermann, 2002; Krishnan, 2005). Some authors denominate this kind of alignment as *interpersonal alignment* (Barrett, 2006).
- The alignment between organizational values and strategy/or goals (Macdonald, 1994; Hall, 1995; Barrett, 2006).

2.2.5.2 Methods to Assess Values Alignment

Much of the work on values alignment does not suggest specific methods to quantitatively calculate or express values alignment, but rather discusses the importance of values alignment and ways to reach this alignment.

Brian Hall and Richard Barrett have defended the importance of fitting the core values held by the organization's members to the core values of the organization. Hall (1995), discusses organizational transformation as a way to achieve alignment between organizational values and organizational strategy. He did not develop specific indicators for values alignment, since his proposal is focused on the organizational transformation process. He argues that organizations should change their set of core values in order to fit a specific profile that fits organizational goals and strategy.

Richard Barrett (2006) considers three types of alignments:

- the consistency between the personal exposed values and personal lived values;
- the consistency between members' values and the organization's current values;
- the consistency between the current organizational values and the desired organizational values.

The alignment is assessed by mapping the values identified as personal values, current cultural values and desired cultural values onto a framework. This framework is called *The Seven Levels of Consciousness,* and classifies the values into 7 categories as illustrated in Figure 2.9.

Figure 2.9. Seven Levels of Corporate Consciousness (adapted from (Barrett, 2006))

Comparing the three maps obtained after mapping the values (Personal Values map, Current Culture Values map and Desired Culture Values map), the alignment is inferred. An example case of values misalignment and another of values alignment is illustrated in Figure 2.10).

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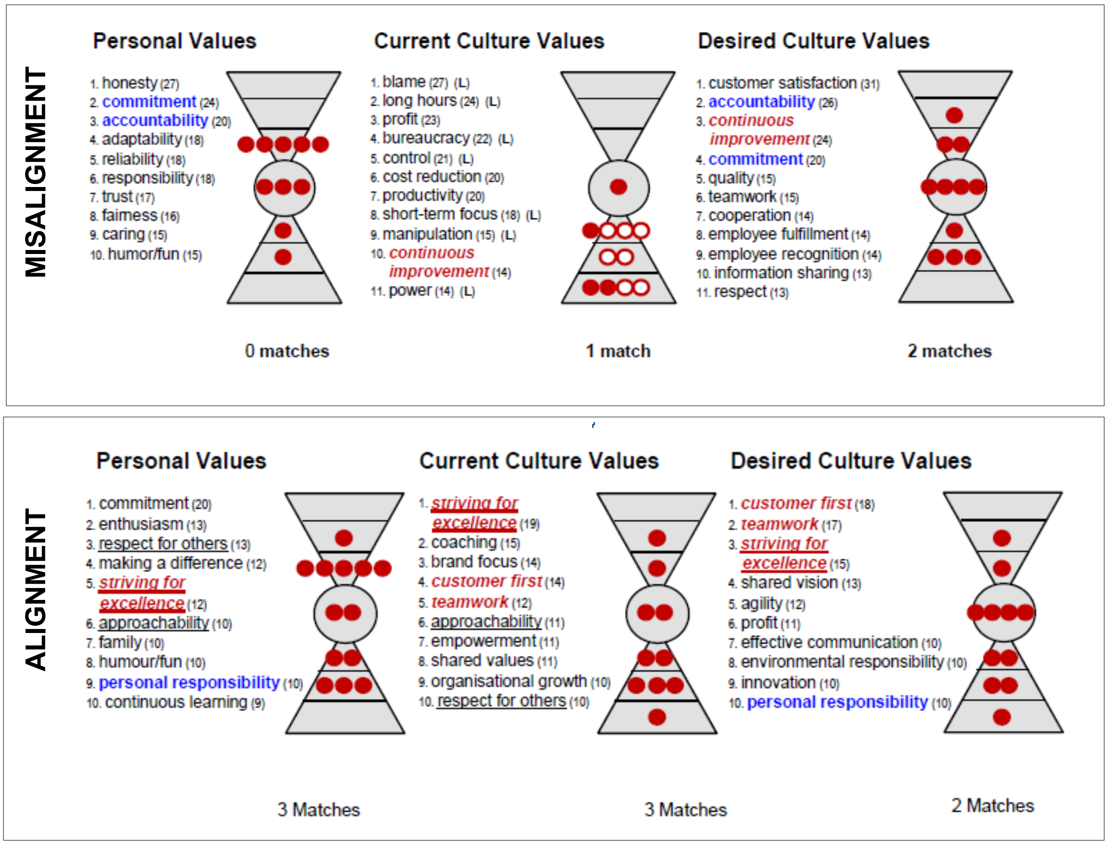


Figure 2.10. Example of values alignment and misalignment (adapted from (Barrett, 2006))

Badovick and Beatty (1987) have proposed a method to quantitatively measure the degree of *value congruency* and the strength of *value consistency* inside organizations. *Value congruence* is defined, as the level of agreement between the individual's *value* perceptions and their desired values. *Value congruence* is calculated by paired t-tests[1] between means for each *value*. This concept represents the degree to which members of the organization are in personal agreement with what they perceive to be the values of the organization. They defined *value consistency* as the level of values shared among individuals. *Value consistency* is determined by analyzing the variance of each measured *value* in conjunction with the mean of each measured *value*.

Krishnan (2005) proposed an indicator to represent the alignment between a leader's Value System and a follower's *Value System*. This indicator measures the similarity between two value systems, and is given by the cosine of the angle between two vectors, where each vector represents a set of values observed. As Krishnan used the Rockeach's Value Survey (see Table 2.6 for details), the values alignment assessment is performed between the instrumental values and the terminal values.

[1] An inferential statistics method that assesses whether the means of two groups are *statistically* different from each other.

2.2.6 Value System Analysis: frameworks and tools

The frameworks and software tools to analyze *Value Systems* have been developed essentially within the field of Organizational Sociology. These analysis frameworks were developed, fundamentally, with two main purposes: (i) to classify organizations according to their value profile; (ii) to analyze the alignment between members' values and organization's values.

Schwartz (1992) developed an online tool for intercultural research called the Schwartz Value Survey. This online tool implements the methods to access the individual *Value System*, based on a questionnaire.

Some researchers argue that it is possible to classify an organization according to the set of values that it holds. Therefore, some organizational culture frameworks were developed in order to assess the cultural profile of an organization. The *Seven Levels of Corporate Consciousness framework* introduced in the last section, is an example of this kind of analysis framework. An internet based application; called Cultural Transformation Tool (CTT) has been developed in order to support the use of this framework and, consequently, the values alignment assessment.

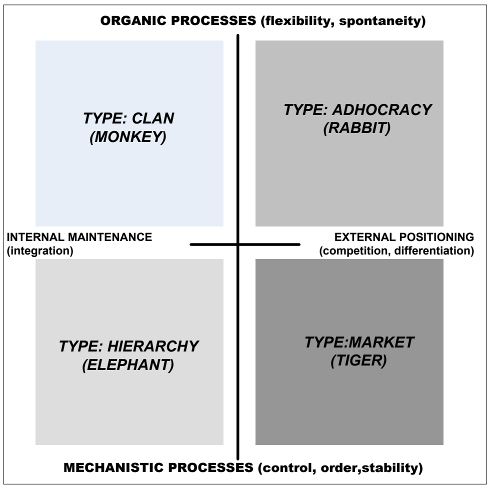


Figure 2.11. Competing Values Framework (adapted from (Cameron and Quinn, 1999))

The Competing Values Framework (CVF) was developed by Cameron and Quinn (1999). From their research work they conclude that organizational core values are clustered into groups. From this, a model of organizational culture was defined, based on two dimensions: (i) organizational process (organic versus mechanistic); (ii) organizational orientation (internal versus external). These two dimensions resulted in four types of organizational culture (see Figure 2.11):

- The 'clan' culture (organic, internal) is characterized by an emphasis on cohesiveness, teamwork and commitment to the organization.

- The 'market' culture (mechanistic, external) is characterized by competitiveness and goal achievement.
- The 'adhocracy' culture (organic, external) focuses on creativity, entrepreneurship and dynamism.
- The 'hierarchy' culture (mechanistic, internal) is characterized by order, rules and regulations, uniformity and efficiency.

However, none of these frameworks or software tools were developed to support the management of *Value Systems* in collaborative network contexts, because their focus is the traditional organizations.

2.3. Value System Models in the Context of Collaborative Networks

In this section we aim to discuss the existing contributions on *Value Systems* for CN. In spite of the fact the contributions presented in the last section about *Value System* models, the values alignment methods and the *Value System* analysis were essentially developed to be applied within the scope of an organization, some of them can also be applied in the collaborative context. These cases are included in the following discussion.

One such case is the *EDA* model proposed by Filipe (Filipe and Liu, 2000), which is a model implemented with agents, where an agent can represent a member of an organization or an organization itself. So, the *EDA* model could be used in the context of CNs, where an agent represents a member of the network. As explained in Section 2.2.3, in spite of this approach to *Value Systems* contributing towards a formal model, the specification of the definition of preferences are limited, and does not include the notion of evaluation functions, or the notion that objects can have several characteristics to be evaluated.

Another example is the work carried out by Antunes and Coelho (1999) which proposes an architecture for agents called *BVG* (beliefs, values, goals). Agents take decisions according to their goals, beliefs about states of the world, and values about desirability of those states. It is assumed that an agent represents a member of the CN, hence its CN member is characterized by a set of beliefs, values and goals. However, this approach does not cover the representation of the values of the network itself, which is an important limitation in the characterization of CNs.

The *e3-value* model proposed by Gordijn and his colleagues (2000) was first developed to support e-commerce business processes in particular, but it has been extended to support networked organizations in general (Tan et al., 2004; Kartseva et al., 2006), covering the representation of the exchange *value* among network entities, and to enable a more detailed

analysis of the *value object* transfers. Even so, one important issue in collaboration sustainability is the agreement about the shared values (Afsarmanesh and Camarinha-Matos, 2005), and the *e3-value* model does not support the idea of *Value System* as the ordering and prioritization of values; it only covers the notion of exchange *value*. Therefore, it is not possible with such a model to analyze whether or not the members of a CN share the same values. Another relevant point in CN management is the agreement among members about the method used to evaluate each object property. This aspect cannot be supported directly with the *e3-value* model, because it does not consider the specification of evaluation method, or the specification of the relations between the evaluation method and characteristics to be evaluated. The *e3-value* models are expressed using UML in general and Petri-nets in the parts of the model concerning the dynamics of *value* exchange. In the cases of UML representation we obtain a model with a high expressiveness, but which is not very accurate, due to the fact that UML is a semi-formal language.

In Katzy (1999) the term *Value System* is used to denominate the "*clusters of companies that come together to exploit the value of a business opportunity".* This definition of *Value System* is quite the definition adopted for *virtual organization.* In fact, this definition encompasses the ones proposed by Porter (1985) for *Value Systems*, but blends the notions of *value* and economic entity. Moreover, we have noticed that this terminology about *Value System* has not proceeded in other research publications.

In the context of CNs, there is the *Multi-value System* model proposed by Romero and his colleagues (2007; 2010). This model was developed specifically for Virtual Organization Breeding Environments (VBEs) as part of the business model for these kinds of CNs. The proposal includes the definition of different values: economic, social and knowledge; and the identification of the stakeholders participating in the *value* generation process. The work presented by these researchers does not include a formal specification of *Value System*, or a precise definition of *value*. They classify values into financial, social and knowledge, but sometimes they also use the term *value* with the meaning of valuable object. In spite of representing a good contribution to the intuitive understanding of the area, this model of *Value System* does not include the concept of different degrees of importance (priorities) of core values and it is essentially focused on the identification of *value* transactions. With regard to the representation of Multi-value System, no modeling language is proposed or suggested. The structure of this model is presented using a table. This modeling option provides models that are difficult to translate into computational language and that might be ambiguous.

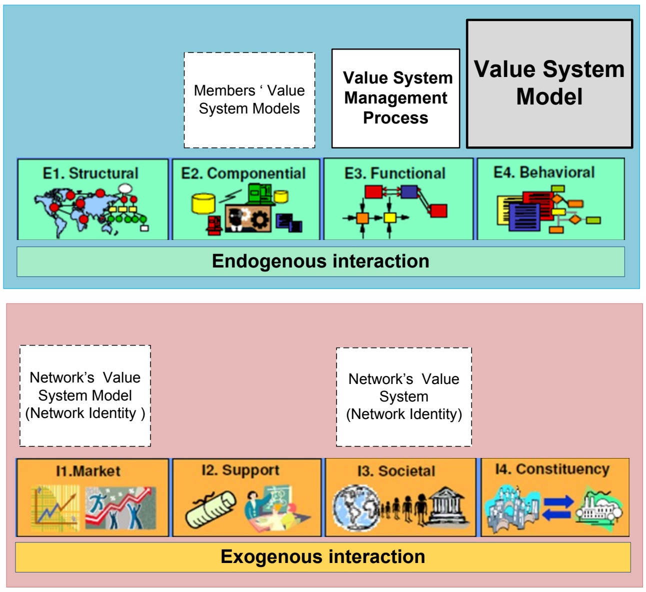


Figure 2.12. Positioning of Value System in ARCON modeling framework.

The ARCON reference framework presented in Section 2.1.3, which was developed as part of the ECOLEAD project (see Section 2.1.2), aims to provide a comprehensive environment for modeling the variety of forms of CNs. Within the scope of the ARCON framework, the Value System should be included in the CN modeling, in distinct dimensions (see Figure 2.12), namely:

- In the Behavioral dimension of Endogenous Elements subspace: as this dimension addresses the principles, policies, and governance rules that drive or constrain the behavior of the CN and its members over time, and as it is considered that a Value System delineates the behavior of an individual or group of individuals, thus the Value System Model should be represented in this dimension.
- In the Functional dimension of Endogenous Elements subspace: as this dimension addresses the "basic functions / operations" available in the network, the specification of methods (processes) to manage the Value System should be considered as a functional element.
- In the Componential dimension of Endogenous Elements subspace: as this dimension focuses on the individual tangible/intangible elements in the CN's network, the information about the Value System of each network member and of the network itself also has to be included in this dimension.
- In the Market dimension of Exogenous Interactions: as this dimension covers the issues related to interactions with "customers" and "competitors", including the definition of the purpose/mission of the CN, and as value statements are directly related to the adopted Value System Model, thus the Value System Model of the CN should also be included in this dimension.

- In the Societal dimension of Exogenous Interactions: as this dimension covers the issues related to interactions with society, which includes the definition of the network identity, thus the definition of the Value System Model of the CN should also be included in this dimension, as being an element that defines its identity.

We can conclude that although the ARCON framework does not propose any Value System model, or specific modeling approach, it clearly identifies Value System as a relevant element to be modeled within the scope of CN modeling. Moreover, ARCON defines that not only should the CN's *Value System* be represented, but also each Member's Value System.

Regarding the "values alignment assessment" methods found in the literature review, none is specific for CNs, since all support only assessment of personal values alignment and organizational values alignment (see section 2.2.5). The same applies to the Value System analysis tools presented in section 2.2.6, which were developed for traditional organizational contexts, and do not take into account the specificities of CNs.

2.4. Chapter Discussion and Conclusions

The two main goals of this chapter were: (i) to present the theoretical body of knowledge that supports this thesis; (ii) to discuss the different contributions from the scientific community to the topic of the thesis, in order to identify its gaps and limitations. In order to give the reader a better perception of the limitations of the Value System models discussed to represent and analyze Value Systems in Collaborative Network environments, the results from analyzing the main *Value System* models according to the parameters defined by Curtis (1992) are presented in the table below (see Table 2.9).

Observing the findings we can notice that in general the proposed models lack:

- Fitness and Prescriptiveness, since some important concepts, such as evaluation, priorities and class of values are not covered by the proposed models. As a result, it is not possible to represent all the relevant aspects of a *Value System*, using any of these models.
- Formality, since some models are described using only informal language, or languages with a low level of formality (e.g. UML). As a result, the obtained models could be ambiguous.
- Granularity, since some models do not have the level of detail necessary to allow comparison among the Value Systems. This is a limitation in the development of methods to reason about the compatibility between *Value Systems*.

Table 2.9. Value System Models Evaluation

Value System Model	Observations	Fitness and Prescriptiveness	Granularity	Precision	Formality
Value System Tree (Goguen, 1994; Goguen, 2003)	Does not support the representation of evaluation mechanisms, or dimensions of values. Not appropriate for CN. The models are not very precise, but they allow distinct levels of granularity. The modeling language is formal.	××	✓	×	✓
BGV L. Antunes e H. Coelho (1999)	Does not support the representation of classes of values, or the notion of economic value. Does not cover different degrees of granularity. The language used is formal.	×	×	✓	✓✓
EDA J. Filipe and K. Liu (2000)	Does not support the representation of evaluation mechanisms, or priorities. Just covers the notion of value as norm. Does not cover different degrees of granularity. It uses a very formal language.	×	×	✓	✓✓
e3-Value Gordjnic, Kartseva, Tan (2000; 2004; Tan et al., 2004)	Does not support the representation of shared values and priorities. Different degrees of granularity are covered. The precision of the model could be better. It uses Petri-nets and UML.	×	✓	×	✓
Exchange Social Values Mode (Dimuro et al., 2005)	Does not support the representation of shared values and priorities. It is focused just on the notion of exchange value. The obtained models are precise and the language used is formal.	×	✓	✓	✓✓
Multi-Value System (Romero et al., 2007; Romero et al., 2010)	Does not support the representation of priorities, or the notion of shared values. It is not a precise model, but allows models to be created with distinct levels of granularity. It uses no standard language to represent the model.	×	✓	×	×

Concerning the values alignment topic, discussed in section 2.2.5, a set of relevant limitations were identified:

- The criteria to be used in the proposed "alignment assessment" are not adequate to be applied in the context of CNs, since they only include the characteristics of sole organizations.
- The criteria used to assess the fitness between *Value Systems* comprise only direct comparison between two set of values.
- Most of the proposed methods to assess values alignment have not been specified as having a *Value System* Model as reference.
- The analysis approaches are qualitative or quantitative. None of the proposed approaches provides a framework that enables a choice to be made between quantitative or qualitative methods.

Regarding the software tools to support *Value System* management, no support could be found regarding the representation and analysis of *Value Systems* in the context of CNs.

The next chapters outline proposed models, methods and tools that aim to overcome the identified limitations.

3

Conceptual Model of Value System for Collaborative Networks

This chapter essentially presents two artifacts: a conceptual model for Value Systems and a framework to analyze Value Systems in collaborative environments. First of all, the set of characteristics relevant for the proposed conceptual model are discussed. Afterwards, the main elements of a Value System are identified and characterized, followed by a formal definition of this concept. Furthermore, the notion of core values is introduced and in order to encompass this concept, the Core Value System, which is a restricted view of the generic proposed Value System, is presented. Starting from the application of graph theory and causal maps to model the relations among core values, organizations, and collaborative networks, an analysis framework is proposed. This framework aims to provide a visual/graphical representation and to be the basis for the development of methods to assess the alignment between Value Systems.

3.1. Conceptual Model of Value System

3.1.1 Main Characteristics of the Conceptual Model

Assuming that models are the starting point for any engineer to analyze, design and build artifacts and systems it is essential to have conceptual models of Value Systems for collaborative contexts. However, the analysis presented in Section 2.4 showed that most of the existing Value System models are not completely satisfactory as regards dealing with the formality, fitness and granularity characteristics. Therefore, we propose a set of characteristics that we deem as being relevant in order to have an adequate model to specify and analyze Value Systems in CNs.

One of these characteristics is formality. Due to the fact that the main concepts around Value System are used in literature in different ways and for different purposes, often with an unclear meaning, no model has been found that incorporates a level of formality that avoids contradictions and ambiguities. Moreover, this is specifically relevant in the case of collaborative networks, because the involvement of different types of stakeholders, representing different interests and concerns of organizations, increases the risk of misunderstandings.

The proposed model aims to cover the representation of the Value System of each network member, and of the network itself, so that potential users of the model (VO broker, VBE manager, VO administrator, etc.) can use it to describe their values, preferences and mechanisms of evaluation (fitness). Moreover, the achieved conceptual model should also be effortlessly translatable to a computer program in order to facilitate the use in practical contexts (prescriptiveness).

With regard to the granularity characteristic, depending on the concrete application purpose of the conceptual model, distinct levels of granularity are needed. In some cases a detailed description of the elements are required but in other cases, when there are not enough data to specify them in detail, a high level description could be adequate. For instance, there is usually not enough information to quantitatively specify the degree of importance of each core value; and yet a qualitative specification might be sufficient to have an overall view of the preferences of the evaluator.

The main characteristics defined for the conceptual model of Value Systems for CNs are summarized in the following table.

Table 3.1. Main characteristics for the conceptual model

Characteristic	Description
Formality	The conceptual model aims to be formal enough to avoid contradictions and ambiguities.
Fitness	The conceptual model aims to cover the representation of the following concepts: value, evaluation, class of value, dimension of value, priority, core value. The conceptual model aims to cover both approaches to evaluation: qualitative and quantitative.
Prescriptiveness	The conceptual model aims to be represented in a way that facilitates its translation to a computer language.
Granularity	The conceptual model aims to be appropriate to represent the Value System of a CN, as well as the Value System of each CN member. The conceptual model aims to support the representation of different levels of detail concerning the elements that comprise the Value System.

3.1.2 Base Concepts of Value and Evaluation

A set of concepts related to value and evaluation are first introduced informally in order to allow a gradual understanding of the proposed *Value System* concept. In Section 3.1.4 a formal definition of these concepts is presented.

As discussed in the previous chapter (see Section 2.2.1), the term *value* is used in diverse ways and for distinct purposes, often with an unclear meaning. In an attempt to cope with the various perspectives mentioned in Table 2.4, the following general definition of value is proposed: value is the relative worth, utility or importance of something.

In order to explain this definition and how it embraces various meanings of *value*, the concepts of object of evaluation, evaluator, and evaluation have to be introduced.

An object of evaluation is considered as being something that can be evaluated, and which has value for the evaluator. Resources, processes, behaviors, relations, beliefs, information are examples of evaluation objects. It should be noticed that the term value is often used to designate the object of evaluation in spite of the *value* itself. When someone states: "*My values are safe in the bank"*, this mean that the objects that are valuable for me are safe in the bank. In this dissertation the terms evaluation object and value are always distinguished.

The evaluator is the entity that performs an evaluation. This entity can be an individual person, or a social group. Individuals, organizations, government, virtual organizations and even instruments are examples of evaluators.

Evaluation is defined as the act of judging, measuring or calculating the quality, importance, or amount of something. Judgments, measurements and calculations are made essentially in two basic ways: (i) in an objective way, by applying rules and formulas to the data that characterize the evaluation object, and (ii) in a subjective way, by using a mental perception about the importance, the quality or the quantity of something. In other words, the value of something depends on the function used to evaluate it. The evaluation function is the mechanism (usually represented by a mathematical function) used to implement the evaluation, and can be:

- A numeric function that assigns a number to an evaluation object. This number represents the value of this object related to a specific characteristic and the function implements the calculation formula of an indicator, an estimation method, or a measurement function of an instrument, as illustrated in Figure 3.1 a) and d). The measurement process involves estimating the ratio between the magnitude of a quantity and the magnitude of a unit of the same type (e.g. length, time, mass, etc.). A measurement is the result of such process expressed as the product of a real number and a unit, where the real number is the estimated ratio. In order to define a function that implements an act of measurement, properties like monotonic, replicability and finite additivity should be studied.
- A qualitative function that represents a mental process or a qualitative judgment. This function assigns a qualitative *value* to something, as illustrated in Figure 3.1b) and c). The properties of monotonicity and replicability should also be satisfied by qualitative functions.

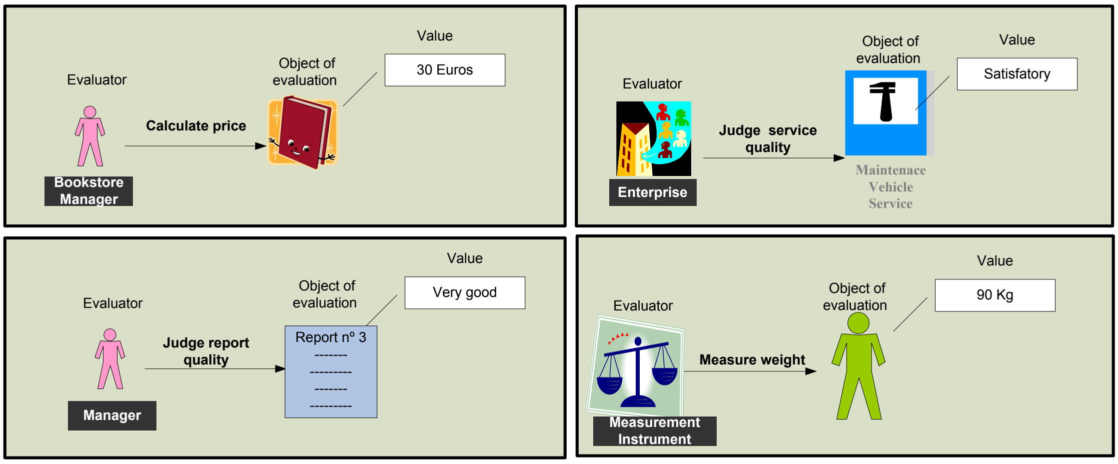


Figure 3.1. Examples of the notions of value, evaluation object and evaluator.

When making an evaluation, we are often evaluating not the overall object but a specific characteristic of this object. Therefore, it is relevant to provide a way to specify the evaluation of a particular property of an object. For instance, products, services and behaviors have several characteristics and each characteristic can be evaluated independently. When making a global evaluation, we are evaluating several characteristics and aggregating the corresponding individual values in order to reach a global value. This notion that each object has several characteristics that can be evaluated, was also explored by Hartman (1967) in his work about theory of Value and later by Hebel (1998) that assumes that value is an "*attribute, quality or desired characteristic*". Furthermore, the idea behind value engineering methods (Cheah and Ting, 2005; Jariri and Zegordi, 2008), where it is assumed that the overall value of an object depends on its internal qualities, is also covered by this notion that we call evaluation dimension.

The different characteristics of an object may have different degrees of importance to the actor that performs the evaluation. Sociologists usually use the term "priority" to denominate the concept of degree of importance. The representation of priorities is essential, since various authors have demonstrated that priorities play a central role in the valuation process (Rokeach, 1973a), (Badovick and Beatty, 1987). Consequently, the decision-making process is strongly influenced by priorities (Ferrell and Gresham, 1985; Keeney, 1994; Saaty, 1994; Glover et al., 1997; Bouzdine-Chameeva et al., 2003). Thus, the degree of importance is defined as the level of importance attached to an evaluation dimension by a given evaluator**.** The idea of distinct priorities is modeled by associating a weight to each evaluation dimension which represents its degree of importance. This weight can be represented either quantitatively or qualitatively. If we want to rank the priorities, then a quantitative approach is required, however if we just want to know what are the most prioritized values, a qualitative representation might be enough.

Depending on the objective of the evaluation, a different set of evaluation dimensions might be considered to evaluate an object, as illustrated in Figure 3.2, whereby these evaluation dimensions can have different degrees of importance. We identify the set of selected evaluation dimensions and the corresponding weights chosen to evaluate an object from a given point of view as the evaluation perspective. Examples of possible evaluation perspectives:

- The business perspective, where a set of characteristics related to the business is considered.
- The social perspective, where a set of characteristics related to social, moral and cultural aspects is considered.
- The collaboration perspective, where a set of characteristics related to collaboration relations, such as: adaptability, affinity, reliability, and agility, is considered.

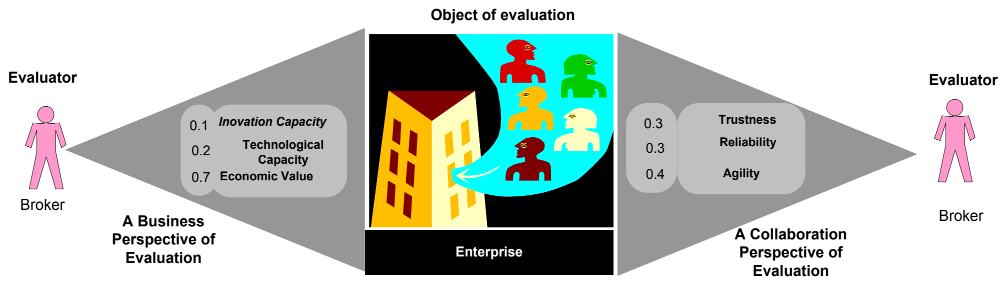


Figure 3.2. Different evaluation perspectives

3.1.3 Value System Concept

As mentioned in Chapter 2, *Value Systems* have been studied mainly in two distinct disciplines: Economics and Psycho-sociology. Each discipline developed a different concept of *Value System*; social sciences consider a *Value System* as the ordering and prioritization of the ethical and ideological *value*s that an individual or society holds, and economists argue that a *Value System* describes the set of activities that add / create value among firms.

In order to develop a model that embraces these two main "schools" and according to the basic concepts introduced in previous section, the following elements should belong to the Value System: (i) Evaluation Objects, all entities that have some value, as products, activities, business processes, and behaviors; (ii) Evaluation Functions, the functions used to evaluate the objects, where metrics and indicators belong to this component; (iii) Evaluation Dimensions, and (iv) Evaluation Perspectives. These elements can be subdivided in two sub-groups (see Figure 3.3):

- Entities that can be evaluated: Evaluation Objects.

- Evaluation Mechanisms: Functions, Dimensions and Perspectives.

According to this approach, the *Value System* will be defined as comprising two subsystems: Value Objects Subsystem and Evaluation Subsystem.

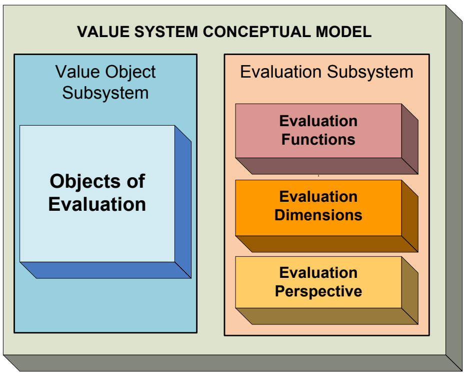


Figure 3.3. Value System conceptual model: main components

The definition of the Value System and its subsystems will be based on the general definition of a system: A system is an assemblage[2] of interrelated elements comprising a unified whole. Any element which has no relation with any other element of the system cannot be a part of that system. As such, it can be considered that a Value System is a system composed of a set of valuable things for an organization, a network, an individual, or a social group, and a set of functions used for its evaluation under different perspectives, where each perspective comprises a weighted set of evaluation dimensions.

3.1.4 Formal Definition of Value System

During the analysis of the main problem addressed by this thesis, the importance of formalizing the Value System Concept has been noticed in order to promote a shared understanding about it. The mathematical language has the advantage of being a "universal" formal language used in almost all scientific areas, which promotes precision. However, it has the disadvantage of not providing a graphical representation, which may hinder the communication of the concepts. In spite of this, as a first approach, the concepts introduced above are now formalized using First Order Logic.

Definition 3.1 (Object of Evaluation)

Object of Evaluation is something (x) to be evaluated, and has value for the evaluator, such that: $x \in S$, where S is the set of things to be evaluated.

[2] Assemblage - a collection of things or a group of people or animals, Cambridge Dictionary.

Definition 3.2 (Evaluation Function)

Evaluation Function is a mathematical function (*f*) that implements the evaluation process.

F is assumed to be the set of evaluation functions and is defined as:

$$F = \{f : \exists x \in S_f \wedge y = f(x)\}$$

where S_f comprises the elements of *S* that can be evaluated using the function *f* and *y* is the value assigned to the element *x*.

Evaluation functions can be divided into: numeric functions and qualitative functions, such that $F = NF \cup QF$, where:

- *NF* is the set of numeric functions. If $f \in NF, f$ is a real function defined as:

  $$f: S_f \rightarrow \Re \; where \; S_f \subset S.$$

  The value resulted from the evaluation of *x* using the numeric function *f* is a real number. In some cases the result of the evaluation is expressed as the product of a real number and a unit.

  $$y[u] = f(x) : f \in NF \wedge y \in \Re \wedge x \in S_f \,,$$

  where *u* is the unit of measurement (e.g. 3[ms-2], 10 [kg]).

- *QF* is the set of qualitative functions. If *f* belongs to *QF* then *f* is a qualitative function defined as:

  $f: S_f \rightarrow Y$ where $S_f \subset S$ and *Y* is a partially ordered finite set with n elements $Y=\{y_1,y_2,...,y_n\}$, where each value y_i is a qualitative label.

  The value resulting from the evaluation of *x* using the qualitative function *f* is a qualitative value.

Definition 3.3 (Value)

The value *(y)* represents the importance of the object of evaluation *(x)*, for a given evaluator. The value *(y)* can be qualitative or quantitative, depending on the kind of evaluation function selected to perform the evaluation.

- Quantitative Value

$$y = f_r(x) : f_r \in NF \wedge y \in \Re \wedge x \in S_f$$

- Qualitative Value

$$y = f_q(x) : f_q \in QF \wedge y \in \{y_1, y_2 .. y_n\} \wedge x \in S_f$$

Definition 3.4 (Evaluation Dimension)

The Evaluation Dimension is a characteristic *(d)* of an object that is evaluated. The set of evaluation dimensions is defined as: $D = \{d_1, d_2 \ldots d_n\}$.

If an evaluation function is defined to evaluate the characteristic *(d)* of an object, this can be formally represented through the introduction of the operator Φ. Thus the statement: *the function (f) allows the evaluation of the characteristic (d)* is formally represented by the following expression:

$f \, \Phi d$, where $d \in D \land f \in F$.

Definition 3.5 (Evaluation Perspective)

The Evaluation Perspective of an object (x) is defined as the tuple:

$ep =< dv, wv >$, where:

- dv is the dimensions-vector of x that is defined as:

  $$dv_x = [d_1, d_2, \ldots d_n] : d_i \in D$$

  This vector expresses the set of characteristics of an object that are evaluated.
- wv is the weights-vector and it represents the degree of importance of the corresponding characteristic specified in dv. The vector *wv is* represented differently according to the nature of the priorities assessed:
  - Quantitative

    $$wv = [w_1, \ldots w_n] : w_i \in [0..1] \land \sum_{i=0}^{n} w_i = 1$$

    and $wv[i]$ is the degree of importance of $dv_x[i]$.
  - Qualitative

    $wv = [w_1, \ldots w_n] : w_i \in \text{Pw}$, where Pw is the partially ordered set of labels and $wv[i]$ is the degree of importance of $dv_x[i]$.

The set of evaluation perspectives is referred to as P.

For each element of the dimensions vector, a function has to be selected in order to evaluate the corresponding characteristic of the object. So, for each dimensions-vector an evaluation-vector can be specified as:

$fv_d = [f_1, f_2 \ldots f_n] : f_i \in F \land fv_d[i] \Phi dv_x[i]$.

In order to represent the fact that an object can be evaluated through a given perspective, the operator Ξ is introduced and defined as: $x \Xi ep$, meaning: *x is evaluated through the perspective (ep)*, where: $x \in S \land ep \in P$.

Definition 3.6 (Value Objects Subsystem)

The Value Objects Subsystem (*OS*) is a system comprising the objects that can be evaluated and is defined as a tuple: $OS = <S, RS>$ where:

- *S* is the set a valuable things ;
- *RS* is the set of relations among the elements of *S*, which can essentially be of two types: composition and specialization (one object can be defined by aggregation of several objects, or an object can be defined as a subtype of another object).

Definition 3.7 (Evaluation Subsystem)

The Evaluation Subsystem (ES) is a system comprising all elements that represent "mechanisms" of evaluation (functions, dimensions and perspectives), and is defined as a tuple: $ES=<EF, RE>$ where:

EF represents all the elements that belong to the evaluation subsystem and is defined as a tuple $EF =< F, D, P >$ where:

- *F* is the set of evaluation functions;
- *D* is the set of evaluation dimensions;
- *P* is the set of evaluation perspectives.

RE is the set of relations among the elements of EF. These relations can be categorized as:

- *Composition-relation* – One function is defined by aggregation of two or more functions.
- *Evaluate-relation* – The relation is specified by the operator Φ that specifies that a function can be used to evaluate a specific dimension.
- *Priority-relation* – The relation that specifies the degree of importance of a characteristic inside an evaluation perspective**.**

Definition 3.8 (Value System)

A *Value System* (VS) comprises an aggregation of two subsystems, the *Value Objects Subsystem* and the *Evaluation Subsystem*, and the set of relations established between them. Thus VS is specified as a tuple: $VS =<<OS,ES>, RVS>$**,** where:

- OS is the Value Object subsystem;
- ES is the Evaluation subsystem;
- *RVS* represents the set of relations between the two sub-systems. According to systems theory, if there is a relation between two elements of different sub-systems, this implies that these two subsystems are related. The two subsystems OS and ES are related by two categories of relations:

- *Value-relation* - What relates a function and an object is the value resulting from evaluating the object using that function.
- *Perspective-relation* - The relation that is defined by the operator Ξ that specifies that an object is evaluated through a given evaluation perspective.

3.1.5 UML Domain Model

In Section 2.2.4 and Section 2.4 some existing approaches to model Value Systems where introduced and discussed. It was stated that models represented with the UML language have a low degree of formality and precision. However, as UML is a graphical modeling language, the models obtained are highly expressive. Due to the fact that the mathematical formalism used to represent the VS model does not provide a holistic view of all the concepts involved, the formal specification is complemented by a UML diagram. Therefore the aim of representing the Value System Conceptual Model using a UML class diagram is to give the reader a better perception about the relations among all the elements that belong to the proposed conceptual model of the Value System.

In order to understand the relations among entities modeled in the diagram presented in Figure 3.4 and the formal expressions presented above, a brief explanation follows.

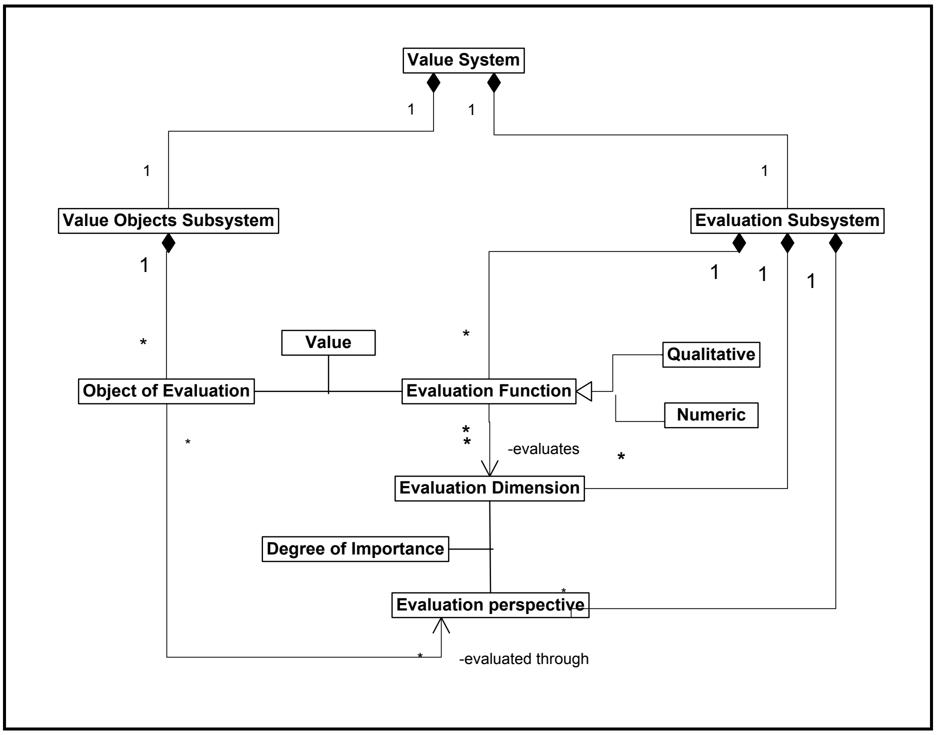


Figure 3.4. UML class diagram of the conceptual model of Value System

In the UML *class diagram* the entity class represents the notion of set. The relations defined among elements of the same set or of distinct sets are implemented in this diagram as:

- UML class-associations: (i) *Value* Class implements the *value-relation*; (ii) *Degree of Importance* Class implements the *priority* relation.
- UML associations: (i) *Evaluates* association implements *Evaluates-relation*; (ii) *Evaluates-through* association implements *perspective* relation.
- UML compositions implement the notion of tuple, namely: *Value System*, *Evaluation Subsystem*, *Value Objects Subsystem*.
- UML specializations implement the two types of *evaluation functions*.

3.1.6 Core Value System Concepts

Each organization (or network of organizations) considers certain characteristics the most important for itself ; these characteristics are called *core values* (Collins and Porras, 1996).

The *core values* are used as the base for the decision-making processes and are the elements that motivate and regulate the organization's behavior (Hall, 1995; Higgins, 2004). Examples of how these characteristics influence the decision-making process and regulate the organization behavior, into the scope of collaborative environments can be found in (O'Neill and Sackett, 1994; Urze, 2006; Flores et al., 2009)).

Therefore we introduce the notion of *Core Value System* to encompass the core values concept. This concept is a restricted view of the generic Value System conceptual model presented above, and can be considered as a specialization of it (see Figure 3.5). The proposed model assumes that the organization (or network of organizations) is the (sole) object of evaluation, and that the selected set of core characteristics and the corresponding priorities will define the core evaluation perspective.

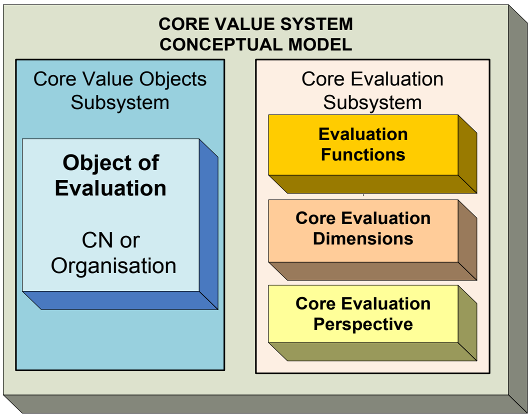


Figure 3.5. Core Value System conceptual model: main components

3.1.7 Formal Definition of Core Value System

A formal specification of the Core Value System conceptual model introduced above follows.

Definition 3.9 (Core value)

Core value (*cv*) is a main characteristic of the organization (or network of organizations) that motivates and regulates its behavior.

The core values set (CV) represent a list of core values.

Note: The Rokeach Instrumental Values (Rokeach, 1973a), the Schwartz Value Survey (Schwartz, 1992), the Cultural Transformation Tool (Barrett, 2006) are examples of organizational value lists (see Table 2.4 for more examples).

Definition 3.10 (Core Evaluation Perspective)

A core evaluation perspective is defined as: $cp = < dv_{core}, wv_{core} >$, where:

- dv_{core} is the vector of core values of the organization (or network),
  $dv_{core} = [cv_1, cv_2, ...cv_n] : cv_i \in CV$;
- wv_{core} represents the weights-vector, where each element defines the degree of importance of the corresponding core value. These weights represent the preferences of the value-system's owner. These preferences can be quantitatively or qualitatively expressed as presented in Definition 3.5.

Definition 3.11 (Core Value System)

A *Core Value System* (CVS) is defined by a tuple, where the first element is defined by the aggregation of two subsystems, the *Core Value Object Subsystem (COS)* and the *Core Evaluation Subsystem (CES)* and the second element defines the relations established between them.

$CVS =<< COS, CES >, CRVS >$, where:

- *Core Value Object Subsystem* (COS) is represented by the organization (or networked organization) itself.
  $COS = \{x\}: x \in (ORG \cup NORG) \subset S$, where:
  - S is the set of the objects of evaluation (see Definition 3.1);
  - *ORG* represents the universe of organizations;
  - *NORG* represents the universe of Networked Organizations.
- *Core Evaluation Subsystem* (CES) is represented by the core-evaluate mechanisms, i.e. it represents how the core-object of evaluation is to be evaluated: its core values, priorities and evaluation functions.
  $CES = < CEF, CRE >$ where:

- *CEF* is defined as a tuple*: CEF=<CF,CV,CP>* such that*: CV* is the set of core values and *CF* is the set of core-evaluation functions, and *CP* is the set of core-evaluation perspectives.
- *CRE* is the set of relations between core values and core-evaluation functions, and between core-evaluation perspective and core values.

- *CRVS* represents the set of relations between the two subsystems, *COS* and *CES*, specifically:
  - *Value relation* – what relates a function and the organization (or networked organization) is the value resulting from evaluating it using that function.
  - *Core-perspective relation* - the relation that is defined by the operator (Ξ) that in this case, specifies that an organization (or networked organization) is evaluated through a given core evaluation perspective.

3.1.8 Modeling Examples in the Context of Collaborative Networks

In order to clarify the notions of Core Value System and Value System, two illustrative modeling examples are presented. The first one introduces the distinction between the collaborative network's Core Value System and Member's Core Value System. The second ones presents the modeling of the Value System of a Virtual Organization (VE) and exemplifies how it can be used to evaluate each CN member, through using different evaluation perspectives.

Example 3.1.VBE Core Value System versus Organization Core Value System

One of the main purposes of the Core Value System Conceptual Model is to have a form of representing core values in the context of Collaborative Networks, in an unambiguous way.

Let us suppose a Virtual Organizations Breeding Environment (VBE) is in place, where the VBE manager selects a set of core values, namely *profit, reliability, reputation,* and *quality*. One of the members of the VBE is taken to be a Logistic Enterprise that has selected the following set of core values: *profit*, *reliability*, and *innovation.* Not all core values have the same degree of importance, thus each manager expresses his/her preferences, giving a weight to each core value, as illustrated in Figure 3.6.

According to the conceptual model presented above, we can formally define the preferences of the VBE and of the Logistic Enterprise, considering the following elements:

- The Logistic Enterprise's Core Value System

- Core Evaluation Objects: Logistic Enterprise (Lg).
- Core values: *profit, reliability* and *innovation* are the characteristics defined as core values for the Logistic Enterprise.
- Evaluation Perspectives: A core-evaluation perspective is defined for the Logistic Enterprise. For this perspective a set of core values is considered and each of them is attributed a relative degree of importance. For instance, the *profit* core value has a relative degree of importance of 0.5 for this organization.

- VBE's Core Value System
  - Core Evaluation Objects: Virtual Organizations Breeding Environments (VBE).
  - Core values: *profit, reliability, reputation,* and *quality* are the characteristics defined as core values for the VBE.
  - Evaluation Perspective: A core-evaluation perspective is defined for the VBE. For this perspective a set of characteristics is considered and each characteristic is attributed a relative degree of importance. For instance, the *reliability* core value has a relative degree of importance of 0.2 for this organization.

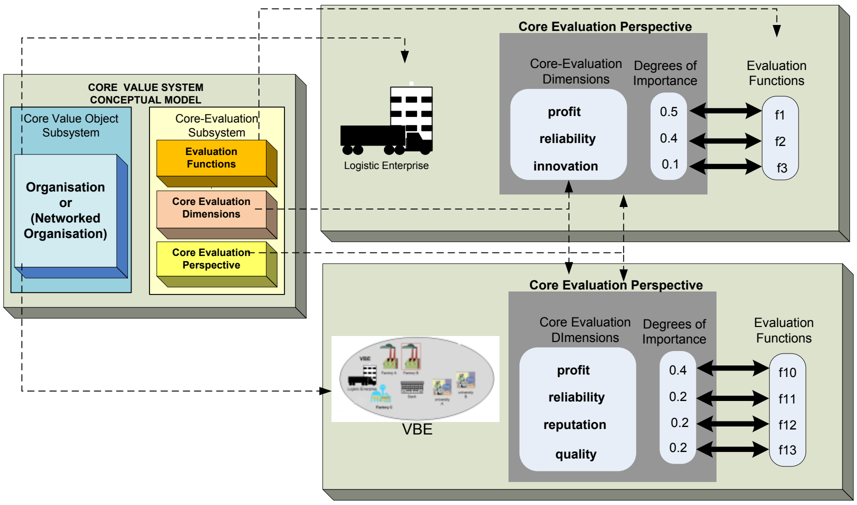


Figure 3.6. Core Value Systems example.

The formalization used to define the conceptual model of Value System can be followed to formally specify the preferences of the Logistic Enterprise and of the VBE.

- Logistic Enterprise's Core Value System

$Lg's\ Core\ Value\ System: CVS_{Lg} =< COS_{Lg}, CES_{Lg} >$

$Lg's\ Core\ Evaluation\ Objects\ Subsystem: COS_{Lg} =< \{Lg\}, \{\ \} >$

$Lg's\ Core\ Evaluation\ Subsystem: CES_{Lg} =<< EV_{Lg}, CV_{Lg}, \{cp_{Lg}\} >, CRE_{Lg} >$

$Lg's\ core\ values\ set: CV_{Lg} = \{profit, reliability, innovation\}$

$Lg's\ Evaluation\ prespective:$

$cp_{Lg} =< [profit, reliability, innovation], [0.5,0.4,0.1] >$

- VBE's Core Value System

$$VBE's\ Core\ Value\ System: CVS_{VBE} =< COS_{VBE}, CES_{VBE} >$$
$$VBE's\ Core\ Evaluation\ Objects\ Subsystem: COS_{VBE} =< \{VBE\}, \{\ \} >$$
$$VBE's\ Core\ Evaluation\ Subsystem:$$
$$CES_{VBE} =<< EV_{VBE}, CV_{VBE}, \{cp_{VBE}\} >, CRE_{VBE} >$$
$$VBE's\ core\ values\ set: CV_{VBE} = \{profit, reliability, reputation, quality\}$$
$$cp_{VBE}(VBE's\ Evaluation\ prespective) =$$
$$< [profit, reliability, reputation, quality], [0.4,0.2,0.2,0.2] >$$

Example 3.2. VO's Value System and members' evaluation

As an illustrative example of the VO's Value System and members' evaluation let us consider the scenario shown in Figure 3.7. Four enterprises join efforts to create a virtual organization in order to exploit a business opportunity to manufacture a four-wheel vehicle.

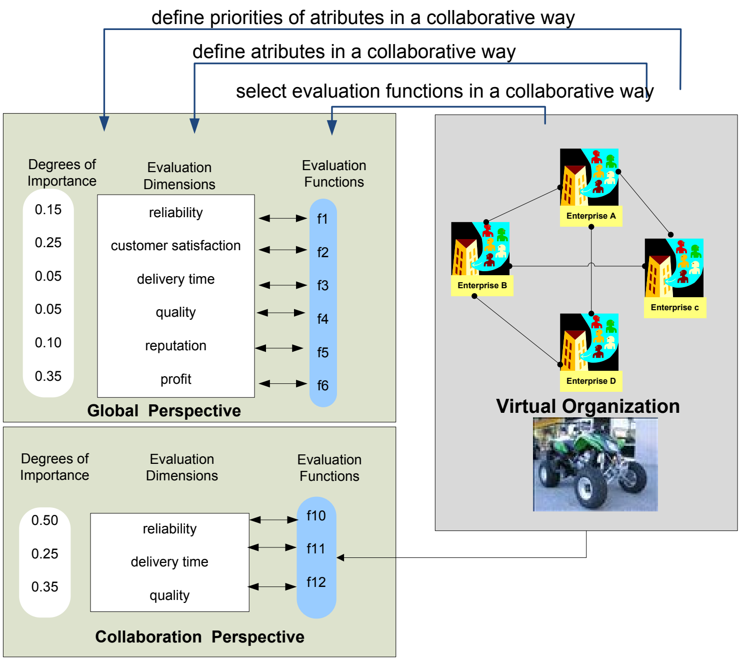


Figure 3.7. VO's Value System scenario.

The definition of the set of evaluation dimensions that are important to the members of the VO and that guide their actions should be specified during the initial setup of the VO. The set of attributes that will be considered to evaluate the value of each partner to the network should also be defined in order to avoid future conflicts and misunderstandings. Note that this example does not intend to specify which characteristics a network should satisfy. It only serves to illustrate how the set of evaluation-dimensions can be specified and analyzed using the proposed conceptual model. Imagine that this VO defines that the most relevant attributes for the network are: *reliability, customer satisfaction, delivery time, quality, reputation,* and *profit*. These six attributes probably do not have the same degree of importance. Thus the VO should specify the degree of importance of each attribute and all members of the VO should be

aware that decisions and behaviors would be "judged" mostly in accordance with this evaluation perspective.

For each evaluation dimension (each attribute) an evaluation function should be defined in a collaborative way or defined by the VO planner and accepted by all. The definition of methods to evaluate *reliability, customer satisfaction, delivery time,* and *quality, reputation* are not standard, and in fact, each organization usually defines its own way of calculating them. The set of attributes that will be considered to evaluate the value of each partner to the VO should also be defined in order to avoid future conflicts and misunderstandings. This set of characteristics is specified in the collaboration evaluation perspective, which represents what is expected in term of value for each VO member. In this example, the attributes that comprise the collaboration perspective are: *reliability, delivery time,* and *quality.* The following elements are considered:

- Evaluations Objects: VO, VO Members (Organizations/Enterprises);
- Evaluation Functions: *f1, f2, f3, f4, f5, f6, f10, f11, f12* are defined as functions that assign a value to the evaluation object. One attribute can have different evaluation functions associated to it. For the purpose of the example, the indicator used to measure the reliability of the network *(f1)* can be different from the one used to evaluate the reliability of a partner *(f10).* For our example the functions are listed in Table 3.2.

