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### On inter-organizational trust engineering in networked collaborations : modeling and management of rational trust

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**Publication date**  
2009

[Link to publication](#)

#### **Citation for published version (APA):**

Msanjila, S. S. (2009). *On inter-organizational trust engineering in networked collaborations : modeling and management of rational trust.*

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## Chapter 3

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# Identification of trust elements for organizations

*Trust is not a single concept that can be applied to all cases for trust-based decision-making. Its measurements depend on both the purpose of establishing a trust relationship and its specific involved actors. The assessment of trust level of organizations may consider a series of trust criteria. The level of trust in organizations is complex and can neither be measured with the single value of a single parameter, nor interpreted with a single metric. In our approach, trust level of an organization is measured rationally in terms of quantitative values of a number of related trust criteria. One key challenge related to the characterization of trust in VBEs is the identification of measurable trust criteria for organizations. This chapter presents an approach for identifying and characterizing the trust elements. The chapter also provides a general comprehensive set of trust criteria for organizations identified by applying the proposed approach and validated by the existing industrial VBE networks.*

*This chapter contains material previously published in two articles, of which one appeared in the International Journal of Production Research [Msanjila & Afsarmanesh, 2007a], and the other appeared in the international journal of software [Msanjila & Afsarmanesh, 2008d].*

### 3.1 Introduction

One important aspect of characterizing trust in VBEs is the identification of trust elements for various organizations. In our study we found that trust elements for organizations are not at the same level of abstraction or measurability (are not equivalent); differences in abstraction indicate their hierarchical relations. Figure 3.1 visualizes the hierarchical relations among trust elements. We define trust elements as follows.

*Trust elements* represents a set of types (classes) defined in the thesis, each encapsulating certain aspects related to measuring trust. These elements are hierarchically inter-related from the abstract (non measurable) ones representing the root of the hierarchy to the real measurable ones which represent the lowest (leaf nodes) in the hierarchy, and that together they characterize both trust and trust-relationships in VBEs. Trust elements form the base for identifying the data needed for assessment of trust level of organizations [Msanjila & Afsarmanesh, 2007c].

Some trust elements defined in the literature related to organizations are *subjective (opinion-based)*, such as the recommendations, polling, voting, and so on. Opinion-based trust elements are not related to measurable facts about organizations, which consequently makes it difficult to support them with formal reasoning mechanisms while assessing level of trust [Weth &

Bohm, 2006]. However, in a different approach a number of performance-based trust elements can be identified for organizations. Namely, with a different approach some *rational* (fact-based) measurements for trust elements of organizations can be defined as addressed in this chapter that are supported with formal mechanisms such as mathematical formulas to assess organization's trustworthiness. In the Section 3.2 we present an approach for identifying such trust elements for organizations. The presented approach also supports the analysis of inter-relations (impact and causal influence relations) among these measurable trust elements. Finally, in Section 3.3 we present a general set of trust elements for organizations.

### 3.2 HICI: An approach for identifying trust elements for organizations

The HICI approach proposed by this thesis constitutes three stages, each one focusing on a specific task related to the identification and characterization of trust elements for organizations. The first stage called the *Hierarchical analysis stage*, further addressed in Section 0, focuses on the identification of types of trust elements and classifying them into a generalization hierarchy based on their level of measurability. The second stage called the *Impact analysis stage*, further addressed in Section 3.2.2, focuses on the analysis of the impact on the trust level of the organization caused by changes in values of trust criteria. The third stage called the *Causal Influence analysis stage*, addressed in Section 3.2.3, focuses on the analysis of causal relations between trust criteria and other VBE environment factors as described in Section 3.2.3. To enhance the presentation of the HICI approach below we present the base definitions of four fundamental terms applied in the classification of trust elements as shown in Figure 3.1.

**Trust objective:** *is the purpose for which the establishment of a trust relationship among the involved organizations is required. Examples of trust objectives include the following: for inviting an organization to join a VO, for appointing or selecting an organization as the VO coordinator, for an organization to decide to join VBE, and so forth.*

**Trust perspective:** *represents the specific "point of view" of the trustor on the main aspects that must be considered when assessing the trustee's level of trust. The trust perspectives help the trustor organizations in deciding what information related to trustee organizations should be considered primarily, or secondarily, etc., and made available to them in order for them to create the required level of trust.*

**Trust requirements:** *represent the essentials (cardinals) that characterize and guide on how the respective trust perspective shall be realized. Thus, trust requirements are the fundamental cardinals that guide or suggest what must be met in order for the respective trust perspective to be realized. For instance, "financial stability" is an example requirement that must be met, to support establishing trust based on the economical perspective; similarly, "compliance with community standards" is a requirement for trust related to social perspective, and "stability in management" is a requirement for managerial perspective.*

**Trust criteria:** *represent the measurable trust elements that characterize each respective trust requirement. Therefore, the values of each organization's trust criteria can be used to make a rational (fact-based) judgment on whether the respective trust requirement is met. Each trust criteria has its own related value structure that defines the acceptable structure for its data, such as the scalars, vectors, arrays, list of strings, and so on. Furthermore, such value structure also defines the metric to be used to scale the specified data. The only source of data for trust criteria is the respective trustee's organization. Therefore in each*

*VBE, member organizations shall submit data related to their trust criteria, and keep them up-to-date. Data related to the trust criteria of organizations will be used in the VBE for different purposes related to trust management.*

In order to enhance the presentation of the HICI approach, in Table 3.1 we introduce an example set of trust elements for two different trust perspectives. A complete set of the trust elements defined for VBE organizations is presented in Section 3.3. In relation to the establishment of different kinds of trust relationships between organizations, we have identified three trust objectives addressed in details in Section 3.3, and five trust perspectives where each trust perspective is characterized by a number of trust requirements, which in turn are characterized by a number of trust criteria. These are later addressed in details in Section 3.3 and more specifically in Figure 3.6.

Table 3.1: Examples of trust elements

Trust perspective	Trust requirements	Trust criteria	Acronym
Structural	Structural strength	Size of an organization	SZ
		Competencies	CP
		Personnel experts	EP
	Business strength	Centers	CT
		Workload allocation	WA
		Geographical coverage	GC
		Joint ventures	JV
Economical	Capital	Cash	CC
		Physical capital	PL
		Material (operational ) capital	MC
	Financial stability	Cash in	CI
		Cash out	CO
		Profit/Loss	PO
		Operational costs	OC
	VO -Collaboration based financial stability	Cash in	VCI
		Cash out	VCO
		Profit/Loss	VPO
	Financial standards	Auditing standards	AS
		Auditing frequency	AF

Table 3.1 includes subordinate trust elements identified for the organizational structural perspective, as well as the economical perspective related to measuring an organization's trustworthiness. The elements in this table are later used within the examples in this chapter. The example set of trust elements as shown in Table 3.1 are related to and characterize a specific trust objective of *creating trust in organizations for inviting them to participate in a VO* as further addressed in Section 0. For example, geographical coverage is one characteristic criterion representing the business strength requirement at the structural perspective of an organization necessary to evaluate its trustworthiness.

### 3.2.1 First Stage: Hierarchical Analysis

The hierarchical relations defined in HICI among the trust elements represent their inter-relations from a highly abstract element as the root node (e.g. trust objective – 1) to all its subordinate measurable elements at the leaf nodes (e.g. trust criteria – 1.1.1.1). We have identified five levels of abstraction (L1 to L5) for representing the hierarchical relations among trust elements. As such trust-relationships are established as a means for involved organizations to achieve a specific trust objective. Trust objectives characterize the reason why

trust relationships must be established when addressing the creation of trust among member organizations in the VBE. In our classification of trust elements for organizations, trust objectives represent the first level (L1) of the abstraction hierarchy, as shown in Figure 3.1.