Table 3.2. Evaluation functions

Function	Description
$f_1 : S_{x1} \rightarrow \Re_0$	f_1= percentage of time without complaint from clients or suppliers.
$f_2 : S_{x2} \rightarrow \{unsatisfied, poorly\ satisfield, satisfied, very\ satisfied\}$	f_2=average level of satisfaction obtained through a survey.
$f_3 : S_{x1} \rightarrow \Re_0$.	f_3=average period of time to satisfy an order.
$f_4 : S_{x1} \rightarrow \{high, medium, low\}$	f_4= level of quality, determined by external auditing.
$f_5 : S_{x1} \rightarrow \Re_0$.	f_5= number of positive citations in national and international business papers in the last year
$f_6 : S_{x1} \rightarrow \Re_0$.	f_6=ROI- return on investment indicator
$f_{10} : S_{x1} \rightarrow \Re_0$	f_{10}= percentage of time without process faults.
$f_{11} : S_{x1} \rightarrow \Re_0$	f_{11}=average period of time to deliver a main-product or a main-service required by another network member.
$f_{12} : S_{x1} \rightarrow \{very\,high, high, medium, low\}$	f_{12}= level of quality, determined by external auditing of the processes related to the production and sales.

- Evaluation Dimensions: reliability, customer satisfaction, delivery time, quality, reputation and profit are the characteristics to be evaluated.

- Evaluation Perspectives: Two evaluation perspectives are defined. The global perspective and the collaboration perspective that is in fact a partial view of the global perspective, considering just the characteristics relevant for collaboration**.** For each perspective, a set of characteristics are considered and for each characteristic a relative degree of importance is associated. For instance, the *customer satisfaction* evaluation dimension has a relative degree of importance of 0.25 for this network.

The conceptual *Value System* model proposed above can be used to formally specify the Value System that characterizes this scenario.

$VS_{VO}(VO's\ ValueSystem) =< EVS_{VO}, RVS_{VO} >$ where:

- $EVS_{VO} =< OS_{VO}, ES_{VO} >$
  - OS_{VO} *(VO's Object Value subsystem)=* $<S_{VO}, RS_{VO}>$ such that:
    - $S_{VO} = \{O, E1, E2, E3, E4\}$ where E_x are the enterprise's VO members.
  - ES_{VO} *(VO Evaluation subsystem)=*$<EF_{VO}, RE_{VO}>$ where:
    - $EF_{VO} =< D_{VO}, P_{VO}, F_{VO}>$ and
      - D_{VO}*={reliability, customer satisfaction, deliver time, quality, reputation, profit}*
      - P_{VO} *={*$ep_{collaboration}, ep_{global}$*}*
      - $F_{VO} = \{f_1, f_2, f_3, f_4, f_6, f_7, f_8, f_9, f_{10}, f_{11}, f_{12}\}$ Note: F_{VO} is the set of evaluation functions used by the VO to make evaluations.

        $ep_{global} =< dv_1, wv_1 > \in P_{VO}$ where:
        - *dv=[reliability, customer satisfaction, delivery time, quality, reputation, profit]*
        - wv_1*=[0.15, 0.25,0.05,0.05,0.1,0.35].*
        - *fv1=[f1,f2,f3,f4,,f5,f6,] is a functions' vector that contains the evaluation functions to evaluate the six selected evaluation dimensions defined in dv.*

        $ep_{collaboraion} =< dv_2, wv_2 > \in P_{VO}$, where
        - *dv2=[reliability, delivery time, quality] wv2=[0.5, 0.25, 0.35].*
        - *fv2=[f10, f11,f12] is a functions' vector that contains the evaluation functions selected to evaluate the three evaluation dimensions defined in dv2.*
    - RE_{VO} comprises the relations among evaluation functions and evaluation dimensions (evaluate-relation), and the relations between evaluation dimensions and evaluation perspectives (priority-relations).

$RE_{VO} = R1 \cup R2 \cup R3 \cup R4$, where:

- $R1 = \{((fv_1[i], dv_1[i] \ ) : (fv_1[i] \phi dv_1[i] i \in \{1,..,6\}\}$, is the set of relations between the evaluation functions defined on fv_1 and the evaluation dimensions defined on dv_1.
- $R2 = \{((dv_1[i], wv_1[i]) : (dv_1[i], wv_1[i]) \in ep_{global}$, is the set of priority-relations defined through evaluation perspective ep_{global} .
- $R3 = \{((fv_2, dv_2[i] \ ) : (fv_2 \phi dv_2[i]) \wedge i \in \{1,..,3\}\}$ is the set of relations between the evaluation functions defined on fv_2 and the evaluation dimensions defined on dv_2.
- $R4 = \{((dv_2[i], wv_2[i]) : (dv_2[i], wv_2[i]) \in ep_{collaboration}\}$, is the set of priority-relations defined through the evaluation perspective $ep_{collaboration}$.

- $RVS_{VO}(relations\ among\ the\ two\ subsystems) = \{(VO, ep_{global}), (E1, ep_{collaboration}), (E2, ep_{collaboration}), (E3, ep_{collaboration}), (E4, ep_{collaboration})\}$

  Note: In this case the set RVS_{VO} comprises the perspective-relations among the two subsystems. These relations specify that VO is evaluated through the evaluation perspective ep_{global} and the VO members are evaluated through the evaluation perspective $ep_{collaboration}$.

Applying the global perspective to evaluate the network will generate a value for each evaluation dimension (see Figure 3.8 for an example) and the use of the collaboration perspective will generate a value for each evaluation dimension for every member. Each value represents the relative worth of this characteristic for the network.

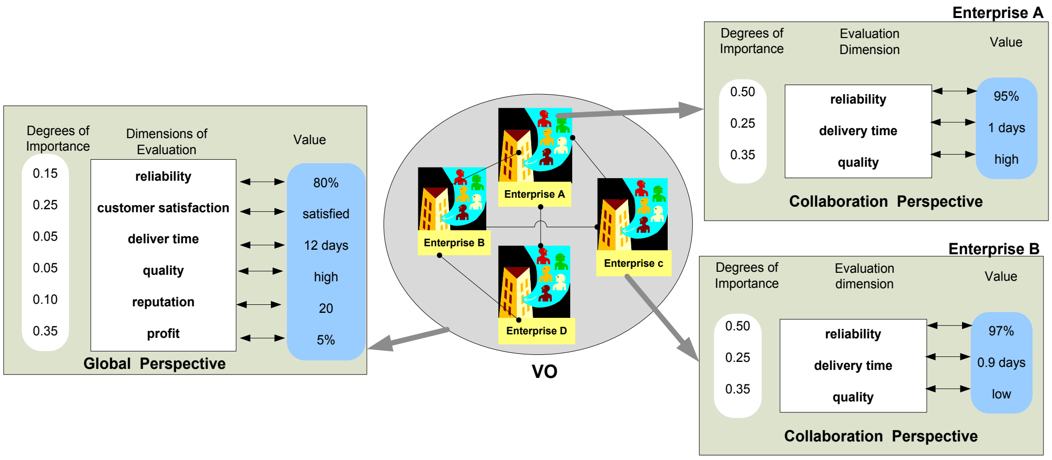


Figure 3.8. Example of evaluation using distinct evaluation perspectives

3.1.9 Discussion

At the beginning of the chapter a set of characteristics that the model should comprise in order to become a useful artifact to solve our main research problem were suggested. The selection of the modeling language/approach is one of the relevant issues, since it influences the level of formality and accuracy of the conceptual model. The decision to use a mathematical formalism was due to the fact that it will allow us to represent the concepts regarding evaluation, value, dimensions of value, perspectives of evaluation, with a high degree of accuracy and formality. The two modeling examples presented above show the high level of formalism of the resulting models.

Concerning the characteristic of granularity, it should be noted that to represent the components of a Value System, distinct levels of granularity are required, depending on the concrete goal of the model. The proposed conceptual model supports distinct levels of granularity, since most of the elements can be defined using the aggregation or specialization mechanism. For instance, we can consider just the organization itself as an object of evaluation, or we can detail the organization and identify all its departments and also evaluate the departments and not just the organization. Another example of distinct granularities is a definition of evaluation perspectives that can include more or fewer evaluation dimensions, thus allowing the level of granularity in the evaluation process to be adjusted accordingly.

The conceptual model of Value System developed can be applied to the network members and to the network itself, allowing the representation of Value Systems in collaborative contexts, as illustrated in the Examples 3.1 and 3.2. Moreover, the proposed approach supports the representation of the evaluation mechanism (priorities and evaluation functions) either qualitatively or quantitatively, as illustrated in Example 3.2. The table below summarizes how the proposed characteristics for the conceptual model were fulfilled.

Table 3.3. Main Characteristics of the conceptual model

	Description	**Discussion**
Formality	The conceptual model is intended to be formal enough to avoid contradictions and ambiguities.	The model is specified using a mathematical formalism, thus the resulting model has a good level of formality.
Fitness	The conceptual model is intended to cover the representation of the following concepts: value, evaluation, class of value, dimension of value, priority, core value in an integrated way.	The concepts of *value*, *evaluation* and *core value* are formally defined. The notion of *dimension of value* developed in sociology by Hartman is implemented through the notion of *evaluation dimension* (see Definition 3.4). The notion of *class of value* explored by Hoolbrook is covered partially by the proposed *evaluation perspective* concept. The concept of *priority* is implemented by attaching a *degree of importance* to each evaluation dimension, as specified in Definition 3.5. The *core value* concept is specified in Definition 3.8. The Value System was specified applying the general notion of system, where all these concepts were introduced as elements of the system, and their relations were specified. The UML representation of the model shows how these concepts are inter-related in one single view.
	The conceptual model is intended to cover both approaches of evaluation: qualitative and quantitative.	The notion of *qualitative evaluation* and *quantitative evaluation* were implemented through the specialization concept, i.e. an evaluation function can be numeric or qualitative (see Definition 3.2).
Prescriptiveness	The conceptual model is intended to be represented in a way that facilitates its translation to a computer language.	The selected modeling languages (mathematical formalism and UML) to represent the conceptual model, provide models easily "convertible" to computer language, as shown in Chapter 5.
Granularity	The conceptual model is intended to represent the Value System of a CN, as well as the Value System of each CN's member.	The conceptual model allows the specification of the Value System of CNs and of each CN's member, as shown in Example 3.1.
	The conceptual model is intended to support the representation of different levels of detail concerning the elements that comprise the Value System.	Each object of evaluation can be detailed. The specification of evaluation perspectives can include several evaluation dimensions if a detailed evaluation is required or just two or three when a higher level representation is preferable. The number of labels specified to define the degree of importance is also a way to implement distinct levels of granularity.

3.2. Conceptual Analysis Framework for Core Value Systems

3.2.1 Main Characteristics of the Analysis Framework

In line with the discussion above, the proposed conceptual model seems to be appropriate to represent the Value System in collaborative networks in terms of granularity, formality and fitness. However, the exclusive use of a mathematical formalism has the disadvantage of not providing a visual perception of the modeled system, hindering the development of a common perception of the Value System of the CN among the several stakeholders involved. Moreover, we believe that the development of a common perception about the interaction between the CN's Value System and members' Value System is a one the goals of Value System modeling in collaborative contexts.

One of the goals of this work is to develop formal mechanisms to analyze Value Systems in collaborative contexts, specifically to develop mechanism to assess the alignment between Value Systems. Additionally, we aim to contribute to the development of tools that facilitate the perception of: (i) the structure of the core values; (ii) the shared values among network members; and (iii) the set of core values belonging to one CVS that have a positive impact on another CVS.

Another important aspect to be considered is how to provide ways of dealing with partially known systems where we may have to work with incomplete and uncertain knowledge. In these cases, quantitative analysis restricts itself to well known mathematical structures and tries to find an approximate model that is close enough to the reality. For instance, stochastic methods are one way to quantitatively deal with uncertainty, where system variables are treated as random. However, there is often not enough available information to choose the correct probability distribution for the random variables. Thus, although quantitative approaches have the advantage of producing precise results, there is often a lack of confidence in the correctness of the model obtained. When conducting organizational studies most of the knowledge at hand is of a qualitative nature rather than exact numerical values, but often qualitative information can be enough to satisfactorily explain and predict organizational behavior (Lang, 2000). There are several reasons for taking a qualitative perspective, including:

- Usually there is not enough numeric information available about the "core - values" and their influence relations, in order to formulate a quantitative model. Thus, in such cases the system has to be modeled using just qualitative data.
- Often, we are not interested in the details of the system but in a qualitative description that provides a general perception of the network in order to address strategic business issues.

- Usually preferences are qualitatively measured and it is not possible to validate the causal links among core values using purely quantitative techniques.
- Therefore, in most cases it is more suitable to apply a qualitative approach to model and analyze Core Value Systems in collaborative environments than quantitative ones. However, since some users feel more confident using a quantitative approach, both approaches will be considered.

The main characteristics defined for the conceptual analysis framework are summarized in the table below:

Table 3.4. Main characteristics to be fulfilled by the analysis framework

	Description
Domain	▪ The framework intends to cover the representation of the following items: ▪ The structure of core values held by each element of the network. ▪ The representation of priorities ▪ The values shared among network members ▪ The relations of influence among core values
Analysis Approaches	The framework intends to provide both a qualitative and a quantitative approach of analysis.
Modes of Representation	The framework intends to provide a visual representation of the concepts involved, as well as a precise representation of them.

3.2.2 Overview of the Value System Analysis Framework

In order to satisfy the requirements presented above, two modeling approaches were selected: (i) *graph theory*, and (ii) *causal maps*.

Graph theory offers an abstract representation of the network in terms of a set of linked nodes, where the relations can be described based on algebraic notation. Social networks analysis (SNA) is one of the known applications of *graph theory* where the nodes are the individual actors (persons, groups, organizations or groups of organizations) within the networks, and ties are the relations between the actors. Methods developed in the scope of *graph theory* are used to characterize the social network and its actors (Tichy et al., 1979; Freeman et al., 1992; Wasserman and Faust., 1994). In this work an extension of the idea behind social networks analysis graphs is proposed. Therefore, graphs are used to represent the networks and their core values in symbolic terms, abstracting reality as a set of linked nodes. In this case each node represents an element (a network, an organization, or a core value) and the directed arcs specify the relations.

Another extension of *graph theory* is *causal models*, which emerged due to the need for a sketching technique to support and facilitate reasoning about cause and effect. The *causal models* term is used for distinct forms of representations and analysis. *Causal maps* (Jenkins,

1998; Laukkanen, 1998; Chaib-draa, 2002), *cognitive maps* (Axelrod, 1976; Kosko, 1986; Eden, 1992b; Bouzdine-Chameeva et al., 2003), *causal models* (Eden, 1992b; Pearl, 2000; Greenland and Brumback, 2002; Salles and Bredeweg, 2004) are examples of distinct terms that are often used to designate this common representation approach. The precursor work developed by Axelrod (1976) on *causal maps* was based on the following five fields: (i) psycho-logic (Zajonc, 1968), (ii) causal inference (Blalock Jr, 1963), (iii) graph theory, (iv) evaluative assertive analysis (Osgood et al., 1954), and (v) decision theory. The follow-up of these five initial contributions gave rise to different forms of causal models, and consequently to different modeling and analysis approaches. The most common are:

- *Cognitive maps* (also called causal maps or causal models) (Eden, 1992b; Jenkins, 1998; Chaib-draa, 2002; Scavarda et al., 2006): where nodes represent thoughts or concepts and links represent the influence among thoughts or concepts. Some researchers have used cognitive maps in the matrix representation form in order to benefit from the work done in social networks analysis, and to derive a set of analysis indicators.
- *Fuzzy causal maps* (Kosko, 1986): where nodes represent concepts, and links represent the fuzzy relation between concepts. The main purpose of this approach is to represent causal reasoning. In causal reasoning, it is possible to infer how the influence is propagated along the network using qualitative methods.
- *Probabilistic causal models* (Jensen, 1996; Pearl, 2000): where the nodes represent the variables, and the links represent the conditional dependencies in the model. The Causal Bayesian models are examples of probabilistic causal models, which are based on the Bayesian probability theory that captures believed relations (which may be uncertain, ambiguous or imprecise) between a set of variables.
- *Systems dynamics* (Forubus and Gentner, 1997; Lang, 2000; Salles and Bredeweg, 2004; Bin and Gongcheng, 2005): where Systems Dynamics is described as a set of variables/facts linked by causal arrows that indicate the causal effects between variables/facts and the respective direction of the relation. One main goal of Systems Dynamics is to start from the description of a system to infer its behavior over time.

In its essence, causal modeling builds upon a binary relation, called an influence relation, between two entities that represent named quantitative or qualitative values or value sets, whereby changes in the influencing entity are conveyed as changes in the influenced entity. Causal modeling has been applied in cognitive sciences and management sciences (Eden, 1992b; Ennis, 1999; Hodgkinson et al., 1999; Chaib-draa, 2002; Scavarda et al., 2006) in order to show the cognitive structure of some concepts. Furthermore, studies in methods to analyze

causal maps have already been carried out by several researchers (Eden, 1992a; Markiczy and Goldberg, 1995; Jenkins, 1998; Laukkanen, 1998; Pearl, 2000; Nadkarni and Shenoy, 2001).

Therefore, the causal modeling approach to model the causal relations among core values is selected. The main idea is to use causal models and graphs using a purely qualitative approach where the relations are just qualitatively specified, as proposed by Kosko (1986). The qualitative approach is selected as the core of this work. However, it is also possible to specify the relation in quantitative terms as it will be shown below.

3.2.2.1 Qualitative Approach

The proposed framework for Value Systems Alignment analysis for Collaborative Network (V-AligN) is based on the definition of three elementary maps:

- Core values influence map – A causal map that illustrates the relations of influence among core values. Where each node represents a core value, and the direct-edge represents the influence relation, and its width represents the strength of the influence.
- Organizations' core values map – A graph that illustrates the core values held by each organization. The edges of the graph have different widths according to the degree of importance of the core value.
- CN's core values map – A graph that illustrates the core values held by a collaborative network. The edges of the graph have different widths according to the degree of importance of the core value.

The following figure represents the elementary maps of the V-AligN framework.

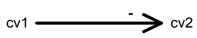
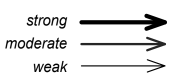
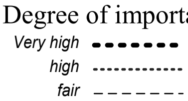
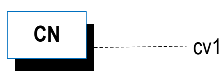
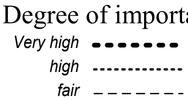
Core values	Organization	*CN*
Core values influence map Use causal maps to show how core values positively or negatively influence each other, and the intensity of the influence. **Type of influence:** *Positive influence*  Negative influence  Intensity of the influence: 	**Organizations' core values map** Use graphs to show the core values held by each organization, and the core values shared by organizations. **Organization O1 holds** the core value *cv1*.  Degree of importance: 	**CN's core values map** Use graphs to show the core values held by the CN, and the core values shared by CNs. **Collaborative Network CN holds** the core value *cv1*.  Degree of importance: 

Figure 3.9. V-AligN framework: qualitative elementary maps

Figure 3.10 gives an example of the elementary maps proposed to model a Core value system of a Virtual Organization (*VO1*). The elementary maps are the basis to construct composite maps that aggregate two or more elementary maps in a unique map. Aggregated maps aim to provide a holistic view of the Core Value Systems of the network and its members.

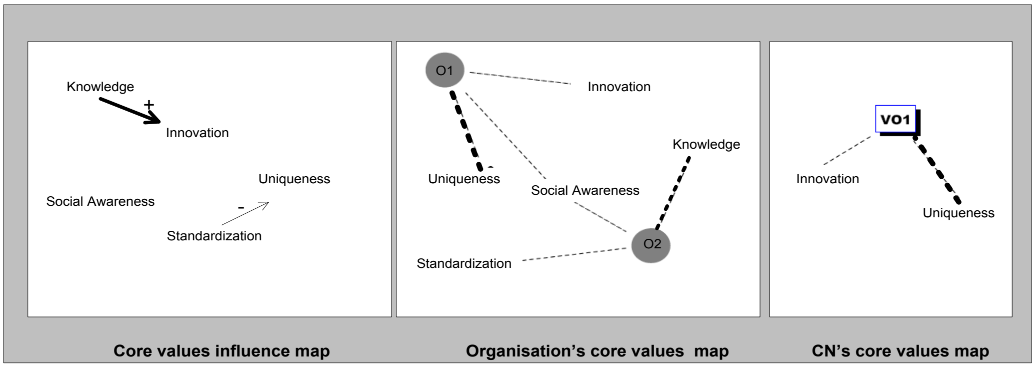


Figure 3.10. Elementary maps: examples

Two types of aggregated maps are proposed (see Figure 3.11):

- Partial Aggregated Maps - Aggregate *core values influence map* and *organization's core values maps*. This aggregated map makes explicit how the core values of one organization influence the core values of another organization.
- Complete Aggregated Maps – Aggregate the three types of elementary maps in a unique map. This map shows the impact of a member's core values in the CN's Core Value System and vice-versa.

In order to illustrate how the aggregated maps are generated let us work through an example. Figure 3.10 presents three elementary maps that correspond to the first row of the framework:

- Core values influence map – that illustrates the relations of influence among the five core values {*Innovation, Knowledge, Uniqueness, Standardization, Social Awareness*}.
- Organization's core values map - that illustrates the core values held by organization O1 and organization O2.
- CN's core values map - that illustrates the core values held by VO1.

Starting from these three elementary maps, two aggregated maps are generated as presented in Figure 3.12. These two maps correspond to the second and third rows in the framework. The first map results from the aggregation of the *core values influence map* and the organization's core values map; the second one results from the aggregation of the three elementary maps.

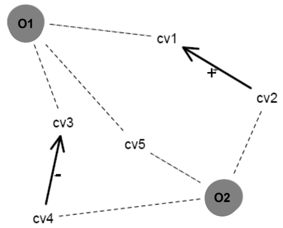
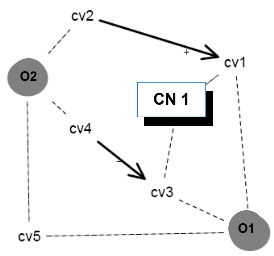
		Core values	Organizations	CN
Aggregated -maps	Partial	Use the aggregation of *core values influence maps* and Organization's core values maps, in order to show how core values of one organization can influence the core values of another organization. 		(hatched)
	Complete	Use the aggregation of *core values influence maps*, plus Organization's core values maps and CN's core values map, in order to show the impact of member's core values on the CN's Core Value System. 		

Figure 3.11. V-AligN framework: qualitative aggregated maps

The complete aggregated map (see Figure 3.12) explicitly outlines the shared values among VO1 members, O1 and O2. Furthermore, it allows the core values from O1 and O2 that have a positive/negative influence on the VO1's core values to be easily identified. In this example O2 holds the core value *Standardization* that has a negative influence on the *Uniqueness* that is a VO1 core value.

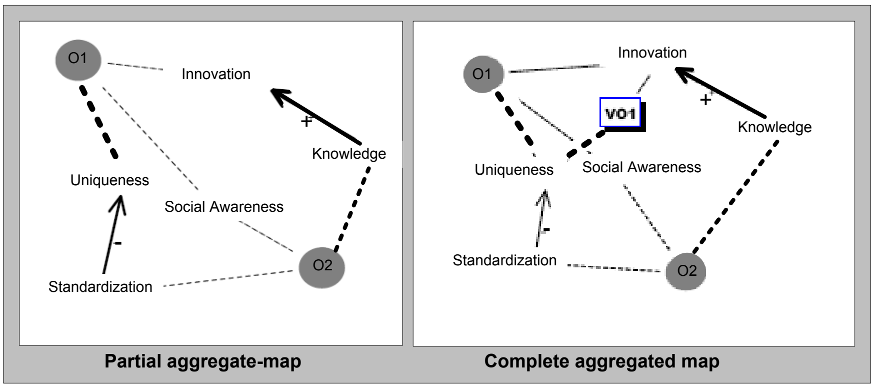


Figure 3.12. Examples of aggregated maps

3.2.2.2 Quantitative Approach

If accurate information is available on: (i) the degree of importance of each core value for its owner, and (ii) the intensity value of the influence among core values, we can use a

quantitative approach in Value System modeling. In this case, the following differences in relation to the previous representation have to be implemented:

- In graphs a numeric value is associated to the edge. This numeric value represents the degree of importance (see Definition 3.5).
- In causal maps, a numeric value is associated to the link, which represents the intensity of influence between core values.

The framework, presented above, can then be modified in order to cover these two quantitative elements, as shown in Figure 3.13.

Core values	Organization	CN
Core values influence map Use causal maps to show how core values positively or negatively influence each other, and the intensity of the influence. **Type of influence:** Positive influence with intensity *v*.: cv1 —v +→ cv2 Negative influence with intensity v. cv1 —v -→ cv2 $\boldsymbol{v} \in]\mathbf{0},\mathbf{1}]$	**Organizations' core values map** Use graphs to show the core values held by each organization, and the core values shared by organizations. **Organization O1 holds** the core value *cv1* with the degree of importance with the value *di*. O1 ---di--- cv1 $\boldsymbol{di} \in]\mathbf{0},\mathbf{1}]$	**CN's core values map** Use graphs to show the core values held by the CN, and the core values shared by CNs. **Collaborative network CN1 holds** the core value *cv1* with the degree of importance with the value *di* CN 1 ---di--- cv1 $\boldsymbol{di} \in]\mathbf{0},\mathbf{1}]$

Figure 3.13. V-AligN framework: quantitative elementary maps

The same example shown in Figure 3.12 is presented in Figure 3.14 using the quantitative approach. In the *core values influence map* it is easily perceptible that the influence intensity of *Knowledge* on *Innovation* is 0.5 and the influence intensity of *Standardization* on *Uniqueness* is 0.2. From the observation of the organization's core values map it can be noticed that *Standardization* is the core value with the highest priority for *O2*, with a degree of importance of 0.4, while *O1* selects *Innovation* as its priority, giving it a priority of 0.6.

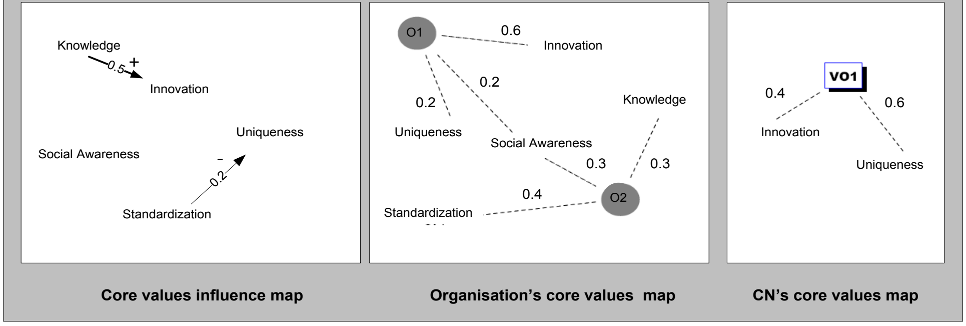


Figure 3.14. Quantitative approach: elementary maps example

3.2.3 Formal Definition of the Core Value System Analysis Framework

This section presents the mathematical formalization (using first order logic) of the elementary maps of the V-AligN Framework presented above. This mathematical formalization seeks to provide a more precise description of the elementary maps and not to propose an alternative way of representing them.

Definition 3.12 (Organization's core values map)

The Organization's core values map is defined as an ordered pair $OCVM = (V, OW)$, such that:

- $V = CV \cup O$, where CV is the set of core values, O is the set of organizations
- OW is a set of relations (edges).

  Qualitative approach

  Considering the partial order set $DI = \{low,\ fair, high\}$

  $OW = \{ow_{ij} = (o_i, cv_j, p): o_i \in O\ \wedge cv_j \in CV \wedge p \in DI\}$.

  The preference operator is defined as:

  $$preference: OW \rightarrow DI, preference(o, cv, p) = p.$$

  Quantitative approach

  $OW = \{ow_{ij} = (o_i, cv_j, p): o_i \in O\ \wedge cv_j \in CV \wedge p \in]0,1]\}$.

  The preference operator is defined as:

  $$\mathrm{preference: OW \rightarrow]0,1], preference(o, cv, p) = p.}$$

Definition 3.13 (CN's core values map)

The CN's core values map is defined as an ordered pair $CCVM = (V, CW)$, where:

- $\mathrm{V = CV \cup CN}$, CV is the set of core values, CN is the set of networked organizations.
- CW is a set of relations (edges).

  Qualitative approach

  Considering the partial order set $DI = \{low,\ fair, high\}$,

  $\mathrm{CW = \{\ cw_{ij} = (cn_i, cv_j, p): cn_i \in CN\ \wedge cv_j \in CV \wedge p \in DI\}}$.

  The preference operator is defined:

  $$preference: CW \rightarrow DI, preference(cno, cv, p) = p.$$

  Quantitative approach

  $CW = \{cw_{ij} = (cn_i, cv_j, p): cno_i \in CN\ \wedge cv_j \in CV \wedge p \in]0,1]\}$.

  The preference operator is defined:

  $$preference: CW \rightarrow]0,1], preference(cn, cv, p) = p.$$

Definition 3.14 (Core values influence map)

A core values influence map is defined by an ordered pair $CVIM = (CV, E)$ where:

- CV is the set of core values.
- E is the set of influences (edges).

  Qualitative approach

  Considering the partial order set $P = \{weak, moderate, strong\}$ and the set $S = \{-1, +1\}$, $E = \{e_{ij} = (cv_i, cv_j, p, s): cv_i \in CV \wedge cv_j \in CV \wedge p \in P \wedge s \epsilon S\}$

  The following operators are defined:

  - $influenceValue: E \rightarrow P \times S,\ influenceValue(cv_i, cv_j, p, s) = (p, s),$
  - $signal: E \rightarrow S,\ \text{signal}(cv_i, cv_j, p, s) = s,$
  - $intensity: E \rightarrow P, intensity(cv_i, cv_j, p, s) = p.$

  Quantitative approach

  Considering the set $S = \{-1, +1\}$,

  $E = \{e_{ij} = (cv_i, cv_j, p, s): cv_i \in CV \wedge cv_j \in CV \wedge p \in]0,1] \wedge s \epsilon S\}$

  The following operators are defined:

  - $influenceValue: E \rightarrow]0,1] \times S,\ influenceValue(cv_i, cv_j, p, s) = (p, s)$
  - $signal: E \rightarrow S,\ signal(cv_i, cv_j, p, s) = s,$
  - $intensity: E \rightarrow]0,1], intensity(cv_i, cv_j, p, s) = p.$

3.2.4 Modeling Example in the Context of Collaborative Networks

In order to illustrates how the V-AligN framework can be used to:

- represent the CVS in the context of collaborative networks;
- identify the shared values among CN members;
- identify the positive impacts between CVS;
- identify the negatives impacts between CVS;

a modeling example is presented. In the following example the qualitative approach has been selected.

Example 3.3. Applying V-AligN framework in VBE and VOs contexts

The proposed scenario considers the existence of a VBE, which initially contains seven organizations: a bank, two universities, three factories and one logistics operator, as illustrated in Figure 3.15. It is assumed a Reference *Core Value*s Ontology is in place, which contains a description of all possible core values that an organization in this context can hold. This

ontology also includes the information about the relations of influence between pairs of core values.

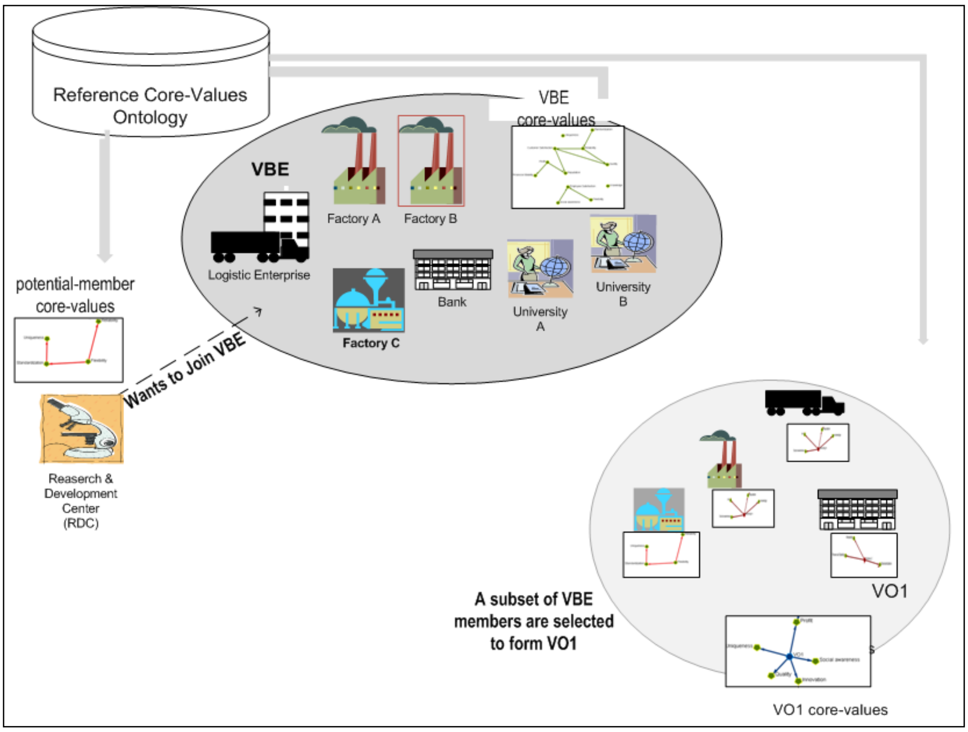


Figure 3.15. Example VBE scenario.

Let us suppose that the VBE manager as well as each organization's manager select the core values presented in Table 3.5. The degree of importance of each core value is also defined.

Table 3.5. Example core values set

Entity	Core values set		
	with **very high** priority	with **high** priority	with **fair** priority
VBE	Quality, Reputation.	Flexibility.	Customer Satisfaction, Knowledge
Factory A	Profit	Standardization.	Customer Satisfaction.
Factory B	Profit	Quality.	Flexibility
Factory C	Profit	Financial Stability	Reliability
University A	Reputation, Knowledge		Employee Satisfaction, Social Awareness
University B	Knowledge	Uniqueness	Profit
Bank	Profit	Customer satisfaction	
Logistic Enterprise	Profit, Flexibility	Employee satisfaction	
RDC	Innovation, Knowledge		Uniqueness

Let us first draw the maps that the VBE Core Value System to be described and analyzed, namely:

- The <u>*CN's core values map*</u> that shows the core values held by the VBE (see Figure 3.16a).
- The <u>*core values influence map*</u> that shows the relations among the core values held by the VBE (see Figure 3.16b).
- The <u>*organizations' core values map*</u> that shows the core values held by VBE's members (see Figure 3.16c).

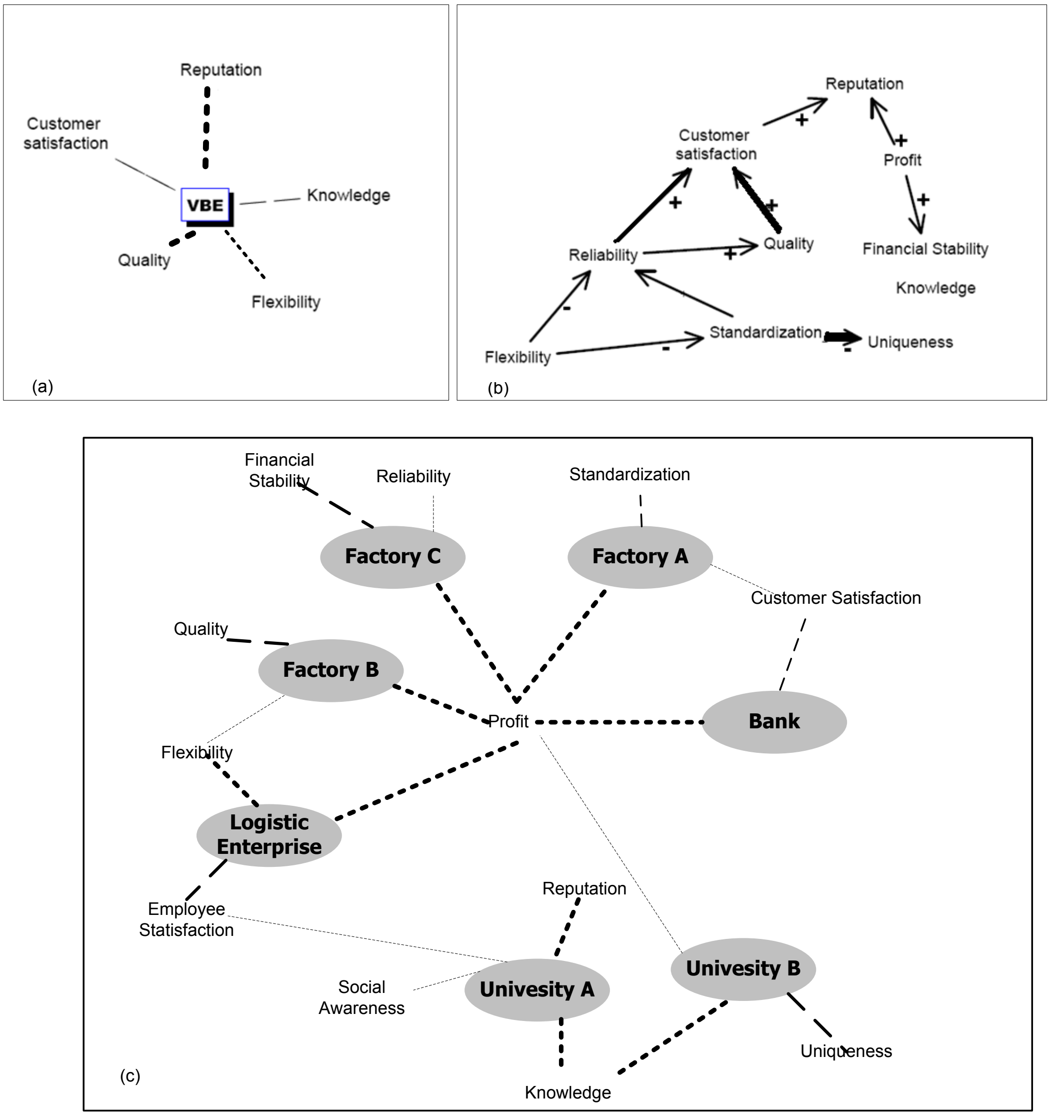


Figure 3.16. VBE: initial maps

From the examination of the *organization's core values map* (Figure 3.16c) it can be noticed that:

- *Profit* is a core value shared by most of the VBE members, and most of them consider it of high priority.

- *Knowledge* is a core value shared by University A and University B;
- all organizations share core values with at least one member;
- Reliability, Quality, Financial stability, Uniqueness, and Social awareness are core values that are not shared inside the VBE;
- *Customer satisfaction* is a core value shared by the Bank and Factory A, but with different degrees of importance.

Starting from this initial scenario, two events will be considered: (i) the Research and Development Center (RDC) wants to join the VBE; (ii) a business opportunity is identified by a broker, and a subset of the VBE organizations are selected to form a VO.

Regarding the first situation, let us consider that the RDC has selected, from the pre-configured list of reference core values, the ones that it considered as its own core values, namely *Innovation*, *Knowledge*, and *Uniqueness*. According to this, a complete aggregated map for RDC and VBE is generated (see Figure 3.17).

The analysis of this complete aggregated map shows that:

(1) The RDC only shares the core value *Knowledge* with the VBE.

(2) *Innovation* is a RDC core value that positively influences *Quality,* which is a core value that belongs to the VBE Core Value System.

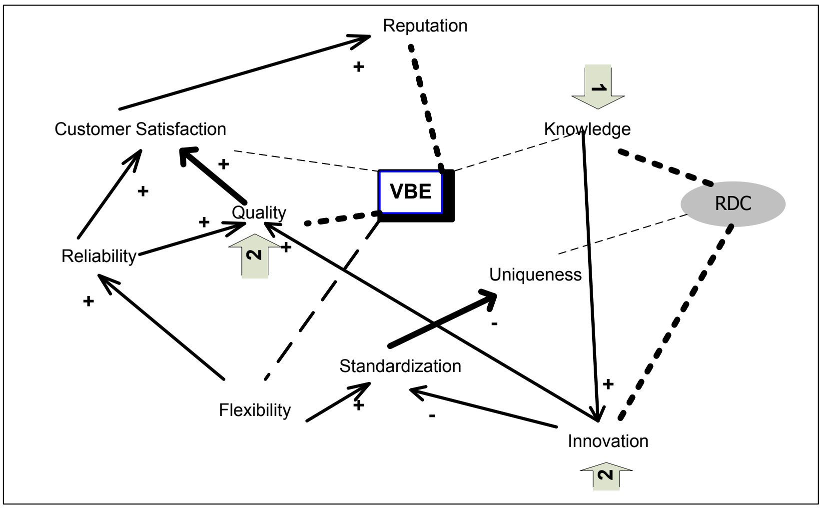


Figure 3.17. Complete aggregated map for VBE and RDC

Another relevant map is the partial aggregated map containing all VBE members, plus the RDC. This map shows the core values shared by the organizations and the influence among their core values. From the observation of the map presented in Figure 3.18 it can be noticed that:

(1) The RDC (new member) shares core values with University A and University B.

(2) The RDC has *Innovation* as a core value, which can negatively influence the core value *Standardization* that is considered of high priority for Factory A.

(3) The core value *Standardization* held by Factory A negatively influences the core value *Uniqueness* belonging to the RDC's CVS, but in this case *Uniqueness* is not considered of high priority.

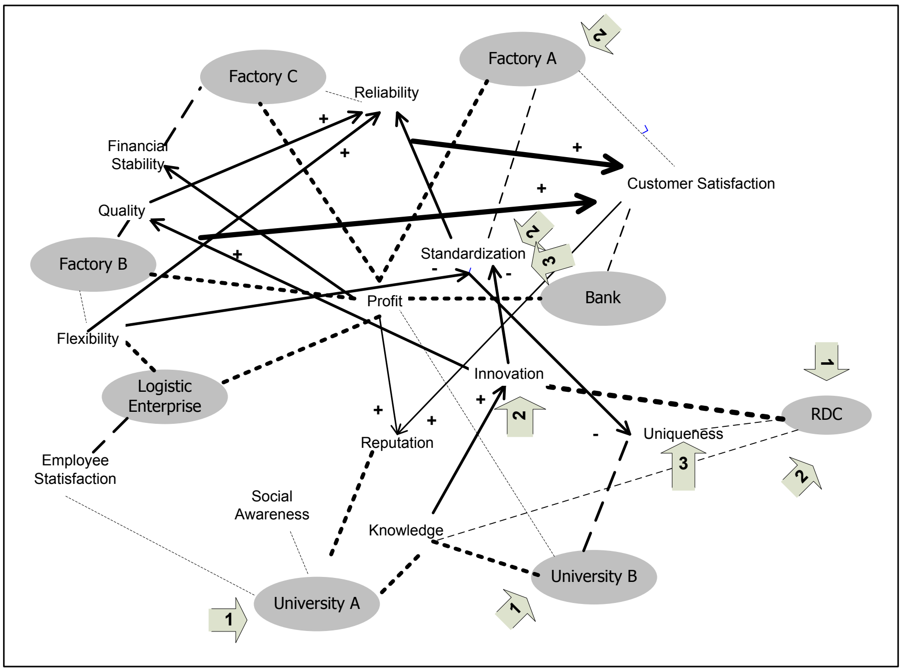


Figure 3.18. Partial aggregated map after RDC joined the VBE.

In the second case, let us assume that VO1 is created to manufacture pharmaceutical equipment and that the VO's planner defines the set of core values that will guide the behavior of this VO. In this case the VO1 planner has selected *Standardization* and *Profit* as very high priority, and *Customer Satisfaction*, with a fair degree of importance. The visual representation of the core values held by VO1 is shown through VO1's core values map presented in Figure 3.19.

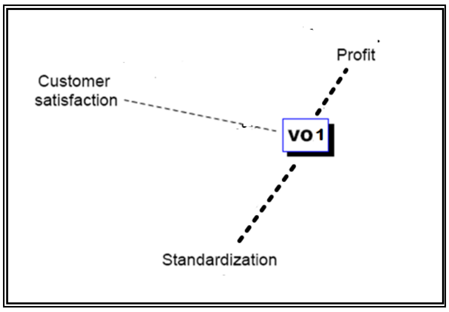


Figure 3.19. CN's core values map for VO1

Given the purpose of VO1, a factory that has the capacity to implement a specific manufacturing process needs to be selected. In order to determine whether Factory A or Factory B is more adequate in terms of core values to integrate the VO1, a complete

aggregated map for VO1 is generated, as shown in Figure 3.20. Based on this complete aggregated map it is possible to detect that:

- Factory A's core values fit VO1's core values better than Factory B's, because Factory A shares three core values with VO1 including *Profit*, while Factory B just shares the *Profit* core value with VO1.
- Factory B's CVS has a negative impact in VO1's CVS, due to the fact the *Flexibility* core value which belongs to Factory B's CVS has a negative influence on *Standardization* which is a high priority core value of VO1.

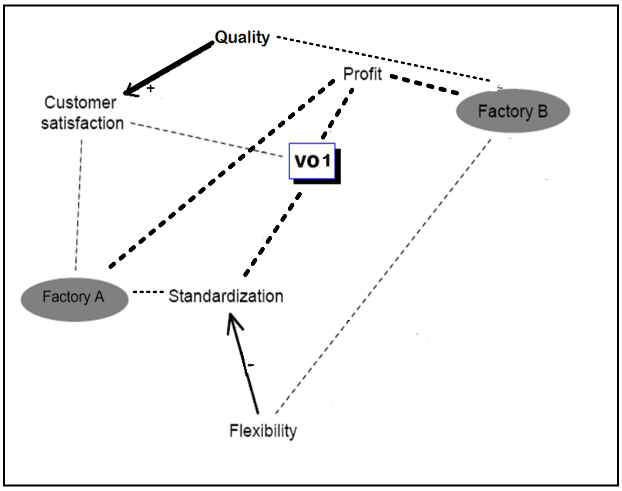


Figure 3.20. Complete aggregated map for VO1, Factory A, and Factory B

Suppose now that VO1 is formed with the following organizations: Bank, Logistic Enterprise, Factory A and Factory C. Starting from this information, the partial aggregated map for VO1 members is built (see Figure 3.21).

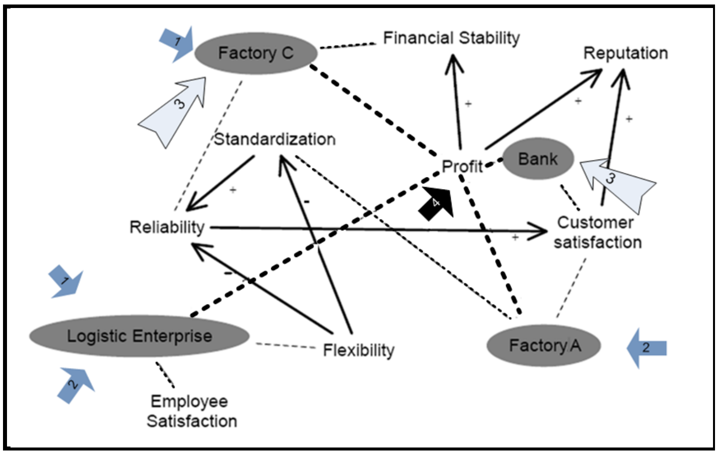


Figure 3.21. Core values' partial aggregated map for VO1 members

From the observation of this map, we can notice that:

(1) The *Flexibility* core value held by the Logistic Enterprise has a negative influence on the *Reliability* core value held by Factory C.

(2) There is a negative impact of the *Flexibility* core value on the *Standardization* core value.
(3) Factory C holds the *Reliability* core value that has a positive influence on the *Customer satisfaction* core value held by Factory A.
(4) All VO1 members share the *Profit* core value, considering it a very high priority core value.

The modeled case not only serves to illustrate the application of the V-AligN framework, but also to show how the characteristics defined for the framework were implemented. This example aims to show the use of the V-AligN framework in distinct moments of VBE's life-cycle. Furthermore it shows how the analysis of the maps drawn up can be used to draw conclusions about the compatibility and impact among *Core Value System*s. However, systematic ways to perform this analysis are needed. The next chapter will explore different approaches to analyze the Core Value Systems in the context of collaborative networks.

3.2.5 Discussion

As explained in the previous section, one of the purposes of the modeling example is to show the characteristics of the V-AligN framework. This framework provides models that cover the representation of the structure of core values held by each element of the network, through the use of the organization's core values map and the CN's core values map, as illustrated in Figure 3.16 and Figure 3.19. Moreover, it also covers the representation of priorities, visually showing which core values are more significant for its owner.

This analysis framework also provides two modes of application: a quantitative, and a qualitative one. In our opinion the qualitative approach is more adequate than the quantitative approach to represent items like strength of influence between core values, and the degree of importance of a core value. However, we believe it can also be useful to have a quantitative mode, since some potential users feel more comfortable using a more traditional method of representation. Furthermore, a quantitative model is easier to convert into a computer program than a qualitative one.

Applying graph theory in conjunction with causal maps allows diagrams to be obtained that facilitate the visual perception of the core values that are shared among different members, and also the impact between Core Value Systems, as shown by Example 3.3.

The table below summarizes how the proposed characteristics for the V-AligN framework were fulfilled.

Table 3.6. Main characteristic of the V-AligN framework

	Characteristic Description	Characteristic Implementation
Items to be represented	The framework is intended to provide a way to represent the structure of core values held by each element of the network.	The representation of the structure of core values held by each element of the network is achieved through the use of the organization's core values map and the CN's core values map, as illustrated in Figure 3.16 and Figure 3.19.
	The framework is intended to provide a way to represent priorities.	In the organization's core values map and the CN's core values map the priority of each core value is represented through the edge that links the core value to an organization or to a CN. In the qualitative approach, priorities are represented through the edge's width, and in the quantitative approach they are represented with the edge numeric label. The VBE members' core values map (see Figure 3.16 c), the organizations' core values map (see Figure 3.16 a) and VO1's core values map (see Figure 3.19) visually illustrate the representation of core value priorities.
	The framework is intended to provide a way to represent the values shared among network members.	A shared core value is represented in the organizations' core values maps and in the complete aggregated map by the set of edges that link this core value to several organizations. Figure 3.16c clearly shows that *Profit* is a core value shared by the majority of VBE's members and Figure 3.20 shows that *Profit* and *Standardization* are the core values shared by VO1 and Factory A.
	The framework is intended to provide a way to represent the relations of influence among core values.	The *core values influence maps* represent the positive and negative influence among core values. The map of Figure 3.16a, represents the influences among the core values of VBE members.
Analysis Approaches/ Mode of representation	The framework is intended to provide a qualitative mode of analysis and a quantitative one.	For all the main elements of the CVS analysis framework, a quantitative approach and a qualitative one have been proposed. Using a quantitative approach, the degree of importance of core values and the strength of influence among core values is represented through numeric values associated to each edge (see Figure 3.13). In the qualitative approach the degree of importance and the strength of the influence among core values are represented through the edge width (see Figure 3.9).
Modes of Representation	The framework is intended to provide a visual representation of the concepts involved, as well as a precise representation of them.	Since the maps presented are an application of graphs and causal maps and both have a visual representation, it follows that the resulting maps also have a visual representation. The modeling Example 3.3 illustrates how the concepts involved are visually represented.

3.3. Chapter Discussion and Conclusions

This chapter presented a conceptual model of Value Systems and a framework to analyze Value Systems in collaborative environments. These two artifacts contribute to solve the main problem addressed by this dissertation, and more specifically to answer the first two research questions defined in Section 1.3.

This chapter began by discussing the main characteristics proposed for the Value System conceptual model in a collaborative context. This set of characteristics was defined having as reference points the inputs that came from the ECOLEAD project experiments, and the literature review about Value Systems. A formal definition of Value System was presented, in order to promote a shared understanding about the proposed Value System concepts, and about the resulting Value System models.

As core values are used as the basis for the decision-making processes and are the elements that motivate and regulate the organization's behavior, the introduction of the notion of core value is essential to characterize organizations and networks. To encompass the notion of core value, a restricted view of the generic Value System was proposed: the Core Value System.

Although the proposed conceptual model and the selected language to represent the conceptual models for the Value System satisfy the characteristics of formality, fitness, granularity, and precision, the exclusive use of a mathematical formalism has the disadvantage of not providing a visual perception of the modeled system. A conceptual analysis framework based on graph theory and causal models was thus proposed, in order to support the development of formal mechanisms to analyze Value Systems in a collaborative context, specifically the mechanism to assess the alignment between Value Systems. This analysis framework provides a visual/graphical representation, but also provides a mathematical formal representation. Therefore, it is a good starting point for the development of formal methods to assess the alignment between Value Systems.

The modeling examples presented during this chapter, assume a relevant role, given that they illustrate the potential use of the proposed conceptual models in distinct collaborative scenarios, highlighting the different stakeholders involved. Moreover, they are used to show how the characteristics specified to the models were relevant for the distinct scenarios. Table 3.7 summarizes the contributions of the illustrative examples presented.

Table 3.7. Main contributions from the modeling examples

Goal	Examples		
	3.1	3.2	3.3
To show how to model Value Systems in distinct scenarios.	✓	✓	✓
To highlight distinct stakeholders.	✓	✓	✓
To show the use of distinct evaluation perspectives.		✓	
To show how to use a quantitative approach.	✓	✓	
To show how to represent priorities.	✓	✓	✓
To show how to use a qualitative approach.		✓	✓
To show the precision and formality of the selected modeling language.	✓	✓	
To show the visual expressiveness of the selected modeling approach.			✓
To show the representation of sharing core values.			✓
To illustrate how to reason about the alignment between Core Value Systems			✓

In conclusion, this chapter introduced a set of artifacts that contribute to solve the main problem addressed by this thesis, given that it presents: (i) a conceptual model that allows the representation of a Value System in a collaborative context, integrating the economic and sociological views on the concept of value; (ii) a conceptual analysis framework that allows visual representation of the notion of Core Value System (CVS) and the interactions between these systems. Furthermore, these conceptual models will be the basis for the development of formal methods to analyze CVS and to assess the alignment between them which will be presented in the next chapter.

4

Some methods to analyze Value Systems in Collaborative Networks

This chapter proposes a set of methods to analyze Value Systems and to assess the alignment level between them. First of all, the chapter discusses the criteria used in the assessment. In order to systematize the analysis process, a method for core values analysis using the V-AligN framework is proposed. Then, two basic approaches to assess the alignment, namely, a quantitative approach based on the matrix representation explored in graph theory, and a qualitative approach based on causal reasoning theory are presented.

Some additional specific issues, such as: using hierarchical taxonomies of values; impact of indirect influences, representation of external and internal factors, and using distinct evaluation perspectives, are discussed within the scope of the V-AligN framework. Some illustrative examples are presented and discussed during the chapter.

4.1. Towards Value Systems Alignment Criteria in Collaborative Contexts

Alignment is a very broad concept involving consistency, fit, and similar ideas. Therefore, in order to be able to propose adequate methods to analyze the alignment between Core Value Systems (CVSs) in a collaborative context, the factors that contribute to the alignment or the misalignment have to be explored.

In Section 2.2.5 the distinct notions of values alignment found in the literature review were discussed. After considering the literature available both on assessment of values alignment and collaborative networks, we have concluded that none of the authors have proposed methods to assess values alignment in collaborative contexts. However, some of the earlier works in the area gave some inputs to our task, namely:

- The studies carried out to assess of the compatibility between the set of values of one individual and that of another individual (Meglino and Ravlin, 1998);
- The studies carried out concerning the assessment of the compatibility between members' values and organization's values (Badovick and Beatty, 1987; Colins and

Chippendale, 1995; Hultman and Gellermann, 2002; Krishnan, 2005; De Clercq et al., 2008).

These two approaches to values alignment involve a comparison between Value Systems. While the assessment of *the compatibility between the set of values of one individual and that of another individual* involves the comparison between individuals' Value System; the alignment assessment *between members' values and the organization's* implies the comparison between an individual's Value System and the organization's Value System. These comparisons are, in essence, the identification of the existing shared values between two Value Systems. In the context of collaborative networks (CNs), this assessment will be considered on two distinct levels:

- The values alignment assessment between network members.
- The values alignment assessment between the network and its member.

In the V-AligN framework presented in Chapter 3, a method to easily represent the shared core values was proposed, as illustrated in Example 3.3. Nevertheless, this approach to alignment might fail when two actors share the same core values and preferences, and they believe that only one of them can maximize his/her core values through a collaborative process. In such a case, no collaborative process can emerge based on these core values. Hence, the shared core values cannot be the only contribution to the sustainability of the collaboration. For example, there are a lot of successful cases of collaboration between universities and industries, although they do not share many core values. A deeper analysis leads us to suggest that the collaboration is successful because the university has core values that positively influence the core values of the industry and vice-versa.

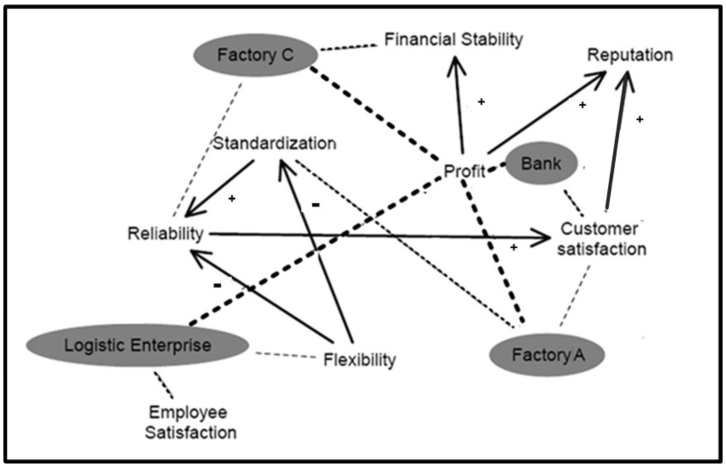


Figure 4.1. Core values' partial aggregated map for VO1 members (copied from Figure 3.21)

Looking again at Example 3.3 given in Chapter 3, and analyzing the partial aggregated map for VO1 members (see Figure 4.1), it can be noticed that:

- Factory C holds the *Reliability* core value, which has a positive influence on the *Customer Satisfaction* core value, held by Factory A.
- Factory A holds the *Standardization* core value, which has a positive influence on the *Reliability* core value, held by Factory C.

These positive influences between Factory A's CVS and Factory C's CVS, suggest that their CVSs fit each other. Therefore, the existence of positive influences among core values of distinct CVSs can be considered as a factor of *values alignment*.

On the other hand, if there are negative influences between core values of distinct members, this may suggest a potential for conflict, since in collaboration conflicts usually occur when individuals' goals and values are not compatible(Dolan and Garcia, 2002; Chao and Moon, 2005) Looking again at the example illustrated in Figure 4.1, we can notice that:

- The *Flexibility* core value held by the Logistic Enterprise has a negative influence on the *Reliability* core value held by Factory C.
- The *Flexibility* core value held by the Logistic Enterprise has a negative impact on the *Standardization* core value held by Factory A.

These negative influences between CVSs suggest that their CVSs do not fit each other; thus, the existence of negative influences among core values of distinct CVSs can be considered a factor of value misalignment**.** However, according to the conceptual model proposed in Chapter 3, the analysis of the alignment between two Core Value Systems should also comprise two main aspects (see Figure 4.2):

- Analysis of the core values alignment, where the "compatibility" between the two sets of core values is analyzed.
- Analysis of the evaluation alignment, to analyze whether the evaluation functions of different Core Value Systems, used to evaluate the same characteristic, are similar. Even if two evaluators hold the same core value, if they use different evaluation functions the evaluation results could be distinct.

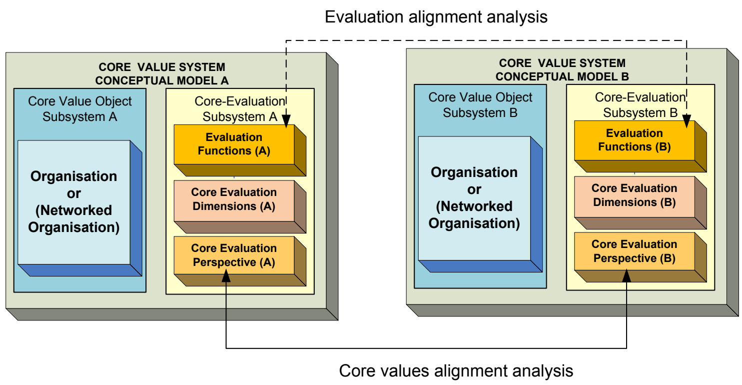


Figure 4.2. Core Value Systems alignment analysis

Nevertheless, the aim of this study is to solely discuss the core value alignment. The selected approach for the values alignment assessment assumes not just a comparison between Core Value Systems (CVSs), but also an estimate of the impact of one CVS on another. In short, the proposed analysis of the alignment between CVSs will consider the following parameters:

- the shared core values between CVSs;
- the positive impacts between CVSs;
- the negative impacts between CVSs;

and will be performed at two different levels:

(i) the CVSs alignment between network members;

(ii) the CVSs alignment between the network and the network members.

4.2. Analysis Method Using the V-AligN Framework

4.2.1 Introduction

In order to systematize the analysis process suggested in the modeling example presented in Chapter 3 (see Section 3.2.4), a method for core value analysis using the suggested framework is proposed. This method can be applied in the context of VBEs and VOs. However, the application has different purposes in these two types of networks, due to the distinct characteristics of each one of them.

Since a VO comprises independent organizations, which have to agree to collaborate towards a common goal, it is important to assure that the candidate's core values are aligned with the ones defined by the VO planner. Furthermore, as VO members are independent organizations, it is natural that conflicts tend to appear, even if they only work together for a short period of time. Thus, it is relevant to analyze the alignment between VO members in order to identify pairs of members for which there is a potential for conflict.

On the other hand, VBEs are characterized as being regulated open associations based on a long-term cooperation agreement, with the goal of increasing their preparedness towards collaboration in potential VOs (Afsarmanesh and Camarinha-Matos, 2005). Thus, if the main purpose of a VBE is to "produce" efficient VOs, then it is important to identify the groups of organizations whose CVSs are aligned, as these groups tend to work well together.

The VBE, like other forms of associations, should define its vision and values (Afsarmanesh et al., 2008a). Therefore, it is also relevant to guarantee, in the VBE member's admission process, that each new member shares at least the vision and the values with the VBE.

The proposed method assumes the existence of a *Reference Core Value Ontology,* which contains:

- a description of all the typical core values that an organization can hold;
- a definition of the relations of influence existing between pairs of such core values.

Such knowledge can be directly provided by experts or from surveys and interviews (see (Hall, 1995; Collins and Porras, 1996; Rekom et al., 2006), as examples). The *Reference Core Value Ontology* has two main purposes:

- To allow the core values to be selected from a limited set. This will guarantee a common terminology, which is essential to provide a common understanding.
- To allow that the consistent generation of core values maps from a subset of core values. This will allow the comparison of core values maps of network members and the analysis of the influences among core values of distinct members.

In short, the analysis method assumes that in the context of VBE management, during its set-up, a *Reference Core Value Ontology* is selected or constructed. This *Reference Core Value Ontology* will be used not only in VBE management, but also for the management of all the VO's created inside that VBE.

4.2.2 Method Description

The proposed analysis method comprises three base activities: (i) selection of core values; (ii) analysis of core values alignment between the CN and its members; (iii) analysis of the potential for conflict among CN members, as illustrated through the IDEF0 diagram in Figure 4.3 and Figure 4.4.

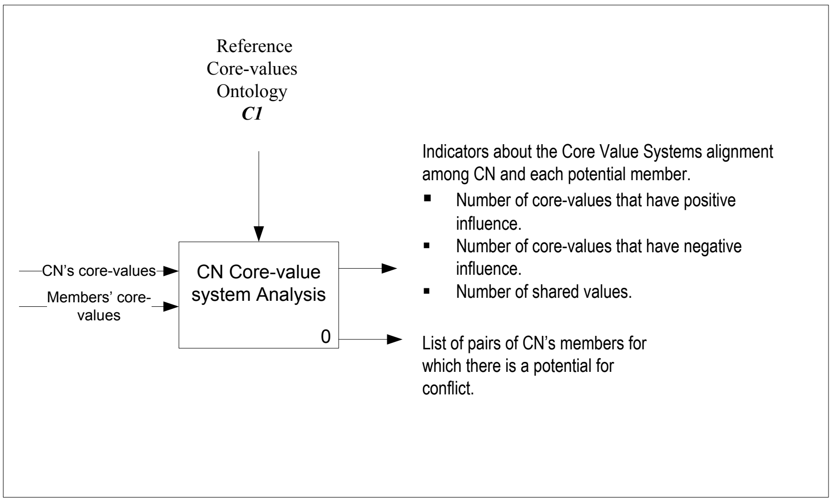


Figure 4.3. IDEF0 layer 0 - Core Value System analysis

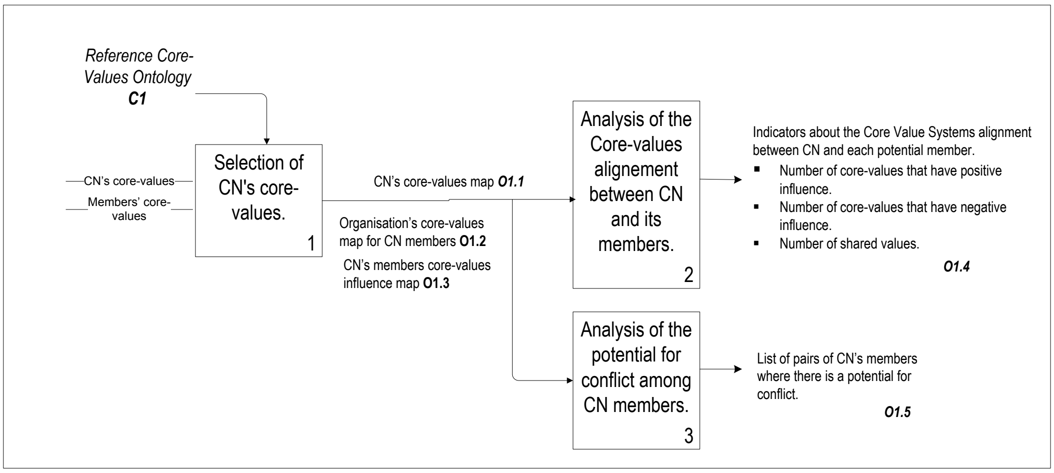


Figure 4.4. IDEF0 layer 1- Steps in the Core Value System analysis

A detailed description of each sub-activity shown in the previous IDEF0 diagrams is given in Table 4.1, where the inputs and outputs of each step are shown.

Table 4.1. Activities description

ACTIVITY	STEPS DESCRIPTION	INPUT/OUTPUT
Activity: 1 Purpose: Selection of CN's core values.	(1) Select from the pre-configured list of core values, (*Reference Core Value Ontology*), the ones that the CN manager considers as the CN's core values. (2) Select for each member, from the pre-configured list of core values, (*Reference Core values Ontology*) the core values that it considers as its core values. (3) Generate the CN's core values map. (4) Generate the Organization's core values map for each CN member. (5) Generate Core values influence maps for the CN.	**Input:** ▪ Reference Core Value Ontology. ▪ CN's members' core values. ▪ CN core values. **Output:** ▪ CN members' core values influence map. ▪ Organization's core values map for CN members. ▪ CN's core values map.
Activity: 2 Purpose: Analysis of the alignment between CN members' core values and CN's core values.	(1) Select the members to be analyzed. (2) Generate the complete aggregated map for these members. (3) For each member identify: a. The number of core values shared with the CN. b. The number of core values that have positive influence in the CN's core values and the ones that have negative influence. Compare the results obtained in step 3. The number of shared core values and positive influence relations indicate the level of alignment of the Core Value Systems. On the other hand, the number of negative relations indicates the level of misalignment.	**Input:** ▪ CN members' core values influence map. ▪ Organization's core values map for CN members. ▪ CN's core values map. **Output:** ▪ For each member, the number of: • shared core values; • core values that have positive influence; • core values that have negative influence.

(Table 4.1 continue)

ACTIVITY	STEPS DESCRIPTION	INPUT/OUTPUT
Activity: 3 Purpose: Analysis of the potential for conflict among CN members.	(1) Generate a partial aggregated map for the CN members. (2) Identify partners that share core values. (3) Identify the negative-influences in the aggregated map that links two core values belonging to distinct members. For each negative influence identified, ascertain the owners of the corresponding core values, in order to identify pairs of CN members for which there is a potential for conflict.	**Input:** ▪ CN members' core values influence map. ▪ Organization's core values map for CN members. ▪ CN's core values map. **Output:** ▪ List of pairs of CN members that share core values. ▪ List of pairs of CN members for which there is a potential for conflict.

4.2.3 Application Example

Example 4.1 (Part A) Analysis of CVSs alignment

In order to illustrate the application of the proposed method, the scenario previously presented in Example 3.3 will be used. As explained earlier, this analysis method is applicable in the same way both for VBEs and VOs. Only the VO1 analysis case is presented (see Figure 4.5). Applying the method to this context will allow us to: (i) check if the VO1's candidate members are aligned with VO1; (ii) identify pairs of VO1 members which have potential for conflict, in order to prevent conflicts during VO1 operation;

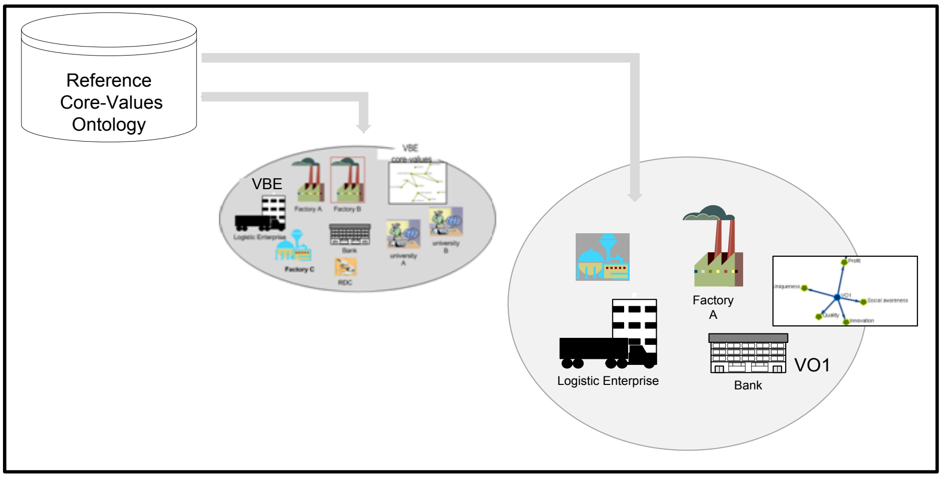


Figure 4.5. Scenario Example

<u>Activity 1 - CN's core values selection</u>

(1) *Select the core values from the Reference Core Value Ontology that the CN manager considers CN's core values* - In this case, the VO1 planner has selected Standardization and Profit with a very high priority, and Customer Satisfaction, with a fair degree of importance.

(2) *Each member selects the core values from the Reference Core Value Ontology that it considers its core values and their respective degree of importance* - In this case, each member selected the core values presented in Table 4.2.

Table 4.2. VO1 members' core value list

Entity	**Core value set**		
	with **very high** priority	with **high** priority	with **fair** priority
Factory A	Profit	Standardization.	Customer Satisfaction
Factory C	Profit	Financial Stability	Reliability
Bank	Profit.	Customer Satisfaction	
Logistic Enterprise	Profit Flexibility	Employee Satisfaction	

(3) *Generate the CN's core values map* - In this case, the generated *CN's core values map* for VO1 is shown in Figure 4.6.

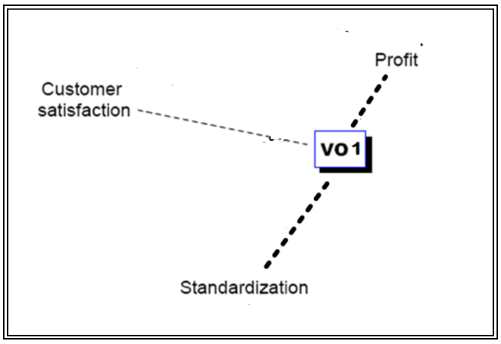


Figure 4.6. CN's core values map of VO1 (a copy of Figure 3.20)

(4) *Generate the Organization's core values map for each CN member* - In this case, the Organization's core values map generated for VO1 members is shown in Figure 4.7

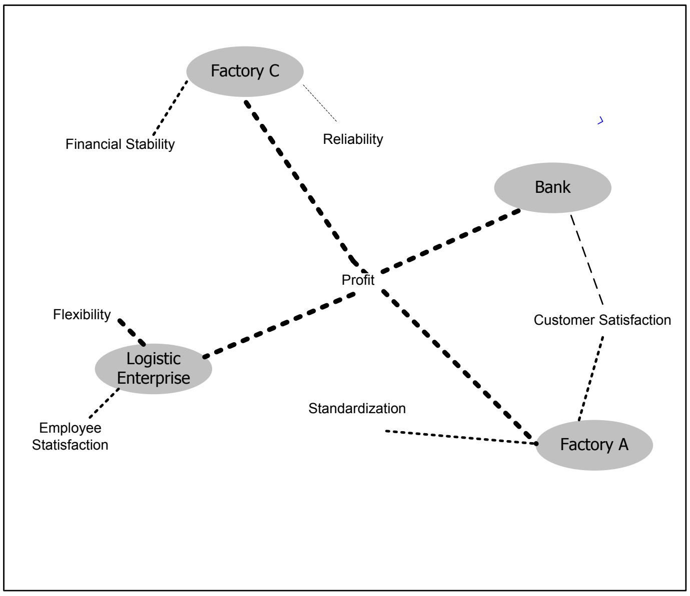


Figure 4.7. Organizations' core values map of VO1 members

(5) *Generate the core values influence map for the CN* - In this case, the core values influence map generated for the VO1 is shown in Figure 4.8.

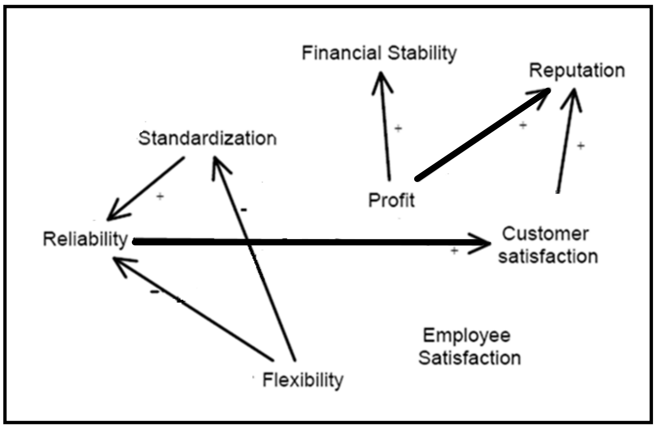


Figure 4.8. Core values influence map of VO1 members

<u>Activity 2 - Alignment analysis between members' core values and CN's core values</u>

(1) *Select the members to be analyzed* - In this case, we would like to determine which out of Factory A or Factory C is more adequate in terms of core values to integrate the VO1.

(2) *Generate the complete aggregated map for these members* - In this case, the complete aggregated map for VO1, Factory A and Factory C generated is shown in Figure 4.9.

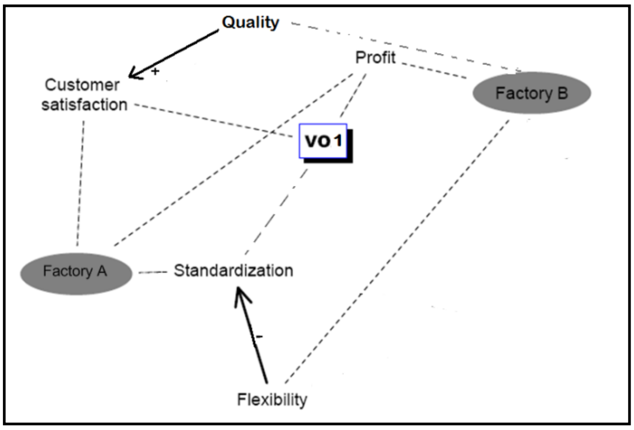


Figure 4.9. Complete aggregated map of VO1, Factory A and Factory B

(3) *For each member identify: (i) The number of core values shared with the CN; (ii) The number of core values that have a positive influence on the CN's core values, and the ones that have a negative influence.*

Factory A:

- Number of core values shared: 3 (Standardization, Profit, Customer Satisfaction).
- Number of positive influences: 0.

- Number of Negative influences: 0.

Factory C:

- Number of core values shared: 1 (*Profit*).
- Number of positive influences: 1 (*Quality* positively influences *Customer Satisfaction*).
- Number of Negative influences: 1 *(Flexibility* negatively influences *Customer Satisfaction*).

(4) *Compare the results obtained in step 3. The number of shared core values and positive influence relations indicate the level of alignment of the Core Value Systems. On the other hand, the number of negative influences indicates the level of misalignment* - In this case, we can conclude that Factory A is totally aligned with VO1, and there is a misalignment between Factory C and VO1.

Activity 3 - Analysis of the potential for conflict among CN members.

Generate a partial aggregated map for the CN members - In this case, a partial aggregated map for VO1 members (Logistic Enterprise, Bank, Factory A and Factory C) was generated.

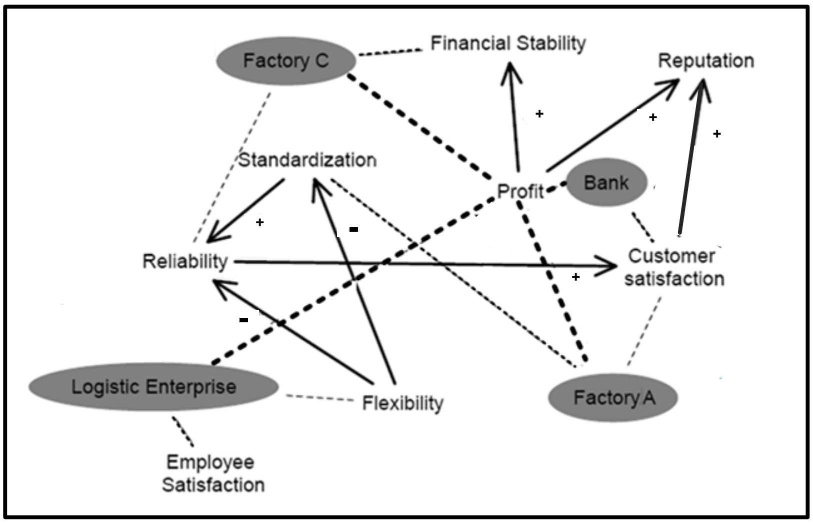


Figure 4.10. Partial Aggregated map for VO1 members (copied from Figure 3.21)

Identify partners that share core values - In this case, the following two sets of members can be identified:

- all members share the *Profit* core value*;*
- Factory A and the Bank share the *Customer Satisfaction* core value.

Identify the negative influences in the aggregated map that link two core values belonging to distinct members. For each negative influence identified, ascertain the owners of the corresponding core values in order to identify pairs of CN members for which there is a potential for conflict - In this case, the following pairs of VO1 members were identified:

- Logistic Enterprise and Factory C (the *Flexibility* core value held by the Logistic Enterprise has a negative influence on the *Reliability* core value held by Factory C).
- Logistic Enterprise and Factory A (the *Flexibility* core value has a negative influence on the *Standardization* core value).

4.3. Value Systems Alignment: towards some indicators

4.3.1 A Qualitative Approach

Based on the work developed on cognitive maps by Eden (1992a), and the work done on qualitative operators for reasoning maps by Montibeller and Belton (2009), a qualitative inference approach was developed in order to assess the level of shared core values, the potential for conflict among network members, and the positive impact between CVSs. For this approach, only the direct influences among core values are considered in a first stage; however, as it was considered that the propagation of influences in core values maps can have some relevance in the assessment, an extension to the method will be proposed.

In Chapter 3 the importance of specifying core value priorities and the strength of influences was discussed. Consequently, these two parameters are taken into account in the definitions of the alignment criteria, as proposed below.

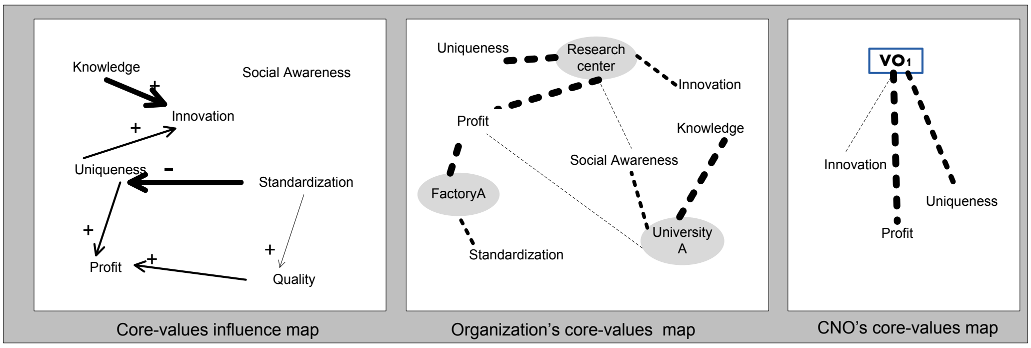


Figure 4.11. Examples of CVS maps

Let us take, for example, the case of the CVS represented in Figure 4.11. The *Profit* core value is shared by the three organizations. However, the level of shared core values with VO1 is higher in the case of the Research Center than in the case of University A, because *Profit* has a very high degree of importance for the Research Center, and a fair degree of importance for University A. In short, <u>if a shared value has a very high priority for both entities, then the shared core value level is very high.</u> If the core values have just a fair priority, then the shared core value level is lower.

In short, we can state that:

- The stronger the positive influence between two core values, the higher the positive impact;
- The higher the degree of importance of the core value (which is positively influenced), the higher the positive impact;
- Regarding the potential for conflict between two members the stronger the negative influence between two core values, the higher the potential for conflict;
- The higher the degree of importance of the core value (which is negatively influenced), the higher the potential for conflict.

In the same example, illustrated above, it can be noticed that since *Standardization* has a strong negative influence on *Uniqueness*, it is likely that there will be a high potential for conflict between Factory A and the Research Center.

Let us now present the formal definition of each alignment criterion. These definitions assume the formal specification of the maps belonging to the V-AligN framework as well as the following definition.

Definition 4.1 (Entities' core value preferences set)

The Entities' core value preferences set (EW) is defined as the union of two basic sets:

- *OW*: the set of the *edges* that belong to the organizations' core values map; (see Definition 3.12)
- *CW*: the set of all edges that belong to CN's core values map *(CW)*, (see Definition 3.13);

that is: $EW = CW \cup OW =$

$$\{ew_{xi} = (cv_i, ent_x, di_x): cv \in CV \wedge ent_x \in (CN \cup O) \wedge (di_x \in DI)\}$$

Additionally, it the *preference* operator is defined, which retrieves the degree of importance of a core value for an entity (a CN or an organization) :

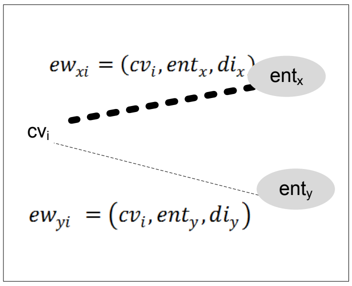
$$preference: EW \to DI, preference(ent, cv, p) = p, \text{where } ent \in (CN \cup O).$$

Definition 4.2 (Shared core values)

There is a *Shared Core Value* between two Core Value Systems, CVS_x and CVS_y, if there is a core value cv_i that belongs to both Core Value Systems.

The SH_{xy} represents the set of shared core values between CVS_x and CVS_y, associated with the respective degrees of importance, and it is defined as follows (see notation in Figure 4.12):

$$SH_{xy} = \{(cv_i, di_x, di_y) : (\exists\, ew_{xi} = (cv_i, ent_x, di_x) \in EW) \wedge (\exists\, ew_{yi} = (cv_i, ent_y, di_y) \in EW)\}$$



Shared core values

Figure 4.12. Elements for the shared core value indicator definition

Let us assume the existence of an auxiliary function *coreValue* that retrieves the core value from the tuple (cv, di_x, di_y):

$$coreValue: SH_{xy} \rightarrow CV \quad , \; coreValue(cv, di_x, di_y) = cv$$

The level of the *Shared Core Values* depends on the degree of importance of that core value in the respective CVS. Consequently, the resulting degree of importance of each shared core value is specified using a decision table $decT1: DI \times DI \rightarrow DI$. Table 4.3 illustrates a possible decision table for this case.

Table 4.3. Decision Table (decT1) example

decT1 (p1,p2)	fair	high	very high
fair	fair	high	high
high	high	high	very high
very high	high	very high	very high

Definition 4.3 (Shared Core Values intensity)

The *Shared Core Values intensity* is calculated as follows:

$$sharedValueIntensity: SH_{xy} \rightarrow DI$$

$$sharedValueIntensity((cv_i, di_x, di_y)) = decT1(di_x, di_y)$$

Consequently, the set of shared core values between two CVSs and their respective level is defined as follows:

$$SharedValues_{xy} = \{(cv_i, dti_{xy}) : \; \exists sh_{xy} \in SH_{xy} \; \wedge_i$$
$$cv_{i=}coreValue(sh_{xy}) \wedge \; dti_{xy} = sharedValueIntensity(sh_{xy})\}$$

The Figure 4.13 presents four illustrative examples, where representative cases of shared core value assessment are given.

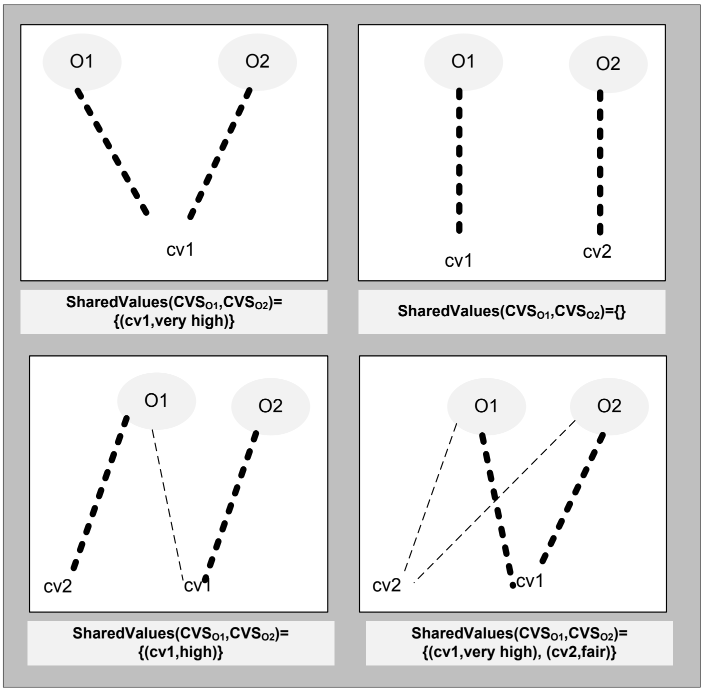


Figure 4.13. Elementary cases of shared core value assessment

Definition 4.4 (Positive Impact)

There is a *Positive Impact* between CVS_x and CVS_y , if there is at least one core value cv_i that belongs to CVS_x and one core value cv_j that belongs to CVS_y, so that cv_i positively influences cv_j.

PI_{xy} is the set of positive impacts of CVS_x on CVS_y (see Figure 4.14 for notation)

$$PI_{xy} = \{e_{ij} = (cv_i, cv_j, p, s) \in E: s = 1 \ \wedge \ cv_i \in CVS_x \wedge cv_j \in CVS_y\}$$

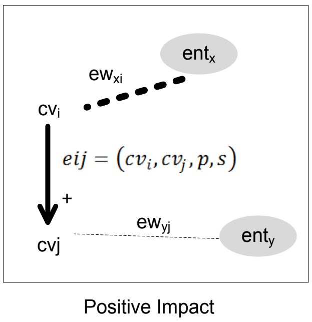


Figure 4.14. Elements for the positive impact indicator definition

The *Positive Impact Intensity* depends on two factors: (i) the intensity of the influence relation; (ii) the degree of importance of the core value. The combination of these two factors can be defined through a decision table with the following signature: $decT2: P \times DI \rightarrow P$.

Table 4.4. Decision table (decT2) example

decT2 (x,y)	fair	high	very high
weak	weak	weak	moderate
moderate	weak	moderate	strong
strong	weak	moderate	strong

Definition 4.5 (Positive Impact Intensity)

The *Positive Impact Intensity* is determined as follows:

$$impactIntensity: PI \times EW \rightarrow P,$$

$$impactIntensity(e_{ij}, ew_{yj}) = decT2(intensity(e_{ij}), preference(ew_{yj})).$$

The cardinal of the $PositiveImpacts_{xy}$ set gives the number of positive impacts one collaborative entity (organization or networked organization) has on another one.

In short, the positive impacts assessment method determines the set of positive impacts of one CVS_x on another CVS_y, and the corresponding inferred intensity for each positive impact.

$$PositiveImpacts_{xy} = \{(cv_i, cv_j, dt_i): \ \exists e_{ij} = (cv_i, cv_j, p, s) \in PI_{xy} \quad \wedge \quad \exists ew_{yj} = (cv_j, ent_y, p)EW \ \wedge \ dt_i = impactIntensity(e_{ij}, ew_{yj})\}$$

In Figure 4.15 four illustrative examples representative of positive impacts assessment are given. The two cases at the top of the figure illustrate how the assessment result depends on the degree of importance of the core value. The two cases at the bottom of the figure, on the other hand, illustrate how the result depends on the intensity of the influence relation.

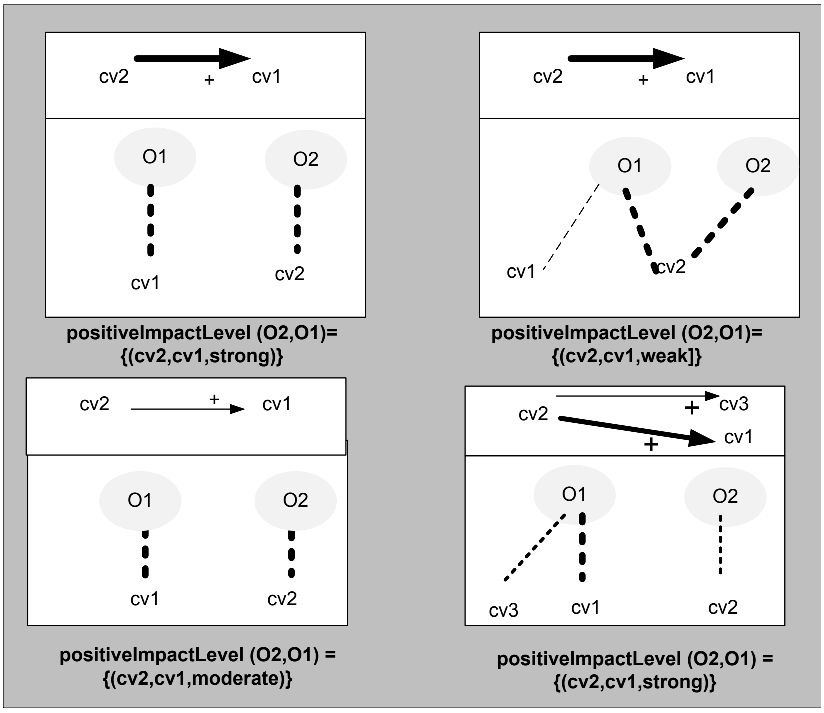


Figure 4.15. Basic cases of positive impacts assessment

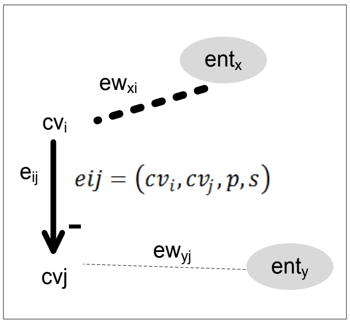
Definition 4.6 (Potential for Conflict)

A *Potential for Conflict* between CVS_x and CVS_y exists if there is at least one cv_i core value that belongs to CVS_x and one cv_j core value that belongs to a CVS_y, so that cv_i negatively influences cv_j, or cv_j negatively influences cv_i.

CI_{xy} represent the set of conflicts between CVS_x and CVS_y (see Figure 4.16 for notation):

$$CI_{xy} = \{e_{ij} = (cv_i, cv_j, p, s) \in E: s = -1 \ \wedge cv_i \in CVS_x \wedge cv_j \in CVS_y \}$$
$$\cup \{eij = (cv_j, cv_i, p, s): s = -1 \ \wedge \ cv_j \in CVS_y \wedge cv_i \in CVS_x \}$$

Like the *Positive Impact intensity*, the intensity of the conflict also depends on the intensity of the influence and the degree of importance of the core values. Thus, a similar inference process is suggested to determine the conflict intensity.



Potential for conflict

Figure 4.16. Elements for the potential for conflicts indicator definition

Definition 4.7 (Potential for Conflict Intensity)

The *Potential for Conflict* intensity is determined as follows:

$$conflictIntensity: CI \times EW \rightarrow DI,$$
$$conflictIntensity(e_{ij}, ew_{yj}) = decT2(intensity(eij), preference(ew_{yj})).$$

The following set specifies all cases of *Potential for Conflict* between two CVSs, and the respective inferred conflict intensity.

$$PotentialforConflict_{xy} = \{(cv_i, cv_j, dt_i): \ \exists e_{ij} = (cv_i, cv_j, p, s) \in CI_{xy}$$
$$\wedge \ \exists ew_{yj} = (ent_y, cv_j, p) \in EW \wedge \ dti = conflictIntensity(e_{ij}, ew_{yj})\}$$

The cardinal of $PotentialforConflict_{xy}$ set gives the number of cases of potential for conflict between two collaborative entities.

In Figure 4.17 four additional representative cases illustrating the application of the *Potential for Conflict* assessment method are shown.

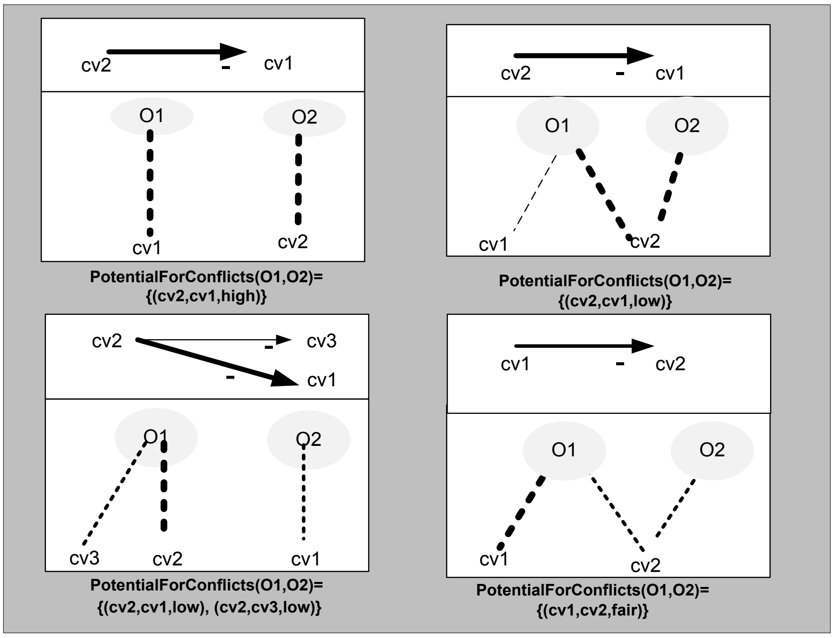


Figure 4.17. Representative cases of potential for conflict assessment

Example 4.1 (Part B) Qualitative assessment of CVSs alignment

Starting from the scenario illustrated in Figure 4.11, the qualitative CVSs alignment assessment introduced above is applied. Although this example is not complex enough to show the utility of the proposed indicators, it aims to illustrate how the proposed qualitative assessment (see Definition 4.2, Definition 4.4, Definition 4.6) can be applied. Furthermore, in order to show the utility of this approach to assess the core values alignment in collaborative contexts, a more complex scenario will be presented.

The findings for that scenario are presented in Figure 4.18. From these results it can be noticed that:

(1) The *Profit* core value is shared to a very high degree between Factory A and the Research Center. The Research Center is the one which causes the highest impact on VO1's CVS. These results show a high level of CVSs alignment between the VO1 and the Research Center.

(2) Although the Research Center and Factory A share the *Profit* core value with a high level of intensity, these two members are also the ones that present a higher potential for conflict. This fact shows that shared value assessment is not enough to conclude that there is alignment between CVSs. Two members can present a high level of shared core values, in spite of holding some core values that are incompatible.

(3) The Research Center and University A have a high level of shared core values, and a null potential for conflict, which suggests a high level of alignment between these two members.

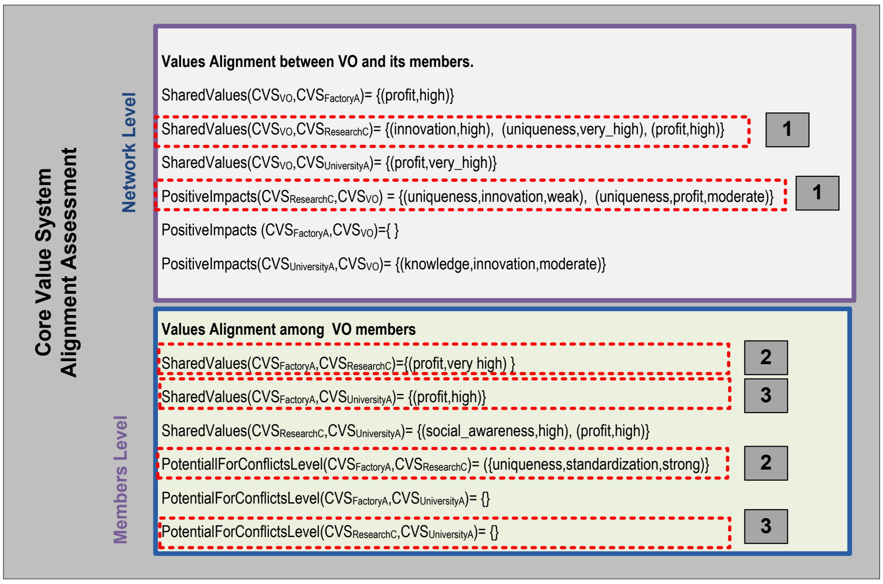


Figure 4.18. Qualitative assessment of alignment: results

4.3.2 A Quantitative Approach

The development of quantitative methods to assess the alignment between CVSs applies some principles of graph theory. Starting from a matrix representation of causal maps and graphs, the assessment methods are defined.

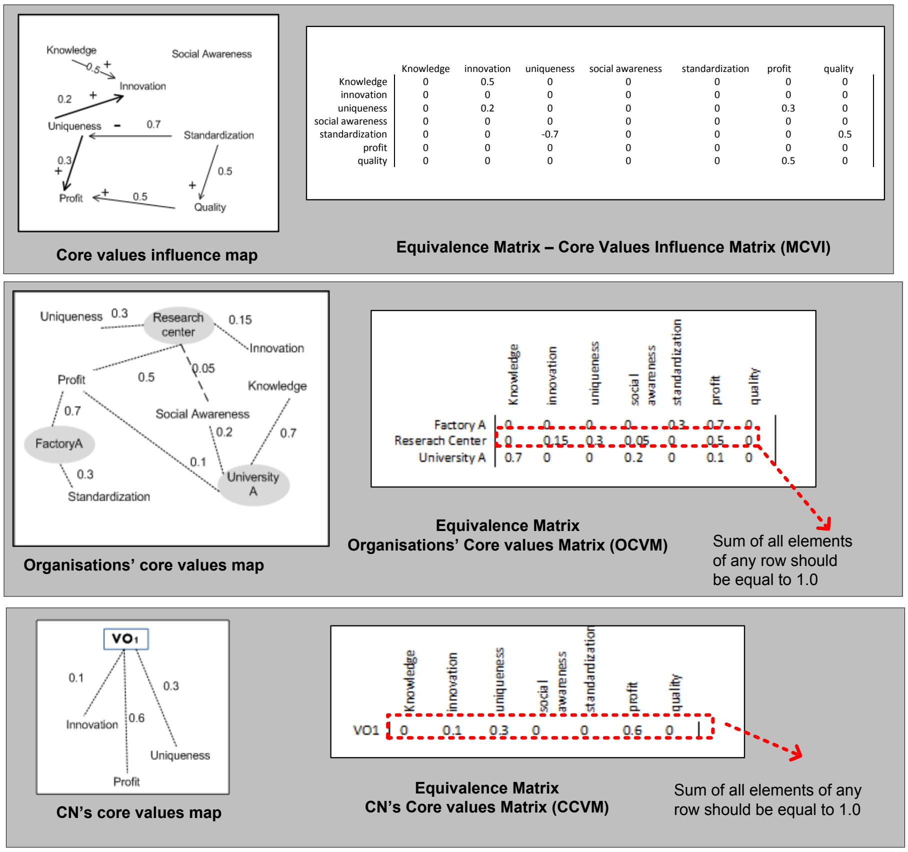
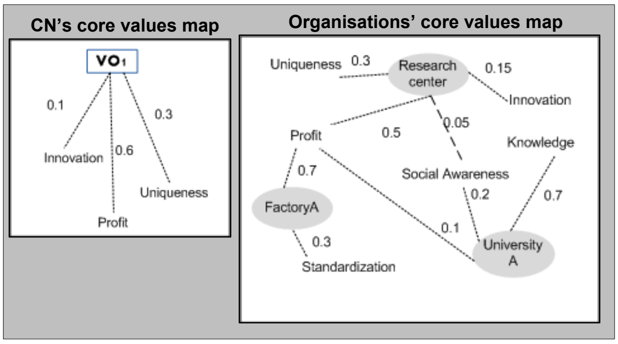


Figure 4.19. Matrix representation of CVS analysis maps

In order to facilitate the understanding of the mathematical formalism presented below, in Figure 4.19 the equivalence matrix for each map of the V-AligN framework, for the scenario introduced in Figure 4.5 is exemplified. As discussed earlier, the alignment assessment can be applied at the network level, or at the members' level. In the first case, the assessment is made between the CVS of the network and the CVS of a member, and in the second case the assessment is made between the members' CVSs. Therefore, to unify the calculation process a matrix is defined that represents the aggregation of the *organization's core values map* with the *CN's core values map*, as illustrated in Figure 4.20. We can notice that this matrix results from joining the lines of the Organizations' core value matrix (OCVM) with the lines of the CN's core value matrix (CCVM) (see Figure 4.19).



Core values Aggregate Matrix (CVAM)

	Knowledge	innovation	uniqueness	social awareness	standardization	profit	quality
Factory A	0	0	0	0	0.3	0.7	0
Reserach Center	0	0.15	0.3	0.05	0	0.5	0
University A	0.7	0	0	0.2	0	0.1	0
VO1	0	0.1	0.3	0	0	0.6	0

Figure 4.20. Core value aggregated matrix

One of the indicators to assess the alignment levels between two CVSs is the *Shared core value level.* This indicator applies the concept of Euclidean distance in a n-dimensional space[3] to show the level of agreement between actors' preferences. If the preferences of two actors are similar, the *Shared core value level* is high. Moreover, as the alignment level should also reflect the degree of importance of the shared core value, a correction factor is included. Thus, it is considered that if the shared core value has a high degree of importance for both members, then the *level of shared core values* is higher than if the shared core value has a low degree of importance.

[3] Euclidian distance between two points in a n-dimensional space:

$$d(p,q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + ... + (p_i - q_i)^2 + ... + (p_n - q_n)^2}.$$

Definition 4.8 (Level of Shared Core Values)

The level of *Shared Core Values* between CVS_x and CVS_y is defined as:

$$sharedValuesLevel(CVS_x, CVS_y) =$$

$$100\sqrt{\sum_{j=1}^{n}\left(\left(1-\left(abs(owner(CVAM[x][j])-owner(CVAM[y][j])\right)\right) * factorImp(x,y,j)\right)^2}$$

where:

$$factorImp(x,y,j) = (CVAM[x][j] + CVAM[y][j])/2$$

$$owner: [0,1] \rightarrow \{0,1\}, owner\ (x) = \begin{cases} 0\ if\ x = 0 \\ 1\ if\ x > 0 \end{cases}$$

such that: *CVAM* is the *core value aggregate matrix* for the network to which CVS_x and CVS_y belong.

If the *Shared core values level* between CVS_x and CVS_y is near 100, then the two entities share most of their core values. If the obtained level is near zero, then the number of *shared core values* between the two entities is insignificant, as illustrated in the next figure.

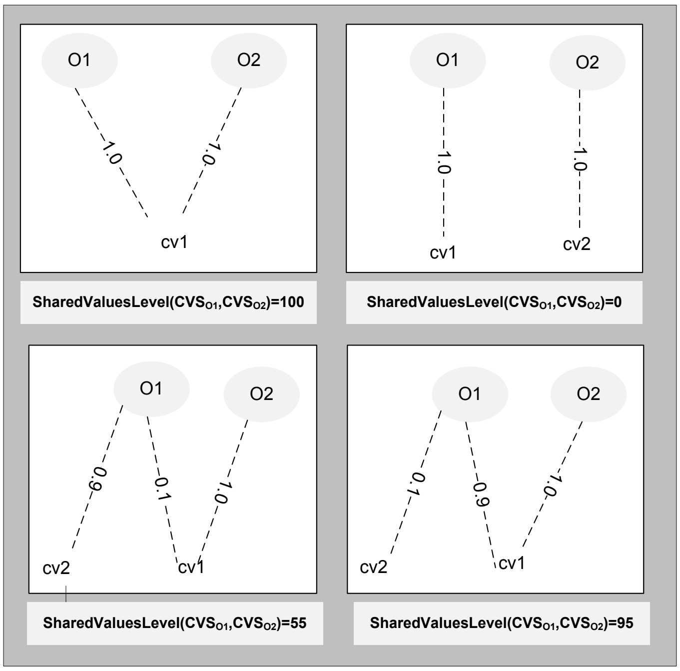


Figure 4.21. Representative cases of *Shared Value Level* assessment

In order to calculate the level of positive impacts, and the potential for conflict, a matrix of impacts is defined. This matrix represents the impacts of the core values of one CVS on the core values that belong to another CVS, as illustrated in Figure 4.22, where the value zero means that the impact is null, as specified below.