- A **trust objective** is characterized by a number of trust perspectives (e.g. structural perspective, economical perspective, etc.). A trust perspective represents a “point of view” on what trust and trust relationships mean to a trustor, therefore a trust perspective indicates the primary aspects preferred by a trustor, in order for him to trust a trustee. In our classification of trust elements, trust perspectives represent the second level (L2) of the abstraction hierarchy.
- A **trust perspective** is characterized by a set of trust requirements (e.g. for structural perspective requirement, it can be structural strength, and business strength). A trust requirement also refers to what details related to each trust objective the trustor believes must be met by the trustee organization before trust is created and realized on the basis of the preferred perspective. For example, in our classification of trust elements the trust requirements represent the third level (L3) of the abstraction hierarchy.
- A **trust requirement** is characterized by a set of trust criteria (e.g. for structural strength requirements the trust criteria include: size of an organization, personnel experts, etc.). Trust criteria are the only real measurable elements from the organizations environments. In order to facilitate their measurement, each trust criterion is specified together with its value structure that defines the magnitude and meaning (SI-Unit) of the possible values. In our classification, trust criteria and value structures represent the fourth (L4) and fifth (L5) levels of the abstraction abstract.

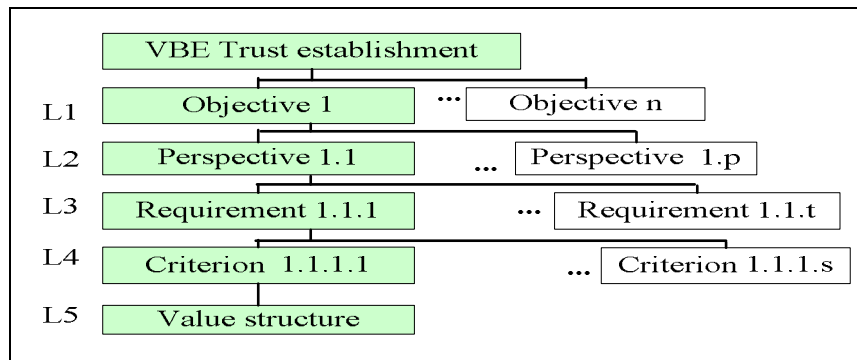


Figure 3.1: General view of hierarchy of trust elements for VBE trust establishment

*This figure shows a classification of trust elements in a generalization hierarchy based on their level of measurability, as described earlier in this section.*

The first stage of the HICI approach can also be applied to customize the identified trust elements to meet specific characteristic of a VBE environment. This aspect is addressed in Section 5.4 in a discussion on the formulation of mechanisms for assessing organization’s trust level. Although each trust criterion only occurs at one trust requirement and at one trust perspective, it does not mean that the trust criteria are totally independent. Inter-relations do exist among some trust criteria and even between different trust perspectives as a result of the existence of “intermediate factors” as discussed in Section 3.2.2.

### 3.2.2 Second Stage: Impact Analysis

A rational (fact-based) assessment of the level of trust in organizations is essentially based on information about their past performance. However, trust criteria that constitute the basis for measurement of level of trust, do not exactly match the *performance indicators* typically defined and applied for measuring the performance of organizations. Research in the past has not addressed the “*direct*” representation of needed organization’s performance in terms of related trust criteria. By means of impact analysis of trust criteria factors, here referred to as “*intermediate factors*”, our approach makes it possible to identify the relationship between trust criteria and some trust related performance indicators. Simultaneously, trust criteria are influenced by the so-called “*known factors*” in the VBEs, as discussed below.

*Known factors* represent a set of domain/application dependent factors that indirectly influence the outcome of measurements of level of trust in the involved organizations. Each domain/application, such as business, manufacturing, medical, and so on, is affected by both the VBE’s internal factors (e.g. the minimum wage per hour for all organizations within the VBE), as well as the VBE’s external factors relating to environment / market / society in consideration of the VBEs scope both geographical and area wise. For example: (1) certain pre-existing regulations or standards (e.g. regional tax subsidies in a given market), (2) an environment’s norm and practice (e.g. minimum number of competencies required for each organization to become a VBE member), or (3) the current state of the market/society (e.g. regional availability of raw material or a market consumption capacity of products/services), etc. These factors indirectly influence the level of trust. For each VBE, its specific known factors are identified during the customization of its generic trust management system (Chapter 5) based on specific domain/application of the VBE. Consequently, the main source of data for the known factors related to the VBE is its administration itself that knows about both its internal and external environments. The data about known factors should also be kept up-to-date by the VBE administration.