MImpacts($CVS_{FactoryA,}$$CVS_{ResearchC}$)

Factory A->ReserachC	Knowledge	innovation	uniqueness	social awareness	standardization	profit	quality
Knowledge	0	0	0	0	0	0	0
innovation	0	0	0	0	0	0	0
uniqueness	0	0	0	0	0	0	0
social awareness	0	0	0	0	0	0	0
standardization	0	0	-0.21	0	0	0	0
profit	0	0	0	0	0	0	0
quality	0	0	0	0	0	0	0

MImpacts($CVS_{UniversityA,}$$CVS_{ResearchC}$)

UniversityA>ReserachC	Knowledge	innovation	uniqueness	social awareness	standardization	profit	quality
Knowledge	0	0.08	0	0	0	0	0
innovation	0	0	0	0	0	0	0
uniqueness	0	0	0	0	0	0	0
social awareness	0	0	0	0	0	0	0
standardization	0	0	0	0	0	0	0
profit	0	0	0	0	0	0	0
quality	0	0	0	0	0	0	0

MImpacts($CVS_{ResearchC,}$ $CVS_{VO,}$)

ReserachC->VO	Knowledge	innovation	uniqueness	social awareness	standardization	profit	quality
Knowledge	0	0	0	0	0	0	0
innovation	0	0	0	0	0	0	0
uniqueness	0	0.2	0	0	0	0.18	0
social awareness	0	0	0	0	0	0	0
standardization	0	0	0	0	0	0	0
profit	0	0	0	0	0	0	0
quality	0	0	0	0	0	0	0

Figure 4.22. Examples of Impact Matrices

Definition 4.9 (Impacts' Matrix)

The matrix of impacts represents the impacts of the CVS_x on the CVS_y and is defined as:

$$MImpacts(CVS_x, CVS_y)[i][j] = (CVIM[i][j] \times CVAM[y][j]) \times owner(CVAM[x][i])$$

where the function ownership is defined as:

$$owner: [0,1] \rightarrow \{0,1\}, owner(x) = \begin{cases} 0 \; if \; x = 0 \\ 1 \; if \; x > 0 \end{cases}$$

Starting from the matrix of impacts, the *Positive Impact level* and the *Potential for Conflict level* are defined. The first indicator is calculated by adding all positive impacts found in the matrix of impacts.

Definition 4.10 (Positive Impact level)

The *Positive Impact level* between CVS_x and CVS_y is defined as:

$$PositiveImpactLevel(CVS_x, CVS_y) = 100 \sum_{i=0} \sum_{j=0} positives(MImpacts(CVS_x, CVS_y)[i][j])$$

where: $positives: [-1,1] \rightarrow [0,1],\; positives(x) = \begin{cases} x & if \; x > 0 \\ 0 & othwerwise \end{cases}$

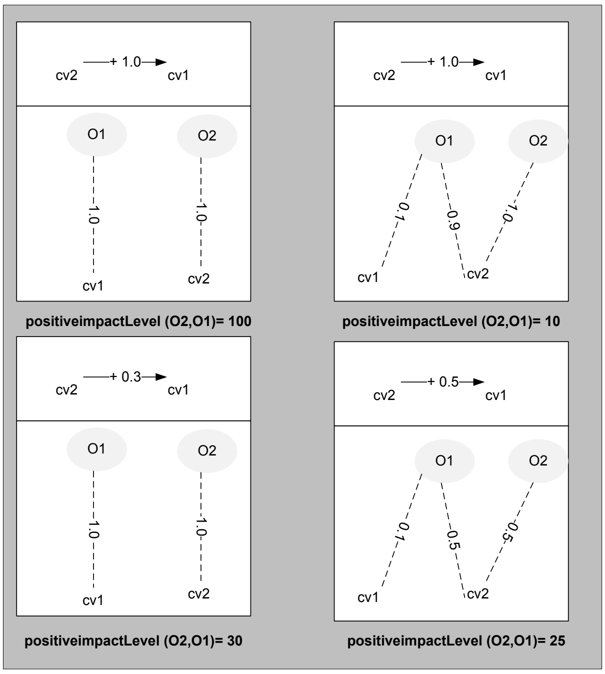


Figure 4.23. Representative cases of *Positive Impact level* assessment

If there is no positive impact of CVS_x on CVS_y, then the *Positive Impact level* is equal to zero. If the *Positive Impact level of* CVS_x on CVS_y is greater than the *Positive Impact level of* CVS_x on CVS_z, this means that CVS_x is more aligned with CVS_y than with CVS_z. In conclusion, based on this perspective, there will be a high level of alignment and a potential motivation to collaborate if the sum of positive impacts is positive and large for both members. On the other hand, if the sum of impacts is null or small, the level of alignment will be weak, as illustrated in Figure 4.23.

The potential for conflict is calculated by summing all the negative impacts between two CVS, as specified below.

Definition 4.11 (Potential for Conflict Level)

The level of *Potential for Conflict* between CVS_x and CVS_y is defined as:

$$PotentialforConflictsLevel(CVS_x, CVS_y) =$$

$$100\left(\sum_{i=0}\sum_{j=0} negatives(MImpacts(CVS_x, CVS_y)[i][j]) + \sum_{i=0}\sum_{j=0} negatives(MImpacts(CVS_y, CVS_x)[i][j])\right)$$

where:

$$negatives: [-1,1] \rightarrow [0,1],\ negatives(x) = \begin{cases} -x & if\ x < 0 \\ 0 & othwerwise \end{cases}$$

The negative impacts indicate that the core values are in some way incompatible, which may boost the potential for conflict between the CVSs owners.

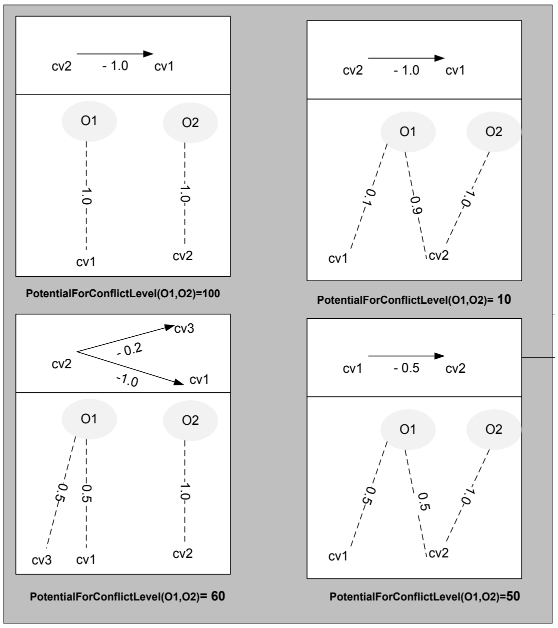


Figure 4.24. Representative cases of *Potential for Conflict level* assessment

In conclusion, there will be a high level of alignment between two members, and a high potential for successful collaboration, if the sum of negative impacts is near zero. On the other hand, if the sum is high, the level of alignment will be weak (see Figure 4.24 for illustrative cases).

Example 4.1 (Part C) Quantitative assessment of CVSs Alignment

Starting from the scenario initially illustrated in Figure 4.5, which was modeled using a quantitative approach (see Figure 4.19), the quantitative alignment assessment was applied. Figure 4.25 shows the findings for the three proposed indicators: *Shared core value level* (see Definition 4.8*), Positive Impact level* (Definition 4.10), and *Potential for Conflict level* (see Definition 4.11).

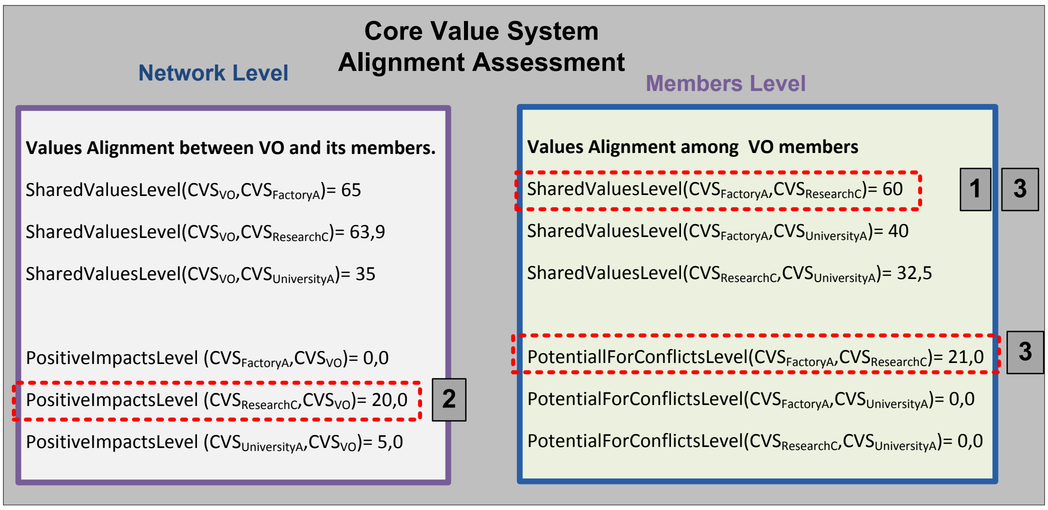


Figure 4.25. Quantitative assessment of alignment

From the findings it can be noticed that:

(1) Factory A and the Research Center have a high level of *Shared Core Values*.

(2) The Research Center is the one which causes a higher *Positive Impact* on the VO's CVS. These results show a high level of CVSs alignment between the VO and the Research Center.

(3) In spite of having the highest *Shared Core Value level,* the Research Center and Factory A are also the ones that present some *Potential for Conflict*. This fact shows that shared core value assessment is not enough to deduce alignment between CVSs. Two members can share a lot of core values, but they can also have incompatible core values.

In fact, this example is not complex enough to show the real utility of the proposed indicators, though its main purpose was to illustrate how the proposed mathematical formulas are applied and how the results obtained can be interpreted.

4.4. Further Issues on Core Value Systems Analysis

The analysis methods proposed above use a set of basic conditions, such as:

- Only a direct influence between core values is considered.
- Actors can select core values only from non-hierarchical taxonomies.
- Internal and external factors that influence core values are not considered.
- Each CVS has just one defined core evaluation perspective.

Addressing each of these aspects represents a new challenge to the CVSs analysis. How these issues can be integrated into the previous methods is now discussed.

4.4.1 Core Value Inferred Influences

By considering the example introduced in the previous section (see Section 4.3.1), and by observing the corresponding core values influence map (see Figure 4.26), we can notice that *Standardization* positively influences *Quality* in a direct way. In turn, *Standardization* influences *Quality,* and *Quality* influences *Profit,* and on the other hand *Standardization* influences *Uniqueness*, and *Uniqueness* influences *Profit*, so we can also conclude that *Standardization* influences *Profit* in an indirect way.

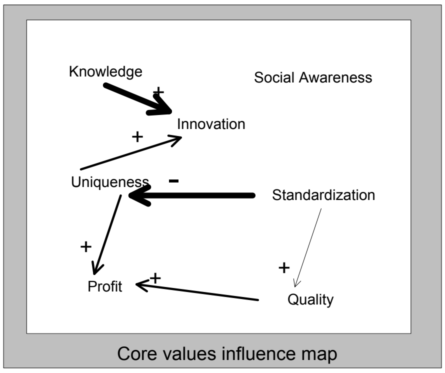


Figure 4.26. Core values influence map (copied from Figure 4.11)

Thus, we can define two kinds of influence relations: the direct influence and the indirect influence. If we have more than one influence path from one core value to another, the total influence has to be calculated. To infer the total influence relation between two core values, the following operations have to be performed (see Figure 4.27):

- Determine all partial influences**:** direct influences and indirect influences.
- Determine the result of the composition of all partial influences (direct and indirect).

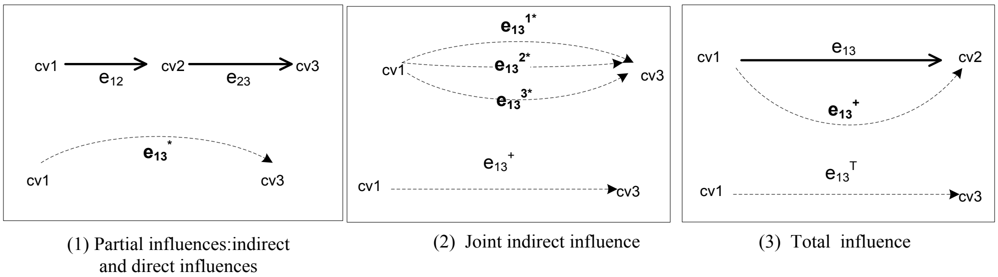


Figure 4.27. Inference Operations

For a better understanding of the inference methods specification, the terminology and symbols that will be used are outlined in the Table 4.5.

Table 4.5. Influence relations terminology

Symbol of the influence	Name	Description	Symbol of the set of influences
e_{ij}	Direct influence	Direct influence between the cv_i core value and the cv_j core value. The edge between two nodes of core values.	E
$e_{ij}^{n}*$	Indirect influence	The nth indirect influence between the cv_i core value and the cv_j core value.	E^*
$e_{ij}^{n}+$	Joint indirect influence	The result from joining the nth indirect influence between the cv_i core value and the cv_j core value.	E^+
e_{ij}^{T}	Total influence	Total influence between the cv_i core value and the cv_j core value.	E^T

In order to characterize each inferred influence relation, it is necessary to specify how the intensity and sign of partial influence and total influence can be inferred. One possible solution is to apply the Fuzzy Operators suggested by Kosko (Kosko, 1986), namely the *minimum* operator and the *maximum* operator. The *minimum* operator reflects a pessimistic approach, while the *maximum* operator reflects an optimistic approach. Both operators can reflect a partial effect. Nevertheless they lead to a degradation of outcomes by compressing or enlarging the intensity of the influence effect (e.g. for the *minimum* operator, the outcome of *min (moderate, weak)* is equal to *min (strong, weak)*). In the case of inferring the total effect, an operator that implements the notion of aggregation of influences is required; however, the *minimum* and *maximum* operators are non-aggregative, only reflecting a partial effect. On the other hand, decision tables are an easier way to elicit the preferences of decision makers, and the partial and the total influence effects can be fully specified by the user (Montibeller and Belton, 2009). Thus, similar to the method used for the qualitative indicators presented above, decision tables will be used here as well.

Definition 4.12 (Direct Influence)

There is a direct influence of the cv_i core value on the cv_j core value if in the *core values influence map* (see Definition 3.14) there is a direct path (link) from the cv_i node to the cv_j node.

Each influence relation is characterized by four variables: (i) core value: “cause/origin”; (ii) core value:”effect/end”; (iii) sign of the influence; and (iv) intensity of the influence. Therefore for each inferred influence it is necessary to determine its sign and intensity. In the case of indirect influence, as more than one path may exist from cv_i to cv_j, an operator is introduced to denote the intensity and sign of the indirect influence of cv_i core value on cv_j core value, through the n^{th} *path* denominated as iValue (e_{ij}^{n}*) (see Figure 4.27). A partially ordered set P_0*={zero, weak, moderate, strong}* is also defined, where the label zero means null influence. This new label was added to the partially ordered set *P* (see Definition 3.14) to “cut” the propagation of weak influences. Therefore, in the case of two successive weak influences, the resulting influence is ignored, as exemplified in Figure 4.28 and specified in Table 4.6.

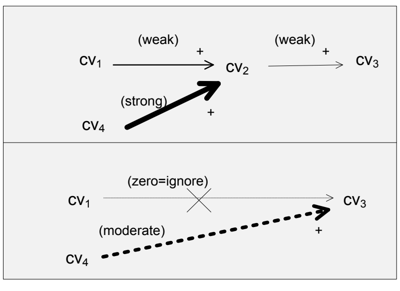


Figure 4.28. Cut propagation of weak influences example

Thus, the indirect influence is defined as follows.

Definition 4.13 (Indirect Influence)

There is an indirect influence of cv_i on cv_j if there is a core value cv_k, such that:

- there is a direct influence between cv_i and cv_k,
- there is at least one path between the cv_k node and cv_j.

The sign and intensity of the *nth* indirect influence ($e_{ij}^{n^*}$) is calculated recursively as follows:

$$iValue: E^* \to (P_0, S)$$

$$iValue(e_{ij}{}^{n*}) = \left(iIntensity(e_{ij}{}^{n*}), iSign(e_{ij}{}^{n*})\right)$$

$$iItensity: E^* \to P_0$$

$$iIntensity(e_{ij}{}^{n*}) = decT3(intensity(e_{ik}), intensity(iIntensity(e_{kj}{}^{n*})\ )$$

$$iSign: E^* \to S$$

$$iSign(e_{ij}{}^{n*}) = \ sign(e_{ik}) \times signal(iSign(e_{kj}{}^{n*})\ )$$

It is assumed that there is a decision table *decT3* (see Table 4.6 as example) with the following signature, $decT3: P_0 \times P_0 \to P_0$.

Table 4.6. Decision table decT3

decT3(P1,P2)	zero	weak	moderate	strong
zero	zero	zero	zero	zero
weak	zero	zero	weak	weak
moderate	zero	weak	moderate	moderate
strong	zero	weak	moderate	strong

In order to specify *Joint Indirect Influence*, let us introduce the operator *jointIValue*($e_{ij}^{n^+}$) to denote the intensity and sign of the aggregation of the *n*-first indirect influences of the cv_i core value on the cv_j core value. In this case the definition of a partially ordered set P_0 is included, where the zero label represents the intensity of the aggregation of two symmetric influences. For example, the aggregation of a strong positive influence with a strong negative influence results in a "null influence" that is, an influence with intensity zero.

Definition 4.14 (Joint Indirect Influence)

The joint indirect influence of cv_i on cv_j results from combining all indirect influences of the cv_i core value on the cv_j core value.

Hence, if there is only one multi-edge-path from cv_i to cv_j, the joint influence is reduced to that indirect influence. The intensity and sign of the joint inferred influence is defined recursively, as follows:

$jointIValue: E^{+} \rightarrow (P_0, S)$

$jointIValue(e_{ij}{}^{1+}) =$

$$\begin{cases} iValue(e_{ij}{}^{1*}), & there\ is\ just\ one\ path\ between\ cv_i\ and\ cv_j \\ decT4((iValue(e_{ij}{}^{n*}), jointIValue(e_{ij}{}^{(n-1)+})), & there\ is\ more\ than\ one\ path\ between\ cv_i\ and\ cv_j \end{cases}$$

The decision table *decT4* (see Table 4.4) is defined as follows:

$$decT4: (P_0, S) \times (P_0, S) \rightarrow (P_0, S)$$

Table 4.7. Decision table *decT4*

decT4(p,s)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)
(strong,-1)	(strong,-1)	(strong,-1)	(strong,-1)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)
(moderate,-1)	(strong,-1)	(strong,-1)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)
(weak,-1)	(strong,-1)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)
(zero,0)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)
(weak,+1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)	(strong,+1)
(moderate,+1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)	(strong,+1)	(strong,+1)
(strong,+1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)	(strong,+1)	(strong,+1)	(strong,+1)

Taking the *totalIValue* $(e_{ij}{}^{T})$ operator to denote the intensity and sign of the total influence effect of the cv_i core value on the cv_j core value, let us present the specification for *Total Influence.*

Definition 4.15 (Total Influence)

The total influence of cv_i on cv_j results from combining the indirect influences and the direct influence of core value cv_i on cv_j. Hence, if there is only a direct influence from cv_i to cv_j, the *Total Influence* is reduced to the direct influence. When there is no direct-path from cv_i to cv_j, the *Total influence* is reduced to the joint indirect influence.

The intensity and sign is defined recursively, as follows:

$totalIValue: E^{T} \rightarrow (P0, S)$

$$totalIValue(e_{ij}) = \begin{cases} influenceValue(e_{ij}), there\ is\ just\ a\ direct\ path\ between\ cv_i and\ cv_j \\ jointIValue\ (e_{ij}{}^{+}), there\ are\ just\ indirect\ paths\ between\ cv_i and\ cv_j \\ decT5(jointIValue\ (e_{ij}{}^{T}), influenceValue(e_{ij})\ ), \quad otherwise \end{cases}$$

Table 4.8. Decision Table *decT5* example

decT5 ((p1,s1),(p2,s2))	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)
(strong,-1)	(strong,-1)	(strong,-1)	(strong,-1)	(moderate,-1)	(zero,0)	(weak,+1)	(moderate,+1)
(moderate,-1)	(strong,-1)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)
(weak,-1)	(strong,-1)	(moderate,-1)	(moderate,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)
(zero,0)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)
(weak,+1)	(strong,-1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)
(moderate,+1)	(moderate,-1)	(weak,-1)	(zero,0)	(weak,+1)	(moderate,+1)	(strong,+1)	(strong,+1)
(strong,+1)	(moderate,-1)	(weak,-1)	(zero,0)	(moderate,+1)	(moderate,+1)	(strong,+1)	(strong,+1)

A decision table *decT5* (see Table 4.8) is proposed with the following signature:

$$decT5: (P_0, S) \times (P_0, S) \rightarrow (P_0, S).$$

This decision table reflects the idea that direct influences contribute more to the total influence than indirect influences.

An illustrative example of CVSs alignment assessment considering the direct and indirect influences between core values follows.

Example 4.1- Part D. Qualitative assessment of CVSs alignment considering indirect influences between core values

In Section 4.3.1 an example (see Example 4.1 Part B) illustrating the application of the qualitative methods to assess CVSs alignment was presented. In that example, the inference process considered only the direct influences. The same scenario will be used to assess alignment between CVSs, now considering the total inferred influences, as specified above.

The inference methods mentioned were implemented in SWI-Prolog. Figure 4.29 shows the main rules to implement the alignment indicators: *Positive Impact level.* The *Positive Impacts* and the *Potential for Conflict* assessment functions use the Prolog predicate *totalInfluence* in order to infer the total influence between two core values (see Definition 4.15). This predicate determines the intensity and sign of the inferred influence, as shown in the code presented in Figure 4.30.

```
%%POSITIVE IMPACTS

positive_Impact(E1, E2, CV1,CV2,I) :-
                  value(E1, CV1, _),
                        value(E2, CV2, DI),
                  CV2\==CV1,
                  totalInfluence(CV1,CV2,pos,I1),
                  decT2(I1,DI,I),
                  I\=ndef.

positive_Impacts(E1,E2,LC) :-
                  findall([CV1,CV2,I],
                          positive_Impact(E1,E2,CV1,CV2,I), LC).


%%POTENTIAL FOR CONFICTS

potential_conflict(E1, E2, CV1,CV2,I):-
           value(E1, CV1, DI1),
            value(E2, CV2, DI2),
            ( totalInfluence(CV1,CV2,neg,In), decT4(In,DI2,I);
             totalInfluence(CV2,CV1,neg,In), decT2(In,DI1,I)),
           I\=ndef.

potencialconflicts(E1,E2,LC):-
           findall([V1,V2,I], potential_conflict(E1,E2,V1,V2,I), LC).
```

Figure 4.29. Alignment assessment methods: Prolog implementation

```
totalInfluence(CV1,CV2,S,I):-direct_influence(CV1,CV2,S,I).

totalInfluence(CV1,CV2,S,I):-joint_influence(CV1,CV2,S,I),I\=ndef,!.


totalInfluence(CV1,CV2,S,I):-direct_influence(CV1,CV2,S1,I1),
                        joint_influence(CV1,CV2,S2,I2),
                        decT5(I1,S1,I2,S2,I,S),
                        I\=ndef.
```

Figure 4.30. Total influence of CV1 on CV2 calculation: Prolog implementation

Starting from the scenario illustrated in Figure 4.5 and considering the CVS maps presented in Figure 4.11 (which represent the CVS involved on the proposed scenario), the *Positive Impacts* and the *Potential for Conflict* were computed. From the results obtained (see Table 4.9), we can observe that University A's CVS and the Research Center's CVS both have a positive impact on VO1's CVS, however the University's CVS has a stronger positive impact in VO1's CVS than the Research Center's CVS.

Table 4.9. Positive Impacts assessment: results

	Nº positive impacts	Positive Impacts
Factory A	0	
University A	1	The *knowledge* value has a **strong** positive impact on the *innovation* value.
Research Center	1	The *uniqueness* value has a **moderate** positive impact on the *innovation* value.

Analysis of the potential for conflict among VO1 members (see Table 4.10) shows that there is potential for conflict between Factory A and the Research Center due to the fact that Factory A considers *Standardization* has an important core value, which has a negative influence in *Innovation* and *Uniqueness*, both core values of the Research Center.

Table 4.10. Potential for Conflict assessment: results

Pair of Members		# Potential Conflicts	Core value Conflicts	
Factory A	University A	0		
Factory A	Research Center	2	standardization and uniqueness	strong
			standardization and innovation	weak
Research Center	University A	0		

Comparing these results with the ones obtained in Example 4.1-part B, we notice that the results obtained do not differ significantly. Nevertheless, we can observe that in the *Potential for Conflict* assessment a new potential conflict is identified. This potential for conflict stems from the existence of an inferred influence of *Standardization* on *Innovation* that is negative and which had not been identified in the Example 4.1-part B.

4.4.2 Hierarchical Structure of *Core value*s

The proposed methods above assume a *Reference Core value Ontology*, where the core values structure is not hierarchical. Please note that the value taxonomies usually referenced, namely the Rokeach Values (Rokeach, 1973a), Schwartz value survey (Schwartz, 1992), OCP items (O'Reilly et al., 1991), value list from Brian Hall(1995), Seven Levels of Consciousness value list (Barrett, 2006), are not hierarchical taxonomies either.

Table 4.11. Example of Organizations' core values

Organization	Type	Core Values
Bayer Diabetes diabetes	Industry	Accountability
		Environmental awareness
		Honesty
		Integrity
		Safety
Cambridge University	Education/Research	Freedom from discrimination
		Freedom of thought and expression
		Internalionalization
		Knowledge
		Quality
EDP	Industry	Ambition
		Efficiency
		Innovatiom
		Openness
		Quality
		Responsibility
		Sustainability
		Trustworthy
Fundation Champ	Fundation	Ambition
		Creativity
		Freedom
Fundation São diego	Fundation	Genorosity
		Integrity
		Knowledge sharing
Fundation Stickel	Fundation	Citizenship awareness
		Enconomic sustainability
		Organizational quality
		Social awareness
Hovione	Industry	Custommer Satisfaction
		Employee awareness
		Environmental awareness
		Innovation
		Quality
		Safety
		Team respect
Inesc	Education/Research	Diversity in solutions
		Knowledge
		Partnership oriented
		Tecnological quality
		Quality in Services
		Safety
		Sustentabilidade financeira
Microsoft	Industry	Accountability for customer
		Accountability for employees
		Accountability for partners
		Constructive self-criticism
		Continual self-improvement
		Honesty
		Integrity
		Mutual respect
		Openness
		Personal excellence
		Quality
MIT	Education/Research	Knowledge
		Openness to communication
		Quality
		Well being
Secil	Industry	Economic development
		Environmental awareness
		Quality
		Responsibility

However, looking at the value statements of some well known organizations (see Table 4.11 for examples), we can notice different levels of detail in value specification. For example, while *Bayer Diabetes* specifies *Accountability* as a generic core value, *Microsoft* details *Accountability for customer*, *Accountability for employees*, *Accountability for partners*. Therefore, one can expect that in a partnership, different members may specify their set of core values at different levels of granularity. In that case, it is relevant to provide methods for alignment assessment that support a hierarchal structure of core values.

A hierarchical structure of core values supposes that core values are classified into types and subtypes, where the level of detail increases with the level of hierarchy. However, the hierarchical taxonomy of core values is not expected to have many levels.

Let us consider a generic structure of core values as illustrated in Figure 4.31 and a scenario where some CN members select the core values from distinct levels of the hierarchy, for instance, one member chooses core values from level one and another from level two. In this case, how can the three alignment indicators proposed in previous sections be calculated?

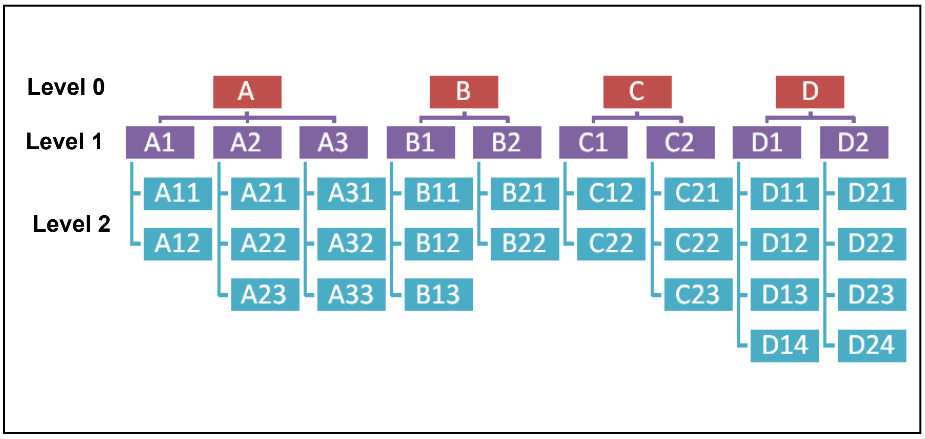


Figure 4.31. Hierarchical structure of core values

The suggested approach is based on the "normalization" of the organization's core values maps and the CN's core values maps to the lowest selected hierarchical level. That is, if one member has defined its Core Value System at the level zero, and another one at the level one, all maps are normalized to the level zero. In fact, when we convert a map from level one to level zero, we are aggregating data, and consequently obtaining a less detailed map. However, this will allow comparison of the CVSs without requiring additional information about each CVS.

In order to formally specify the steps for the "normalization" map, we first have to introduce some definitions.

Definition 4.16 (Core Values Hierarchical Set)

The *Core Value Hierarchical Set* is a hierarchal structure of core values, and is defined as:

$$CVHL = \{(cv_i, cv_j\ , l): cv_i \in CV\ \wedge cv_j\ \in CV \cup \{null\}\ \wedge\ l\ \in \mathbb{N}_0\}$$

where:

- l is the level of the hierarchy where the core value cv_i belongs;
- cv_j represents the parent core value in the hierarchy. If cv_i belongs to level 0, then cv_j is null.

The $CVHL_k$ is a subset of *CVHL* and defines the set of core values belonging to the hierarchy level (*k*).

$$CVHL_k = \{(cv_i, cv_j\ , k): cv_i \in CV\ \wedge\ cv_j\ \in CV\ \cup\ \{null\}\} \subset CVHL$$

The operator *sup* returns the parent's core value, such as:

$$sup: CV \rightarrow CV \cup \{null\}$$

$$\big((cv_i, cv_j\ , l) \in CVHL\ \big) \Rightarrow \big(sup(cv_i) = cv_j\big)$$

Definition 4.17 (Core Values Clustering Set)

The Core Values Clustering Set ($EW_{x,cv}$) is the set containing all the edges belonging to the *Organization's core values map* or the *CN's core values map* (see Definition 4.1 for EW definition). Each edge links a specific entity *x* (an organization or network) to a core value cv_i, which is a descendent of the core value *cv* in the hierarchy.

$$EW_{x,cv}\ = \{(x, cv_i, di) \in EW\ : cv_i \in CVHL_k\ \wedge\ sup(cv_i) = cv\}$$

Steps for Organization's core values map normalization:

- Determine the lowest level *k* of the core value hierarchy used in all the CVSs considered.
- For each entity *x* belonging to the map, if the entity *x* has chosen a core value from $level_i$, such as $i>k$, then each core value of CVS_x is normalized to the hierarchy $level_k$, and its new degree of importance is calculated, as follows:
  - In quantitative assessment, the new degree of importance is equal to the sum of the degree of importance of all core values with the same parent.

    $di_{normalized} = \sum_{j=1}^{n} di_j$, where:

    $$di_j\ \in DI_{x,cv} = \{di\!: \exists\ ew = (x, cv, di) \in EW_{x,cv}\}$$
  - In qualitative assessment, the new degree of importance is equal to the higher degree of importance of all core values with the same parent.

    $di_{normalized} = max(DI_{x.cv}\ )$ where:

    $$DI_{x,cv} = \{di\!: (x, cv, di) \in EW_{x,cv}\}$$

After the "normalization", the *Shared core values*, *Positive Impact* and *Potential for Conflict* indicators are calculated exactly as explained in Section 4.3.

In order to illustrate this new concept, a brief example is given below.

Example 4.2. Qualitative assessment of CVSs alignment using hierarchical l sets of core values

Let us consider the *Core Value Hierarchical Set* presented in Figure 4.32, and the Organizations' core values map presented in Figure 4.33, which illustrates the priorities of CN members.

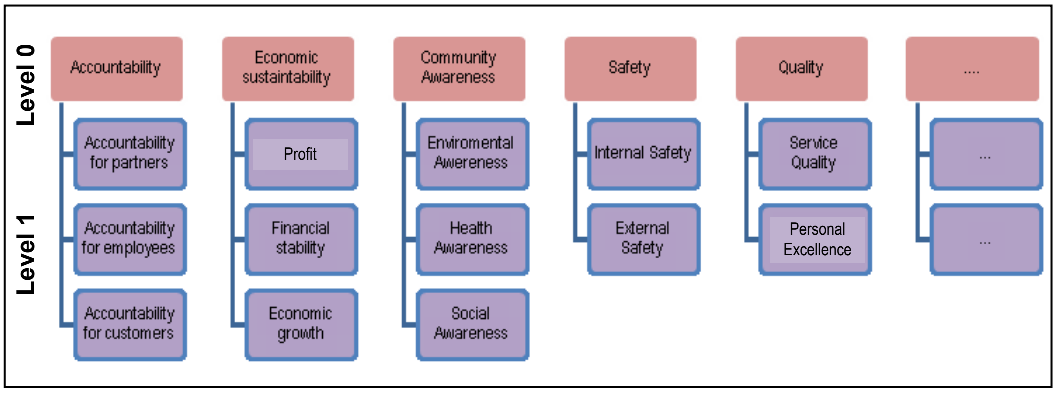


Figure 4.32. Example of hierarchical core value set

From the analysis of the map, we can notice that Member A and Member C have core values belonging to the level zero of the core value taxonomy, and Member B has core values of level one. An immediate analysis of this map can lead us to draw wrong conclusions; for instance, it seems that Member B does not share any core values with the others members, which is not exactly right.

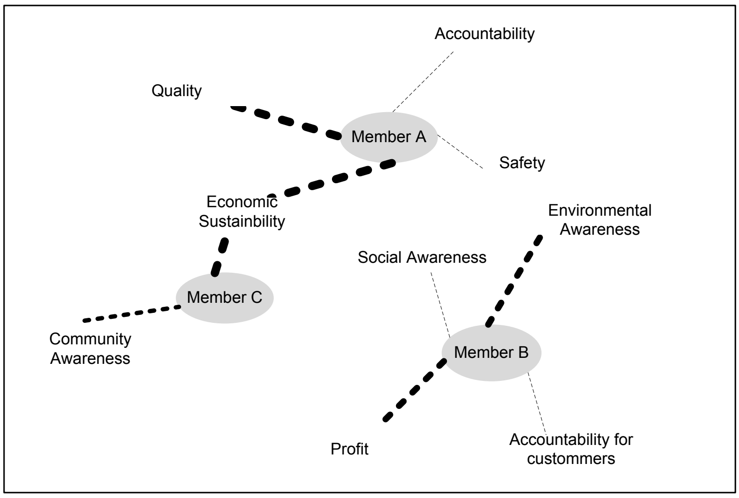


Figure 4.33. Organizations' core values map

In order to determine the alignment indicators, the maps have to be "normalized". The map shown in Figure 4.34 results from the application of the "normalization" steps specified above.

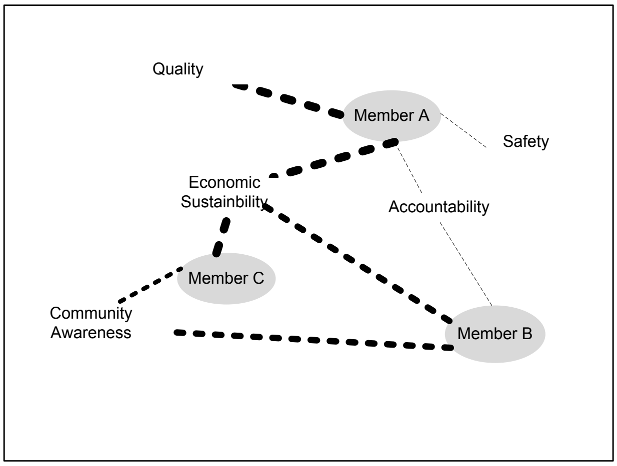


Figure 4.34. Normalized Organizations' core values map

Observing the normalized map above, where every core value belongs to the level zero of the hierarchical set, we can easily notice that all members share the *Economic Sustainability* core value, and the *Accountability* value is shared by Member A and Member B. The *Community Awareness* core value is shared by Member B and Member C. In the initial map, Member B holds the *Social Awareness* core value and the *Environmental Awareness* core value that in the normalization process were grouped into a single core value: *Community Awareness*. The degree of importance of the *Community Awareness* core value for member B is determined by applying the rules specified above, as follows:

$$DI_{MemberC,\ CommunityAwareness} = \{fair, high\}$$

$$di_{normalized} = max\left(DI_{MemberC,\ CommunityAwareness}\right) = high$$

After the normalization of the maps, the alignment assessment is performed as specified in sections 4.3.1 and 4.3.2

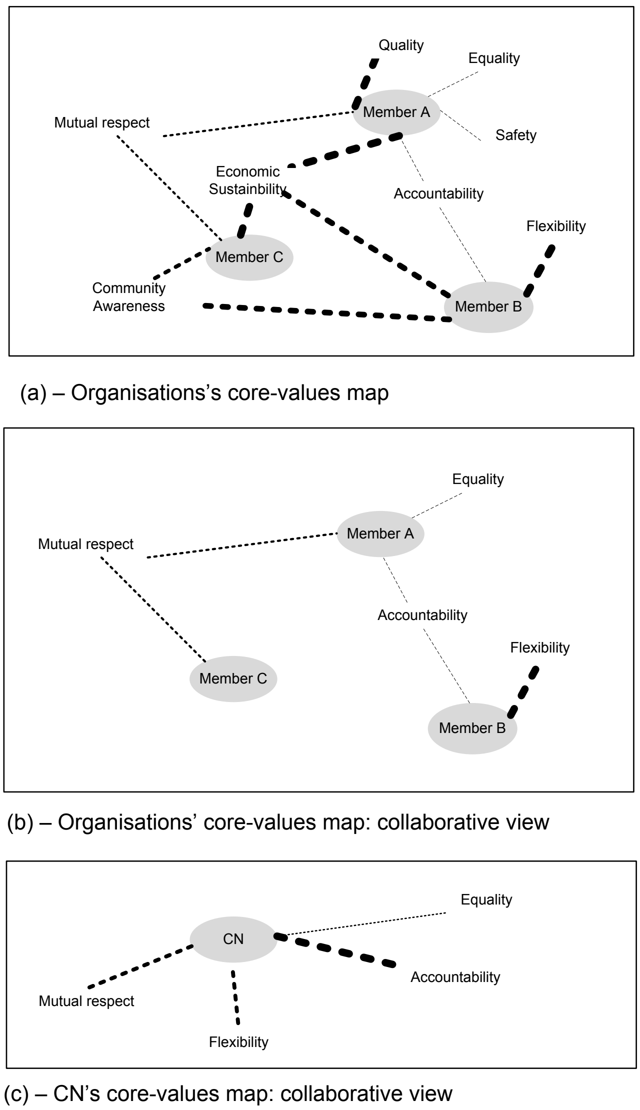
4.4.3 Distinct Evaluation Perspectives

The notion of evaluation perspective was introduced (see Definition 3.5) as being an element of the Value System. Moreover, how distinct evaluation perspectives may be defined to detail the evaluation process has been discussed. However, this idea was not yet conveniently explored within the scope of the V-AligN framework, and it can be useful when we intend to analyze only a specific set of core values. In a collaborative context it may be pertinent to consider a collaborative perspective, which aggregates all characteristics related to the collaboration perspective (e.g. adaptability, reliability, mutual respect), and to assess the CVSs alignment, with respect to this perspective alone.

To implement multiple evaluation perspectives within the scope of the V-AligN framework, it is proposed that each map comprises several layers, each layer corresponding to an evaluation perspective. In order to analyze the maps according to a specific evaluation perspective, the maps show only the core values belonging to the corresponding layer, as illustrated in the next example.

Example 4.3. Qualitative analysis of CVSs alignment considering distinct evaluation perspectives

In Figure 4.35 three maps that intend to illustrate the notions of distinct evaluation perspectives and the notion of map layers are presented. In part (a) we can observe the complete map with all the layers, in which all the core values appear. In part (b), only the core values belonging to a collaborative evaluation perspective are shown. In part (c) the collaborative view of the CN's core values map is presented.



(a) – Organisations's core-values map

(b) – Organisations' core-values map: collaborative view

(c) – CN's core-values map: collaborative view

Figure 4.35. Distinct evaluation perspectives in CVS analysis maps

In this scenario the collaborative evaluation perspective is not specified by each member, but by the network manager, as discussed in the Example 3.2. In this case it was assumed that the network manager specified the collaborative evaluation perspective as follows:

$ep_{collaboration} =< dv, wv >\in P_{VO}$, where:

- *dv=[mutual respect, accountability, flexibility, equality]*
- *wv=[high, very high, high, fair].*

This simplified illustrative example allows us to show how the CVS analysis can be performed considering a specific subset of core values. In order to analyze the specific set of core values that according to the CN manager influence the collaborative behavior, the *shared core values* indicator is computed, considering only the collaboration perspective

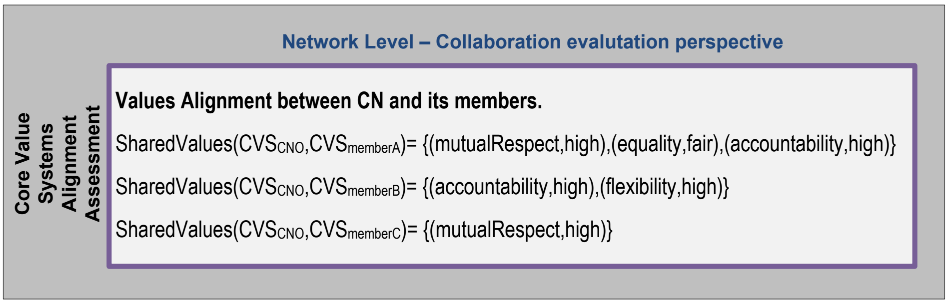


Figure 4.36. Shared Values assessment for the collaborative evaluation perspective

Figure 4.36 presents the results obtained, which indicate to what degree the characteristics of collaboration required by the CN are considered by its members. It can be concluded that Member A is the one that satisfies the collaborative characteristics required by the CN.

4.4.4 Internal and External Influences

One of the main goals of the identification and specification of the CN's core values is to guarantee that all the CN's members are aware of the CN's priorities. As the set of core values and their priorities are one of the main elements that will guide the behavior of the CN, it is also important to identify and represent the main external and internal factors that influence the CN's core values.

Questions such as the following may be pertinent in the context of CN management: (i) will an increase in sales influence the profit positively? (ii) will an increase in social initiatives enhance its reputation? (iii) will a decrease in the suppliers' flexibility affect the flexibility of the network? Therefore, in order to improve the decision-making process in collaborative contexts, the factors that influence core values should be visually represented to promote a common understanding among partners about them.

According to the proposed model, core values are the most important evaluation dimensions for an entity (organization or network in this case), thus when we say that a factor will

influence a core value, what we mean is that this factor will directly or indirectly influence the level of one main characteristic. For instance, we can consider that if there is an increase in *Social Facilities,* then the level of *Employee Satisfaction* will also increase.

The definition of influencing factors follows.

Definition 4.18 (Influencing factor)

A fact or situation, which influences the level of a core value.

Fa is considered the set of influencing factors and an influencing factor can be one of two types: external (FE) or internal (FI).

$$Fa = FI \cup FE$$

The introduction of the notion of *influencing factor* and consequently the introduction of a new kind of influence relation implies a change in the V-AligN framework in order to support these new concepts. Thus, an extension to the *core values influence map* is introduced, called the *overall core values influence map,* in order to cover the representation of the influence of the factors on the core values, as specified in Definition 4.19, and graphically defined in Figure 4.37.

Definition 4.19 (Overall core values influence map)

An overall *core values influence map* is defined by an ordered pair $CVIM = (\mathrm{N}, EO)$ where:

- $N = CV \cup Fa$
    - CV is the set of core values;
    - Fa is the set of influencing factors.
- EO is the set of influences (edges). $EO = E \cup EF$, where E is the set of core values' influences, as specified in Definition 3.1.3; and EF is the set of factors' influences specified as follows:

  <u>Qualitative approach</u>:

  $$EF = \{ef_{ij} = (f_i, cv_j, p, s): f_i \in Fa \ \wedge cv_j \in CV \ \wedge \ p \in P \ \wedge \ s \in S\}$$, where:

    - $P = \{weak, moderate, strong\}$, intensity of the influence;
    - $S = \{-1, +1\}$, sign of the influence (negative or positive.

  The following operators are defined:

    - $influencefactorValue: EF \rightarrow P \times S$, $influenceValue(f_i, cv_j, p, s) = (p, s)$,
    - $signalfactor: EF \rightarrow S, \ signalfactor(f_i, cv_j, p, s) = s.$
    - $intensityfactor: EF \rightarrow P, intensityfactor(f_i, cv_j, p, s) = p.$

<u>Quantitative approach:</u>

$EF = \{ef_{ij} = (f_i, cv_j, p, s): f_i \in Fa \ \wedge cv_j \in CV \ \wedge \ p \in]0,1] \ \wedge \ s \in S\}$, where:

$S = \{-1, +1\}$.

The following operators are defined:

- $influencefactorValue: EF \rightarrow]0,1] \times S,\ influencefactorValue(f_i, cv_j, p, s) = (p, s)$.
- $signalfactor: EF \rightarrow S,\ signalfactor(f_i, cv_j, p, s) = s$.
- $intensityfactor: EF \rightarrow]0,1], intensityfactor(f_i, cv_j, p, s) = p$.

Applying the method to this context will allow us to: (i) check if the VO1's candidate members are aligned with VO1; (ii) identify pairs of VO1 members which have potential for conflict, in order to prevent conflicts during VO1 operation.

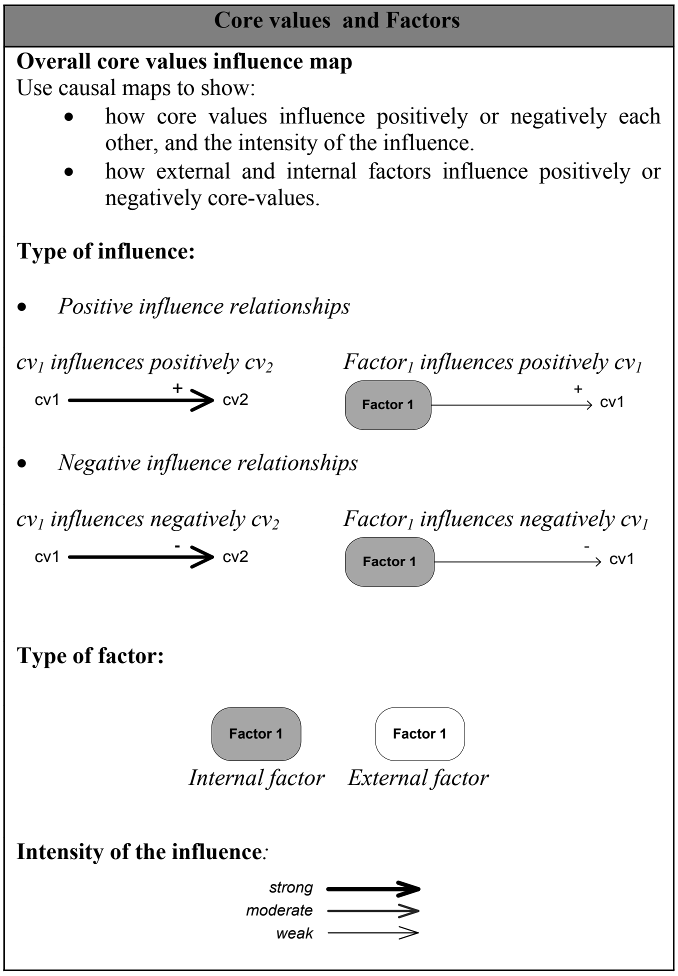


Figure 4.37. Overall *core values influence map* specification

Example 4.4. Analyzing CVSs alignment considering influencing factors

Based on the *overall core values influenced map*, it is also possible to define an aggregated map as proposed in the V-AligN framework (see Figure 3.11). This kind of aggregated map

will allow a holistic perception of the influencing factors that have an impact on the CN's CVS to be obtained.

The overall aggregated map presented in Figure 4.38 illustrates the representation of all the main factors and core values that influence the core values belonging to VO1.

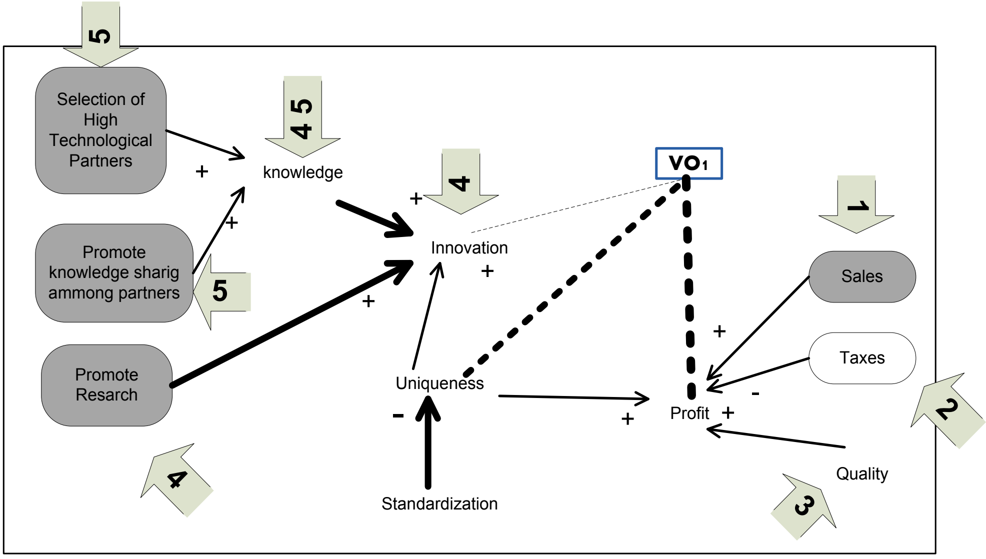


Figure 4.38. Overall aggregated map for VO1

Observing the map it can be noticed that:

(1) If *Sales* increase, it is expected that the *Profit* will increase too.

(2) If some *Taxes* increase (an external factor to the network), it is expected that the *Profit* will decrease.

(3) The *Profit* is also influenced positively by *Quality*, so if the overall *Quality* level increases, it is expected that the *Profit* will increase too.

(4) It is expected that the level of innovation increases if:

- the degree of *Knowledge* among partners increases;
- *Research is promoted* inside the network.

(5) As knowledge is positively influenced by two factors: (i) *selection of high technological partners,* (ii) *promotion of knowledge sharing among partners*; it is expected that if there is an investment in fulfilling these factors, the level of *Innovation* inside the VO1 will increase.

4.5. Chapter Discussion and Conclusions

This chapter proposed a set of formal mechanisms to analyze CVSs alignment. First, it proposed a method to analyze Core Value Systems using the V-AligN framework presented in Chapter 3, and a set of indicators to assess the alignment level between CVS in collaborative

contexts. The selected indicators to assess the alignment were: (i) *Shared Core Values level*, (ii) *Positive Impact level*, (iii) *Potential for Conflict level*. This set of indicators aims to represent not just the existing common core values between two entities, but also the positive and negative influences that a set of core values can have on another set. Furthermore, not only the alignment assessment between the network's CVS and its members' CVSs is considered, but also the assessment of the alignment among the CVSs' members in order to identify the pairs of members where the potential for conflict is high.

Chapter 3 proposed a conceptual model that supports a quantitative and a qualitative approach. In line with these approaches, we have developed quantitative and qualitative mechanisms in this chapter to assess the alignment between CVSs. In the case of qualitative assessment, a qualitative inference approach has been developed based on the work developed on qualitative operators for reasoning maps by Montibeller and Belton (2009). As these operators are essentially based on decision tables, they can be customized according to the preferences of the user, thus the qualitative assessment proposed can be easily adjusted. At this stage, the main goal was to provide a mechanism to qualitatively infer the alignment level between CVSs. In the case of quantitative assessment, starting from representation of graphs and causal maps in terms of matrices, an algebraic expression is proposed to express each indicator.

The analysis methods proposed in the initial part of this chapter were developed considering a set of basic conditions, such as: (i) only direct influences between core values are considered; (ii) core values can be selected solely from non-hierarchical taxonomies; (iii) internal and external factors that influence core values are ignored; and (iv) a unique evaluation perspective alone is considered. These set of basic conditions contributed to develop analysis mechanisms that were easy to understand and to implement. However, in certain conditions it may be useful to have these additional features available. Therefore, the integration of each of these issues in the basic methods was discussed.

During the entire chapter, in order to show how the methods to analyze Value Systems and how the indicators to compute the alignment level can be applied, several illustrative examples were presented. Table 4.12 shows a summary of the main mechanisms to analyze CVSs, as proposed in this chapter and the respective examples that illustrate its application.

This chapter contributes a set of artifacts to solve the problems indentified for this thesis in the way that it presents: (i) criteria to assess CVSs alignment in collaborative contexts; (ii) a method to analyze CVSs alignment; and (iii) a set of formal methods to implement these alignment criteria using both approaches (quantitative and qualitative).

Furthermore, the set of proposed methods were developed under the V-AligN framework presented in Chapter 3, thus underlining the usefulness of the proposed framework.

Table 4.12. Main contributions from illustrative examples

Goal	Examples					
	4.1-A	4.1-B	4.1-C	4.1-D	4.2	4.3	4.4
To show how to apply the analysis method to study CVS in collaborative contexts.	✓						
To show how to apply a qualitative assessment.	✓	✓		✓	✓	✓	
To show how to apply a quantitative assessment.			✓				
To show how to calculate the shared values level.		✓	✓	✓	✓		
To show how to calculate the positive impact level.		✓	✓	✓	✓		
To show how to calculate the potential for conflict.		✓	✓	✓	✓		
To show how to calculate the inferred influences among core values.				✓			
To show how to do the alignment assessment using hierarchical taxonomies of core values.					✓		
To show how to analyze CVS using several evaluation perspectives.						✓	
To show how to consider external and internal factors in CVS analysis.							✓

5

Tool for Analysis of Core Value Systems in Collaborative Networks

This chapter presents a software system designed to support the management and analysis of Core Value Systems in CNs, by implementing the models and methods proposed in chapters three and four. First, the chapter introduces the Unified Process as being the adopted software method for the system development. Within the scope of this Unified Process method, the performed requirements' analysis and specification are presented. The system design specification is also briefly presented and discussed, followed by a description of its implementation. Finally the strategy adopted to verify the system is described.

5.1. Introduction

In the previous section, the CVS definition and CVSs alignment analysis was discussed. In order to be able to implement this in a real world context, a software tool to support the CVS analysis was developed. The tool was designed in order to support the CVS management in an integrated way, i.e. to support the activities of creation, modification and analysis of CVSs. The CVS analysis includes assessment of the alignment between the CVSs of the different entities that comprise the CN. However, the purpose of this prototype is not to fully automate the process of CVS analysis, but rather to assist CN managers in this analysis.

The main contribution of the work presented in this chapter is not the prototype itself, but rather the specification of the system that forms a basis for future developments. However, the development of the prototype allows assessment of the usability of the designed system and the extent to which the developed models and mechanism can be implemented by a computer program.

5.2. Approach for Software System Development

The development of the Tool for Analysis of CVSs in CNs follows an incremental iterative software development process. The basic idea behind this iterative enhancement is to develop the software system incrementally. The development process starts with a simple

implementation of a subset of the software requirements, and iteratively enhances the evolving sequence of versions until the full system is implemented. In each iteration, all phases of the software life-cycle development are followed and, as a result, new functional capabilities are added. This development model is used not just in classic methodologies, such as the Unified Process (UP) (Arlow and Neustadt, 2005), but also in agile development methodologies, such as SCRUM and XP (Martin, 2003). The development process adopted followed a *light* version of the UP method, as illustrated in Figure 5.1.

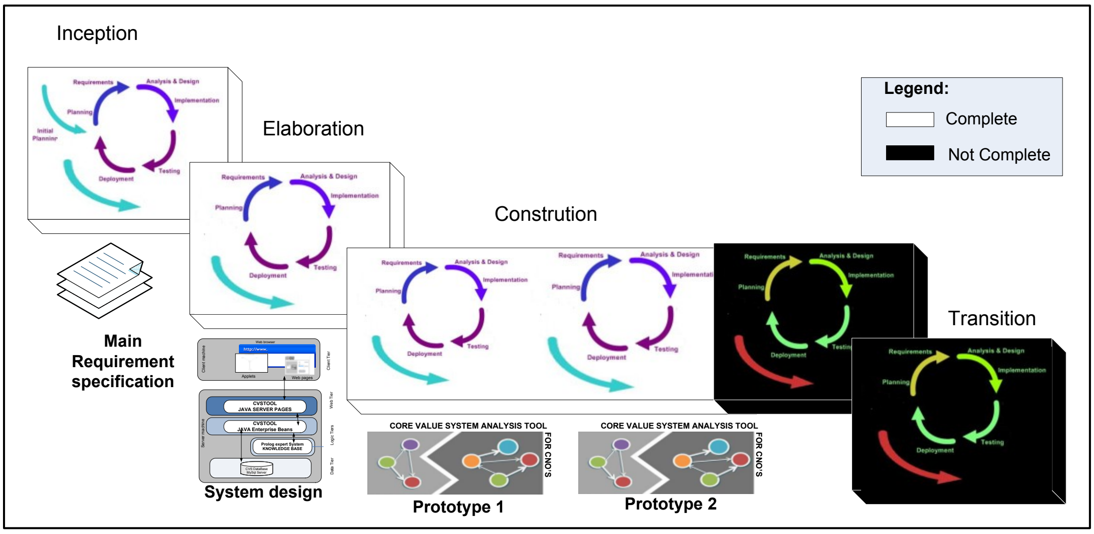


Figure 5.1. Development process

As the aim of this work was not to develop a commercial product, but rather a prototype to illustrate the integration of the proposed models and analysis methods for Value System management, only the first three phases of the UP development process were completely implemented, as described below.

- **Inception phase** - The main objective of this phase is to scope the system effectively. In this phase the business case, which includes the business context, was established. The main requirements were understood and shown by primary use cases.
- **Elaboration phase** - The main objective of this phase is to analyze the problem domain and to design the system. First of all, most of the system requirements were specified and the corresponding use cases were designed. Additionally, the software architecture was specified, and some small experiments were carried out in order to check some technological details.
- **Construction phase** - The main objective of this phase is to build the software system by developing the components and other features of the designed system. This was the phase where the bulk of the coding took place. In larger projects, several construction iterations may be developed in an effort to divide the use cases into manageable segments that produce demonstrable prototypes. In this case, it was divided into three iterations. The two

main iterations comprise all the use cases concerning the CVS management which were implemented. The third iteration comprises the user access management and was not totally implemented in the scope of this thesis work.

- **Transition phase** - The main objective is to make the transition of the system from development into production, making it available to and understood by the end user. As explained above, since this software system was not developed for a specific end user, activities such as end user training and beta testing of the system to validate it against the end users' expectations were not carried out.

5.3. Analysis and Specification

This section addresses the analysis and specification of the Tool for Analysis of CVSs in CNs by identifying and classifying potential users, and defining the roles and rights of each user. This is specified through the use of *use case diagrams*, as suggested in UP method. This section also addresses the specification of the system logic architecture and the discussion of some design details.

5.3.1 Requirements Specification

5.3.1.1 Functional Requirements

From the information provided by CN experts during the performance of ECOLEAD's project experiments, a set of distinct potential stakeholders for the CVS management process was identified. These distinct types of stakeholders were introduced in Chapter 2 Section 2.1.1, and can be classified in two groups:

- **Member Level User** – This type of user will have access to the features concerning CVS analysis at member level. Users can be:
  - **VBE member –** This type of stakeholder assume the basic role played by those organizations that participate in the VBE activities. The VBE member will have access to define the organization's CVS.
  - **VO member -** During the participation on a VO, this member will have access to consult the results of the CVSs alignment assessment between its organization and each member of the VO, and between it and the VO.
- **Network Level User** – This type of user will have access to the features concerning CVS analysis at network level. Users can be:
  - **VBE manager –** This type of stakeholder uses the system in order to define and analyze the VBE's CVS. VBE manager may use it to assess the CVSs

alignment in order to prevent conflicts among members and to support decision making during the process to admit new members.

- **VO manager –** This type of stakeholder manages the VO during its life cycle. In some scenarios, it is the VO manager who defines the initial VO's CVS. The VO manager will analyze the VO's CVS and will assess the alignment between VO members, in order to check if there is a high potential for conflicts. VO manager may also use the features offered by the software system to assess the alignment level between VO's CVS and each member's CVS.
- **VO broker -** This type of stakeholder is the one that during a business opportunity, *finds* the core members to form a VO in order to carry through this business opportunity. The broker will define the network and may use the system to support the partner selection process. In some scenarios, it is the VO broker who also defines the VO's CVS.

Two additional types of users are considered, who use the system as a "supplier" of information, namely:

- **Knowledge manager** – The knowledge manager is an expert on core values. Thus, Knowledge manager uses the system to fill the core value reference ontology with all the information about core values, evaluation functions and relations of influence among the core values.
- **Application Manager –** The application manager is the one who administers the software tool in order to make the initial configuration and to manage accesses and profiles.

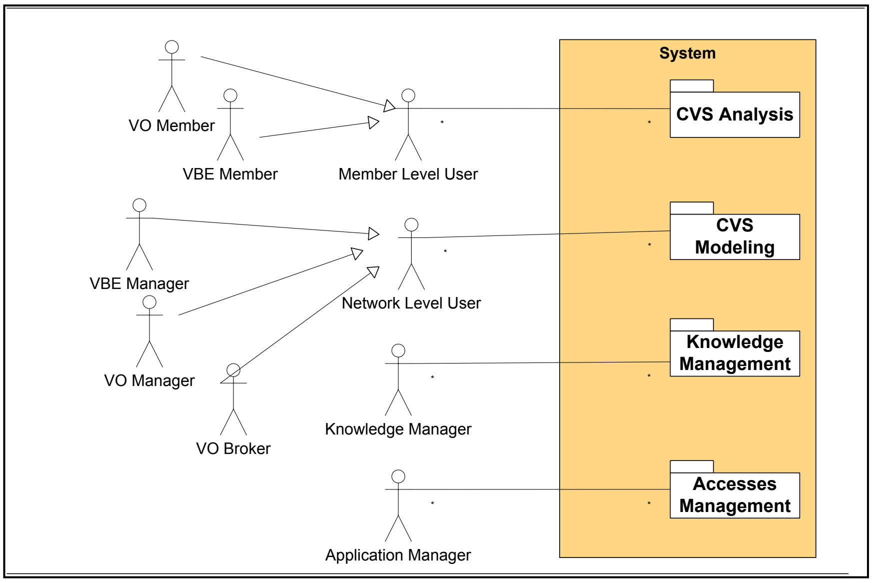


Figure 5.2. CVS analysis Tool for CNs System – use case diagram

The list of features required for the system is split into four subsystems. Each subsystem corresponds to a functional module that aggregates interrelated features, namely: Core Value System modeling, Core Value System analysis, Access management, and Knowledge management. The use case diagram presented in Figure 5.2 specifies the subsystems that can be accessed for each actor (user type).

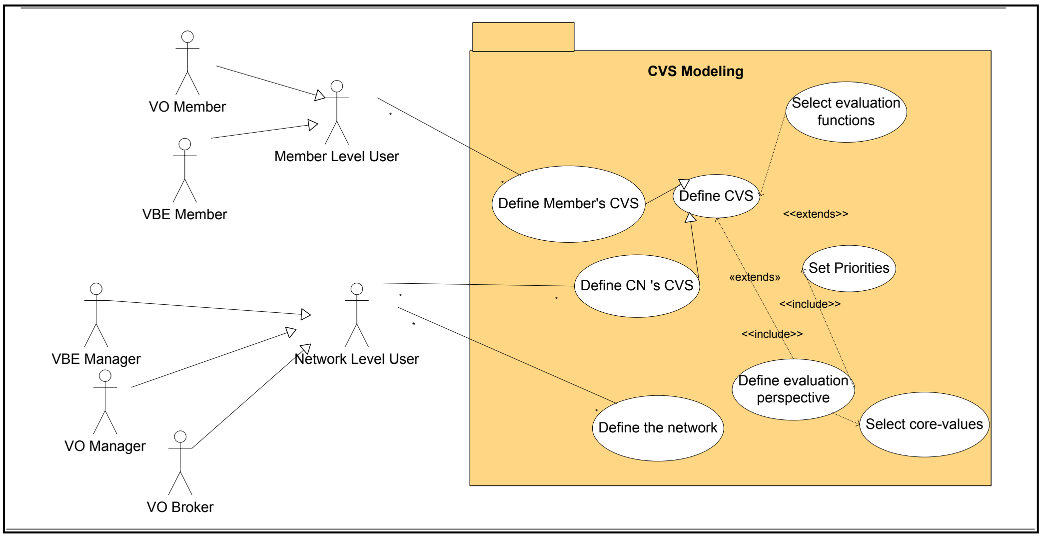


Figure 5.3. Value System modeling subsystem - use case diagram

The aim of the CVS Modeling subsystem is to provide a way for network managers, VO brokers and organization managers to define and update their CVSs, as documented in the use case diagram of Figure 5.3.

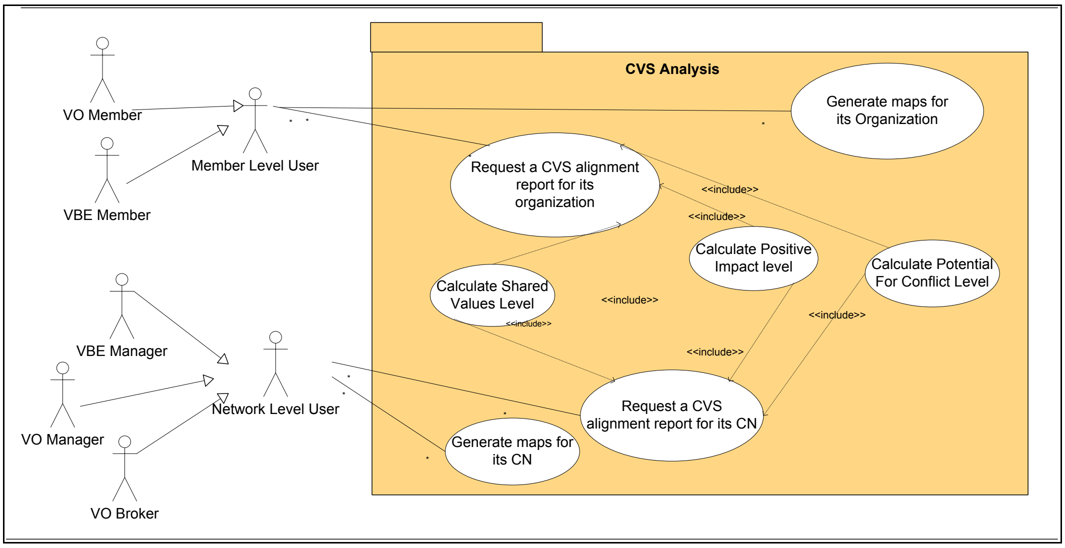


Figure 5.4. Value System analysis subsystem - use case diagram

The aim of the CVS Analysis subsystem is to provide VO brokers, network managers and network members with a way to analyze their CVS. This component will implement the following analysis features (see use-case diagram of Figure 5.4):

- Show all the maps provided by the V-AligN framework.
- Provide a report with the results of the CVSs alignment assessment: (i) between the network and its members, or potential members; and (ii) among network members.

The aim of the Knowledge Management subsystem is to provide a way to manage core value knowledge, allowing the creation, modification and deletion of core value entities and evaluation functions. This component will also provide a way to associate evaluation functions to core values and to specify the influence relations between core values, as specified in the use case diagram presented in Figure 5.5.

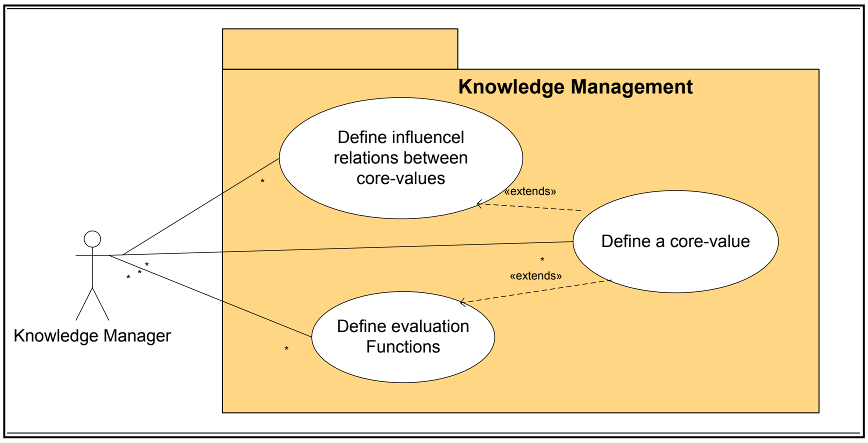


Figure 5.5. Knowledge management subsystem - use case diagram

The aim of the Access Management subsystem is to support the access management. It will implement the features related to the creation and modification of user profiles and accesses, as specified in the use case diagram presented in Figure 5.6.

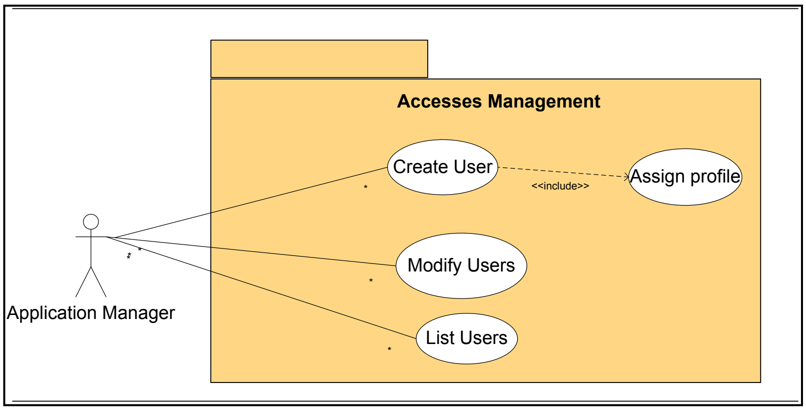


Figure 5.6. Access management subsystem - use case diagram

5.3.1.2 Non-Functional Requirements

This software tool is to be operated in a network where users are dispersed, thus web access to the system is required. The tool should also run in the most well known browsers, such as *Internet Explorer*, *Mozilla* and *Google Chrome*. This application is developed in an academic context, where the funds to pay software licenses are limited. Therefore, the use of free-ware

technologies to support the development process and to implement it is also a basic requirement to be taken into account in the system design. The following table summarizes the non-functional requirements.

Table 5.1. Non-Functional requirements.

Requirement	Description
Accessibility	The system should be accessed through the web.
Portability	The application should be portable so that it may run in different browsers such as Internet Explorer, Mozilla and Google Chrome.
Platforms/IDE	The application should be developed and implemented using free-ware technologies only.

5.3.2 System Specification

5.3.2.1 Logical Architecture Overview

Starting from the pre-analysis of the functional and non-functional requirements, a *Thin Web Client* architecture pattern is proposed to develop the web system. This architecture pattern is in fact a client-server architecture, used mostly for internet based systems, in which there is a little control of the client configuration (Conallen, 2003). The client requires only a standard web browser, and all of the business logic is executed on the server. As illustrated in Figure 5.7, the server side will be logically split into three layers.

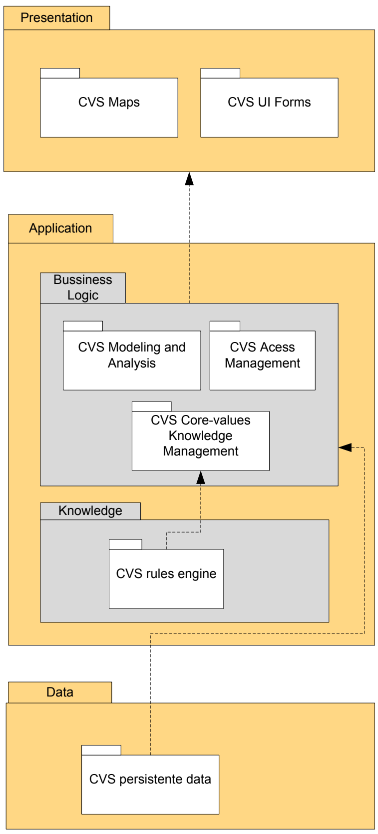


Figure 5.7. Logical architecture

Presentation Layer - This layer deals with the delivery of information from the Business Logic Layer to the user interface in a format that is user friendly. This layer also handles the transformation of the data submitted by users to the format that can be processed to the modules of the Business Logic Layer. The information delivery to the user has to be essentially presented in two ways:

- In forms – where data is basically presented using standard GUI web components such as: *text boxes, labels, list boxes*, etc.
- In two-dimensional graphics – where data is graphically presented. All the CVS maps (graphs and causal models) specified in the V-AligN framework (see Section 3.2.2) have to be rendered in run time.

Business Layer - This layer implements the main logic of the system, and all the knowledge rules associated with the reasoning mechanisms for alignment assessment. This layer is subdivided into two sub-layers.

- Application Logic - implements the logic of the application and is responsible for controlling the workflow of the system according to each user profile. It is also responsible for communication with the data layer implementing the logic to access the persistent data. This layer is logically composed of three modules:
  - CVS Knowledge Management implements the logic associated with the knowledge management feature (specifies core values, evaluation functions and core value relations of influence).
  - CVS Access Management implements the logic associated to the manager user accesses (user creation/update/deleting, configuring accesses).
  - CVS Modeling and Analysis implements the logic associated with the CVS modeling and analysis (specifies networks and the CVSs and generates analysis reports). This module is also responsible for the communication with the Knowledge sub-layer in order to request alignment assessment "services".
- Knowledge – This sub-layer implements the expert's knowledge on core values, the qualitative inference methods specified in Section 4.3.1, namely:
  - sharedValues (see Definition 4.1);
  - positiveImpacts (see Definition 4.2);
  - potentialConflicts (see Definition 4.3).

Data Layer - This layer implements all the persistent data required for the system. It essentially implements the entities referent to:

- the elements identified in the conceptual model of Value System proposed in Chapter 3;
- the data needed to characterize users and networks.

5.3.2.2 User Interface Design

The design of user interfaces aims to satisfy some functional and non-functional system requirements specified in Section 5.3.1, namely:

(i) The system should provide user access through a web interface.

(ii) The system should provide a way to enable users to visualize all types of maps, as specified in the V-AligN framework.

(iii) The system should provide specific accesses, according to the user's profile.

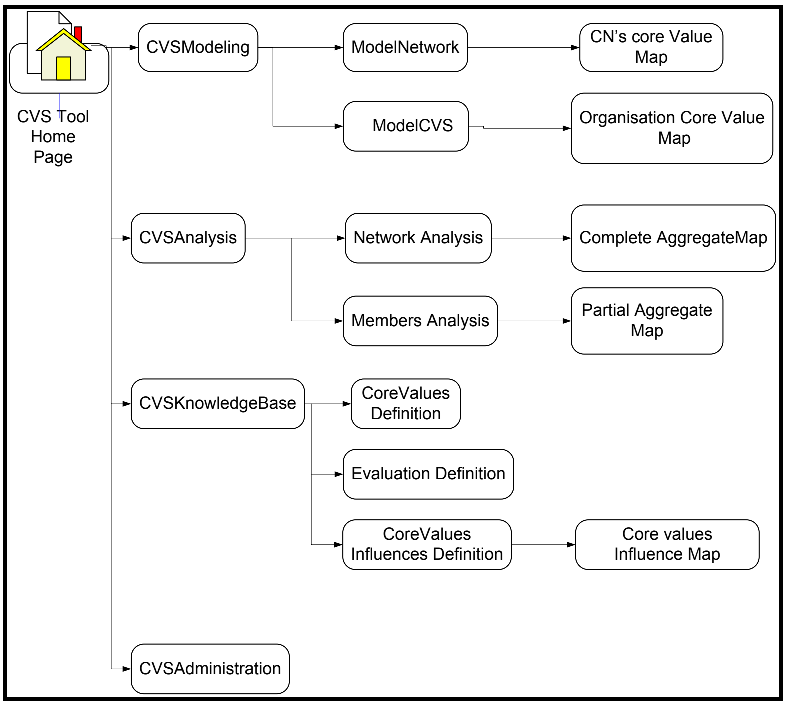


Figure 5.8. User interface: navigation model

The logical architecture adopted (see Figure 5.7) enables these three main requirements to be satisfied. Access to the system requires two main parameters: username and password. These parameters are used to check if the user is an authorized user, and to customize the access for features provided by the system. In order to implement this feature, each username is associated a user role, and the access to data and features depends on the user role information which is transparent to the user. The navigation model shown in Figure 5.8 illustrates how the user interface is structured.

One of the development challenges was to implement the rendering of CVS maps in run time. The CVS maps shape the structure of graphs, i.e. each map comprises a set of nodes (vertices) and a set of arcs (edge) that link the nodes. Arcs and nodes can take on distinct

visual formats in line with the entity that they implement, as specified in the V-AligN framework (see Figure 3.11). Nodes can assume distinct shapes: circles, rectangles, just labels, depending on whether the node represents an organization, a CN or a core value. On the other hand, arcs assume different patterns and widths according to the link type. In this case, a logic component called CVS Maps was designed in order to implement all the classes needed to support the construction of CVS maps. This component is structured as shown in the UML class diagram of Figure 5.9.

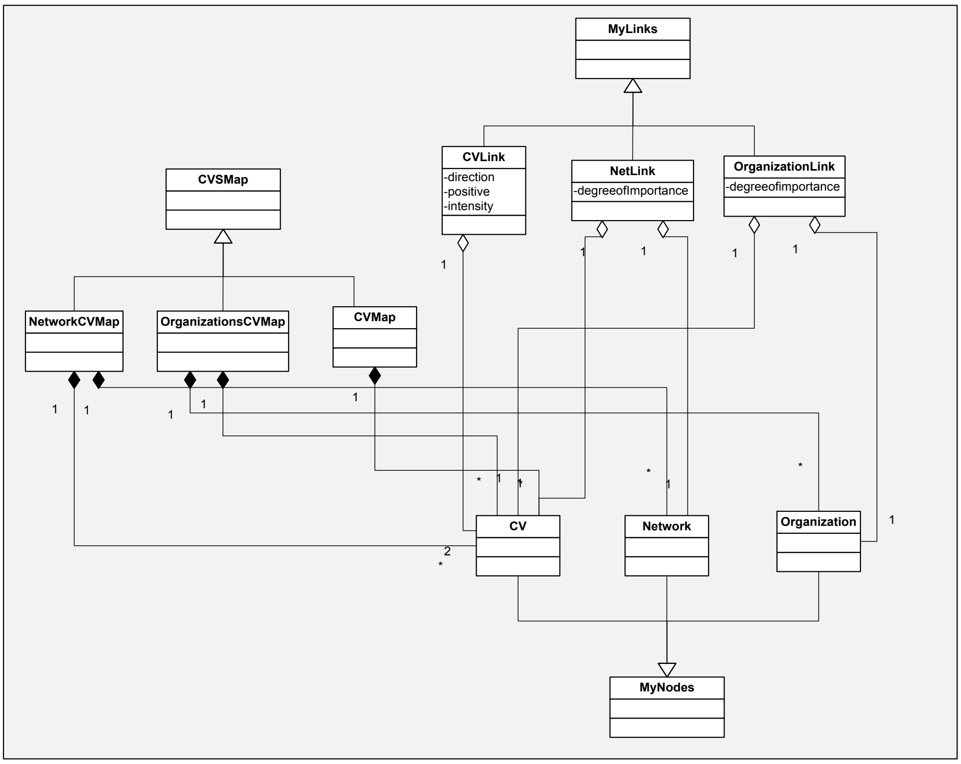


Figure 5.9. Class diagram for CVS maps

5.3.2.3 Database Schema Design

In Chapter 3 a conceptual model of CVS and a conceptual analysis framework for CNs (V-AligN) were presented. These artifacts are used here to support the design of a database schema for the CVS Analysis Tool for CNs, as shown in Figure 5.10.

The data required to support the system's features can be categorized into four main groups:

- **Network related data** – This refers to the information necessary to identify each network and each organization. For this prototype, basic information only is provided. However, naturally it is possible to easily add more data fields, in order to characterize networks and organizations into a *network table* and a *members table* respectively.
- **Core values related data –** This refers to the information provided by knowledge experts related to core values, relations of influence between core values and

evaluation functions. This information is stored in the following tables: *core values, evaluationfunctions and relations.*

- **Core Value System related data –** This refers to the information that is necessary to specify a CVS, namely the information about the core-evaluation perspectives. This information is stored in the following tables: *corevalueslements, cvprespective and cvsystem.*
- **User Profile related data –** This refers to the information necessary to manage user's profiles and user's accesses. This category of data is the one that deals with data not covered by the conceptual model specified in Chapter 3. This information is stored in the following tables: *useraccess, usertype, userapp*

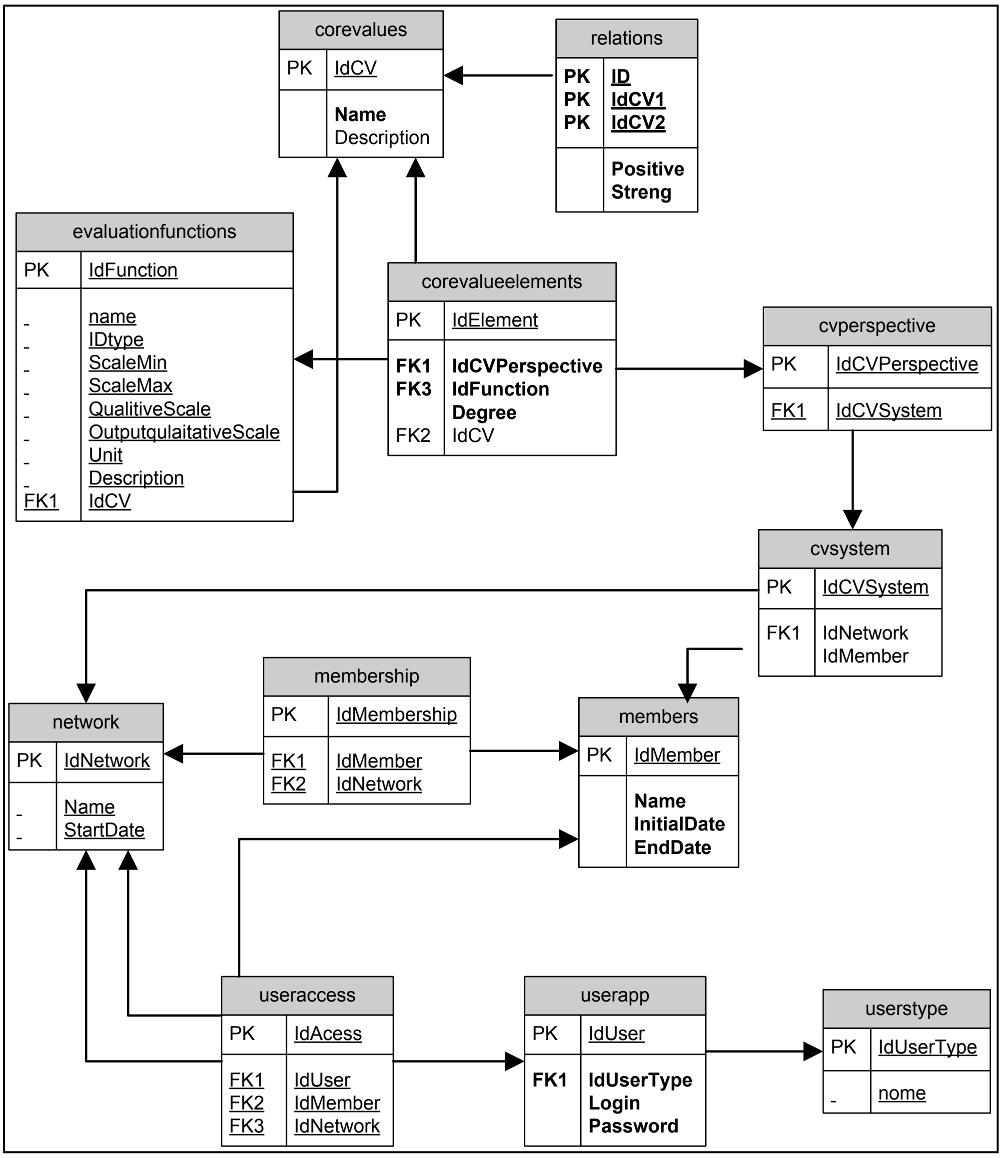


Figure 5.10. Data schema

5.4. System Implementation

The *Thin Web Client* architecture pattern proposed in Section 5.3.2.1 will be implemented in order to develop a web-based system. The JAVA 2 platform Enterprise Edition (J2EE) was selected as the basic platform to support this implementation (see Figure 5.11), due to the fact that it is platform-independent, suitable for developing, building and deploying web-based applications, providing a powerful model architecture component (Singh et al., 2002).

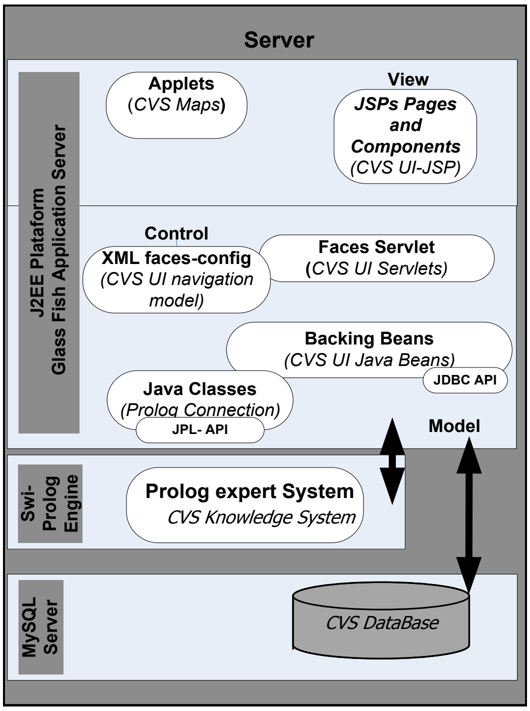


Figure 5.11. Overview of the deployment architecture

The J2EE platform was designed for multi-tier applications, and it offers flexibility in distributing functionalities across tiers. In a web-centric design, the system is typically split into three or four tiers: (i) the Client Tier provided by the browser; (ii) the Web Tier provided by the application server; (iii) the Enterprise Java Beans Tier provided also by the application server; and (iv) the Data tier provided usually by a database server or an enterprise information system. In small web applications, we may have just three tiers, since tier components can communicate directly with the system resources that hold the application data.

In order to implement the web interface within the scope of J2EE platforms, Java Server Faces (JSF) and Java Applets technologies were selected. The choice of JSF technology is explained by the fact that it provides a set of User Interface (UI) component classes that are managed on the server side (Schalk et al., 2006) enabling faster development. These component classes specify all of the UI component functionality, such as holding component state, maintaining a reference to objects, event handling and rendering for a set of standard graphical UI components. Moreover, the JSF implementation is based on the Model-View-

Controller (MVC) design pattern (Mukhar et al., 2006; Buschmann et al., 2007). This pattern contains three main component groups: (i) The Model that implements the logical structure of the application independently from the user interface; (ii) the View, which represents everything the user sees in the interface to interact with the application; (iii) the Controller, which is used for communication between the model and the view. The biggest advantage of JSF is that it is both a Java Web user-interface standard and a framework that fits well with the MVC design pattern. It offers a clean separation between presentation and behavior, where UI can be built using reusable UI components and the business logic part can be implemented using J*ava backing beans*. Therefore, the JSF framework was used to implement all CVS UI Forms module (see Section 5.3.2.1), including the navigation model (see Section 5.3.2.2), and the application logic modules (Classes of CVS Knowledge Management module and CVS Modeling & Analysis module) allowing us to implement the business layer and the presentation layer separately, in spite of not using Enterprise Java Beans.

However, as it was not possible to implement the graphical features needed to render the CVS maps using the JSF technology alone, applets have been selected in order to achieve these visual requirements. In this case, an API developed for JAVA to implement graphs and networks is used – the JUNG 2.0 API. This software library written in Java provides a common and extendible language for modeling, analysis, and visualization of data that can be represented as a graph or network allowing us to easily implement the graph class hierarchy presented previously in Figure 5.9.

With regard to the implementation of the knowledge sub-layer, which comprises the CVS knowledge expert-system, a Prolog rule engine has been selected. This option to implement all the knowledge involved in the qualitative alignment assessment, using Prolog, relies on the fact that:

(i) It is suitable to represent knowledge in a declarative form, supporting an easy way to implement qualitative data (Cercone and McCalla, 1987; Merritt, 1989).

(ii) It is suitable to implement causality through rules (Bratko, 2001).

(iii) It supports a backward inference chain, allowing easy implementation of the proposed qualitative inference methods (Merritt, 1989).

(iv) It provides an inference engine that enables the Prolog component to be developed independently from the web system.

The integration with other Java components in this system is implemented using the *jpl-API* for Java, defining two types of interactions:

- Input Data: The information is loaded into the component by performing a set of "assert" instructions.
- Query: The knowledge base is queried by executing "query instructions".

The interactions between the system user (VO manager in this case), webpage and Knowledge Expert System implemented in Prolog are modeled as represented in the UML sequence diagram shown below.

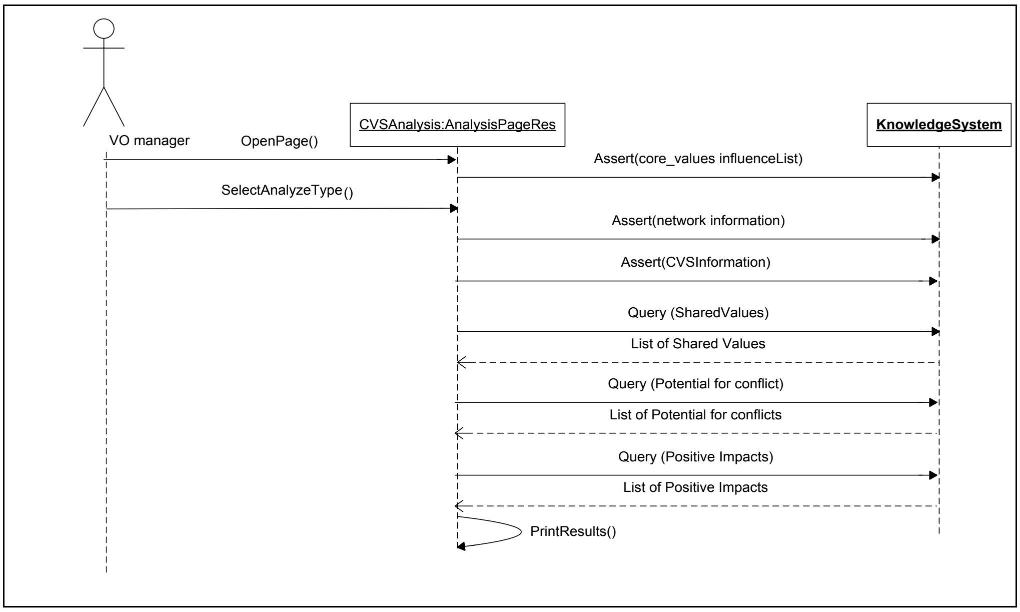


Figure 5.12. Sequence diagram - interaction between Prolog component and Java components

The Persistent Data Module was implemented using a *MySQL* data base server, and the *JDBC API* (JDBC, 2008) was used to communicate with the database.

5.5. Approach to System Verification

In line with the development approach adopted (based on the UP) each phase comprises some tests. Tests in software development can be categorized as:

- **Unit tests** - these kinds of tests verify that the software subsystems and components work correctly in isolation, and as specified in the detailed design;
- **Integration tests** – these kinds of tests aim to verify that the major software components work correctly with the rest of the system, and as specified in the architectural design;
- **System tests** – these tests aim to verify that the software system meets the software requirement;
- **Acceptance tests** – these tests verify that the software system meets the user requirements.

In our case, the software development process covered the Inception phase, the Elaboration phase and the Construction phase. As the development process has not reached the Transition phase, the acceptance tests performed by end-users have not been performed. The system’s

tests are guided by the use cases specified during the requirement specification. Therefore, a test case has been built for each use case in order to verify the system. Moreover, the CVS analysis tool was used during the ECOLEAD case study, covering all the main features of this tool. The case study is presented in the next chapter, as well as the test cases specified to execute system tests. The findings are presented in Annex A.

5.6. Chapter Discussion and Conclusions

This chapter addressed the analysis and design of a software system to support inter-organizational CVS management in VBE contexts. The system requirements resulting from the analysis of the information were provided from three distinct sources:

- literature review;
- the knowledge of CN experts, retrieved from the ECOLEAD project experience;
- the models and methods for CVS analysis, which were presented in Chapters 3 and 4.

The result of the requirement analysis process was presented in the form of a system requirement specification, as introduced in Section 5.3.1, where a set of use case diagrams was developed. As the system development process adopted UP method, all the development process, from the requirement phase to the verification, was guided by the use cases.

The main contribution of the work presented in this chapter is not the prototype itself, but rather the specification of a system that can be the basis for future development. The development of the prototype allows evaluation of the usability of the system designed, and verification that the models and methods proposed in Chapters 3 and 4 can be implemented by a computer program.

6

Validation and Discussion

This chapter is devoted to the thesis validation. First, the validation process is introduced, and the difficulties in performing a validation in a project involving organizations in a collaborative context are pointed out. The validation strategy adopted in the context of the constructive research method is then described.

The artifacts used in the validation process are presented and discussed. A case study was developed inside the ECOLEAD project, in order to illustrate how the distinct methods and tools presented throughout the last three chapters can be integrated in order to solve the main problem addressed by this research.

6.1. Aspects of the Validation

Validation is a crucial step in all research processes. However, validation and verification have specific challenges and particularities according to the research area and the research method adopted. According to Kasanen et al. (1993) and March and Smith (March and Smith, 1995) natural science deals with explaining natural phenomena, and answering questions like how and why, while design science, on the other hand, attempts to create artificial artifacts that serve human purposes. These artifacts have to be evaluated in order to draw conclusions about the success of the artifacts according to different devised measures. As explained and discussed in the first chapter, the constructive research method (Kasanen et al., 1993) was the method selected to guide this research process. In line with the constructive approach (see Figure 6.1), a concept introduced through previous research can be applied to solve a specific problem, usually through the development of an artifact or a set of artifacts (models, diagrams, frameworks). March and Smith (1995) claim that in this case, “the research contribution lies in the novelty of the artifact and in the persuasiveness of the claims that it is effective (March and Smith, 1995). Therefore, in order to validate the subsequent solution, two points have to be demonstrated:

1. *That the proposed artifacts solve the domain problem and/or create knowledge about how the problem can be solved.*
2. *That the proposed solution is new or better than previous ones.*

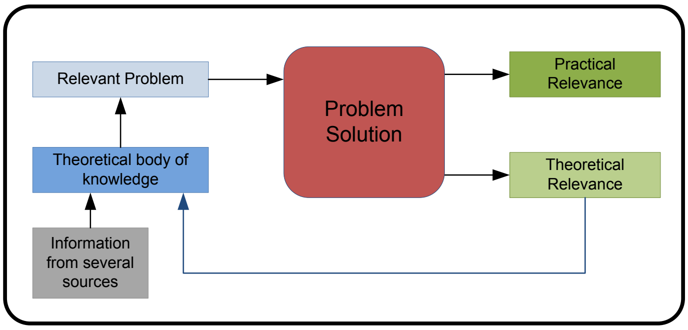


Figure 6.1. Constructive research method

Both points are subjective to some degree, which makes validation in some aspects problematic. The *Validation Square Framework* (see Figure 6.2) provides some guidelines to validate the internal consistency as well as the external relevance of a specific solution. This validation framework was proposed by Pedersen and his colleagues (2000) in order to evaluate the effectiveness and efficiency of the design solution, based on qualitative and quantitative measures.

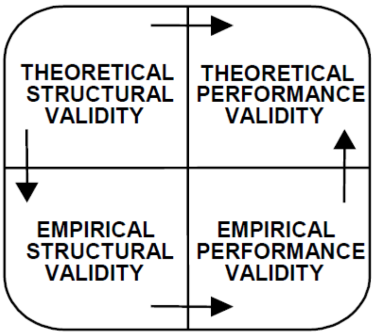


Figure 6.2. Validation Square Framework (Pedersen et al., 2000)

This validation strategy comprises the following assessments:

1. Assessment of *theoretical structural validity*, which is concerned with accepting the construct's validity and accepting the method's consistency.
2. Assessment of *empirical structural validity,* which is concerned with building confidence about the appropriateness of the examples (and/or case studies) (according to the literature review and/or experts' opinion), selected to show the usefulness of the method.
3. Assessment of *empirical performance validity,* which deals with showing that the method designed is useful to solve the problem illustrated by the examples selected in point (2).
4. Assessment of the *theoretical performance validity* is concerned with building acceptance for the usefulness of the design method beyond the example problems.

According to the authors (Pedersen et al., 2000), the purpose of going through the validation square is to present circumstantial evidence in order to create a belief in the general usefulness of the design models/or method with respect to the articulated purpose.

Concerning the object of study - Collaborative Networks (CNs) - there are also some additional specific challenges. One of the specific challenges derives from the fact that CNs are socio-technical systems and it is well known that it difficult to implement any (short term) validation process when we are dealing with these kinds of systems. Furthermore, the behavior of organizations or the CN is hard to predict, and moreover, it is quite impossible to repeat an experiment in an organizational environment that has exactly the same conditions. This fact represents a pertinent problem regarding validation, since in scientific research, the repeatability (identical results should be achieved, if the experiment is performed in identical conditions) is a key condition to consider the results of an experiment valid. Therefore, in research where the object of study is a socio-technical system, experimentation is often not a possible option for validation. Regarding these cases, an accepted way to validate the model or the methods is to use the data provided by some past cases. However, in the CN topic, there is a lack of documented cases. Moreover, almost all of the available cases are successful cases, while for this research documented cases about partnerships with emerging conflicts are required. Thus, this lack of valid information also brings a significant limitation to the validation process that we have to deal with.

6.2. Validation Strategy Adopted

According to the research method adopted, and the characteristics of the object of study (CNs), a multi approach to validation is considered, where a range of evidence is collected in order to prove:

- The practical and theoretical relevance of the proposed solution.
- The validity of each formulated hypotheses.

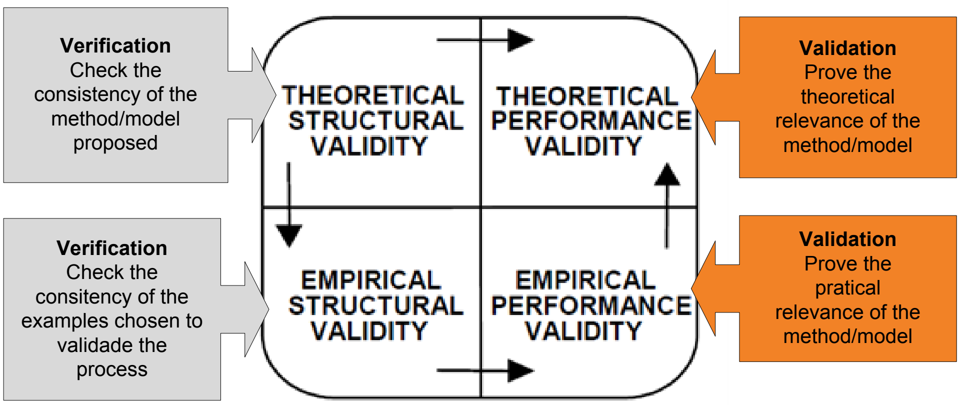


Figure 6.3. Using *Square Validation Framework* in the Constructive Research method

The proposed solution consists of four main artifacts:

1. The Value System conceptual model (see Chapter 3, Section 3.1).
2. The V-AligN framework (see Chapter 3, Section 3.2).
3. The set of methods for Core Value Systems alignment assessment (see Chapter 4).
4. The system specification and respective prototype of the Core Value System Analysis Tool for CNs (see Chapter 5).

The main guidelines suggested by the *Square Validation Framework* are followed to prove the practical and theoretical relevance of the proposed artifacts as illustrated in Figure 6.3. The proof of the consistency of the developed models and methods will allow us to verify whether the proposed artifacts correctly answer each research question. In this approach the proof of consistency is not referring to the mathematical proof of consistency of a theory, but rather demonstrating that the method does not generate information that is inadequate or not necessary (Pedersen et al., 2000). Although the Square Validation framework has been developed to validate methods, in our opinion the overall approach can also be followed to validate models, and in this case the proof of the consistency of the models consists of showing that the models are in agreement with the characteristics previously shown or stated.

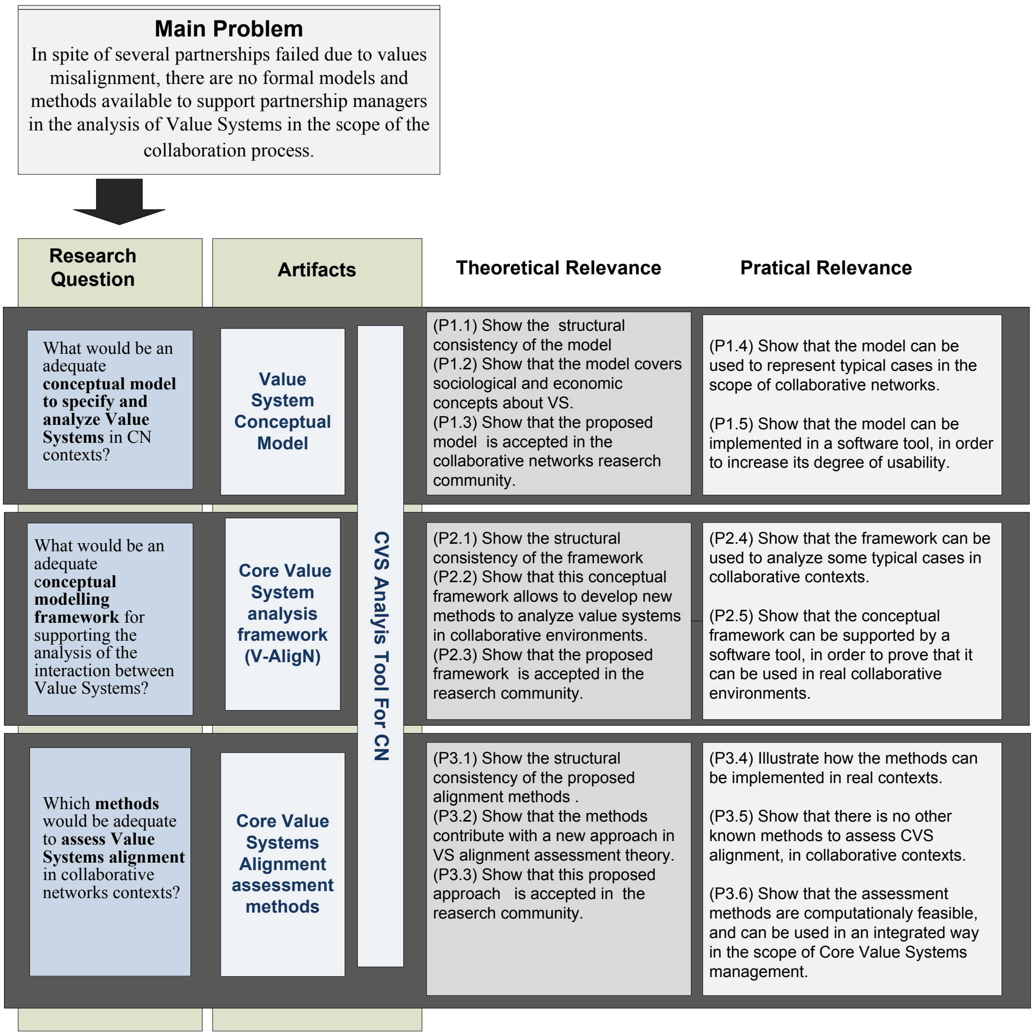


Figure 6.4. Strategy to validate the proposed solution

In Figure 6.4 the overall strategy is presented in order to prove that: (i) the set of proposed artifacts contribute to solve the main research problem, and (ii) these artifacts are relevant.

As explained above, this validation process aims to demonstrate the theoretical and practical relevance of the proposed artifacts, as well as to verify the hypotheses formulated. As each hypothesis points to a possible solution for the respective research question, the set of procedures proposed to validate each artifact also gives evidence that allows us to draw conclusions about each hypothesis. The tests to verify the research hypotheses are summarized in the diagram presented in Figure 6.5.