*Intermediate factors* represent the factors that play an intermediary role in relating the VBE’s known factors to its organizations trust criteria. In principle, both trust criteria and known factors do influence each other. Their influences are twofold, consisting of causal and impact influences. However, these influences are not direct, but occur through some intermediate factors. In Section 3.2.3 the analysis of causal influences among the trust criteria and known factors is represented diagrammatically in the so-called causal diagram. Based on the results of this causal analysis, the influence relations are used for the derivation of mathematical equations, which formally show relationships between trust criteria and known factors, through specific intermediate factors. These equations are further used to calculate the values for each intermediate factor in relation to every organization, and thus acting as a means of partial trust level assessment for the organizations in VBEs. Consequently, unlike the trust criteria and known factors for which the data is respectively assigned by the organization and the VBE administration, the intermediate factors must be calculated through these equations. Namely, if needed, the only way that the value of an intermediate factor can be improved is either through the changes in the values of the organizational trust criteria, or changes in the known factors of the VBE that can be decided internally within the VBE, since these are the only controllable factors that influence the intermediate factors.

For example as shown in Figure 3.2, consider the intermediate factor “organizational expenditure”, which is influenced by the two trust criteria of size (from a structural perspective) of an organization referring to the number of employees, the operational cost (from an economical perspective) referring to the minimum wage of employees acceptable at

the VBE. Changing the expenditure of an organization can be achieved by changing the values of the two above stated trust criteria.

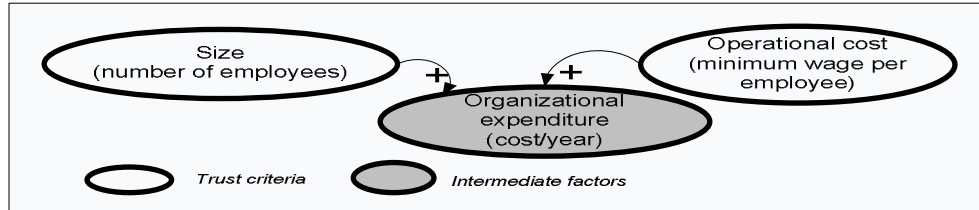


Figure 3.2: Example relation between trust criteria from different trust perspectives

This figure exemplifies how the causal influences between trust criteria and intermediate factors can be analyzed and diagrammatically represented.

Intermediate factors are identified through the *impact analysis* which is the main focus of the second stage of the HICI approach as presented in this Section 3.2.2. Impact analysis enables both the identification of intermediate factors and an analysis of their relations to trust criteria and to the performance of organizations.

In order to further describe this concept, consider an example related to *structural perspective* as presented in Table 3.1. Using an empirical study of the organization's domain that is validated by domain experts, we have identified a set of trust criteria and intermediate factors that we apply to show the example of impacts analysis. Figure 3.3 shows how changes in values of trust criteria (i.e. size of an organizations [SZ], organizational competency [CP], personnel experts [EP], of the structural strength requirement, and the trust criteria centers [CT], Workload allocation [WA], geographical coverage [GC], and joint ventures [JV] for business strength requirements) can create impact on the intermediate factors (i.e. social capital [SC], connections [CN], common context [CC], and production capacity [PC]), that can in turn directly affect the improvement of the performance of organizations in relation to its structural perspective, and thus influencing its trust level.

To further describe the impact analysis, consider an example in Figure 3.3 addressing how the changes in values of the trust criteria "size" of an organization can produce impact on its trust level through the intermediate factor "social capital" as is detailed out below. As defined in this thesis, the size of an organization increases when the number of employees increases. The increase of size of an organization creates an impact on the organization's social capital through the connections of its individual employees [Putnam, 1995]. Social capital here refers to the aggregation of the actual or potential resources which are linked to possession of a durable network (of individuals), representing more or less institutionalized relationships of mutual acquaintance and recognition [Bourdieu, 1983]. When the social capital increases it will improve the structural performance of the organization, such as related to increasing in chances of acquiring opportunities through the use of its employees' durable network within the society. In turn, the structural performance of an organization increases then its trust level will also rise. Section 5.4.5 further addresses the aspects presented in this figure in more details. Two more specific examples of impact relations (examples 3.1 and 3.2) are provided below in this section.