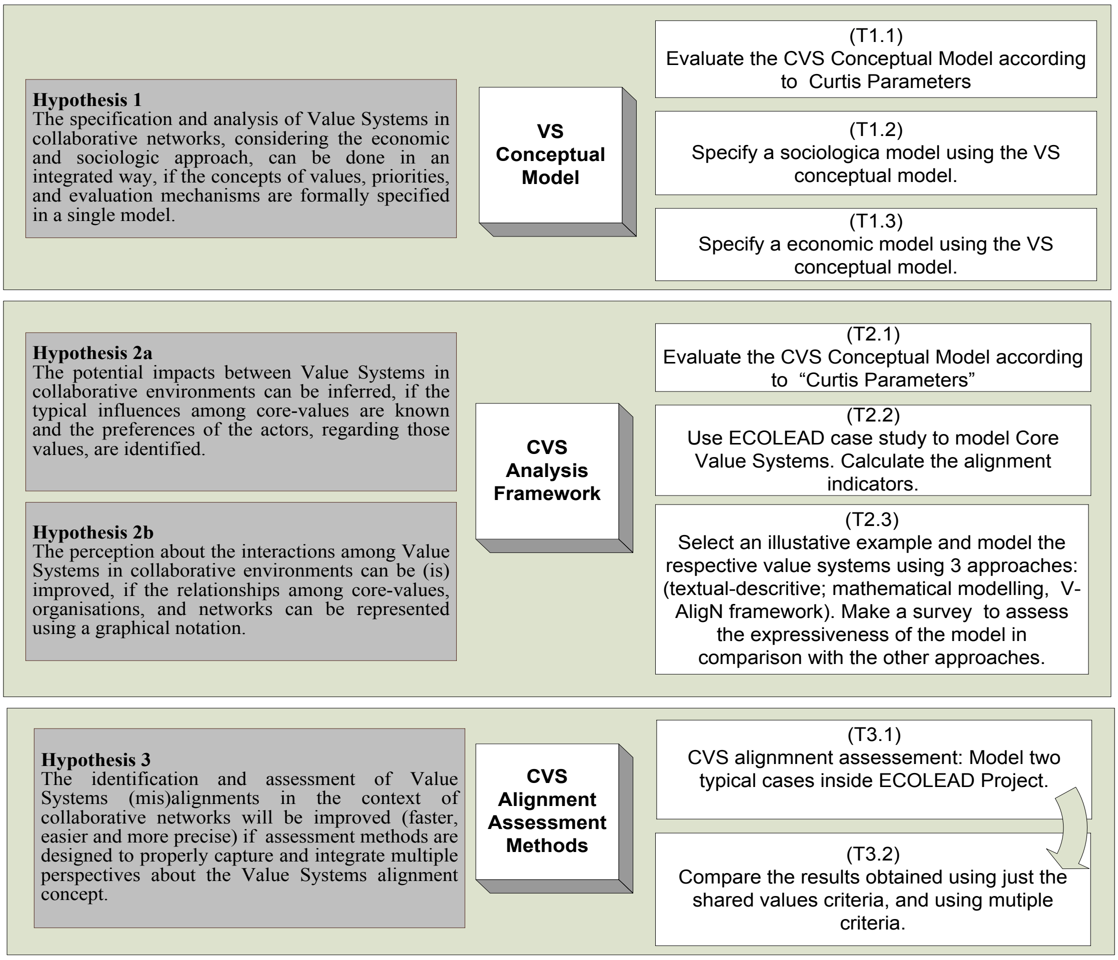


Figure 6.5. Strategy to validate hypotheses

6.3. Validation Elements

As explained above, a number of validation elements are used to validate each hypothesis, and to show the practical and theoretical relevance of the proposed artifacts. Some of these validation elements have already been presented in previous chapters and the new validation ones are presented below in this section. Moreover, it should be noticed that each validation element can be used in more than one validation procedure as summarized in Table 6.1.

Table 6.1 Validation elements

	Validation Element ID	Validation Element	Used in: See Figure 6.4	Used in: See Figure 6.5	Presented in Section
NEW	VdE-1	Validation of the research by peers	P1.3 P2.3 P3.3		6.3.1
NEW	VdE-2	VS Conceptual Model: Economic approach example	P1.2	T1.2	6.3.2
NEW	VdE-3	VS Conceptual Model: Sociological approach example	P1.2	T1.3	6.3.3
NEW	VdE-4	VS Model assessment using Curtis Parameters	P1.1	T1.1	6.3.4
NEW	VdE-5	CVS Analysis Model (V-AligN) assessment using Curtis Parameters	P2.1	T2.1	6.3.5
NEW	VdE-6	ECOLEAD illustrative case		T2.1 T3.1 T 3.2	6.3.6
NEW	VdE-7	Comparative survey about the performance of the framework in terms of usability		T2.2	6.3.7
ALREADY PRESENTED	VdE-8	Modeling example in the context of Collaborative Networks using the Value System conceptual model.	P1.4		3.1.8
ALREADY PRESENTED	VdE-9	Modeling example in the context of Collaborative Networks using the V-AligN framework.	P2.5		3.2.4
ALREADY PRESENTED	VdE-10	Illustrative examples of application of the qualitative and quantitative methods to assess CVSs alignment.	P.3.1		4.3.1 4.3.2
ALREADY PRESENTED	VdE-11	Web tool design, Prototype development.	P1.5 P2.5 P3.6		5.2 5.3

6.3.1 Validation of the research by peers (VdE-1)

This research received significant "inputs" from the findings of the ECOLEAD project, in which it was possible to interact with several researchers concerning the topics of this research. These interactions took place namely in the form of:

- Theoretical Foundation work package meeting in Aveiro, Portugal on November 15th-16th 2006 – Soft modeling experiments.
- Theoretical Foundation work package meeting in Valencia, Spain on March 14th-15th 2007 – Workshop on Reference Models for Collaborative Networked Organizations.
- General meeting in Brussels, Belgium May 9th–11th 2007 – Workshop on Soft-computing approach in decision making for future CNs.

The feedback and suggestions about this work obtained during these meetings and workshop were an important element in the consolidation of the research lines followed. Since this research started in the ECOLAED project, it was possible to contribute to the writing of the following project deliverables, which are directly related to this thesis:

- D53.1 – Motivation and approach for soft modeling for Collaborative Networked Organizations.
- D53.2 – Experimentation on Soft Modeling for Collaborative Networked Organizations.
- D54.1 – Basis for interoperability among models.
- D54.2 – Experiments on interoperability among models.

Moreover, a contribution was made to the *Collaborative Networks: Reference Modeling* book (Camarinha-Matos and Afsarmanesh, 2008a), for which a chapter was written. Additionally, a number of publications in conference proceedings and journals were made, aiming to disseminate the work and receiving inputs and constructive feedback from the reviewers. Figure 6.6 shows the correspondence between the different publications and the findings of this research.

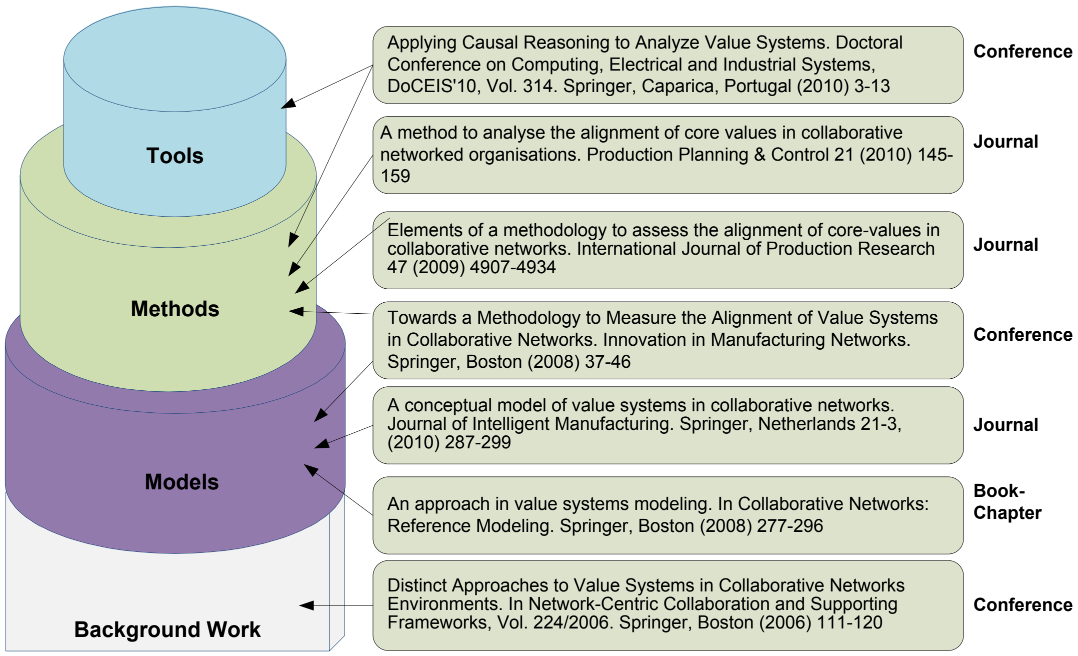


Figure 6.6. Work validation and dissemination through publications

6.3.2 VS Conceptual Model – Economics approach example (VdE-2)

The idea behind the following examples is to show that the Value System conceptual model proposed in Chapter 3, Section 2 covers the representation of the economic notion of value. With this purpose in mind, three value assessment models within the scope of Knowledge Capital Management were selected:

(i) Intangible Asset Monitor Model (Sveiby, 1993), which is a well known model to assess intellectual capital inside organizations.
(ii) Industry Standard Method (Razgaitis, 2003), which is a well known method for intellectual property valuation.
(iii) Rate/ranking Method (Razgaitis, 2003), which is a well known method for intellectual property valuation.

Intangible Asset Monitor Model

Intellectual capital is considered the value embedded in ideas, embodied in people, processes and customers/stakeholders. Several models have been developed to measure these intangible assets (Sveiby, 1997; Sullivan, 2000). The Intangible Asset Monitor (Sveiby, 1997) is one of the most well known models to measure intangibles inside organizations. This model comprises a set of indicators, based on the strategic objectives of the organization referring to three different types of intangibles assets:

(1) assets related to the External Structure,
(2) assets related to the Internal Structure, and
(3) assets related to People's competences.

These three types of assets can be evaluated according to four aspects:

(1) Growth, (2) Innovation; (3) Efficiency/Utilization; and (4) Stability/Risk reduction.

Table 6.2 Intangible asset monitor framework (Sveiby, 1997))

Intangible Assets			
	(1) External Structure Indicators	**(2) Internal Structure Indicators**	**(3) Competence Indicators**
(1) Growth	Organic Growth.	Investment in IT Investments in Internal Structure	Competence Index Number of Years in the Profession. Level of Education. Competence Turnover.
(2) Innovation	Image Enhancing Customers Sales to new customers	Organization Enhancing Customers. Proportion of new products/services New processes implemented	Competence-Enhancing Customers. Training and Education Costs. Diversity
(3) Efficiency	Profitability per Customer. Sales per Customer. Win/Loss Index.	Proportion of Support Staff	Proportion of Professionals. Leverage Effect. Added Value per Employee. Added Value per Professional. Profit per Employee. Profit per Professional.
(4) Stability	Satisfied Customers Index. Proportion of Big Customers. Age Structure. Devoted Customers Ratio. Frequency of Repeated Orders.	Proportion of Professionals. Leverage Effect. Added Value per Employee. Added Value per Professional. Profit per Employee. Profit per Professional.	Professionals Turnover. Relative Pay. Seniority.

This model is described using the table presented in Table 6.2. However, it is important to state that the indicators presented are only examples. Each organization should select its indicators according to its own characteristics.

This framework can be represented using the VS conceptual model, since this framework essentially defines a set of evaluation mechanisms. Figure 6.7 illustrates how the elements that compose the Intangible Asset Monitor framework can be covered by the concepts presented in the VS conceptual model.

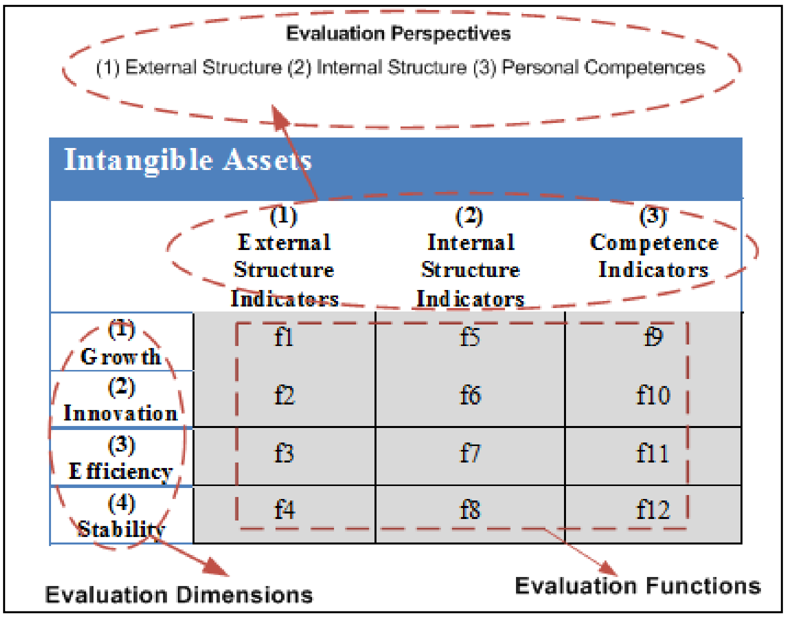


Figure 6.7. Intangible Asset Monitor framework mapped in VS conceptual model

The organization to be assessed is the main object of evaluation, which will be evaluated through three perspectives of evaluation (1) external structure perspective, (2) internal structure perspective; and (3) personal competences perspective. In each evaluation perspective the organization is evaluated in four distinct aspects. Therefore four evaluation dimensions are specified: (1) Growth, (2) Innovation, (3) Efficiency, and (4) Stability. Since this framework does not distinguish the relative importance of each aspect, all evaluation dimensions are assumed to have the same weight (same degree of importance). The indicators specified are in fact evaluation functions. For each evaluation dimension of each evaluation perspective an evaluation function is specified.

Similar to what was presented in Example 3.1, Table 6.2 shows the formal representation of the Intangible Asset Monitor framework, using the VS conceptual model.

Table 6.3. Formal specification for the Intangible Asset Monitor framework

Specification	
Value System	$VS_O = < EVS_O, RVS_O >$
Value Objects Subsystem	$OS_O = < S_O, RS_O >$ such that: $S_O = \{Organization\}$
Evaluation Subsystem	$ES_O = < EF_O, RE_O >, EF_O = < D_O, P_O, F_O >$
Evaluation Dimensions Set	$D_O = \{Growth, Innovation, Efficiency, Stability\}$
Evaluation Perspectives Set	$P_O = \{ep_{ExternalStructure}, ep_{InternalStructure}, ep_{PCompetences}\}$
	$ep_{ExternalStructure} = < dv_1, wv_1 >$ $ep_{InternalStructure} = < dv_2, wv_2 >$ $ep_{PCompetences} = < dv_3, wv_3 >$ *where:* $dv_i = [Growth, Innovation, Efficiency, Stability]$ $wv_i = [0.25, 0.25, 0.25, 0.25]$, *where* $i \in \{1,2,3\}$
Evaluation Functions Set	$F_O = \{f1, f2, f3, f4, , f5, f6, f7, f8, f9, f10, f11, f12\}$
Evaluation Vectors	$fv_1 = [f1, f2, f3, f4]$, $fv_2 = [f5, f6, f7, f8]$, $fv_3 = [f9, f10, f11, f12]$
Relations between Evaluation Functions and Evaluation Dimensions	• $R1 = \{\forall_{i \in [1.4]} (fv_1[i], dv_1[i]) : fv_1[i] \phi dv_1[i]\}$ is the set of relations between the evaluation functions defined on fv_1 and the evaluation dimensions defined on dv_1. • $R2 = \{\forall_{i \in [1.4]} (fv_2[i], dv_2[i]) : fv_2[i] \phi dv_2[i]\}$ is the set of relations between the evaluation functions defined on fv_2 and the evaluation dimensions defined on dv_2. • $R3 = \{\forall_{i \in [1.4]} (fv_3[i], dv_3[i]) : fv_3[i] \phi dv_3[i]\}$ is the set of relations between the evaluation functions defined on fv_3 and the evaluation dimensions defined on dv_3.

Intellectual Property Assessment Methods

Intellectual Property (IP) is considered a component of Intellectual Capital, and it can be defined as documented or undocumented knowledge, creative ideas, or expressions from the human mind that have monetary value and are protectable under copyright, patent, service mark, trademark. In order to value Intellectual Property several methods have been developed, such as: *Auction, Industrial Standard, Rules of Thumbs, Monte Carlo, Discounted Cash Flow, Rate/Ranking* , etc (Razgaitis, 2003). In order to show that the Value System conceptual model covers the concepts involved in IP valuation, the Industry Standard method and the Rate/Ranking method have been selected as examples.

The *Industry Standard* method of valuation is also referred to as the *Market* or *Comparable Technology* method. This method values an intellectual property asset by referring to royalty rates and the value of similar past transactions, as illustrated in Figure 6.8.

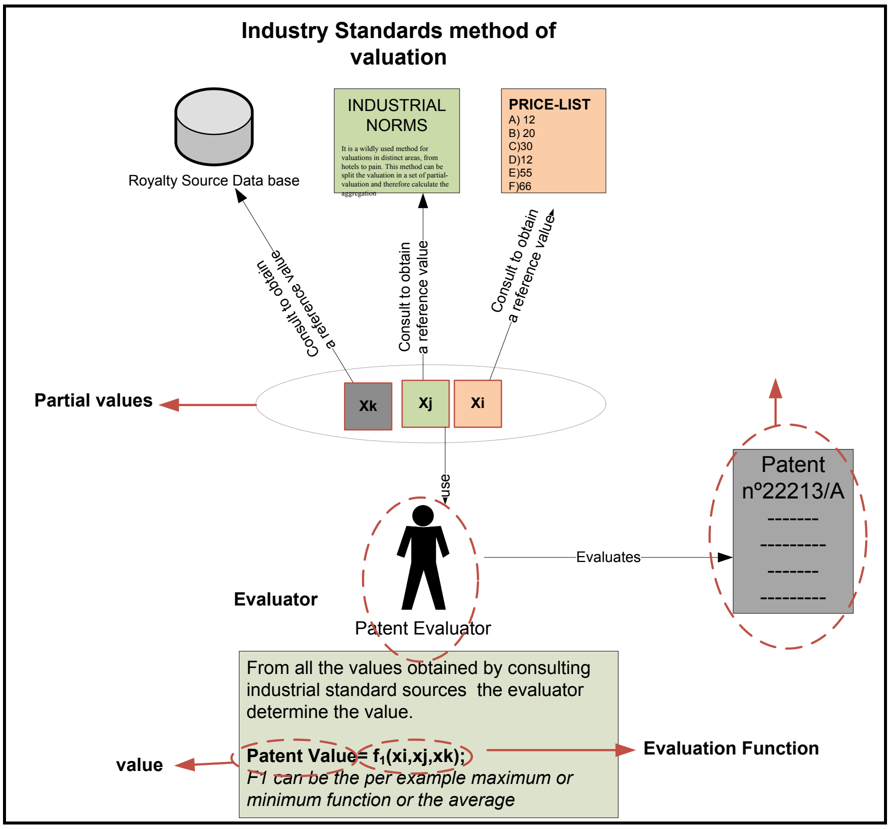


Figure 6.8. Industrial Standard method for IP valuation mapped in VS conceptual map

The *Industrial Standard* method can be modeled using the VS conceptual model as suggested in Figure 6.8. The Patent Evaluator aims to assess an object of evaluation, a patent in this example. The valuation process is represented by an evaluation function, to calculate a final value, starting from a list of partial values. Each partial value results from the action to assess the object of evaluation by comparing it with reference royalty rates, information available on industrial norms (surveys, publications, proprietary databases, and reports, published agreements), and similar past transactions.

The *Rating* method of valuation compares the intellectual property asset to be valued to a reference asset. Therefore, using a set of criteria and respective weight factors a composite score for the intellectual property asset is calculated. Afterwards, in order to determine the relative value, this score is compared to the score obtained for an intellectual property reference asset (see Figure 6.9).

The Rating method can be modeled using the VS conceptual model as illustrated in Figure 6.9. This method illustrates the use of the qualitative value *vs.* quantitative value (see Definition 3.3) concept. The patent to be assessed is the main object of evaluation, which will be scored using three criteria (criteria A, B and C), therefore for each criterion a qualitative evaluation dimension is specified. To implement the distinct weighting factors of each criterion, an evaluation perspective is specified, where the degree of importance of each evaluation dimension is defined (*wa, wb* and *wc*). As a result of patent evaluation complying with the three criteria defined, three qualitative values are obtained (*xk, xj and xi*), which are

aggregated according to their degree of importance. The resulted qualitative value (*X*) is rated in comparison with a reference patent, in order to determine its relative economic value (quantitative value).

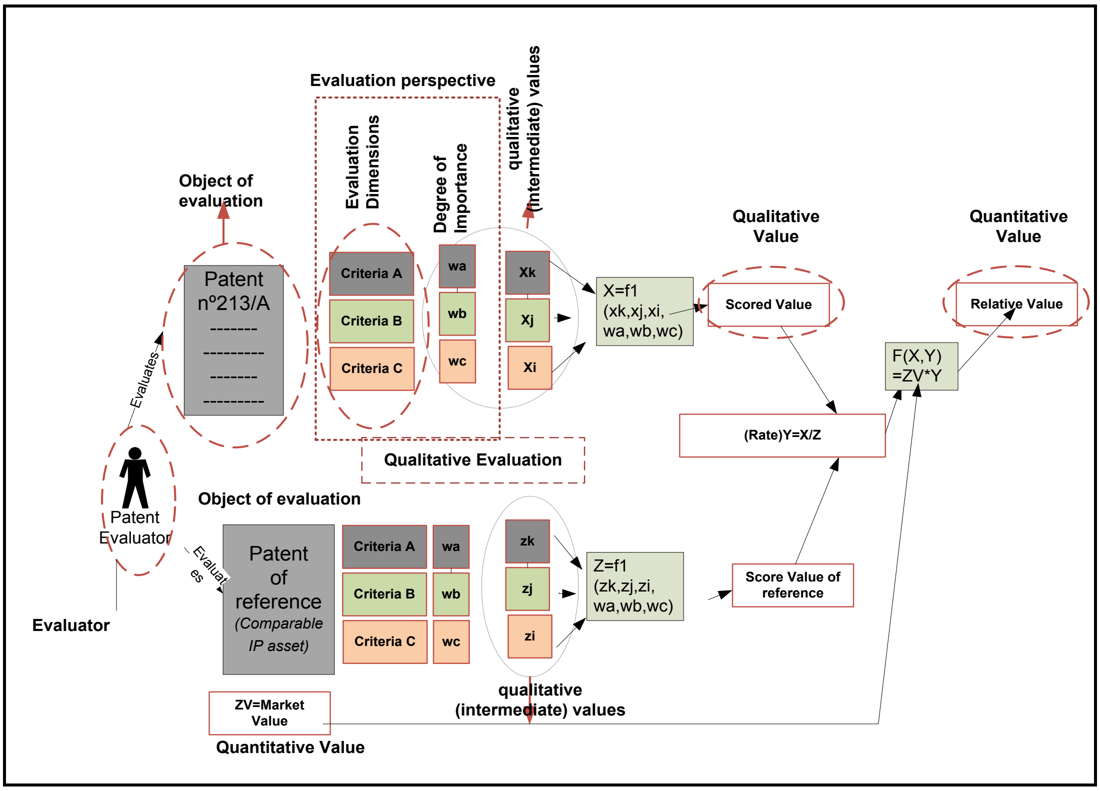


Figure 6.9. Rating method for IP valuation mapped into the VS conceptual map

These three examples above illustrate how the concepts defined under the VS conceptual model fit the concepts used in Intellectual Capital assessment models and methods. The idea behind these examples is not to propose that the VS conceptual model should be used as a modeling tool for the specification of Intellectual Capital Assessment models, but rather to show that it covers the economic approach of value systems.

6.3.3 VS Conceptual Model – Sociology approach example (VdE-3)

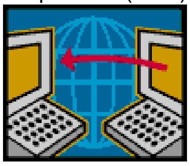
The aim of this subsection is to show how the domain problems described by the sociological researchers Brian Hall (Hall, 1995) and Venkat R. Krishnan (Krishnan, 2005) can be represented using the proposed VS conceptual model.

Brian Hall Corporate Report of Computer Engineering Corporation

Brian Hall (1995) is a sociological researcher who has proposed a Value System model and a set of sociological methodologies for core value alignment assessment (see Chapter 2 Section 2.5.5). In the proposed organization three groups of values are considered to the assessment: (i) The Focus Values, (ii) the Foundation Values, and (iii) the Vision Values. These three sets of values define the profile of the organization in terms of values. Brian Hall does not propose

any formalism or notation to specify the set of values held by the organization or its members. However, the proposed CVS conceptual model can be used to specify them formally. Figure presents an example constructed with data available in the *Values Corporate Report of the Computer Engineering Corporation* presented in (Hall, 1995), where the values assessment comprises the identification of the three groups of values.

Computers Engineering Corporation (CEC)



Values Corporate Report

The Focus Values	Foundation Values	Vision Values
Competence/ Confidence	Fammily/belonging	Construtive/New order
Management	Self-Worth	Growts/Expantion
Service/Vocation	Support/Peer	Faith/ Risk
Productivity		
Self-Actualization		

Information extract from the Corporate Report of CEC (Hall, 1994) pp249-260

Figure 6.10. Values Corporate report from Brian Hall approach

In this illustrative example, the Computer Engineering Corporation (CEC) is the main object of evaluation, which will be analyzed through three core perspectives of evaluation: (i) the Focus Values perspective (cp_{focus}), (ii) the Foundation Values perspective ($cp_{foundation}$); and (iii) the Vision Values perspective (cp_{vision}). For each evaluation perspective a set of distinct core values is selected, For instance, the core values: *Family, Self-worth* and *Support* were considered as being the Foundation Values, thus these three core values are defined in the Foundation values perspective ($cp_{foundation}$). Since this model does not distinguish the relative importance of each aspect, we can assume that all core values have the same degree of importance. In this case it was considered that all core values have a *very high* priority (see Definition 3.10).

As in Example 3.2, Table 6.3 shows the formal representation of the *Values Corporate Report of CEC* using the conceptual model of CVS.

Table 6.4. Formal specification for *Values Corporate Report* example

Specification	
Core Value System	$CVS_{CEC} = < CEVS_{CEC}, CRVS_{CEC} >$
Core value Objects Subsystem	$COS_{CEC} = < S_{CEC}, RS_{CEC} >$ such that: $S_{CEC} = \{CEC\}$
Core Evaluation Subsystem	$CES_{CEC} = < CEF_{CEC}, CRE_{CEC} >$ $CEF_{CEC} = < CV_{CEC}, CP_{CEC}, CF_{CEC} >$ *where:*
Core Evaluation Perspectives Set	$CP_{CEC} = \{cp_{focus}, cp_{fundamental}, cp_{vision}\}$
	• cp_{focus}=<[competence,management,service,productivity,self-actualization], [very high, very high, very high, very high, very high]> • $cp_{fundamental}$=<[belonging,self-worth,support],[very high, very high, very]> • $cp_{fvision}$=<c onstrutive, grows, risk],[very high, very high, very high]>

Leader-Member Exchange, Transformational Leadership Study

Krishnan presented a study about Leadership (Krishnan, 2005), which analyzed the congruence between a leader's and a follower's value systems, and their relative impact on four outcomes: (i) perceived effectiveness of the leader and work unit, (ii) the follower's satisfaction with the leader, (iii) the follower's motivation to put in extra effort, and (iv) the follower's intention to quit the organization. The study used a sample of 100 pairs of managers and subordinates from a non-profit organization in the United States. According to Krishnan, a value system consists of two lists of 18 values each: the instrumental values (the preferred ways of being) and the terminal values (the preferred goals of life). Each list is sorted by degree of importance of values as guiding principles.

Table 6.5. Formal specification for the *Value System Congruence Assessment* example

Specification	
Core Value System	$CVS_{leader} =< COS_{leader}, CES_{leader} >$
Core Evaluation Subsystem	$CES_{leader} =<< CEV_{leader}, CV\ ,\ CEP_{ter} >, CRE_{VBE} >$ $CV\ = Tv\ \cup Iv$, *where:* *Tv are the 18 terminal Rokeach values* *Iv are the 18 instrumental Rokeach values*
Core Evaluation Perspectives	$cp_{terminal} =< dv1_{leader}, wv1_{leader}>$ $cp_{instrumental} =< dv2_{leader}, wv2_{leader}>$ • *$dv1_{leader=}$[A Comfortable Life, An Exciting Life, A Sense of Accomplishment, Freedom, Health, Friendship, Mature Love, National Security, Pleasure, Inner Harmony, Social Recognition, True, Wisdom, A World at Peace, A World of Beauty, Equality, Family Security, Self-Respect,Salvation]* • *$wv1_{leader}$[0.005848, 0.011696, 0.000103, 0.000137, 0.000171, 0.000205,0.000239, 0.000274, 0.000308, 0.000342, 0.000376, 0.00041, 0.000445, 0.000479, 0.000513, 0.000547, 0.000581, 0.000616]* • *$dv2_{leader}$= [Responsible, Ambitious, Helpful, Independent, Obedient, Broad-minded, Intellectual, Capable, Clean, Loving, Courageous, Loyal, Forgiving, Logical, Polite, Honest, Imaginative, Self-controlled,]* • *$wv_{leader2=}$[0.005848, 0.011696, 0.000103, 0.000137, 0.000171, 0.000205,0.000239, 0.000274, 0.000308, 0.000342, 0.000376, 0.00041, 0.000445, 0.000479, 0.000513, 0.000547, 0.000581, 0.000616]* Note : the two weigh vectors satisfy the following properties: $\forall_i\, wv[i] <> wv[i+1], \quad \sum_{i=1}^{18} wv[i] = 1$

The domain problem of this study can also be specified using the proposed VS conceptual model. In this illustrative example, each leader and each subordinate defines his/her Core Value System. In the CVS specification two core evaluation perspectives are specified: (i) the

terminal perspective ($cp_{terminal}$); and (ii) the instrumental perspective ($cp_{instrumental}$). The 18 terminal core values and the corresponding priorities define the terminal perspective, while the 18 instrumental core values and corresponding priorities (degrees of importance) define the instrumental perspective. As the alignment assessment method proposed by Krishnan assumes that core values in each list are ordered by priorities (degree of importance), we have to quantitatively specify the priorities (see Definition 3.10), making sure that all core values inside a perspective have a distinct numeric value to measure their priority. Moreover, it has to be guaranteed that the sum of all value priorities is one (see Definition 3.10) and that the weights vector is filled in descending order to make sure that the core-evaluation vectors (dv_O) can be compared consistently. The example presented in Table 6.5 illustrates the specification of a value system following the Krishnan definition.

These two previous examples show how the concepts proposed under the Value System conceptual model cover the sociological notion of core values, priorities and Value System. Moreover, they illustrate how to implement the cases where just the relative order of core-values' priorities is given.

Comparing these two examples with the ones presented in the previous section (see Section 6.3.2), we notice that the evaluation perspective concept was applied in a slightly different way. In the examples concerning Economics approach the evaluation perspective is used to specify the characteristics that will be assessed, while in the sociological examples the perspective is used to specify the set of core values and respective priorities defined by an entity (organization or person).

6.3.4 VS Conceptual Model evaluation (VdE-4)

The VS Conceptual model was analyzed according to the parameters suggested by Curtis (Curtis et al., 1992). These parameters were already introduced in Chapter 2, and are summarized in Table 6.6, and the analysis is presented further ahead. The main purpose of this assessment is to show the consistency of the VS conceptual model.

Table 6.6. Curtis Parameters for VS conceptual model evaluation

Parameter	Test description
Granularity	Does this conceptual model allow us to build models that represent the subject with the level of detail necessary for the domain problem?
Precision	Does this conceptual model allow us to build models that represent the subject with the accuracy necessary for the domain problem?
Prescriptiveness	Does this conceptual model allow us to build models that the user may faithfully follow?
Fitness	Does this conceptual model allow the modeler to represent the subject?
Formality	Does the model built with this conceptual model have the level of formalism that enables us: (i) to translate it easily into a computer language; and (ii) to avoid ambiguity?

Granularity

The examples presented in Chapter 3 and Chapter 4 illustrate how the VS conceptual model allows us to represent the notion of value system with distinct levels of detail in the context of CNs. The evaluation objects, the evaluation dimensions and the evaluation perspective, are elements that enable the construction of models with different levels of granularity. For instance, the organization itself can be the evaluation object, or we can decompose the organization into several components, where each component can be an evaluation object, thus obtaining a value system with a higher level of detail. The same could happen with the use of evaluation dimensions and evaluation perspective. We can define evaluation dimensions that are more general, or more detailed, according to the required granularity level. The example discussed in Chapter 4 Section 2 introduces the idea of core values hierarchy that in fact, is a way to use different levels of granularity in value system modeling. If several evaluation perspectives were specified, then the evaluation can be decomposed into diverse components, increasing the level of detail of the evaluation process. In conclusion, we can state that the proposed conceptual model allows us to represent the domain problem with distinct levels of granularity.

Precision

The illustrative examples presented through Chapter 3 and Chapter 4 show that concepts of value, evaluation, priorities and value system can be represented in a concise and accurate way. Although the mathematical formalism does not guarantee the accuracy of the resulting models, mathematical formalism usually contributes to obtain more accurate models then just using informal methods of representation. However, this approach does not allow a precise specification of the meaning of each evaluation dimension. This fact enables some ambiguity regarding the definition of evaluation dimensions. Nevertheless, if evaluation functions are correctly specified and associated to the evaluation dimension, then the meaning of each evaluation dimension is specified indirectly. In conclusion, we can state that the suggested model allows us to represent value systems in quite a precise way if the user input data is itself accurate.

Prescriptiveness

The use of mathematical formalism helps build accurate models, avoiding ambiguities when we try to analyze them. However, the exclusive use of mathematical formalism has the disadvantage of not providing a visual perception of the modeled system, which can make it more difficult to follow. On the other hand, if the resulting model has to be processed by a computer program, then the use of mathematical formalism is advantageous. In conclusion, we can state that the models built using the proposed conceptual model are easily processed by a

computer program. Nevertheless, the use of mathematical formalism requires that potential users are familiar with this type of notation in order to be able to follow the model.

Fitness

The proposed conceptual model and the selected modeling language allow representation of the domain required. The examples presented in Chapter 3 Section 1.8 show how the proposed conceptual model is suitable to represent value systems in CN contexts. Moreover the examples presented in Section 6.3.2.2 and 6.3.2.3 illustrate how the notions of Economics and Sociology concerning Value Systems can be represented using the proposed conceptual model. In some sociological studies value priorities are specified using a relative value instead of an absolute value (the second example presented in Section 6.3.3 is a case where priorities are specified relatively and not absolutely). In these cases the value of priorities cannot be represented by the proposed conceptual model of VS in a straightforward way, but only in an indirect way. In conclusion, we can state that the VS conceptual model allows the modeler to represent the value system of the collaborative contexts, including the representation of evaluation functions, core values, priorities, evaluation objects, and evaluation perspectives.

Formality

Due to the fact that a mathematical notation is selected to specify the conceptual model, the resulting model has a good degree of formalism. One of the advantages of having a model with a high level of formalism is the possibility of easily implementing the model using a computer language. In fact the model was “translated” to a schema database (see Chapter 5 Section 3.2.4) in a quite straightforward way. Furthermore, the formality of the conceptual model representation helps define the VS without ambiguities (integrity), since the mathematical formalism obliges all the elements and relations among the elements that composed the system to be rigorously specified. In conclusion, we can state that the high level of formalism of the proposed model contributes to an easier implementation of the model in a software system, moreover it also helps obtain VS models with a good level of integrity.

In overall conclusion, we can state that the VS conceptual model is internally consistent, because its elements work in an integrated way and are in agreement with the characteristics previously stated (see Section 3.1.1 in Chapter 3 for a list of the VS conceptual model characteristics).

6.3.5 CVS Analysis Framework evaluation (VdE-5)

The set of analysis parameters suggested by Curtis (Curtis et al., 1992) were used to guide the evaluation of the theoretical performance of the proposed framework. These parameters are summarized in Table 6.7 and the analysis is presented further ahead.

Table 6.7. Curtis parameters for CVS analysis (V-AligN) framework evaluation

Parameter	Test description
Granularity	Does this conceptual framework allow us to build models that represent the subject with the level of detail necessary for the domain problem?
Precision	Does this conceptual framework allow us to build models that represent the subject with precision, avoiding ambiguity?
Prescriptiveness	Does this conceptual framework allow us to build models that the user may faithfully follow?
Fitness	Does this conceptual framework allow the modeler to represent the subject?
Formality	Does the model built with this framework have the level of formalism that enables us: (i) to translate it easily into a computer language; and (ii) to avoid ambiguity?

Granularity

The framework allows us to represent the notions of core values, shared values, degree of importance with a level of detail necessary to permit the analysis of the alignment between value systems, as illustrated by the examples presented in Chapter 3 and Chapter 4. Although, the framework does not allow different levels of detail, in the qualitative approach it is possible to modify the Partial Order sets in order to provide more labels to classify the intensity of the influence among core values, and the importance of core values (for instance, we can define the following Partial order set to classify the degree of importance {extreme, very high, high, high, moderate, moderate, low, moderate, low}. In the quantitative approach it is possible to modify the level of detail changing the precision of the numeric value attributed to the degree of importance (for instance, we can just use numbers rounded to one decimal digit, like 0.2; 0.3, etc, or we can use numbers with four decimal digits 0.4501; 0.1201 etc).

Precision

The selection of causal maps and graphs to model the interactions among core values, organizations and CNs enhances the construction of rigorous models, since each map has an equivalent mathematical representation, as illustrated in Chapter 3, Section 2.3. However, the precision of the models obtained depends essentially on the precision of the inputs provided by the user.

Prescriptiveness

The use of a graphical notation allows us to produce models with a good degree of expressiveness (evidence will be presented below, which shows the expressiveness of the proposed models), making it easier to process. Due to the fact that each visual representation has a corresponding mathematical model, these resulting models can be easily processed ("followed") by a computer program.

Fitness

The framework allows us to represent the required domain. The examples presented in Chapter 3 Section 2.3 show how the framework is suitable to represent the concepts of core values, priorities and shared values, and the interactions among core values, organizations and CN. In some sociological studies, value priorities (the degree of importance) are specified such as the ordering of core values. In these cases, it is not possible to represent them using the proposed qualitative approach. However it is possible to quantitatively represent the relative degree of importance, in an indirect way by attributing distinct real numbers to the degree of importance of each core value, and ordering the core values by their respective degree of importance (see the example in Section 6.3.3).

Formality

Due to the fact that a mathematical representation is associated (see Section 3.1.7) to each map of the framework, the resulting model has a good degree of formalism, which allows it to be converted in a quite straightforward way to a computer language. Furthermore, the formality used to represent the maps that comprise the framework contributes to obtain models with a good level of integrity, since the mathematical formalism obliges that all the elements that comprise the whole framework's models and relations among them are rigorously specified.

In overall conclusion, we can conclude that the V-AligN framework is internally consistent, because their components (simple and aggregated maps) work in an integrated way and are in agreement with the characteristics previously stated (see Section 3.2.1. in Chapter 3 for a list of the V-AligN framework characteristics).

6.3.6 ECOLEAD Case Study (VdE-6)

A real case observed inside the ECOLEAD project is presented. The data used for assessing this case is based on questionnaires filled in by the partners. Owing to privacy issues, the partners will not be identified, and a code will be used.

In spite of the ECOLEAD project not being classified as a VBE, due to the impossibility of having available data about a real VBE, the ECOLEAD project was taken as an example, with the following assumptions:

- The ECOLEAD project is considered to be a VBE. It brings together partners (universities, industries and research institutions) in a four-year cooperation agreement aiming to reach the goals of the project.
- The ECOLEAD project is divided into several work packages (WP). Each WP team is considered as being a short-term collaborative network, like a virtual organization (VO), created to respond to a specific set of objectives.

6.3.6.1 Context Description

The case is related to two groups established inside the ECOLEAD project:

1. The group in charge of the specification and development of the *VO Creation Framework* (VOCF) prototype. This prototype (Camarinha-Matos et al., 2008) integrates a set of services that support the VO creation process, namely: *Collaboration Opportunity Identification, Collaboration Opportunity Characterization* and *Rough Planning, Partner Search and Suggestion*, and *Contract Negotiation*.
2. The group was formed inside the ECOLEAD project in order to publish a Collaborative Network Reference Modeling Book. This book aimed to establish a theoretical foundation for Collaborative Networks, contributing with a comprehensive modeling framework that captures and structures the diverse aspects and perspectives of Collaborative Networks.

Table 6.8. Collaboration opportunity's partners.

Collaboration opportunity	Members
VOCF Group	O1,O2,O3,O4,O5,O6,O7,O8
Book Editing	O1,O2,O6,O7,O8,O9,O10

The objectives of each partnership were intended to be achieved through a collaborative research work among different organizations. Some of these organizations belong to both partnerships, as shown in Table 6.8 and illustrated in Figure 6.11.

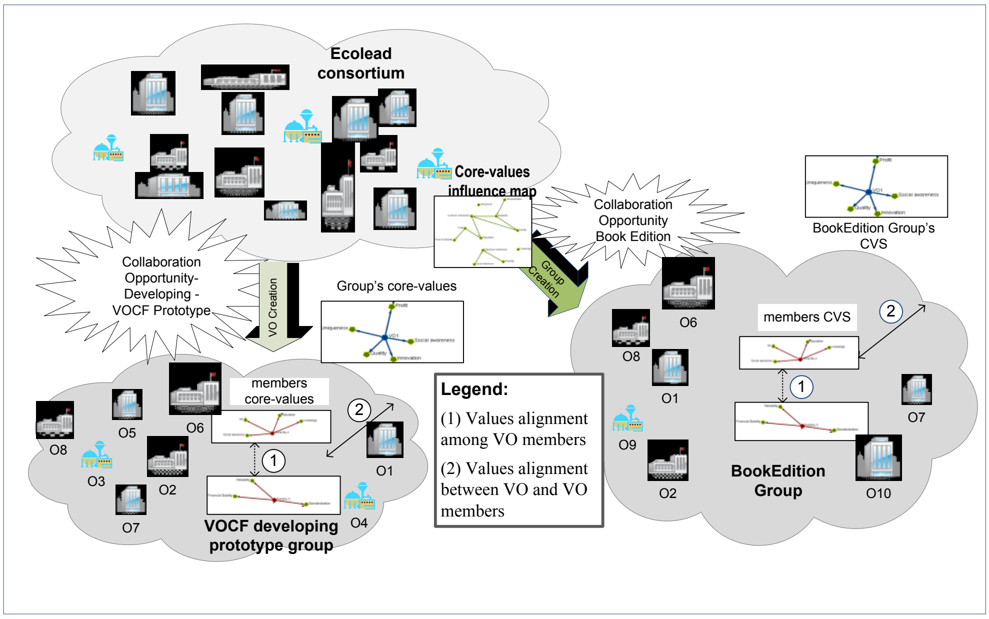


Figure 6.11. ECOLEAD Scenario

The data used to define each organization's CVS (core values and priorities) were provided by the partners involved in the ECOLEAD consortium and is presented in Table 6.9.

Table 6.9. Core values and Priorities of each entity

	Values and Priorities
O1	Innovation very high; Interdisciplinary fair; Knowledge very high; Reputation high; Quality very high; Sharing high
O2	Innovation very high; Knowledge very high; Reputation fair; Quality high; Reliability high, Sharing high.
O3	Agility fair; Financial Stability high; Profit very high; Quality very high; Standardization very high.
O4	Innovation high; Profit high; Quality high; Reliability very high; Responsiveness very high.
O5	Financial Stability very high; Innovation high; Profit high; Reliability high; Responsiveness high
O6	Employee Satisfaction very high; Equity high; Innovation high; Interdisciplinary high; Knowledge high; Reputation high.
O7	Interdisciplinary fair, Knowledge high; Self-Interest high; Uniqueness high.
O8	Innovation very high; Profit high; Reputation very high, Responsiveness very high;
O9	Agility/flexibility very high; Employee Satisfaction very high, Financial Stability high; Innovation very high, Interdisciplinary high.
O10	Innovation very high, Interdisciplinary high, Quality high, Reliability high.
VOCF Group	Agility very high; Innovation high; Profit fair; Reliability high; Responsiveness very high, Sharing high.
Book Publication Group	Knowledge very high; Reputation fair; Quality very high; Sharing high, Control/Order high.

6.3.6.2 Value System Analysis

CVSs alignment evaluation for VOFC group is illustrated using the web-based tool described in Section 5, and is performed at two levels: (i) assessment of CVSs alignment between the group and each group's member; (ii) assessment of CVSs alignment between group members. The CVSs alignment evaluation assumes the existence of an ontology of core values and the definition of the relations of influence between pairs of core values. Such knowledge can be directly provided by experts or result from surveys and interviews (see as examples (Collins and Porras, 1996; Rekom et al., 2006)). For this case study, the *core values influence map* considered is shown in Figure 6.12.

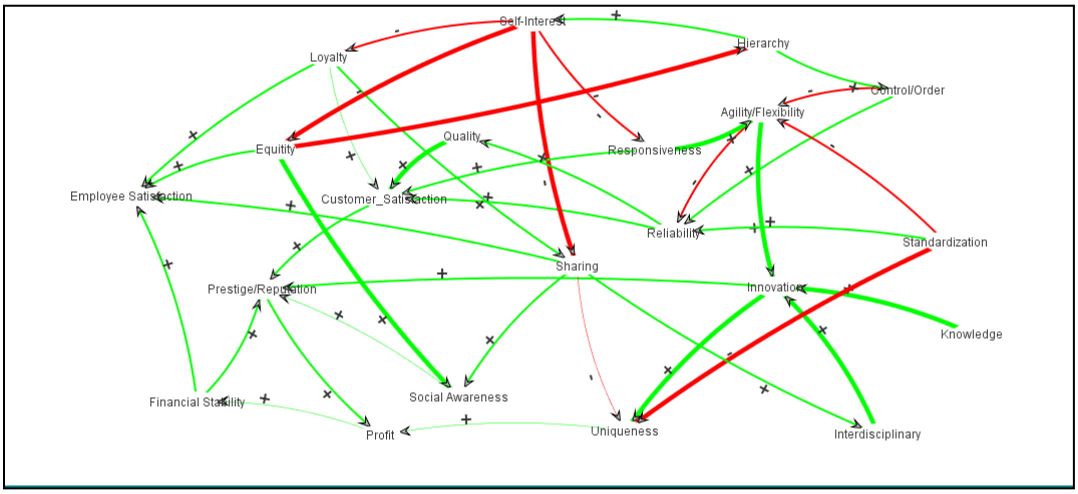


Figure 6.12. Core values influence map for the case study

The Value System analysis is supported by the CVS Analysis tool for CNs presented in the previous chapter and will comprise the following steps:

Step 1 – Network Configuration

The network manager configures the network, specifying the members (organizations or teams) that compose that network (see Figure 6.14 as an example for configuration of the VOCF group).

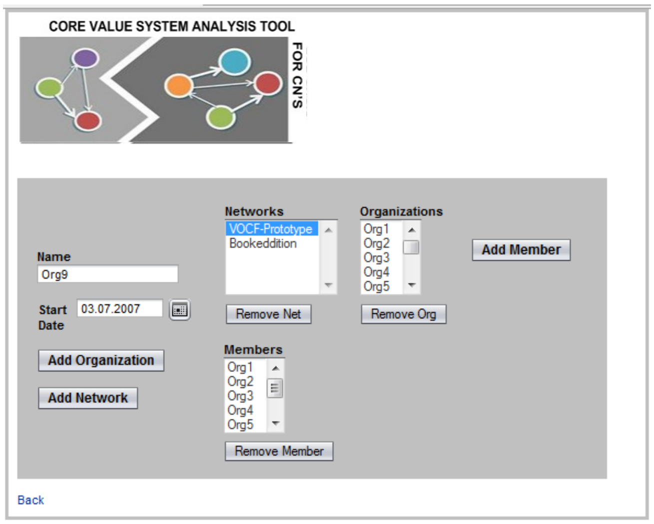


Figure 6.13. CVS Analysis Tool User Interface for Network Modeling Component

Step 2 – Define CVS of each member

Each network member has to define its preferences (main core values and the degree of importance of each one), and the VO manager or VO planner defines the network's CVS (see Figure 6.13 as an example).

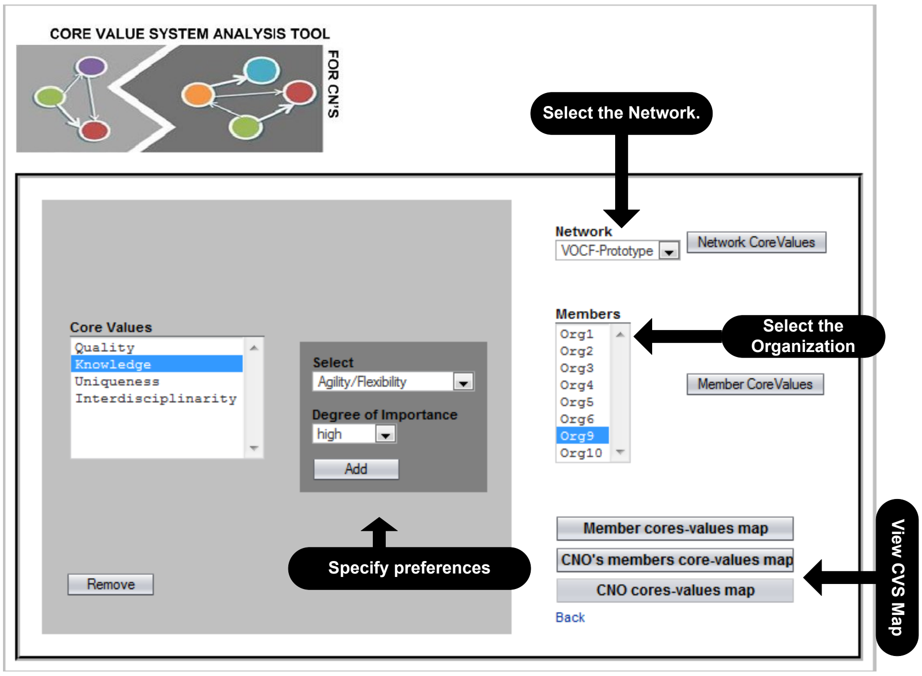


Figure 6.14. CVS Analysis Tool User Interface for Value System Modeling Component

Figure 6.15 shows the CN's core values maps for the two groups, where the priorities of each group are outlined.

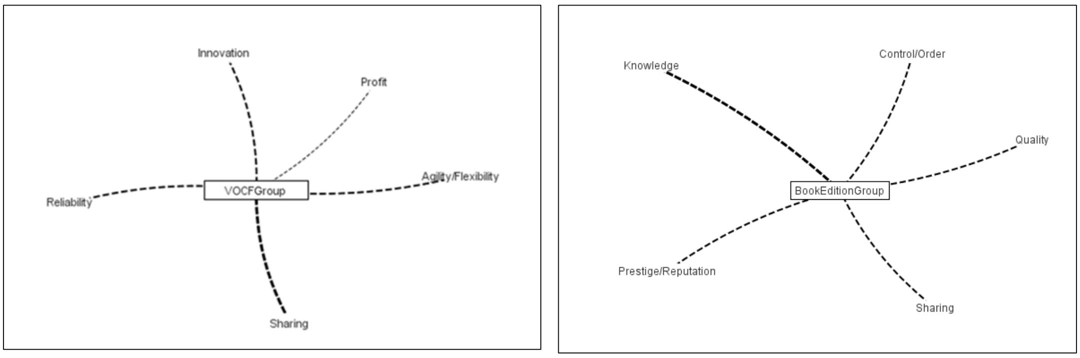


Figure 6.15. CN's core values maps generated by CVS Analysis Tool for CNs

Figure 6.16 presents the Organization's core values map for all members that comprise the VOCF group. This map shows the CVS of each partner, and outlines the shared core values among them.

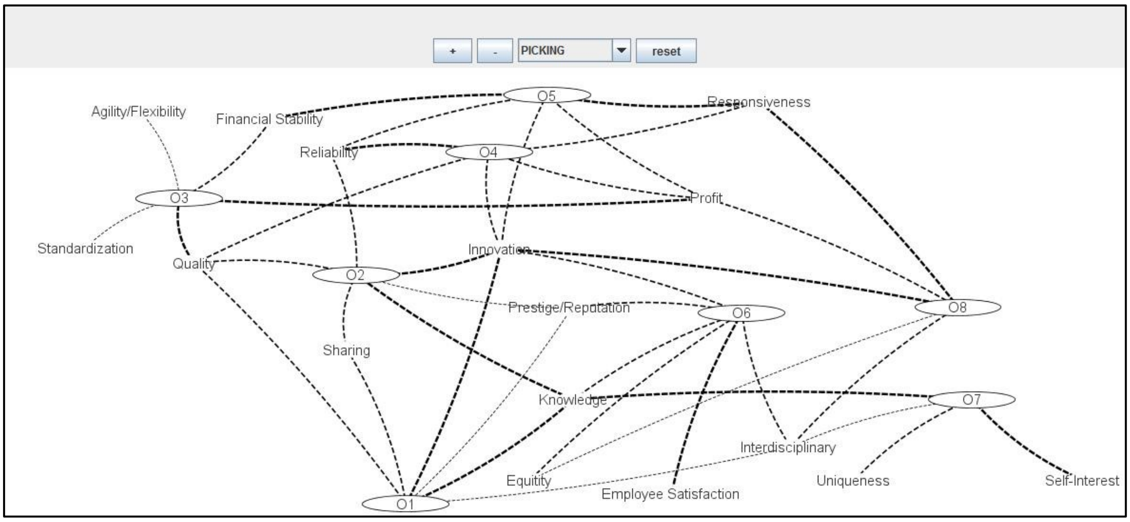


Figure 6.16. Organization's core values map generated by CVS Analysis Tool for VOCF group

In Figure 6.17 the Organization's core values map for all members that comprise the Book Publishing group is shown.

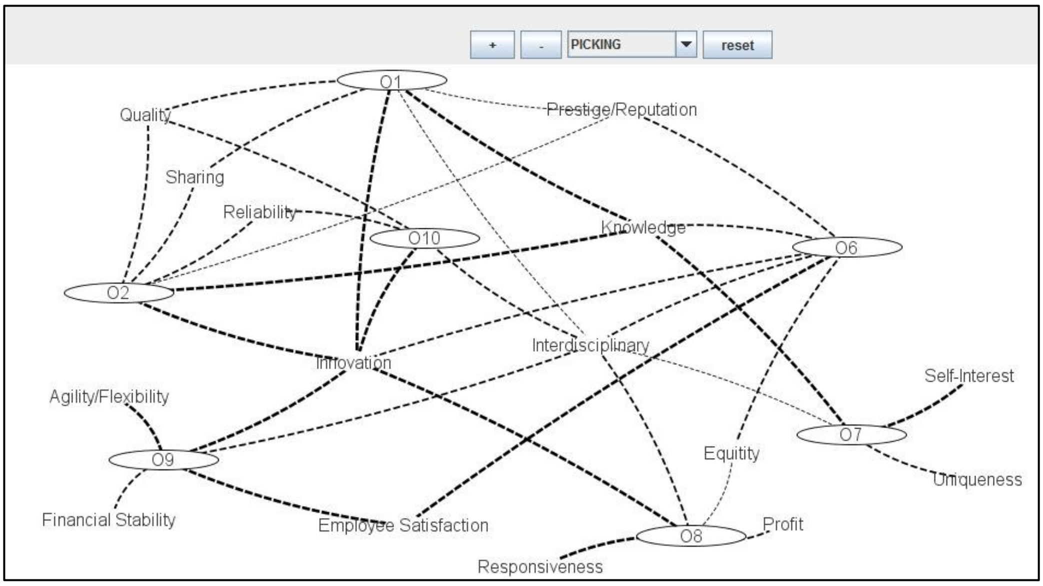
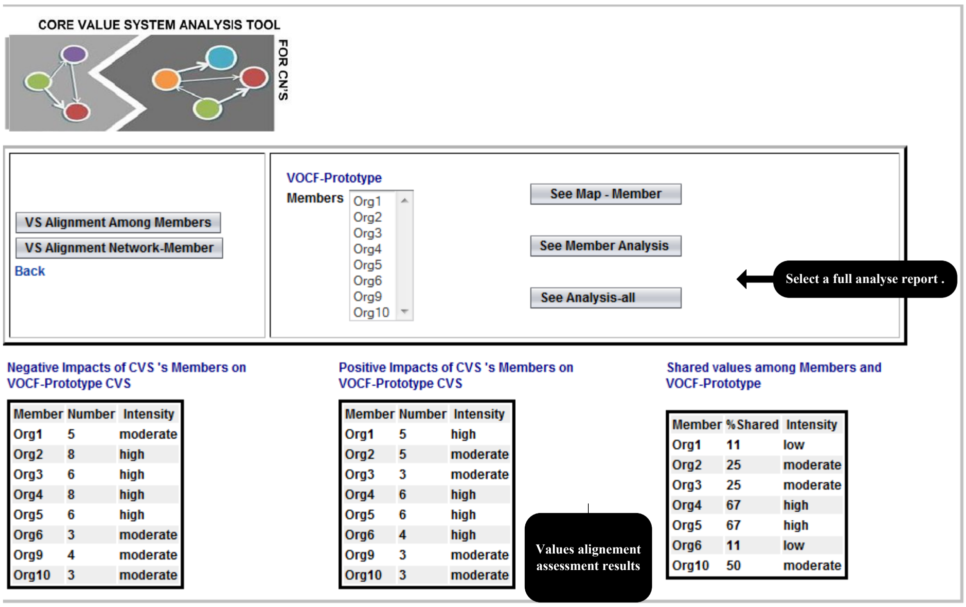


Figure 6.17. Organization's core values map for Book Publishing group

Step 3 – Analyze CVSs alignment

CVSs alignment evaluation is required. A set of qualitative indicators is provided for the two levels of alignment: (i) network level, and (ii) member level.

An example for the Network level assessment for the VOCF-prototype case can be seen in Figure 6.18.



Member	Number	Intensity
Org1	5	moderate
Org2	8	high
Org3	6	high
Org4	8	high
Org5	6	high
Org6	3	moderate
Org9	4	moderate
Org10	3	moderate

Member	Number	Intensity
Org1	5	high
Org2	5	moderate
Org3	3	moderate
Org4	6	high
Org5	6	high
Org6	4	high
Org9	3	moderate
Org10	3	moderate

Member	%Shared	Intensity
Org1	11	low
Org2	25	moderate
Org3	25	moderate
Org4	67	high
Org5	67	high
Org6	11	low
Org10	50	moderate

Figure 6.18. Usage of the CVS analysis component: network level

An example of the usage of the CVS Analysis Tool for member level assessment is shown in Figure 6.19.

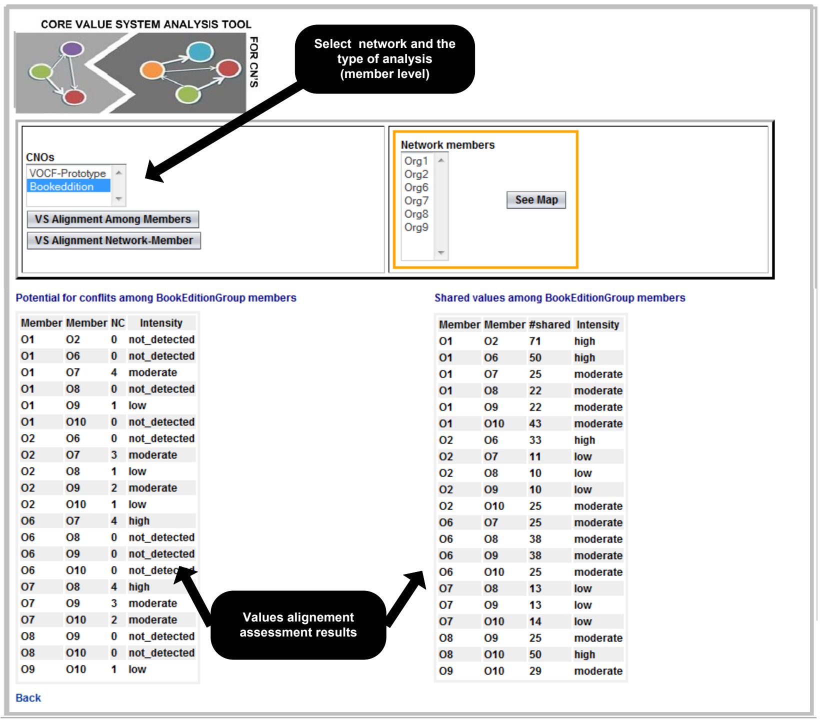


Figure 6.19. Usage of the CVS analysis component: members' level

The results of the assessment of the CVS (considering direct and indirect influences) for the VOCF group are presented in Table 6.10.

Observing the results it can be seen that all members have a significant positive impact (high or moderate) on the group. Moreover, except for member O7, all the others present a high level of shared core values with the group's CVS. The analysis of the potential for conflicts among the VOCF group members shows that there is no potential for conflict between O1 and O2, O4, O5, O6 and O8, and also between O6 and O1, O2, O4 and O8. This suggests that O1 and O6 are members that represent a low risk in terms of potential for conflicts with their partners. On the other hand, O7 is the member that has a higher potential for conflict with the other group members, since the level of potential for conflict with O6 and O8 is high, and a low level of potential for conflict was only obtained with O4 and O5. Additionally, O7 is also the organization that in global terms, has the lowest level of shared core values with its partners, and that has the lowest positive impact on the group's CVS. This suggests that O7 is the organization that has the weakest alignment level with the group in terms of core values. By looking at the partial aggregate core values maps, a detailed analysis of the misalignment can be undertaken. For example, observing the map from O7 and O8 in Figure 6.20, it can be seen that the core value *Self-interest* owned by O7, has a negative influence on the *Equity* and *Responsiveness* core values, both of which are core values owned by O8. Additionally we can conclude that the *shared core value level* is low, because O7 and O8 only share the *Interdisciplinary* core value.

Table 6.10. CVSs alignment evaluation assessment results for VOCF group.

Network level			Members level		
Member	Positive impact level (on CN)	Shared core values level (with CN)	Members	Potential for conflicts level	Shared core values level
O1	HIGH	MODERATE	O1,O2	*NOT_DETECTED*	HIGH
O2	HIGH	MODERATE	O1,O3	MODERATE	LOW
O3	HIGH	MODERATE	O1,O4	*NOT_DETECTED*	MODERATE
O4	HIGH	MODERATE	O1,O5	*NOT_DETECTED*	LOW
O5	HIGH	MODERATE	O1,O6	*NOT_DETECTED*	HIGH
O6	HIGH	MODERATE	O1,O7	MODERATE	MODERATE
O7	MODERATE	LOW	O1,O8	*NOT_DETECTED*	MODERATE
O8	HIGH	MODERATE	O2,O3	MODERATE	LOW
			O2,O4	LOW	MODERATE
			O2,O5	LOW	MODERATE
			O2,O6	*NOT_DETECTED*	HIGH
			O2,O7	MODERATE	LOW
			O2,O8	LOW	LOW
			O3,O4	MODERATE	MODERATE
			O3,O5	LOW	MODERATE
			O3,O6	MODERATE	*NOT_DETECTED*
			O3,O7	MODERATE	*NOT_DETECTED*
			O3,O8	LOW	LOW
			O4,O5	MODERATE	HIGH
			O4,O6	*NOT_DETECTED*	LOW
			O4,O7	LOW	*NOT_DETECTED*
			O4,O8	LOW	MODERATE
			O5,O6	*NOT_DETECTED*	LOW
			O5,O7	LOW	*NOT_DETECTED*
			O5,O8	LOW	MODERATE
			O6,O7	HIGH	MODERATE
			O6,O8	*NOT_DETECTED*	MODERATE
			O7,O8	HIGH	LOW

Another interesting aspect to note is the fact that although O4 and O7 do not share any core value, their potential for conflicts is still low. This suggests that these two partners are quite indifferent towards each other in terms of CVS. The same happens between O5 and O7. The pairs of organizations (O1, O2), (O1, O6), (O2, O6) have a high level of shared core values, which means that the CVS of O1, O2 and O6 are quite similar. The organizations O4 and O5 have also a high level of shared core values, but their level of potential for conflict is moderate. This means that in spite of the similarity between the two CVSs, they have core values that are incompatible.

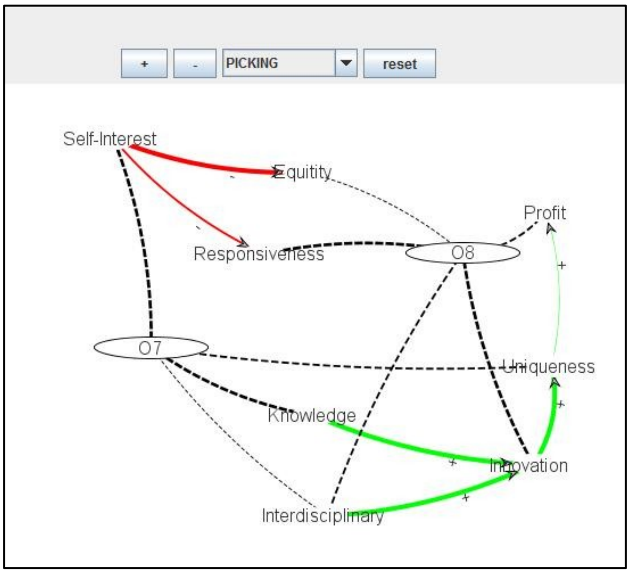


Figure 6.20. Partial aggregate core values map for O7 and O8

The results from the CVS assessment for the Book Publishing group network are presented in Table 6.11.

Table 6.11. CVSs alignment assessment results for Book Publishing group

Network Level			**Members level**		
Member	Positive impact	Shared core values	Members	Potential for conflicts level	Shared core values level
O1	HIGH	HIGH	O1,O2	*NOT_DETECTED*	HIGH
O2	HIGH	HIGH	O1,O6	*NOT_DETECTED*	HIGH
O6	MODERATE	MODERATE	O1,O7	MODERATE	MODERATE
O7	MODERATE	LOW	O1,O8	*NOT_DETECTED*	MODERATE
O8	HIGH	*NOT_DETECTED*	O1,O9	LOW	MODERATE
O9	HIGH	*NOT_DETECTED*	O1,O10	*NOT_DETECTED*	MODERATE
O10	HIGH	LOW	O2,O6	*NOT_DETECTED*	HIGH
			O2,O7	MODERATE	LOW
			O2,O8	LOW	LOW
			O2,O9	*MODERATE*	LOW
			O2,O10	LOW	MODERATE
			O6,O7	HIGH	MODERATE
			O6,O8	*NOT_DETECTED*	MODERATE
			O6,O9	*NOT_DETECTED*	MODERATE
			O6,O10	*NOT_DETECTED*	MODERATE
			O7,O8	HIGH	LOW
			O7,O9	MODERATE	LOW
			O7,O10	MODERATE	LOW
			O8,O9	*NOT_DETECTED*	MODERATE
			O8,O10	*NOT_DETECTED*	HIGH
			O9,O10	LOW	MODERATE

By looking at the findings, it can be noticed that all members have quite a significant *positive impact* on the Book Publishing group. However, as O7 does not share any core value with the network's CVS and the positive impact is just moderate, we can conclude that there is a misalignment between the CVS of the Book Publishing group and O7's CVS. On other hand,

O1 and O2 have a high level alignment with the Book Publishing group, since they have a high positive impact level and a high shared core value level.

The use of a complete aggregated map supports a deeper alignment analysis, for instance from the observation of the complete aggregated map for O2 shown in Figure 6.21, it can be noticed that:

- Since, *Innovation* and *Knowledge* are both core values of the O2's CVS that direct or indirectly positively influence the Book Publishing group's CVS, then there is a positive impact of O2's CVS on the Book Publishing group's CVS.
- There are no direct negative influences of core values that belong to O2's CVS on core values belonging to the *Book Publishing* group's CVS.

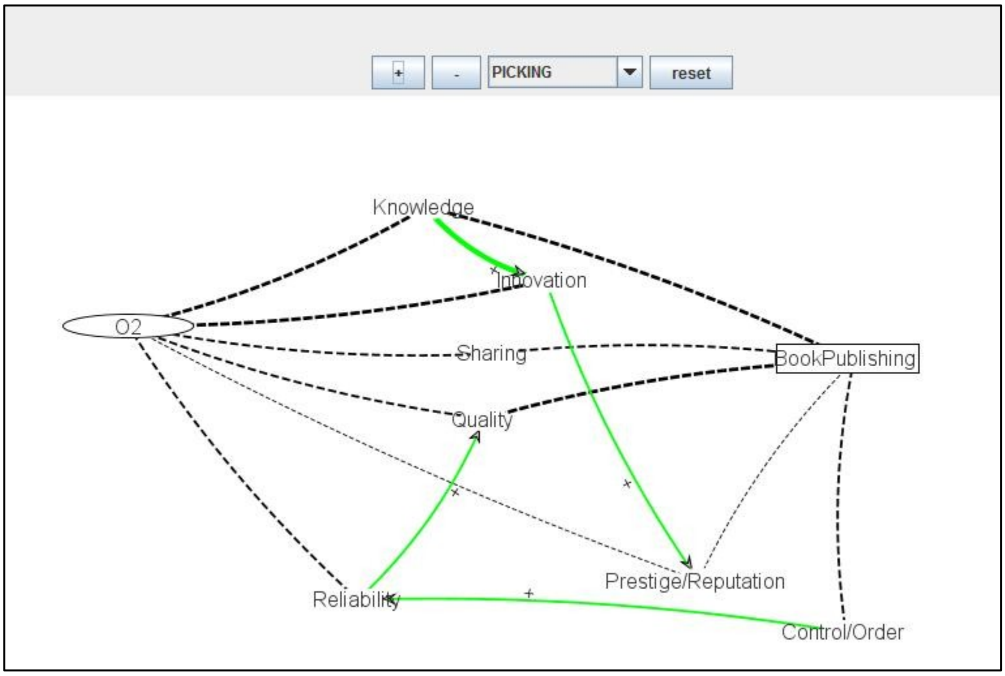


Figure 6.21. Complete aggregated map for Organization *O2* in Book Publishing group

Analyzing the findings for member level alignment evaluation, we can see that there are several pairs of members for which no potential for conflict was detected, which suggests that in general the group should work well together. As in the case of the VOCF group, also in this case it is the O7 member that represents more risk in terms of conflict to this group, since the level of potential for conflict with O6 and O8 is high, and moderate with the others members. Furthermore, O7 is also the organization that in global terms has the lowest level of shared core values with its partners.

Comparing the assessment findings in the two groups the following aspects were noticed:

- O7 is a member that belongs to both groups, and in both cases, it presents a profile of conflict and misalignment with the group itself and its partners.
- It is expected that the Book Publishing group should work better, since its members present a lower level of potential for conflict.

- In general the findings in the two cases are quite similar. This is due to the fact that both groups were formed within a scientific project, so the core values and priorities selected by the partners are quite similar as well as the Core Value Systems defined by each working group.

Comparing the alignment evaluation results with the feedback obtained from ECOLEAD managers, we can conclude that the indications provided by the proposed assessment model are in accordance with the opinion of the participants in this collaborative process. The ECOLEAD project managers are of the opinion that O7 was the most incompatible participant in these tasks, negatively contributing to the collaborative process. From the results presented above, we may observe that O7 is the organization that has the lowest alignment level with the group and presents a high potential for conflict with several members. Furthermore, the findings for O3 and O2, suggest that O3 and O2 also present some risks to the network in terms of potential for conflicts, but the project managers did not detect any kind of problem with the behavior of O3 or O2. ECOLEAD managers transmitted the idea that in general the Book Publishing group worked better, with less conflicts than the VOCF group. This perception is also in accordance with the results obtained through our analysis process.

The small discrepancies between the findings from the CVSs alignment evaluation and the opinion of the project managers may have diverse causes, such as:

- The specification of the CVS for each member derives from data provided by the leaders of each group. Therefore, the resulting CVS reflects the CVS observed by the other participants, and not exactly the actual partner's CVS. If a more structured method (like the ones suggested in (Barrett, 2006), (Collins and Porras, 1996) or (Rekom et al., 2006)) is used to identify the core values and preferences of each organization, a more accurate CVS could probably be obtained, and consequently, more precise outputs from the alignment assessment could be expected.
- The *core values influence map* is of decisive importance in the results obtained, since the assessment of the positive impact level and the potential for conflict level is based on the specified set of relations of influence between core values. Therefore more work needs to be done in order to increase the correctness of the proposed map.
- Supposing that collaboration is based on the development of a project, the role of individuals is significantly important, overriding the importance of the organization's role. Therefore, in these cases the degree of success and sustainability of the collaboration essentially depends on the attitudes and behaviors of the individuals that work directly in the project. Therefore, the modeled CVS should represent the CVS of the individuals and not the institutional CVS of each organization, since in less formal collaboration types, the CVS of each organization does not reflect the behavior of its members.

6.3.7 A Survey to Evaluate the Performance of the V-AligN Framework (VdE-7)

In order to understand the performance of the V-AligN framework with regard to its usability and expressiveness, a case study in the domain of value systems was selected and the following three distinct approaches were used in modeling.

(i) Textual description using tables (similar to that shown in Table 6.9)

(ii) Mathematical notation (similar that proposed in Example 3.1).

(iii) V-AligN framework (graphs and causal maps).

Survey to evaluate the performance in terms of usability of the modeling approach proposed in the CVS analysis framework

Q	Ordering the 3 modeling approaches according to:	Textual	Formal	V-AligN Framework
1	Ease of building the Value System Models. *(1 to 3, 1 for the easier)*			
2	Ease of understanding the Value System Model. *(1 to 3, 1 for the easier approach)*			
3	Efficiency to highlight the core-values with high priority and the shared values. *(1 to 3, 1 for the more efficient)*			
4	Efficiency in identify the impacts between Value Systems. *(1 to 3, 1 for the more efficient)*			

Figure 6.22. Survey to assess usability of the V-AligN framework models

The selected case is the illustrative Example 4.1A described in Section 4.2.4. The models generated using each of the approaches defined above can be consulted in Annex B. A survey was elaborated to comparatively evaluate the performance of the three approaches. Ten researchers from the Collaborative Networks field took part in the survey. Each participant filled out a questionnaire (see Figure 6.22). The findings are presented in the diagram (bar chart) of Figure 6.23.

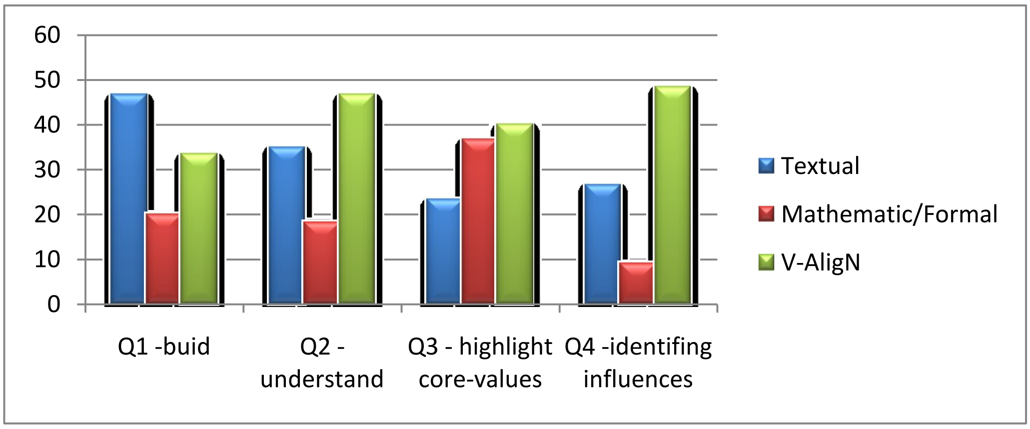


Figure 6.23. Results from survey

Looking at the chart we can clearly see that the model built using the V-Align framework is the one that is considered the easiest to understand, and that best expresses the notion of core

values and influences among core values. The use of a textual notation was considered to be the easiest as regards representing the models. However, we think that this result arises from the inexperience of some users in graph theory and Causal maps. Afterwards, the same potential users used the CVS analysis tool in order to support them in the CVS modeling process. All potential users were able to build the CVS model directly from their textual description, and automatically generate the corresponding maps of the V-AligN framework.

6.4. Findings on the Research Questions and Hypotheses

The elements presented in the previous section belong to the validation process introduced in Section 6.2. These elements, together with those introduced in Chapters 3 and 4, provide a basis to discuss the findings on each research question.

Research Question 1: What would be an adequate conceptual model to specify and analyze Value Systems in collaborative network contexts?

The proposed VS conceptual model (see Chapter 3) allows a Value System in collaborative environments to be specified. The proposed conceptual model has practical and theoretical relevance. According to the proposed validation strategy (see Figure 6.4) the following elements enable us to draw conclusions about the relevance of the proposed solution:

- (P1.1) It was shown that the models created using the conceptual model are adequate in terms of precision, granularity, fitness, and formality (see Section 6.3.4).
- (P 1.2) It was illustrated how sociological models and economic models (see Section 6.3.2 and 6.3.4) can be represented using the proposed VS conceptual model. These examples indicate that the proposed VS conceptual model allows sociological and economic aspects of Value Systems to be represented in an integrated way.
- (P 1.3) Through diverse publications (VdE-1) it was confirmed that this solution was accepted by peers.
- (P 1.4) Through the modeling of illustrative cases (VdE-10) in the context of CNs, it was shown that in practice it is possible to specify VS for CNs using this approach.
- (P 1.5) The design and development of a software prototype (VdE-11), and more specifically the design and implementation of the data layer of the application allow us to confirm that the theoretical conceptual model can be translated to a data model, and also that the model can be implemented in a computer program.

For this first research question the following hypothesis was formulated:

Hypothesis 1: The specification and analysis of Value Systems in collaborative networks, considering the economic and the sociological approaches, can be done in an integrated way if the concepts of values, priorities, and evaluation mechanisms are formally specified in a single model.

Starting from a set of examples (VdE-2 and VdE-3), it was illustrated how the concepts of value, evaluation, core values, priorities developed in Sociology and Economics are covered by the proposed VS conceptual model (T1.2 and T1.3). Moreover, it was shown in Section 6.3.5 (VdE-4) that the selected mathematical formalism allows the specification of adequate VS models in terms of precision, granularity, prescriptiveness and fitness (T1.1).

Research Question 2: What would be an adequate conceptual modeling framework to support the analysis of the interactions between Value Systems?

The proposed V-AligN framework (see Chapter 3) enables Value Systems in collaborative environments to be analyzed. The proposed framework has practical and theoretical relevance. According to the proposed validation strategy (see Figure 6.4) the following evidence allows us to draw conclusions about the relevance of the proposed solution:

- (P 2.1) The internal consistency has been shown in two steps: (i) It has been shown that the analysis framework is in agreement with the set of characteristics previously stated, and it is adequate in terms of granularity, precision, fitness, prescriptiveness and formality (VdE-5).
- (P 2.2) It has been shown that the V-AligN framework serves as base to develop indicators for CVSs alignment evaluation, through the set of indicators proposed in Chapter 4.
- (P 2.3) Through diverse publications (VdE-1) it was shown that this solution was accepted by peers.
- (P 2.4) Through the modeling of illustrative cases (VeD-11) in the context of CNs it was shown that in practice it is possible to represent Core Value Systems in the CN context in order to reason about the alignment level between Core Value Systems. The ECOLEAD case study (VE-6) shows how this framework can be used in practice to analyze Value Systems in an integrated way.
- (P 2.5) The design and development of a software prototype (VeD-12), and more specifically the design and implementation of the "CVS analysis maps" showed that the proposed solution can be implemented by a computer program.

For this research question the following two hypotheses were formulated:

Hypothesis 2 a): The potential impacts between Value Systems in collaborative environments can be inferred, if the typical influences among core values are known and the preferences of the actors, regarding those values, are identified.

Hypothesis 2 b): The perception about the interactions among Value Systems in collaborative environments can be (are) improved, if the relations among core values, organizations, and networks can be represented using a graphical notation.

The ECOLEAD case study (VdE-6) has shown that if the influence among values is known and the preferences of the actors is known, then the potential impacts (positive and negative) between CVSs can be inferred (T2.1). Furthermore, from the survey to evaluate the performance of the V-AligN framework in terms of usability (VE-7), it may be concluded that the use of a graphical notation to represent the influence among core values and the actors' preferences improves the user perception about the interactions among CVSs (T2.2).

Research Question 3: Which methods would be adequate to assess Value Systems alignment in collaborative networks contexts?

In order to access the CVSs alignment in collaborative networks contexts, a set of methods based on qualitative inference have been proposed. According to the proposed validation strategy (see Figure 6.4) the following evidences lead to a conclusion about the relevance of the proposed solution.

- (P 3.1) The proposed methods are considered structurally consistent in the way they apply accepted rules and methods developed in qualitative inference and graph theory. Namely, the quantitative methods are constructed based on the matrix representation explored in graph theory; and qualitative methods based on the causal reasoning theory. The examples presented in Chapter 4, Section 4.31 and 4.3.2 show that the proposed methods work consistently in diverse situations.
- (P 3.2) The literature review presented in Chapter 2 Section 2.5.2 shows that none of the known approaches suggest a multi perspective assessment that integrates the notion of impact between CVSs. Therefore, we can argue that the proposed method contributes with a new approach to CVS assessment theory.
- (P 3.3) Through diverse publications (VdE-1) it was shown that this solution was accepted by peers.
- (P 3.4) The ECOLEAD example case (VdE-6) shows how, in practice, the methods can be applied to CVS assessment.

- (P 3.5) From the literature review we conclude that no software tool has been developed to support the CVSs alignment analysis in a collaborative context (see Chapter 2 Section 2.2.6), thus the proposed set of methods to assess and analyze Value Systems alignment explicitly contributes towards the implementation of this type of assessment in collaborative contexts.
- (P 3.6) The design and development of a software prototype (VeD-12), and more specifically the design and implementation of the qualitative CVSs alignment assessment methods, show that the proposed solution can be implemented by a computer program.

For this research question the following hypothesis was formulated:

Hypothesis 3: The identification and assessment of Value Systems (mis)alignments in the context of collaborative networks will be improved (more complete and easier) if assessment methods are designed to properly capture and integrate multiple perspectives about the Value Systems alignment concept.

The CVSs alignment assessment performed within the scope of the ECOLEAD case study (VdE6) allows us to argue that it is possible to identify CVS misalignment in a more precise and informed way if the assessment includes not only the shared value identification (traditional approach), but also the interactions among values. Moreover, this case study suggests that the implementation of a purely qualitative assessment is feasible, and can provide useful information for the decision maker.

The presented argumentation supported by the Validation Square Framework showed the validity of the hypotheses formulated for this research work, which led us to conclude that the proposed model and methods are plausible to be applied within the scope of CN management and contribute to solve the main problem addressed by this work: ***There is a lack of formal models and mechanisms to analyze Value Systems within the scope of collaborative networks.***

7

Conclusions and Future Work

This chapter summarizes the main findings and results obtained. First a summary of the work undertaken is made, followed by corresponding findings and contributions. Finally, a number of open issues established for future work are discussed.

7.1. Summary of the Work

This research work aimed to develop mechanisms to model and analyze Value Systems in the context of collaborative networks, in order to be able to identify misalignments among partners' values, assess the fit among Value Systems, and evaluate the impact of each partner in the network (in terms of values).

This overall objective was refined through three more specific research questions:

- What would be an adequate conceptual model to specify and analyze Value Systems in collaborative networks contexts?
- What would be an adequate conceptual modeling framework to support the analysis of the interaction between Value Systems?
- Which methods would be adequate to assess Value Systems alignment in collaborative networks contexts?

The constructive research method was the selected method to guide this research process. Starting from a body of knowledge that included work developed in the areas of: (i) collaborative networks, value systems and value networks, (ii) graph theory and social networks analysis, (iii) causal maps, and qualitative reasoning; a set of new models, methods and tools were proposed in order to solve the main research problem, as well as to attempt to find a solution to the research questions.

A conceptual value system model was thus proposed, which aimed to cater for the economic and sociologic views of Value Systems in an integrated way, and specify the main elements that should comprise a Value System and the relations among them. Given that core values are used as the basis for the decision-making processes and are the elements that motivate and regulate an organization's behavior, the introduction of the notion of core value

is essential to characterize the organization and networks. To encompass the notion of core value, a restricted view of the generic Value System was proposed: the Core Value System.

Graph theory and causal maps were applied in order to model the relations among core values, organizations, and collaborative networks, and a conceptual framework was proposed in order to systematize Core Value System modeling in the context of collaborative networks. This framework was called V-AligN framework and provides a visual/graphical representation and was the basis for the development of methods to assess the alignment between Value Systems. Considering this analysis framework, a method to analyze Core Value Systems and a set of indicators to assess the alignment level between CVSs in collaborative contexts are proposed. A qualitative and quantitative approach for Core Value System representation and assessment has been explored.

A software system was designed to support, in an integrated way, the management and analysis of a Core Value System for CNs, by implementing the models and the proposed methods. Within the scope of the software development method, the requirements analysis and specification was presented, as well as the system design specification. A prototype was developed in order to verify the usability of the proposed software tool in an inter-organizational context, and to gauge to what extent the developed models and mechanism can be implemented by a computer program.

In order to validate the solution achieved, in accordance with the research method adopted, two points had to be demonstrated: (i) That the set of models and methods proposed solve the domain problem and/or create knowledge about how the problem can be solved; (ii) How the proposed models and methods are new or better than previous ones. To demonstrate these two issues a validation strategy based on the Validation Square Framework (Pedersen et al., 2000) was selected. This strategy included carrying out a number of experiments in order to illustrate the employment of the proposed conceptual models and methods in the analysis and assessment of Value Systems in specific situations. With the purpose of illustrating how the distinct methods and tools can be integrated in order to solve the main problem addressed by this research, a case study inside the ECOLEAD project was developed.

7.2. Concluding the Research Hypotheses

The findings on the research questions and hypotheses were discussed in detail in the previous chapter. As explained there, the validation of the work presented several challenges, since this work has a multidisciplinary character and the object of study was a socio-technical system. However, the implementation of a multi-faceted and systematic strategy of validation brought together a set of preliminary results that support the following theses.

Thesis 1

> The specification and analysis of Value Systems in collaborative networks, considering the economic and the sociological approaches, can be done in an integrated way, when the concepts of values, priorities and evaluation mechanism are formally specified in a single model.

The Value System conceptual model proposes a formal way to specify the concepts of values, evaluation mechanism and priorities in a single model, allowing economic and sociologic aspects of Value Systems and of Valuation Process to be represented, as shown through the diverse modeling examples presented.

Thesis 2

> The potential impacts between Value Systems in collaborative environments can be inferred, when the typical influences among core values are known and the preferences of the actors, regarding those values, are identified. Furthermore, the perception about the interactions among Value Systems in collaborative environments is improved when the relations among core values, organizations and networks are represented using a graphical notation.

Several experiments were carried out within the scope of collaborative networks in order to illustrate how the use of the conceptual analysis framework (V-AligN) supports the inference of the interaction among Value Systems. These cases showed how it is possible to identify not only the shared core values but also the positive and negative impacts between value sets. The survey carried out with potential users in order to verify the usability of the proposed framework leads us to believe that the perception about the interaction among Value Systems within the scope of collaborative networks is enhanced, compared to the use of non-graphical approaches.

Thesis 3

> The identification and assessment of Value Systems (mis)alignments in the context of collaborative networks is improved when assessment methods are designed to properly capture and integrate multiple perspectives about the concept of Value Systems alignment.

The findings in the ECOLEAD case study suggest that in fact, the alignment assessment should consider a multi-criteria approach. Moreover, this case study has shown that the

implementation of a purely qualitative assessment is also feasible, and it can provide useful information for the decision maker.

The validation of models and assessment methods involving socio-technical systems has been a continuous challenge for researchers, and in most cases it takes several years before we can be sure that a new model truthfully represents the real world problem or that the proposed assessment methods provide trustworthy and useful indications. Therefore, in this case, which involves human and social aspects; validation becomes a matter of establishing credibility in the proposed approach and collecting a range of positive evidences. Although, distinct evidence has been acquired, which allows us to draw conclusions about the theoretical and practical relevance of the approach suggested, more case studies involving different kinds of collaborative networks are required, in order to evaluate its coverage and to "tune" the proposed methods.

7.3. Contributions

The main contributions of this work were essentially in terms of conceptual aspects, providing a set of concepts, models, and methods to represent and analyze Value Systems within the scope of Collaborative Networks, as illustrated in Figure 7.1 and described further below.

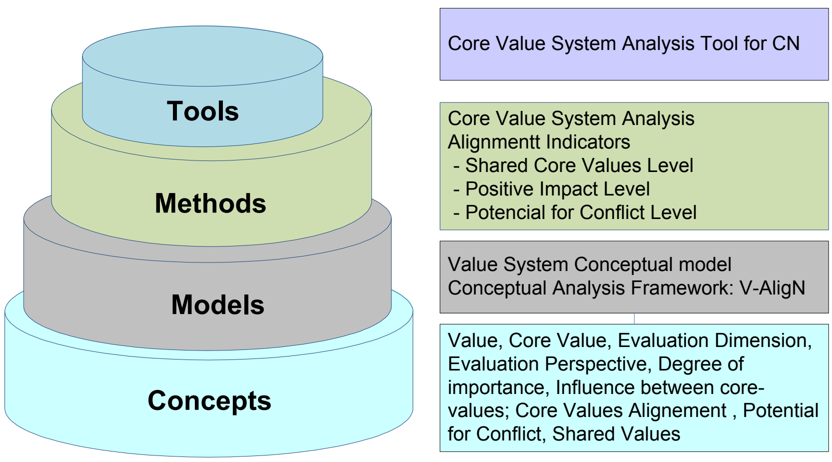


Figure 7.1. Contributions

Concepts

A set of concepts related to values and evaluation processes within the scope of Value Systems were discussed and formally defined. This attempt to give a formal description of the concepts contributed to clarify their meaning. The concepts of value alignment and Core Value Systems alignment were introduced and also formally specified.

Models

A Value System conceptual model that supports in an integrated way the economic and sociologic views of Value Systems was proposed. This conceptual model integrates the concepts of value, evaluation, and priority, also introducing the concepts of evaluation dimensions and evaluation perspectives as mechanisms of evaluation. The model is represented using First Order Logic in order to guarantee that the model's results are precise and use a universal notation, since precision and "universality" are essential characteristics, in order to promote a shared understanding about the Value System Model, among the CN's stakeholders.

A conceptual analysis framework (V-AligN) was proposed, which includes a set of maps, based on graph theory and causal maps to model the relations among core values, organizations, and collaborative networks. This framework provides a twofold representation, using visual/graphical notation, and a mathematical representation with matrices, allowing a good visual perception of the interaction between Core Value Systems. This framework supports the use of both a qualitative and a quantitative approach.

Methods

Considering the V-AligN framework, a method to analyze Core Value Systems and a set of indicators to assess the alignment level between Core Value Systems in collaborative contexts were proposed. The three main indicators proposed to assess the alignment were: (i) Shared Value Level, (ii) Positive impact level (iii) Potential for conflict level. This set of indicators aims to represent not only the common values between two entities, but also the positive and negative influences that one set of values can have on the other set. Furthermore, not only the Core Value Systems alignment assessment between the network's and its members was considered as relevant, but also the assessment of the alignment between Core Value Systems of the network members, in order to identify pairs of members where the potential for conflict is high. Another contribution was to provide not just a traditional quantitative approach to represent and assess Core Value Systems but also an attempt to provide a qualitative approach for all models and methods.

Moreover, within the scope of the methods to analyze Value Systems, the discussion of some additional specific issues, such as: using hierarchical taxonomies of values; indirect influence inference, external and internal factor representation, and using distinct evaluation perspectives, contribute to enrich the analysis.

Tool

A software system was designed to support the management and analysis of the Core Value System for CNs in an integrated way, by implementing the proposed models and the methods.

Within the scope of the software development method, the performed requirement analysis and specification are presented, as well as the system design specification. The main contribution of the developed tool is to show how the set of models and methods can be integrated and implemented into a single product in order to support Value Systems management within the scope of collaborative networks.

7.4. Future Work

This work was in its essence a "pathfinder". As such, it contributed to open more doors, raised even more questions, and may have identified many issues still to address. This could be seen as a negative aspect. However, successful research processes are likely to open up new paths and cross new boundaries, leading to the formulation of new questions.

The very first impression is that the Value System analysis is a large and complex subject with multiple areas of application and diverse aspects that need to be improved and other ones that need to be explored. Some of the issues scheduled for subsequent research are summarized below.

The representation of evaluation functions has to be explored in depth. Although some experiments concerning the aggregation of qualitative and quantitative functions have been carried out (Camarinha-Matos and Macedo, 2010), detailed work on methods to aggregate and to decompose evaluation functions need to proceed.

During the Value Systems alignment criteria definition, two types of alignment have been identified: (i) the evaluation systems alignment, and (ii) the core value alignment. However, this work only deals with the later. Therefore, it is important to develop methods and indicators to assess the alignment between two evaluation systems. This is a pertinent issue in order to construct a common evaluation system among a network's partners and/or to develop processes to improve the compatibility among evaluation systems. Another subject that should be discussed in more detail is how to guarantee that the meaning of each core value is the same for all the stakeholders, given that "it is easy to agree on words, however the difficulty is in developing a shared meaning for our words"(Sandow and Allen, 2005).

An issue which also deserves additional work is to construct an adequate *core values influence map*. A simple map was proposed in the ECOLEAD case study, which was considered as plausible for diverse researchers in the area. However, the findings in the Core Value Systems alignment assessment are dependent on the *core values influence map* adopted. Therefore, methods to construct and evaluate *core values influence maps* should be explored and validated. Data mining methods to discover core value influence relations seem to be an

adequate approach. However, a partnership with social researchers will be required in order to be able to validate findings.

In spite of the core values and priorities assessment being out of the scope of this research work, this is an issue that deserves additional attention and where the collaboration of social researches can also be useful.

The proposed Core Value Systems alignment assessment methods need to be applied to more examples of partnerships. It is desirable that these cases consist of both past and futures ones. This will help ascertain whether the model can be applied and explain what happens in these cases in terms of collaboration. If the approach is applied to a significant number of cases, a statistical validation can also be undertaken.

Concerning the software tool, there is a set of issues related with the V-AligN framework, such as: hierarchical taxonomies of values, representation of external and internal factors that influence core values, alignment assessment considering distinct evaluation perspectives, which are not yet supported. These issues need additional work, in order to ensure that these aspects can be correctly integrated into the software system presented.

It is expected that the proposed theoretical models and methods to analyze Value Systems in a collaborative context, can be explored in several processes concerning Collaborative Networks management such as for instance: partner selection, incentive policy management, and performance system management.

As a final remark, considering the research, findings and discussions carried out, the overriding belief of this research work is that it is a first step in this field, and that it can serve as a theoretical basis for further research in the area.

References

Abreu, A. & Camarinha-Matos, L. (2008) A benefit analysis model for collaborative networks. *Collaborative networks: Reference modeling*, 253-276.

Adkins, C. L., Ravlin, E. C. & Meglino, B. M. (1996) Value congruence between co-workers and its relationship to work outcomes. *Group & Organization Management,* 21:4, 439.

Afsarmanesh, H. & Camarinha-Matos, L. M. (2005) A framework for Management of Virtual Organization Breeding Environments. *Collaborative Networks and their Breeding Environments.* Springer, 35-48.

Afsarmanesh, H., Camarinha-Matos, L. M. & Ermilova, E. (2008a) Vbe Reference Framework *Methods and Tools for Collaborative Networked Organizations.* Springer, 35-68.

Afsarmanesh, H., Camarinha-Matos, L. M. & Ollus, M. (2008b) Ecolead and CNO Base Concepts. *Methods and Tools for Collaborative Networked Organizations.* Springer, 4-31.

Afsarmanesh, H., Ermilova, E., Msanjila, S. & Camarinha-Matos, L. M. (2009) Modeling and Management of Information Supporting Functional Dimension of Collaborative Networks. *Transactions on Large-scale Data-and Knowledge-centered Systems I*, 1.

Albert, S. & Whetten, D. (1985) Organizational identity. *Research in organizational behavior,* 7, 263-295.

Allee, V. (2000a) Reconfiguring the Value Network. *Journal of Business Strategy,* 21:4, 36-39.

Allee, V. (2000b) The Value Evolution. *Journal of Intellectual Capital* 1:1, 17-32.

Allee, V. (2002) A Value Network Approach for Modeling and Measuring Intangibles. *Proceedings Transparent Enterprise.* Madrid.

Allee, V. (2008) Value network analysis and value conversion of tangible and intangible assets. *Journal of Intellectual Capital,* 9:1, 5-24.

Antunes, L. & Coelho, H. (1999) Decisions based upon multiple values: the BVG agent architecture. . *EPIA'99.* Barahona, P. e Alferes, Springer-Verlag.

Antunes, L., Coelho, H. & Faria, J. (2000) Improving choice mechanisms within the bvg architecture. IN LESPRANCE, C. C. A. Y. (Ed.) *Agent Theories, Architectures, and Languages - ICMAS 2000.* Springer-Verlag. 209-304.

Arlow, J. & Neustadt, I. (2005) *UML 2.0 and the unified process*, Addison-Wesley.

Axelrod, R. (1976) *Structure of decision: The cognitive maps of political elites*, Princeton University Press Princeton, NJ.

Badovick, G. & Beatty, S. (1987) Shared organizational values: measurement and impact upon strategic marketing implementation. *Journal of the Academy of Marketing Science,* 15:1, 19-26.

Bamford, J., Ernst, D. & D.G, F. (2004) Launching a World-Class Joint Venture. *Harvard Business Review,* 82:2, 90-100.

Barrett, R. (2006) *Building a Vison-Guided, Values-Driven organization,* Burlington, Butterworth-Heinemann.

Bin, H. & Gongcheng (2005) Integrated Description and Qualitative Simulation Method for Group Behavior *Journal of Artificial Societies and Social Simulation,* 8:2.

Bititci, U., Turner, T., Mackay, D., Kearney, D., Parung, J. & Walters, D. (2007) Managing synergy in collaborative enterprises. *Production Planning & Control,* 18:6, 454-465.

Blalock Jr, H. (1963) Making causal inferences for unmeasured variables from correlations among indicators. *American Journal of Sociology,* 69:1, 53-62.

Boff, E., Santos, E. R. & Vicari, R. M. (2006) Social Agents to Improve Collaboration on an Educational Portal. *Sixth IEEE International Conference on Advanced Learning Technologies (ICALT'06).*

Bouzdine-Chameeva, T., Durrieu, F. & Mandják, T. (2003) *Understanding Relationship Value Applying a Cognitive Mapping Approach: A Customer Perspective*, Budapest University of Economics and Public Administration Department.

Bozbura, F. T. & Beskese, A. (2007) Prioritization of organizational capital measurement indicators using fuzzy AHP *International Journal of Approximate Reasoning* 44:2, 124-147.

Bratko, I. (2001) *Prolog programming for artificial intelligence*, Addison-Wesley Longman Ltd.

Buschmann, F., Henney, K. & Schmidt, D. (2007) *Pattern-oriented software architecture: On patterns and pattern languages*, John Wiley & Sons Inc.

Camarinha-Matos, L. & Afsarmanesh, H. (2006) Collaborative Networks -Value creation in a knowledge society. IN KOVAC, K. W. (Ed.) *Knowledge Enterprise: Intelligent Strategies in Product Design, Manufacturing, and Management.* Springer Boston, 26-40.
Camarinha-Matos, L. & Afsarmanesh, H. (2008a) *Collaborative Networks: Reference Modeling*, Springer-Verlag New York Inc.
Camarinha-Matos, L. & Afsarmanesh, H. (2008b) A Survey of modeling methods an tools. *Collaborative Networks: Reference Modeling.* Springer-Verlag New York Inc, 139-164.
Camarinha-Matos, L., Oliveira, A., Demsar, D., Sesana, M., Molina, A., Baldo, F. & Jarimo, T. (2008) Vo Creation Assistance Services. *Methods and Tools for Collaborative Networked Organizations*, 155-190.
Camarinha-Matos, L., Silveri, I., Afsarmanesh, H. & Oliveira, A. (2005) Towards a framework for creation of dynamic virtual organizations. *Collaborative networks and their breeding environments*, 69-80.
Camarinha-Matos, L. M. & Abreu, A. (2005) A contribution to understand collaboration benefits. *Emerging Solutions for Future Manufacturing Systems,* 159.
Camarinha-Matos, L. M. & Afsarmanesh, H. (1998) Virtual Enterprises: Life cycle supporting tools and technologies. *Handb. of life cycle engineering: concepts, tools, and technologies*.
Camarinha-Matos, L. M. & Afsarmanesh, H. (1999) The Virtual Enterprise Concept. *Infrastructures for Virtual Enterprises: Networking Industrial Enterprises.* Porto, Kluwer,
Camarinha-Matos, L. M. & Afsarmanesh, H. (2003) Elements of a base VE infrastructure. *J. Computers in Industry,* 51:2, 139-163.
Camarinha-Matos, L. M. & Afsarmanesh , H. (2004) *Collaborative Networked Organizations - A research agenda for emerging business models.*, Kluwer Academic Publishers.
Camarinha-Matos, L. M. & Afsarmanesh, H. (2005a) Collaborative Networks: A new scientific discipline. *J. Intelligent Manufactoring,* 16:4-5, 439-452.
Camarinha-Matos, L. M. & Afsarmanesh, H. (2005b) ECOLEAD: A holistic approach to creation and management of dynamic virtual organizations. *Collaborative Networks and their Breeding Environments.* Valencia, Springer, 3-16.
Camarinha-Matos, L. M., Afsarmanesh, H. & Ollus, M. (2006) Network-centric collaboration and Supporting Frameworks.
Camarinha-Matos, L. M. & Macedo, P. (2010) A conceptual model of value systems in collaborative networks. *Journal of Intelligent Manufacturing,* 21:3, 287-299.
Cameron, K. S. & Quinn, R. E. (1999) *Diagnosing and Changing Organizational Culture-Based on the Competing Values Framework*, Addison-Wesley.
Carlton, D. W. & Perloff, J. M. (2000) *Modern Industrial Organization*, Addison Wesley Longman.
Cercone, N. & McCalla, G. (1987) *The knowledge frontier: essays in the representation of knowledge*, Springer.
Chaib-draa, B. (2002) Causal Maps: Theory, Implementation, and Practical Applications in Multiagent Environments. *IEEE Transactions on Knowledge and Data Engineering,* 14:6, 1-17.
Chao, G. T. & Moon, H. (2005) The cultural mosaic: A metatheory for understanding the complexity of culture. *Journal of Applied Psychology,* 90:6, 1128.
Cheah, C. & Ting, S. (2005) Appraisal of value engineering in construction in Southeast Asia. *International Journal of Project Management,* 23:2, 151-158.
Chituc, C. M. & Nof, S. Y. (2007) The Join/Leave/Remain (JLR) decision in collaborative networked organizations. *Computers & Industrial Engineering,* 53:1, 173-195.
Colins, C. & Chippendale, P. (1995) New wisdom II: Values-based development. Acorn Publications, Brisbane.
Collins, J. & Porras, J. (1996) Building your Company's Vision. *Havard Business Review,* 74:5, 62-70.
Collins, J. & Porras, J. (1998) Organizational vision and visionary organizations Collins. *California Management Review,* 34, 30-52.
Conallen, J. (2003) *Building Web applications with UML*, Addison-Wesley Professional.
Cooley, C. R. (1977) Cultural Effects in Indian Education:An Application of Social Learning Theory. *Journal of American Indian Education,* 17:1.
Curtis, B., Kellner, M. & Over, J. (1992) Process Modeling. *Communication of the ACM,* 33:9.
De Clercq, S., Fontaine, J. R. J. & Anseel, F. (2008) In Search of a Comprehensive Value Model for Assessing Supplementary Person: Organization Fit. *The Journal of Psychology: Interdisciplinary and Applied,* 142:3, 277-302.
Dimuro, G. P., Costa, A. C. & Palazzo, L. A. M. (2005) Systems of exchange values as tools for multi-agent organizations. *Journal of the Brazilian Computer Society,* 11, 31-50.