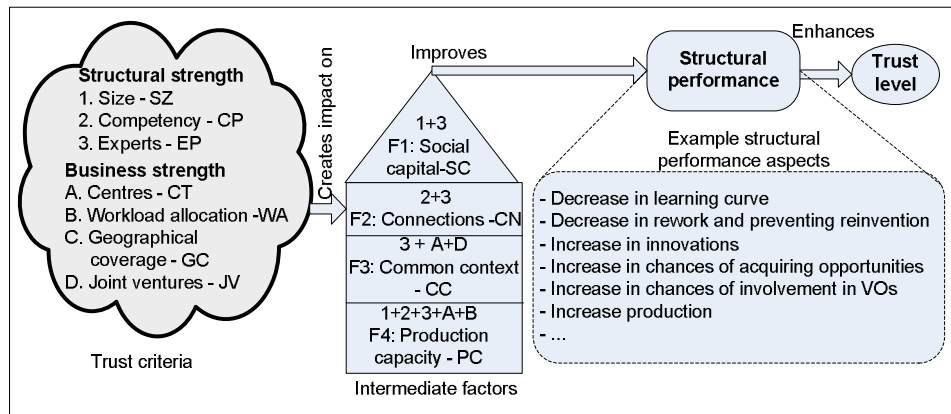


Figure 3.3: Analysis of the impact of trust criteria on performance for structural perspective

This figure shows the relation between trust criteria and organization's trust level through the defined intermediate factors (as also exemplified in example 3.1 and 3.2 below), which in turn provide means for expressing performance data (e.g. structural performance) of organizations in terms of trust criteria. The figure also presents a number of example performance aspects for the structural perspective.

Here “Workload allocation or WA” refers to the *maximum level* to which an employee of a certain organization can produce. The level of workload varies according to the specific domains, business environments, legal systems, and so on. For example, the workload of doctors in medical organizations is typically measured in terms of “the number of patients to which a single doctor can attend per day”, while the workload of employees in a business organization is typically measured in terms of “the number of hours that each employee must spend at work”, similarly in manual production/processing businesses, this may be measured in terms of the amount or number of items produced or processed per day, and so forth.

**Example 3.1:** Consider an organization, for example a research center, that increases the number of its employed experts (EP); it is shown here how this increase can improve the level of trust in this organization. Usually, employees do maintain their connections. For example, email communication with their academic colleagues who may be employed in other organizations, etc. Therefore, when an organization employs new experts, through these experts it indirectly expands its connectedness to other organizations, even including potential customers (CN in the middle of Figure 3.3). At the same time, through these experts some common context on interests may develop among different organizations (CC in the middle of Figure 3.3); with the aim, for example, of finding solutions to certain common problems. Furthermore, the connections and common context serve as a way to enhance the communication between organizations both directly and indirectly. If common context and connections among organizations exist then unnecessary rework and reinventions can be avoided, as well as learning curves can be reduced, both achieved through sharing of new ideas and information between organizations. The result of this will be an improvement in the structural performance of the organization and consequently an increase in its level of trust.

**Example 3.2:** A second example represents how the SZ, CP, EP, CT, and WA trust criteria as shown in Figure 3.3 influence the production capacity (PC) of an organization. Basically, if an organization grows in size (number of employees), increases the number of its centers (e.g. production centers), enhances its competencies, or acquires more



experts, it will - assuming the employees can highly be exploited (such as for supporting manufacturing production) - in turn enhance its production capacity. This will then also directly improve its performance, which will result in an increase in its level of trust.

Results from impact analysis assist the VBE actors with their understanding of relations between trust criteria, performance, and level of trust. In short, when the rational trust level of an organization is decreasing or falls below the acceptable level, a number of performance aspects, such as the level of its production, innovation, acquisition of opportunities, etc., shall be analyzed in order to support discovering which aspects of the organization are getting weaker. Through the analysis, in turn, the related trust criteria whose change of values has impacted the performance aspects through intermediate factors can also be identified. Therefore, with impact analysis as presented in this section it is possible to identify certain trust criteria for which the values need to be improved in order to enhance the level of trust in an organization.

### 3.2.3 Third Stage: Causal Influence Analysis

The level of trust in an organization is causally related to past recorded events and actions taken or caused by the respective organizations. These relations are not direct or straightforward and in most cases there is a lack of fundamental comprehensive data, which is necessary to reason (or support reasoning) about them. Therefore, in order to analyze these relations and build a good understanding about the causal influences of past performance on current or future level of trust, we need to apply approaches which support reasoning with partial and or incomplete data.

Causal analysis, as applied in the discipline of System dynamics and/or systems engineering, and specifically related to structural modeling of causally related factors, supports the evaluation of relations between factors for which quantitative data may be incomplete or missing [Iriundo, et al., 2003, Parnell, et al., 2008]. This analysis then provides the means to qualitatively represent and reason about the continuous aspects of the world, such as the space, time, quantity, and so on. Furthermore, it is an “approximate” reasoning approach, which supports an analysis and even its argumentation with insufficient information [Greenland & Brumback, 2002]. In this study, we adopt and apply causal reasoning and analysis to examine the causal influences among trust criteria, known factors and intermediate factors.

Causal analysis supports the study and analysis of influence of inter-relationships between different factors in an environment. Causal modeling and causal sketching, which are special aspects of causal reasoning, are predominantly used for sequences of reasoning where the sequences are characterized by keywords such as ‘leads to’, ‘influences’, ‘causes’ on one hand, and ‘if-then’, ‘when-then’, ‘on-then’, ‘as-then’ or ‘supposing-then’, on the other hand [Akkok, 1998; Hovmand, 2003]. Typical examples are statements such as “when the accelerator is depressed, the speed increases” or “as more fuel flows into the engine, the speed increases” or “the amount of fuel flowing influences the speed”. This approach has been in the past used in population growth modeling, the modeling of decision-making processes, the modeling of policy analysis processes, to name but a few [Msanjila & Afsarmanesh, 2008c]. In VBEs, causal reasoning can be effectively used for the analysis of:

- Social networking side-effects that can be experienced by partners due to their participation in a VO, configured to respond to a specific brokered business opportunity (i.e. side-effects of business opportunity),
- Influences of different VBE administrative decisions on the general VBE’s performance,

- Inter-relations between the measurable trust criteria, influencing the trust level of organizations.

For this thesis the focus is on the last usage. Nevertheless, understanding the essentials of a given causal model requires adequate amount of knowledge in the field and the context within which it is being developed [Akkok, 1998]. The causal modeling approach (as shown in Figure 3.4) does not provide standard-building blocks or factors that are typically considered for modeling. Therefore, factors that are included in a certain causal model vary widely from one model to another and depend mainly on (1) the modeler, (2) the problem addressed, (3) the application domain, and (4) the stakeholders.