Dingwei, W., Yung, K. & Ip, W. (2002) Partner selection model and soft computing approach for dynamic alliance of enterprises. *Science in China,* 45:1**,** 68-80.
Dolan, S. L. & Garcia, S. (2002) Managing by values: Cultural redesign for strategic organizational change at the dawn of the twenty-first century. *Journal of Management Development,* 21:2**,** 101-117.
Eden, C. (1992a) The Analysis of Cause Maps. *Journal of Managemnet Studies,* 29:3**,** 309-324.
Eden, C. (1992b) On the Nature of Cognitive Maps. *Journal of Managemnet Studies,* 29:3**,** 261-265.
Egri, C. & Herman, S. (2000) Leadership in the North American environmental sector: Values, leadership styles, and contexts of environmental leaders and their organizations. *Academy of Management Journal***,** 571-604.
Ennis, S. (1999) Growth and the small firm: using causal mapping to assess the decision-making process- a case study. *Qualitative Market Research: An International Journal,* 2:2**,** 147-160.
Enz, C. A. (1986) *Power and shared values in corporate culture*, UMI Research.
Ermilova, E. & Afsarmanesh, H. (2007) Modeling and Management of Profiles and Competencies in VBEs. *Journal of Intelligence Manufacturing,* 18:5**,** 561-586.
Ermilova, E. & Afsarmanesh, H. (2008) Competency Modeling Targeted on Promotion of Organizations Towards VO Involvement. *Pervasive Collaborartive Networks.* Springer Boston, 3-14.
Ferrell, O. & Gresham, L. (1985) A contingency framework for understanding ethical decision making in marketing. *The Journal of Marketing,* 49:3**,** 87-96.
Filipe, J. (2003) The organizational semeiotics normative paradigm *Collaborative Networked Organizations.* London, Springer, 261-272.
Filipe, J. & Liu, K. (2000) The EDA Model: An Organizational Semiotics Perspective To Norm-Based Agent Design. *Agents'2000 Workshop on Norms and Institutions in Multi-Agent Systems.* Barcelona, Spain.
Findlay-Brooks, R., Visser, W. & Wright, T. (2007) Cross-Sector Partnership as an Approach to Inclusive Development. *University Cambridge Programme for Industry Research Paper Series,* 4, retrieve from: http://www.cpi.cam.ac.uk/cms/pdf/RP4%20Partnerships.pdf, on 29-11-2009.
Flores, M. (2006) Towards a taxonomy for networking models for innovation. *Network-Centric Collaboration and Suporting Frameworks.* Boston Springer, 55-66.
Flores, M., Al-Ashaab, A. & Magyar, A. (2009) A Balanced Scorecard for Open Innovation: Measuring the Impact of Industry-University Collaboration. *Leveraging Knowledge for Innovation in Collaborative Networks***,** 23-32.
Forubus, K. & Gentner, D. (1997) Qualitative mental models: Simulations or memories? *Eleventh International Workshop on Qualitative Reasoning.* Cortona, Italy.
Freeman, L., White, D. & Romney, A. (1992) *Research methods in social network analysis,* New Jersey Transaction Publishers.
Fujii, S., Kaihara, T. & Morita, H. (2000) A distributed virtual factory in agile manufacturing environment. *International Journal of Production Research,* 38:17**,** 4113-4128.
Galliers, R. D. & Land, F. F. (1987) Choosing appropriate information systems research methodologies. *Communications of the ACM,* 30:11**,** 901-902.
Glover, S., Bumpus, M., Logan, J. & Ciesla, J. (1997) Re-examining the influence of individual values on ethical decision making. *Journal of Business Ethics,* 16:12**,** 1319-1329.
Goguen, J. (1992) The dry and the wet. *IFIP TC8/WG8.1 Working Conference on Information System Concepts: Improving the Understanding.* Alexandria, Egipto. 1-17.
Goguen, J. (1994) Requirements Engineering as the Reconciliation of Technical and Social Issues. *Requirements engineering: social and technical issues.* 162-199.
Goguen, J. (1997) Towards a Social, Ethical Theory of Information. IN GEOREY BOWKER, LES GASSER, LEIGHSTAR & TURNER, W. (Eds.) *In Social Science Research, Technical Systems and Cooperative Work: Beyond the Great Divide.* Erlbaum, 27-56.
Goguen, J. (2003) Semiotics, compassion and value-centered design. *Keynote lecture, in Proceedings of the Organizational Semiotics Workshop, University of Reading.* UK.
Gordijn, J., J.M. Akkermans & Vliet, J. C. v. (2000) Value based requirements creation for electronic commerce applications. *33rd Hawaii International Conference on System Sciences.* Hawai. 6025-6035.
Greenland, S. & Brumback, B. (2002) An overview of relations among causal modeling methods. *International Journal of Epidemiology,* 31:5**,** 1030-1037.
Hall, B. (1995) *Values Shift: A Guide to Personal and Organizational Transformation,* Rockport, MA, Twin Lights Publishers.
Harshman, E. & Harshman, C. (1999) Communicating with employees: Building on an ethical foundation. *Journal of Business Etichs,* 19:1**,** 3-19.

Hartman, R. S. (1967) *The Structure of Values: Foundations of Scientific Axiology,* Carbondale, Illinois, Southern Illinois University Press.
Hebel, M. (1998) Value Systems-A way to Greater Understanding. *Systemic Practice and Action Research,* 11:4**,** 381-402.
Higgins, E. T. (2004) Regulatory Fit: An Experience that Creates Value. *Journal of Cultural and Evolutionary Psychology ,Akadémiai Kiadó* 2:1 -2 9-22.
Hodgkinson, G., Bown, N., Maule, A., Glaister, K. & Pearman, A. (1999) Breaking the frame: An analysis of strategic cognition and decision making under uncertainty. *Strategic Management Journal,* 20:10**,** 977-985.
Hoffmann, W. H. & Schlosser, R. (2001) Success Factors of Strategic Alliances in Small and Medium-sized Enterprises--An Empirical Survey. *Long Range Planning,* 34:3**,** 357-381.
Homans, G. C. (1958) Social Behavior as Exchange. *American Journal of Sociology,* 63**,** 597-606.
Hoolbrook, M. (1999) *Consumer value: A framework for analisis and research,* New York, Routledge.
Huang, C.-Y. & Wu, Y.-W. (2003) Decision model for partnership development in virtual enterprises. *International Journal of Production Research,* 41:9**,** 1855 - 1872.
Hultman, K. & Gellermann, W. (2002) *Balancing individual and organizational values: Walking the tightrope to success*, Jossey-Bass/Pfeiffer, San Francisco.
Jarimo, T. & Pulkkinen, U. (2005) A multi-criteria mathematical programming model for agile virtual organization creation. *Collaborative networks and their breeding environments***,** 127-134.
Jarimo, T. & Salo, A. (2008) Multicriteria partner selection in virtual organizations with transportation costs and other network interdependencies. *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews* 39:1**,** 124-129.
Jariri, F. & Zegordi, S. (2008) Quality Function Deployment, Value Engineering and Target Costing, an Integrated Framework in Design Cost Management: A Mathematical Programming Approach. *Scientia Iranica,* 15:3**,** 405–411.
JDBC (Java Data Base Connectivity), Sun Microsystems [Computer Program].
Jehn, K. A., Chadwick, C. & Thatcher, S. M. B. (1993) To agree or not to agree: The effects of value congruence, individual demographic dissimilarity, and conflict on workgroup outcomes. *International Journal of Conflict Management,* 8:4**,** 287-305.
Jenkins, M. (1998) The theory and practice of comparing causal maps. *Managerial and organizational cognition-Theory, methods, and research.*, Colin Eden,J.-C. Spender, 231-249.
Jensen, F. V. (1996) Bayesian Networks basics. *AISB Quarterly,* 94**,** 9-22.
Kartseva, V., Gordijn, J., Akkermans, H. & (2004) A Design Perspective on Networked Business Models: A Study of Distributed Generation in the Power Industry Sector. *12th European Conference on Information Systems.*
Kartseva, V., Gordijn, J. & Tan, Y. (2006) Inter-organisational controls as value objects in network organisations. *Lecture Notes in Computer Science,* 4001**,** 336.
Kasanen, E., Lukka, K. & Siitonen, A. (1993) The Constructive Approach in Management Accounting Research. *Journal of Management Accounting Research,* 5**,** 245-266.
Katzy, B. (1999) The Value System designer- an infrastructure for building the virtual enterprise. *IFIP TC5 WG5.3 / PRODNET Working Conference on Infrastructures for Virtual Enterprises: Networking Industrial Enterprises* Porto, Portugal.
Keeney, R. (1994) Creativity in decision making with value-focused thinking. *Sloan Management Review,* 35**,** 33-33.
Kehoe, S. M. & Ponting, J. R. (2003) Value importance and value congruence as determinants of trust in health policy actors. *Social Science & Medicine,* 57:6**,** 1065-1075.
Kelly, M. J., Schaan, J.-L. & Joncas, H. (2002) Managing alliance relationships: key challenges in the early stages of collaboration. *R&D Management,* 32:1**,** 11-22.
Kosko, B. (1986) Fuzzy cognitive maps. *International Journal of Man-Machine Studies,* 24:1**,** 65-75.
Krishnan, V. R. (2005) Leader-Member Exchange, Transformational Leadership, and Value System. *EJBO Electronic Journal of Business Ethics and Organization Studies,* 10:1**,** 14-21.
Lang, K. R. (2000) Simulation of Qualitative Models to Support Business Scenario Analysis. *18th International Conference of the System Dynamics Society.* Bergen, Norway.
Laukkanen, M. (1998) Conducting causal mapping research: opportunities and challenges. *Managerial and organizational cognition: Theory, methods and research***,** 168-191.
Liu, F. & Ding, Y. (2008) Social network-based trust computing in P2P environments. *7th World Congress Intelligent Control and Automation, WCICA 2008.* . Chongging, IEEE. 2130-2135.
Liu, P.-Y. & Hsieh, Y.-C. (2005) A study based on the Value System for the interaction of the multi-tiered supply chain under the trend of e-business. *The 7th international conference on Electronic Commerce.* Xian, China 385-392.

Luna-Reyes, L. F. & Andersen, D. L. (2003) Collecting and analyzing qualitative data for system dynamics: methods and models. *System Dynamics Review,* 19:4**,** 271-296.

Macdonald, K. H. (1994) Misalignment as an Impediment to Progress in Organisational Development. *Information Management & Computer Security,* 2:4**,** 16-29.

March, S. T. & Smith, G. F. (1995) Design and natural science research on information technology. *Decision Support Systems* 15:4**,** 251-266.

Markiczy, L. & Goldberg, J. (1995) A method for eliciting and comparing causal maps. *Journal of Management,* 21:2**,** 305.

Martin, R. (2003) *Agile software development: principles, patterns, and practices*, Prentice Hall , NJ, USA.

Martins, A., Jj, P. F. & Mendonca, J. M. (2004) Quality management and certification in the virtual enterprise. *International Journal of Computer Integrated Manufacturing,* 17:3**,** 212-223.

Materu, J., Land, T., Hauck, V. & Knight, J. (2000) *Decentralised cooperation and joint action: building partnerships between local government and civil society in Africa*, European Centre for Development Policy Management.

Mattessich, P., Murray-Close, M., Monsey, B. & Foundation, A. H. W. (2001) *Collaboration: What makes it work*, Amherst H. Wilder Foundation St. Paul, Minn.

McWhinney, I. (1998) Primary care: core values Core values in a changing world. *British Medical Journal,* 316**,** 1807-1809, retrieve from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1113320/, on 03-05-2010.

Meglino, B. & Ravlin, E. (1998) Individual values in organizations: Concepts, controversies, and research. *Journal of Management,* 24:3**,** 351.

Merritt, D. (1989) *Building expert systems in Prolog*, Springer-Verlag.

Molina, A. & Flores, M. (1999) A Virtual Enterprise in Mexico: From Concepts to Practice. *Journal of Intelligent and Robotics Systems,* 26**,** 289-302.

Montibeller, G. & Belton, V. (2009) Qualitative operators for reasoning maps: Evaluating multi-criteria options with networks of reasons. *European Journal of Operational Research,* 195:3**,** 829-840.

Moore, R. E. (1966) *Interval Analysis,* Englewood Cliffs, Prentice-Hall.

Msanjila, S. & Afsarmanesh, H. (2007) Modelling trust relationships in Collaborative Networked Organisations. *International Journal of Technology Transfer and Commercialisation,* 6:1**,** 40-55.

Msanjila, S. & Afsarmanesh, H. (2008) A multi-model approach to analyze inter-organizational trust in VBEs. *Collaborative networks: Reference modeling***,** 195-214.

Mukhar, K., Zelenak, C., Weaver, J. & Crume, J. (2006) *Beginning Java EE 5: from novice to professional*, Springer.

Mun, J., Shin, M., Lee, K. & Jung, M. (2009) Manufacturing enterprise collaboration based on a goal-oriented fuzzy trust evaluation model in a virtual enterprise. *Computers & Industrial Engineering,* 56:3**,** 888-901.

Myers, M. & Tan, F. (2003) Beyond models of national culture in information systems research. *Advanced topics in global information management.* USA, IGI Publishing Hershey, PA,

Nadkarni, S. & Shenoy, P. (2001) A Bayesian network approach to making inferences in causal maps. *European Journal of Operational Research,* 128:3**,** 479-498.

Nonaka, I. (1991) The knowledge creating company. *Harvard Business Review,* 69,:6**,** 96-104.

O'Neill, H. & Sackett, P. (1994) The extended manufacturing enterprise paradigm. *Management Decision,* 32:8**,** 42-49.

O'Reilly, C. A., Chatman, J. & Caldwell, D. F. (1991) People and organizational culture: A profile comparison approach to assessing person-organization fit. *Academy of Management Journal,* 34**,** 487-516.

Oliveira, A., Camarinha-Matos, L. M. & Pouly, M. (2008) Agreement negotiation support in VO creation. *Pervasive collaborative networks, International Federation for Information Processing (IFIP),* 283**,** 107–119.

Osgood, C., Saporta, S. & Nunnally, J. (1954) Evaluation Assertive Analysis. Chicago, IL: University of Chicago Press.

Pearl, J. (2000) *Causality Models, Reasoning, and Inference.,* New York, Cambridge University Press.

Pedersen, K., Emblemsvag, J., Bailey, R., Allen, J. & Mistree, F. (2000) Validating Design Methods and Research-The Validation Square.

Pereira-Klen, A., Klen, E., Loss, L., Crispim, J. & Sousa, J. (2008) Selection of a virtual organization coordinator. *Collaborative networks: Reference modeling***,** 297-310.

Piaget, J. (1965) *Essay sur la Th´eorie des Valeurs Qualitatifs en Sociologie Statique,* Paris, Librairie Droz.

Porter, M. (1985) *Competitive Advantage.* , New York: The Free Press.
Porter, M. E. (1980) *Competitive Strategy. Techniques for Analysing Industries and Competitors,* Toronto, Free Press.
Ragin, C. C. (2000) *Fuzzy-set social science*, University of Chicago Press.
Rajsiri, V., Lorré, J., Bénaben, F. & Pingaud, H. (2008) Collaborative process definition using an ontology-based approach. *Pervasive Collaborative Networks. IFIP International Federation for Information Processing.* 205–212.
Razgaitis, R. (2003) *Valuation and pricing of technology-based intellectual property*, Wiley.
Rekom, J. v., Riel, C. B. M. v. & Wierenga, B. (2006) A Methodology for Assessing Organizational Core Values. *Journal of Management Studies,* 43:2**,** 175-201.
Rezgui, Y., Wilson, I., Olphert, W. & Damodaran, L. (2004) Socio-organizational issues. *Collaborative Networked Organizations.* Springer 187-198.
Rodrigues, M. R., Costa, R. & Bordini, R. (2003) A System of Exchange Values to Support Social Interactions in Artifical Societies. *AAMAS.* Melbourne, Australia.
Rodrigues, M. R. & Luck, M. (2005) Analysing Partner Selection Through Exchange Values. *MABS.* J.S. Sichman and L. Antunes. 24-40.
Rokeach, M. (1973a) *The Nature of Human Values,* New York, John Wiley.
Rokeach, M. (1973b) The nature of human values. *New York: Free Press.*
Romero, D., Galeano, N. & Molina, A. (2007) A Conceptual Model for Virtual Breeding Environments Value Systems. *Establishing the Foundation of Collaborative Networks.* Springer, 43-52.
Romero, D., Galeano, N. & Molina, A. (2008) A virtual breeding environment reference model and its instantiation methodology. *Virtual Enterprises and Collaborative Networks, IFIP,* 283**,** 15–24.
Romero, D., Galeano, N. & Molina, A. (2010) Virtual organisation breeding environments value system and its elements. *Journal of Intelligent Manufacturing,* 21:3**,** 267-286.
Rosas, J. & Camarinha-Matos, L. (2008) Modeling collaboration preparedness assessment. *Collaborative networks: Reference modeling***,** 227-252.
Rosas, J., Macedo, P. & Camarinha-Matos, L. (2009) An Organization's Extended (Soft) Competencies Model. *Leveraging Knowledge for Innovation in Collaborative Networks.* Springer, 245-256.
Saaty, T. (1994) How to make a decision: the analytic hierarchy process. *Interfaces,* 24:6**,** 19-43.
Salles, P. & Bredeweg, B. (2004) Qualitative Reasoning about Population and Community Ecology. *AI Magazine,* 24:4.
Sandow, D. & Allen, A. (2005) The nature of social collaboration: how work really gets done.Volume 6, Number 2/3. Retrieved May, 20, 2005, from *Reflections - The SOL e-Journal* 6, retrieve from: http://www.solonline.org/attachmentview!/490278/8869715/Reflections6-2.pdf, on October 2010.
Sarros, J. C., Judy Gray, Densten, I. L. & Cooper., B. (2005) The organizational culture profile revisited and revised: an Australian perspective. *Australian Journal of Management,* 30:1**,** 159-182.
Scavarda, A. J., Bouzdine-Chameeva, T., Goldstein, S. M., Hays, J. M. & Hill, A. V. (2006) A Methodology for Constructing Collective Causal Maps *Decision Sciences,* 37:2**,** 263-283.
Schalk, C., Burns, E. & Holmes, J. (2006) *JavaServer faces: the complete reference*, McGraw-Hill Osborne Media.
Schein, E. (1996) Three cultures of management: The key to organizational learning. *Sloan Management Review,* 38:1**,** 9-20.
Schmidt, S., Steele, R., Dillon, T. & Chang, E. (2007) Fuzzy trust evaluation and credibility development in multi-agent systems. *Applied Soft Computing,* 7:2**,** 492-505.
Schwartz, S. H. (1992) Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in experimental social psychology***,** 1-65.
Shneiderman, B. (1998) *Designing the User Interface: Strategies for Effective User Interface Interaction*, Addison Wesley Longman.
Singh, I., Stearns, B. & Johnson, M. (2002) *Designing enterprise applications with the J2EE platform*.
Stamper, R. (1996) Signs, Information, Norms and Systems. *Signs of Work, Semiosis and Information Processing in Organizations.*, In Holmqvist et al. (Eds.)Walter de Gruyter Berlin, New York.,
Stott, L. (2007) Conflicting Cultures: Lessons from a UN-Business partnership.
Strader, T. J., Lin, F. R. & Shaw, M. J. (1998) Information infrastructure for electronic virtual organization management. *Decision Support Systems,* 23:1**,** 75-94.
Sullivan, P. H. (2000) *Value Driven Intellectual Capital: How to Convert Intangible Corporate Assets into Market Value,* New York, John Wiley & Sons, Inc.
Sveiby, K. E. (1993) The intangible assets monitor. *Journal of Human Resource Costing & Accounting,* 2:1**,** 73-97.

Sveiby, K. E. (1997) *The new organizational weath: managing & measuring knowledge base-assets*, Berrets-Koehler.

Tan, Y.-H., Thoen, W. & Gordijn, J. (2004) Modeling Controls for Dynamic Value Exchange in Virtual Organizations. IN JENSEN, C., POSLAD, S. & DIMITRAKOS, T. (Eds.) *Trust Management.* Berlin, Springer Berlin, 236-250.

Tichy, N., Tushman, M. & Fombrun, C. (1979) Social network analysis for organizations. *Academy of management review*, 507-519.

UcaNET-project (2002) Understand the Consequences of the Adoption of tools and systems to support dynamic Networked and virtual organisations - "Survey on research projects".

Urze, P. (2006) Industrial networks trust bonds: A sociological perspective. *Network-Centric Collaboration and Supporting Frameworks*, 199-210.

Wasserman, S. & Faust., K. (1994) *Social Network Analysis - Methods and Applications.*, Cambridge University press.

Westkamper, E. & Tutsch, H. J. (1998) Manufacturing in Networks - Competitive Advantages for Virtual Enterprises. *Tenth International IFIP WG5.2/WG5.3 Conference on Globalization of Manufacturing in the Digital Communications Era of the 21st Century.* Deventer, The Netherlands. 749--760.

Wiendahl, H.-P. & Lutz, S. (2002) Production Networks. *CIRP Annals - Manufacturing Technology,* 51:2**,** 573-582.

Wiener, Y. (1988) Forms of value systems: A focus on organizational effectiveness and cultural change and maintenance. *The Academy of management review,* 13:4**,** 534-545.

Williams, S. (2002) Strategic planning and organizational values: links to alignment. *Human Resource Development International,* 5:2**,** 217-233.

Wondolleck, J. & Yaffee, S. (2000) *Making collaboration work: Lessons from innovation in natural resource management*, Island Pr.

Zaidat, A., Boucher, X. & Vincent, L. (2005) A framework for organization network engineering and integration. *Robotics and Computer Integrated Manufacturing,* 21:3**,** 259-271.

Zajonc, R. (1968) Cognitive theories in social psychology. *The handbook of social psychology,* 1**,** 320-411.

Zammuto, R. F. & Krakower, J. Y. (1991) *Quantitative and qualitative studies of organizational culture. Research in organizational change and development. ,* Greenwich, JAI Press.

Zhang, X., Austin, S., Glass, J. & Mills, G. (2008) Toward collective organizational values: a case study in UK construction. *Construction Management and Economics,* 26:10**,** 1009-1028.

ANNEX A
CVS Analysis Tool for CNs: System verification

Test case: Define a *core-value*

The following table presents the test case for the definition of a core-value. This test includes the definition of the core-value name and its description. The test also includes the definition of the influence relations between the new core-value and the existing ones. Figure A1, Figure A2 and Figure A3 show screenshots obtained during the execution of the following test case.

Table A1 – Test Case: Define Core-value

Test Case: Define Core-value	**Id:** 1	
Preconditions	**Steps**	**Expected Results**
• The user is logged on the application with the expert user profile. • Some core-values already exist in the knowledge base, namely the *Employee Satisfaction* core-value	1. **Add *Core-value*** In the Name field type: Social Awareness *1.1.* In the Description field type: *the quality of being aware of the social issues inside the organization and in society*. 1.2. Click on the Add button. 1.3. Select the core-value: *Social Awareness*. 1.1. **Add influence relations** Select the influence relations link 1.2. In the influence relations page select the *Social Awareness* core-value. 1.3. Check that this core-value has not influenced any core-value yet. 1.4. Click on the Create Relation button 1.5. Select the core-value - *Employee Satisfaction* from the combox, select as intensity (*high*) and the radio button *Positive*. 1.6. Click on the Add button **2. Check Core-values Influence Map** 2.1. Click on See *Core-values* Map	1. The text that appears in the text box description is the one inserted in 1.2 2. The core-value *Employee Satisfaction* should appear in the list box labelled Influences Positively. 3. A *core-values influence map* should appear where the core-value *Social Awareness* is linked positively with the core-value *Employee Satisfaction*.

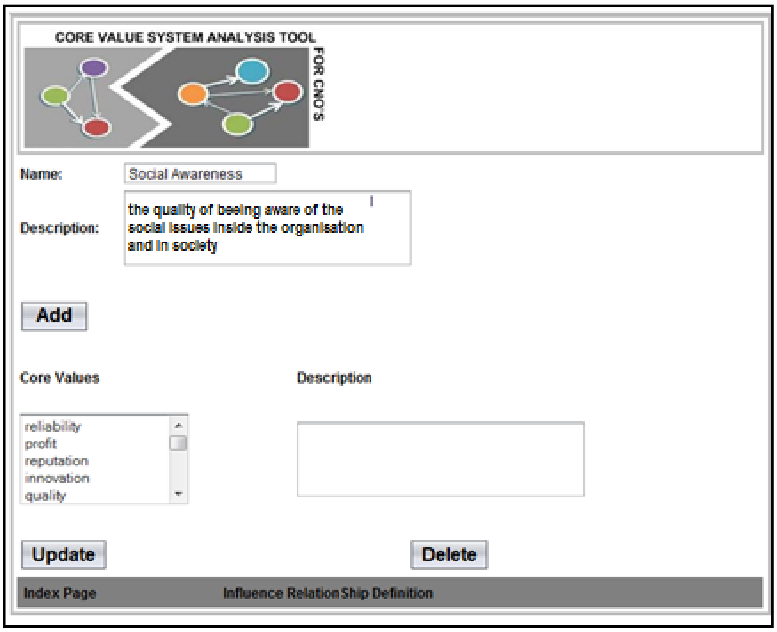


Figure A1 - Define Core-values Page screenshot

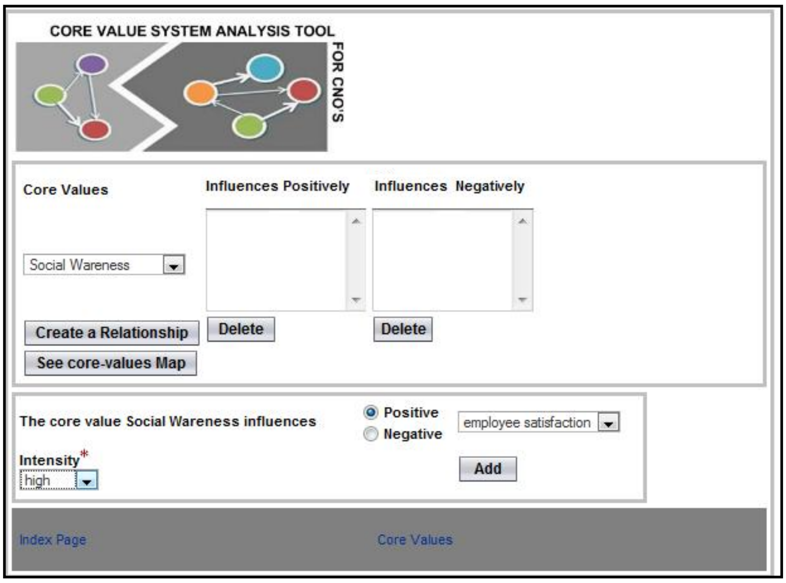


Figure A2 - Define an influence relation between two core-values screenshot

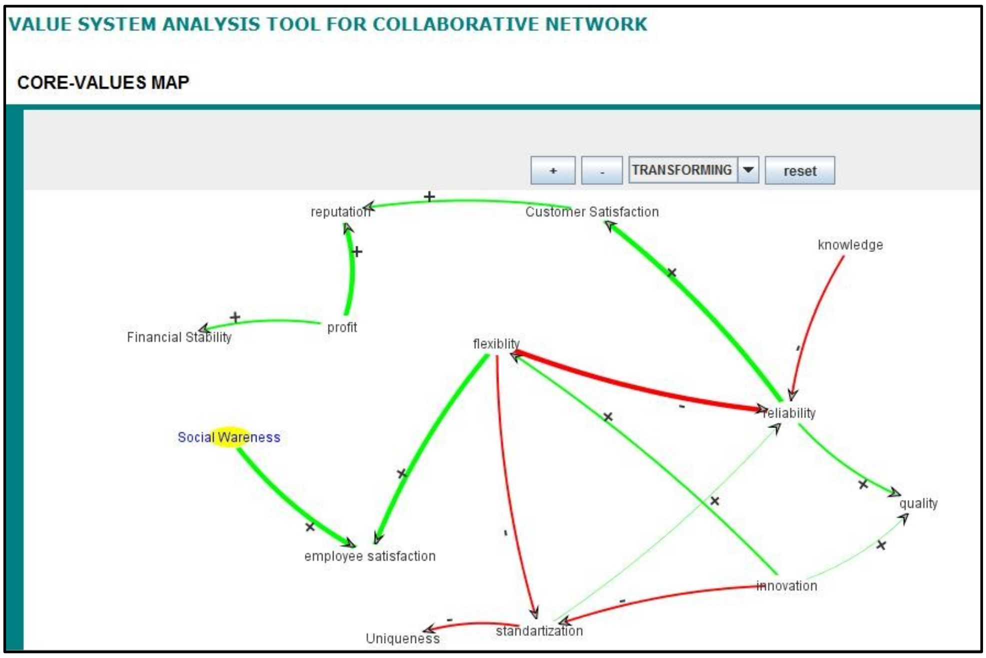


Figure A3 - See *Core-values influence* map Page

Test case: Define a *Core Value System* for a VO

Table A2 presents the test case for the definition of a *Core Value System* for a VO. This test includes the definition of the core-evaluation perspective, and the visualization of the CN core-values map for the resulted VO2's CVS. show screenshots obtained during the execution of this test case.

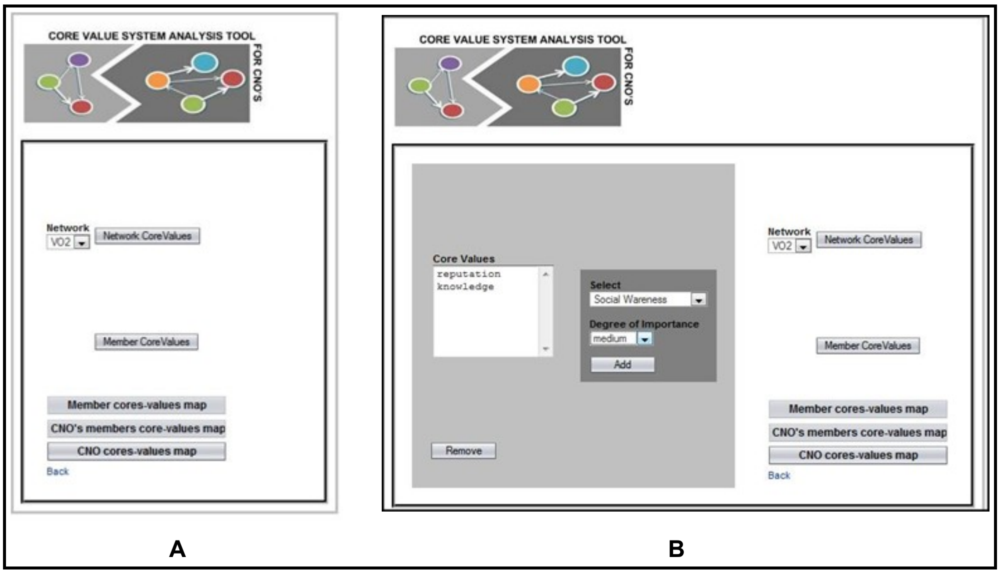


Figure A 4 – VS Modeling Page and Define the Core Evaluation Perspective screenshots

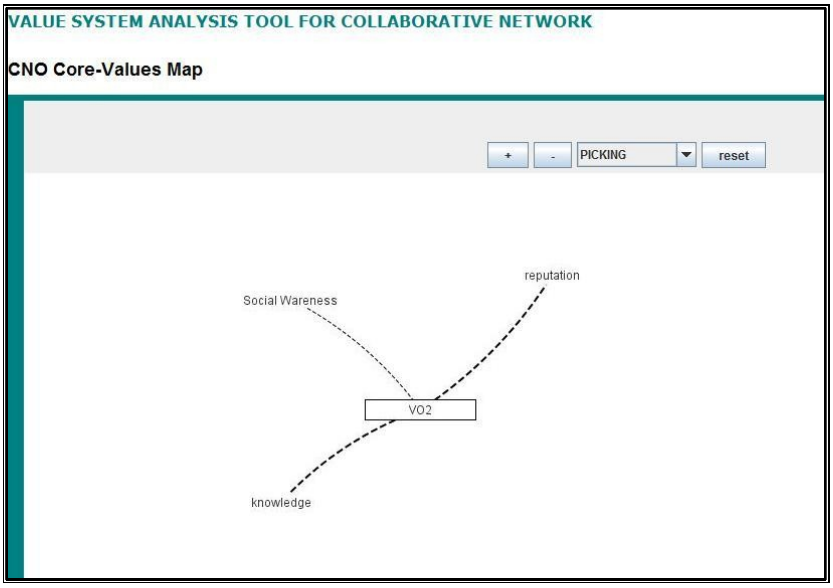


Figure A5– CN's core-values map for VO screenshot

Table A2 – Test Case: Define the Core Value System for a CN

Test Case: Define Core Value System for a CN		**Id:** 2
Preconditions	**Steps**	**Expected Results**
• The user is logged on with a VO manager user profile, and has access rights to the network VO2. • The user is in the VS modeling Page • The Virtual organization VO2 is already defined in the system, but its CVS has not yet been specified. • A knowledge base already exists.	**1. Select the Network** 1.1. In the VS Modeling page, select VO2 network in the combo-box. 1.2. Click on the Network Core Values button. **2. Specify the Core-Perspective** 2.1. Select the *reputation* core-value and the priority *high*. Click on the Add button. 2.2. Select the *knowledge* core-value and the priority *high*. Click on the Add button. 2.3. Select the *social awareness* core-value and the priority *medium*. Click on the Add button **3. Check CN's core-values map** 3.1. Click on the CN's core-values map button	1. The list box of core-values should appear empty. 2. (1) The list box of core-values should appear with the *reputation* value. (2) The list box of core-values should appear with the core-values: *reputation*, *knowledge* (3) The list box of core-values should appear with the core-values: *reputation*, *knowledge* and *social awareness.* 3. The CN's core-values map is drawn on the screen, where the values *reputation*, *knowledge* and *social awareness* can be noticed, linked to the VO2 node. The edge that links the social awareness core-value should be thinner than the other edges.)

Test case: Analysis of CVS Alignment Network-Members

The following table presents the test case for analysis of the CVS alignment between the VO1 and two organizations: factory A and factory C. The data used for the definition of CVS is the

one presented in the illustrative example in Section 3.2.4. This test includes the creation of the analysis report and the visualization of the complete aggregated map that gives a holistic view of the CVS interactions, as suggested in the analysis method presented in Section 4.2. Figure A6 and show screenshots obtained during the execution of this test case.

Table A3 - Test Case: Member-Network CVS alignment analysis

Test Case: Member-Network CVS alignment analysis		**Id:** 3
Preconditions	**Steps**	**Expected Results**
• A knowledge base already exists. • VO1 is defined as specified in example 3.2.4 • The VO1's CVS is defined as specified in example 3.2.1. • The VO1 members' CVS have already been defined, as specified in example 3.2.1, Table 3.2 • The user is logged on with a VO manager profile, and has access rights to the VO1 network. • The user is in the CVS Analysis Page	**1. Select the Network** 1.1. In the VS Analysis page, select *VO1* network from the combo-box. **2. Specify the Analysis** 2.1. Click the VS Alignment Network Member button 2.2. Select *factory A* and *factory C* in the members list box, and click on the See Analysis button. **3. See Analysis Map CN's core-values map** 3.1. Select *factory A* in the members list box, click on the See Map button. 3.2. Select *factory C* in the members list box, click on the See Map button.	2. 2.1. The list box with the VO1 members should appear. 2.2. Three tables should appear: a table with the qualitative level of potential conflict between *VO1* and *Factory A*, and *VO1* and *Factory C*; a table with the qualitative level of positive impacts of *Factory A* and *Factory C* on *VO1*; a table with the number of shared values between *VO1* and *Factory A*, and *VO1* and *Factory C*. 3. 3.1. The complete aggregated map for *Factory A* and *VO1* is drawn. 3.2. The complete aggregated map for *Factory C* and *VO1* is drawn.

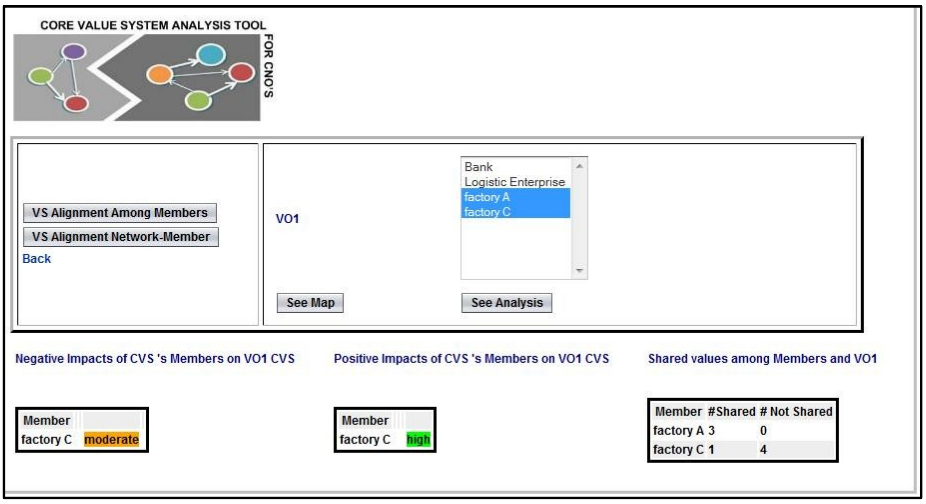


Figure A6 - CVS Alignment analysis summary for Factory A and C screenshot.

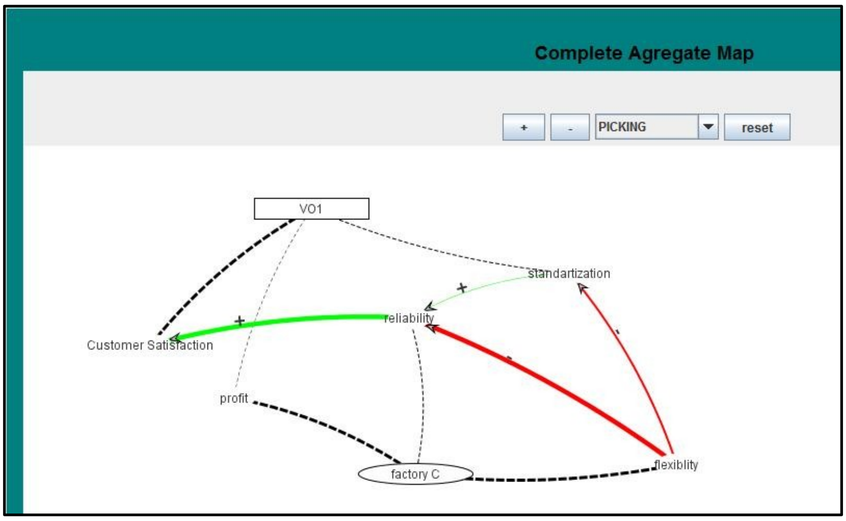


Figure A7 - Complete Aggregate Map for VO1 and Factory C screenshot

Test case: Analysis of CVS Alignment between CN's members

The following table presents the test case for analysis of the CVS alignment between VO1 members. The data used for the definition of CVS is the same presented in the illustrative example in Section 3.2.4. This test includes the creation of the analysis report and the visualization of the partial aggregated map that permits to give a holistic view of the members' CVS interactions, as suggested in the analysis method presented in Section 4.2. Figure A8 and Figure A9 show screenshots obtained during the execution of this test case.

Table A4 – Test Case: CVS alignment between CN's members analysis

Test Case: CVS alignment between CN's members analysis		**Id:** 4
Preconditions	**Steps**	**Expected Results**
• A knowledge base already exists • The VO1 members CVS have already been defined, as specified in example 3.2.1, Table 3.2 • The user is logged with a VO manager profile and has access rights to the network VO1. • The user is in the CVS Analysis Page	**1. Select the Network** In the VS Analysis page, select *VO1* network from the combo box. **2. Specify the Analysis** Click on the VS Alignment between Member button **3. See Analysis Map** Click on the See Map button	2. The list box with the VO1 members should appear. (Two tables should appear: A table with the qualitative level of potential conflict between VO1 members, and a table with the number of share values among VO1 members. The partial aggregated map for all VO1 members

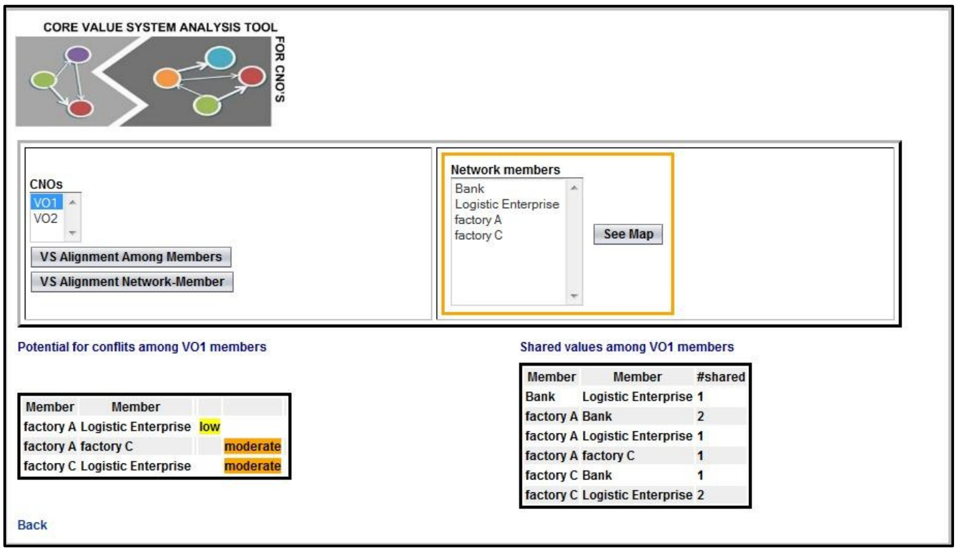


Figure A8 - CVS Alignment Analysis among VO1 members screenshot.

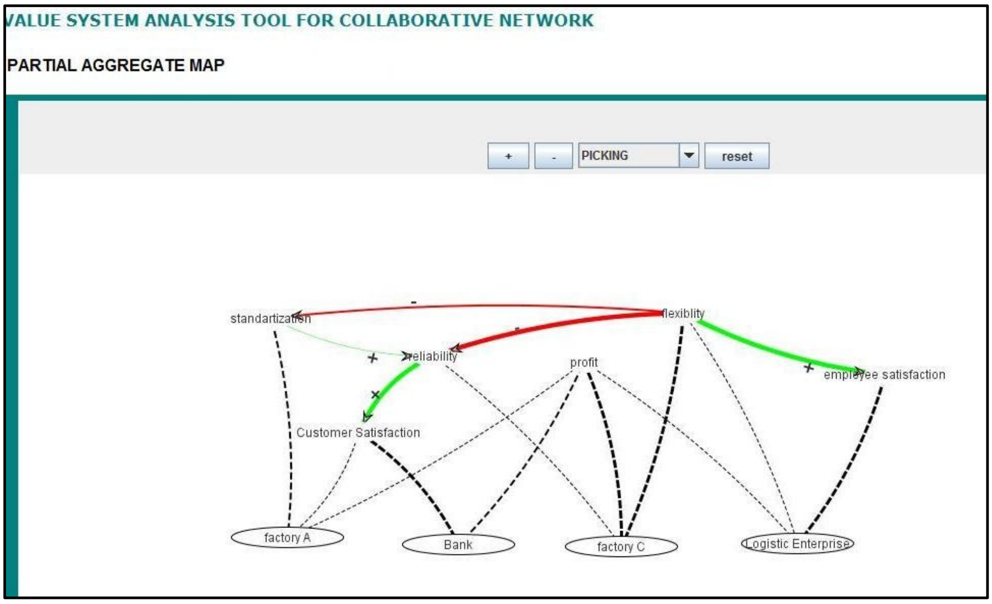


Figure A9 - Partial Aggregate Map for VO1 member's screenshot.

ANNEX B
Elements for test usability of the modeling approach

1 – Using a Textual Representation

Table B1 - CN Members

CN	Members
VO1	Factory A, Factory C, Bank, Logistic Enterprise

Table B2 - Core values and Priorities of Members

	Core values and Priorities
Factory A	Profit very-high; Standardization high, Customer Satisfaction fair.
Factory C	Profit very-high; Financial Stability high, Reliability fair.
Bank	Profit very-high; Customer Satisfaction high.
Logistic Enterprise	Profit very-high; Flexibility very-high; Employee Satisfaction high.
VO1	Profit very-high; Standardization very-high, Customer Satisfaction fair.

Table B 3 - Core values influences

	Core values Influences
Profit	Influences positively Reputation with moderate intensity. Influences positively Financial stability with moderate intensity.
Employee Satisfaction	None
Customer Satisfaction	Influences positively Reputation with weak intensity.
Flexibility	Influences negatively Standardization with weak intensity. Influences negatively Reliability with moderate intensity.
Financial Stability	None
Reliability	Influences positively Customer Satisfaction with moderate intensity.

2 – Using a Formal Representation (mathematical formalism)

Factory A (Fa)'s Core Value System

$CVS_{Fa} =< COS_{Fa}, CES_{Fa} >$

$COS_{Fa} =< \{Fa\}, \{\} >$

$CES_{Fa} =<< EV_{Fa}, CV_{Fa}, \{cp_{Fa}\} >, CRE_{Fa} >$

$CV_{Fa} = \{Profit, Standardization, Customer\ Satisfaction\}$

$cp_{Fa} =<$
$[Profit, Standardization, Customer\ Satisfaction], [veryhigh, high, fair] >$

Factory C (Fc)'s Core Value System

$CVS_{Fc} =< COS_{Fc}, CES_{Fc} >$

$COS_{Fc} =< \{Fc\}, \{\} >$

$CES_{Fc} =<< EV_{Fc}, CV_{Fc}, \{cp_{Fc}\} >, CRE_{Fc} >$

$CV_{Fc} = \{Profit, Financial\ Stability, Reliability\}$

$cp_{Fc} =< [Profit, Financial\ Stability, Reliability], [veryhigh, high, fair] >$

Bank (Ba)'s Core Value System

$CVS_{Ba} =< COS_{Ba}, CES_{Ba} >$

$COS_{Ba} =< \{Ba\}, \{\} >$

$CES_{Ba} =<< EV_{Ba}, CV_{Ba}, \{cp_{Ba}\} >, CRE_{Ba} >$

$CV_{Ba} = \{Profit, Customer\ Satisfaction\}$

$cp_{Ba} =< [Profit, Customer\ Satisfaction], [veryhigh, high] >$

Logistic Enterprise (Lg)'s Core Value System

$CVS_{Lg} =< COS_{Lg}, CES_{Lg} >$

$COS_{Lg} =< \{Lg\}, \{\} >$

$CES_{Lg} =<< EV_{Lg}, CV_{Lg}, \{cp_{Lg}\} >, CRE_{Lg} >$

$CV_{Lg} = \{Profit, Flexibility, Employee\ Satisfaction\}$

$cp_{Lg} =< [Profit, Flexibility, Employee\ Satisfaction], [veryhigh, veryhigh, fair] >$

VO1's Core Value System

$CVS_{Vo1} =< COS_{Vo1}, CES_{Vo1} >$

$COS_{Vo1} =< \{VO1\}, \{\} >$

$CES_{Vo1} =<< EV_{VO1}, CV_{Vo1}, \{cp_{Vo1}\} >, CRE_{Vo1} >$

$CV_{Vo1} = \{Profit, Standardization, Customer\ Satisfaction\ \}$

$cp_{Vo1} =< Profit, Standardization, Customer\ Satisfaction, [veryhigh, veryhigh, fair] >$

Values Influence

Core-values influence map: CVIM=(CV,E),

- *CV={Profit, Standardization, Customer Satisfaction, Employee Satisfaction, Financial Stability, Flexibility, Reliability}*
- *E={ e1,e2,e3,e4,e5,e6,e7}*
    - $e1 = (Profit, Reputation, moderate, +1)$
    - $e2 = (Profit, Finantial\ Stability, moderate, +1)$
    - $e3 = (Customer\ Satisfaction, Reputation, weak, +1)$
    - $e5 = (Flexibility, Relaibility, moderate, -1)$
    - $e6 = (Flexibility, Standardization, weak, -1)$
    - $e7 = (Relaibility, Customer\ Satisfaction, moderate, +1)$

3 – Using V-AligN framework

Elementary maps

(1) Core values influence map

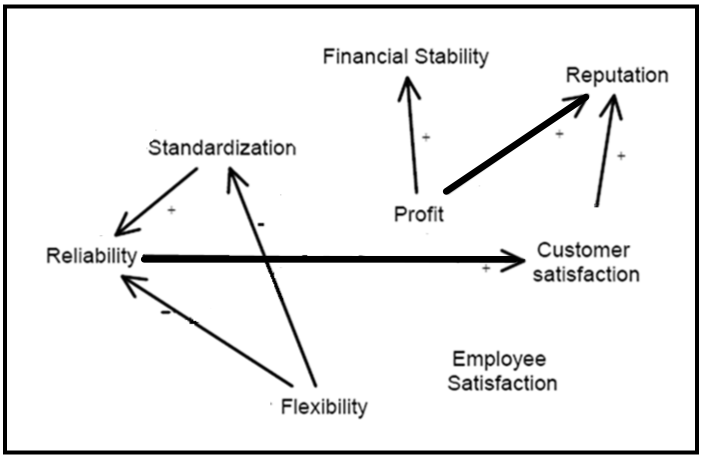


Figure B1 - Core values influence map

(2) Organizations' core-values map

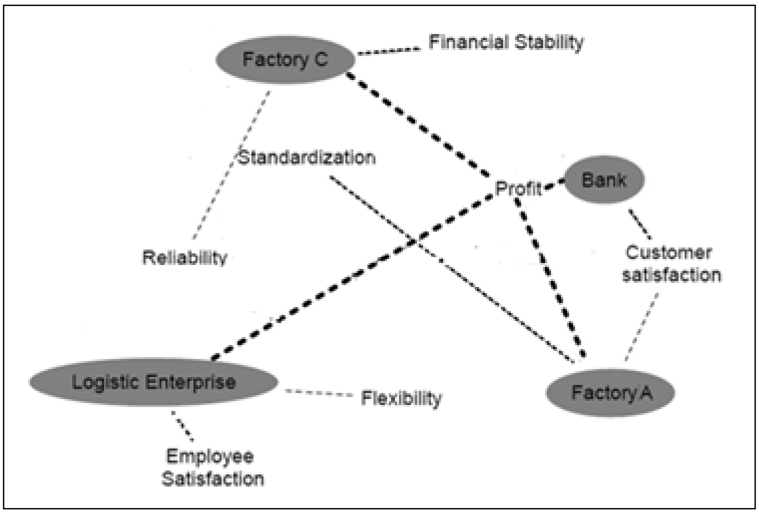


Figure B2 - Organisations' core values map

(3) CN’s core-values map

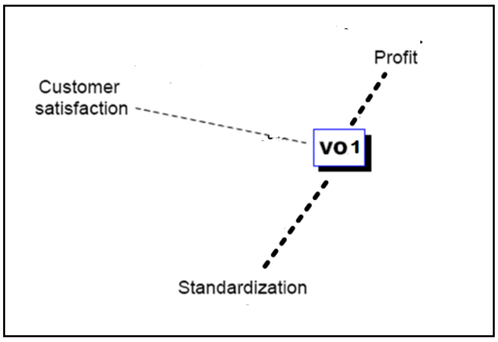


Figure B3 - CN's core values map

Aggregate maps

(1) Partial Aggregate Map

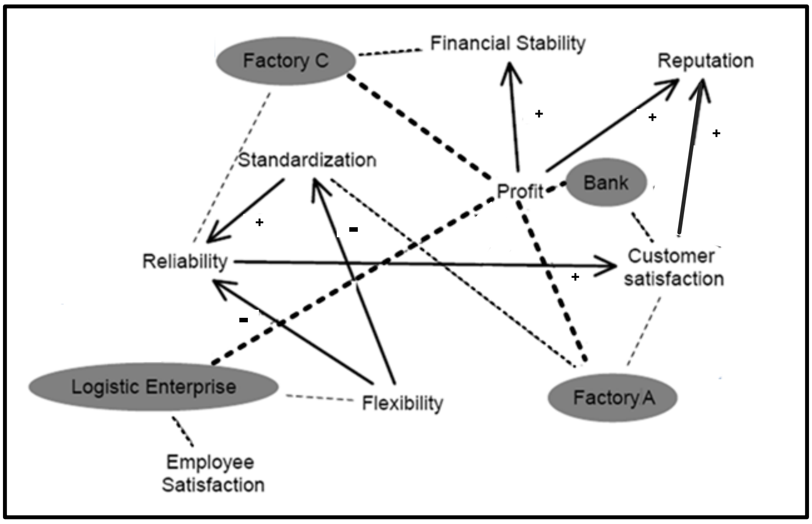


Figure B4 - Partial aggregate map

(2) Complete aggregated map

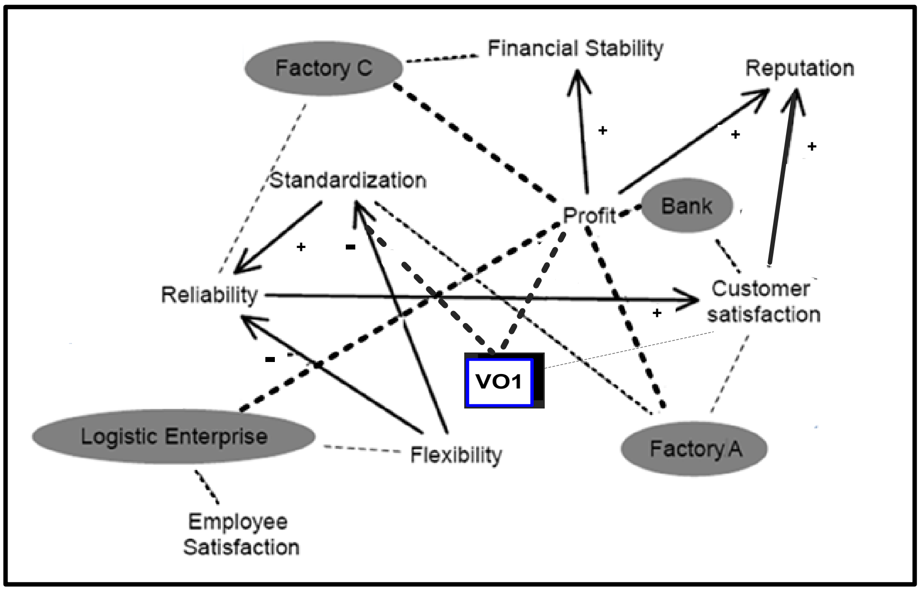


Figure B5 - Complete aggregate map