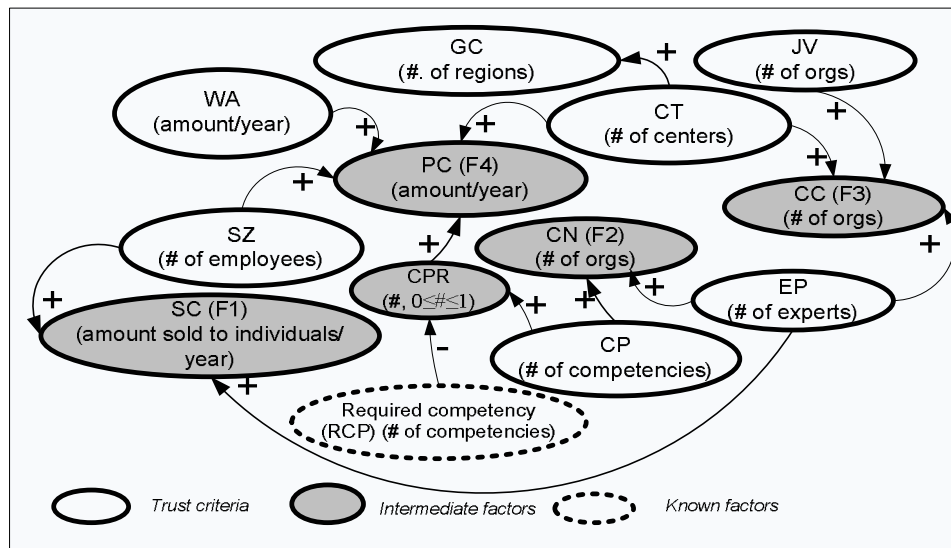


Figure 3.4: Causal influences between trust criteria for structural perspective

Where CPR represents competency ratio and RCP represents required competency in the VBE and all other parameters are defined earlier in Section 3.2.2, and also represented in Table 3.1 and Figure 3.3. This figure shows a qualitative analysis of causal influences between measurable parameters for the structural perspective, namely, the associated trust criteria (size, workload allocation, competencies, experts, centers, joint ventures, and geographical coverage), known factors (required competencies) and intermediate factors (social capital, competency ratio, connections, common context, and production capacity). As an example, please note in Figure 3.4 that the intermediate factor CPR (competency ratio) is positively influenced by one trust criteria CP (competency) and negatively influenced by one known factor RCP (required competency).

For an assessment of the level of trust in different organizations in VBEs, in the third stage of the *HICI approach*, we first use causal analysis and reasoning to understand influences among the measurable elements of trust, organizations' activities, and the environments; and then we use it as a means to identify their behavioral influences on the level of organization trust. For example, in order to analyze whether the behavioral changes of one specific trust criterion, causally influences the changes of several other specific trust criteria. Also, since the assessment of an organization's level of trust depends on the values of these trust criteria, changes in these values will also causally influence the variation in the organization's trust level.

Usually, causal relations between different trust criteria are not direct, rather through some defined intermediate factors. A causal diagram can be developed to *diagrammatically*

represent the results of the causal analysis among different factors and the qualitative reasoning on the behavior of a trust system, based on its measurable trust elements whose values are continuously changing [Msanjila & Afsarmanesh, 2006a]. Figure 3.4 shows the relations between some trust criteria in the *structural perspective*, diagrammatically represented in a causal diagram. We have used causal diagram for representing the causal inter-relationships among trust criteria, intermediate factors and known factors and how they causally influence each other. A plus sign (+) on an arrow indicates that the increase or decrease of the source (first) factor respectively causes an increase or decrease in the destination (second) factor. On the contrary, the minus sign (-) indicates that the increase or decrease in the first factor respectively leads to a decrease or increase in the second factor [Kirkwood, 1998].

The results of these causal analyses are applied to the formulation of mathematical equations [Byne, 2006] that constitute the base for our developed mechanism for assessing the level of trust in organizations, as further discussed in Chapter 5.

### 3.3 Trust elements related to organizations in VBEs

In order to study the requirements for trust in VBEs, to model them as well as to validate and verify the approach of HICI, and to identify general trust elements for organizations participating in VBEs, three approaches are considered and applied as follows.

#### *Approach A: State of the art study and other research*

As a research area, VBEs are newly defined collaborative environments addressed within the last five years. Inter-organizational trust in VBE as one of the fundamental VBE research topics still lacks the needed research. As a result, there is little in the literature to start with and against which to compare and validate our new multi-criteria approach for analyzing inter-organizational trust. However, some limited research is performed related to the identification of “trust criteria” for systems or agents, but either in very specific domains such as health [Rolfe, 2006], or for some very specific applications such as the multi-agent systems, network certificate systems, internet applications, and so on, [Zhang, 2005]. In view of these facts, we opted for the other following two approaches (B and C), in order to examine the innovative aspect of the HICI approach.

#### *Approach B: Expert based requirement analysis and validation*

By means of questionnaires, we have collected data from experts relating to their judgments on the validity and applicability of our identified trust elements, as well as rating the innovative features of the HICI approach. The results of these questionnaires, which were conducted during the trial sessions of our system (the trust management system) in the context of the ECOLEAD project are presented in Section 6.6.2.

#### *Approach C: Empirical based requirement analysis and validation*

Several industrial running VBE networks were consulted in order to validate the identified set of generic trust elements in practice. We mostly focused our analysis on innovative aspects and potential applications of the trust elements identified by applying the HICI approach in real life businesses. Again, the consultation was achieved through a set of questionnaires that were completed by the industrial VBE networks (Annex C) which participated through the ECOLEAD project.

On the basis of the above three approaches, we have identified the following three categories of trust objectives for establishing trust among organizations in VBEs:

- ✦ Trust of a VBE member organization to another VBE member organization,
- ✦ Trust of a VBE member organization to the VBE administration organization, and
- ✦ Trust of an external stakeholder organization to the VBE.

These trust objectives are first introduced below and then in following sub-sections they are further discussed including their subordinate trust elements. Furthermore as addressed in Chapters 5 and 6, a detailed implementation of the Trust Management system (TrustMan) is achieved for the first category of trust objectives required to create trust among the VBE member organizations.

**a) *Creating trust among VBE member organizations:***

The main aim of establishing and promoting trust relationships between VBE member organizations is to enhance the efficiency and success of both their cooperation within the VBE, as well as their potential collaboration in VOs that will be configured within the VBE environment. Further to the achievement of VBE member organizations, the main aspects that influence the level of trust a VBE member organization has towards other VBE member organizations is mainly its past performance in activities within the VBE, and from its participation in configured VOs. In addition, other aspects that may influence an organization's level of trust include its roles, reputations, membership level at the VBE, and so on. The subordinate trust elements for this trust objective are addressed in Section 3.3.1.

**b) *Creating trust of the VBE member organization to the VBE administration:***

Trust of a VBE member organization towards the VBE administration enhances the chance of the member organization remaining loyal to the VBE, increases its willingness for active involvement in the VBE, and encourages the respective VBE member organization to invite and bring other valuable organizations into the VBE. Among the main issues that influence the creation of trust in member organizations towards the VBE administration are found to be: successes in managing the VBE environments, a VBE's successes in external markets and recognitions achieved through VBE's marketing and branding, the transparency of the administration procedures and rules, the transparency and efficiency of procedures used for measuring the performance of member organizations, the frequency of and support for collaboration opportunities brokerage, and an equal opportunity for all VBE member organizations to get involved in potential VOs. The subordinate trust elements for this trust objective are addressed in Section 3.3.2.

**c) *Creating trust of external stakeholders to the VBE:***

A VBE must be trusted by its external stakeholders, including invited organizations and customers. On the one hand, invited organizations must be convinced that the VBE environment is trustworthy for their businesses and, in addition, that they will benefit more than they would if they were to work individually. On the other hand, customers that create business opportunities in the market (to which VBE can respond by creation of VOs) must recognize and trust the VBE in order to accept its proposed bid. Consumers (end users of VBE results) also need to trust the VBE in order to decide positively on purchasing or accepting the VBE's products and services that have been produced / provided through VOs. The subordinate trust elements for this trust objective are addressed in Section 3.3.3.

### **3.3.1 Trust elements for creation of trust between organizations**

There are *five potential trust perspectives* [Msanjila & Afsarmanesh, 2006b] that a trustor organization can assume, or choose from, for representing its "primary aspects" as a means to assess the level of trust in a trustee organization. These perspectives constitute the so-called

“trust perspective pentagon” (Figure 3.5), where the detail inside this figure is represented in Figure 3.6. When a VBE organization needs to trust another VBE organization, five trust perspectives to be measured may be of interest or concern to the trustor organization, with the base assumption of their independence these perspectives include: Structural (STP), Economical (ECP), Technological (TEP), Managerial (MGP), and Social (SOP).

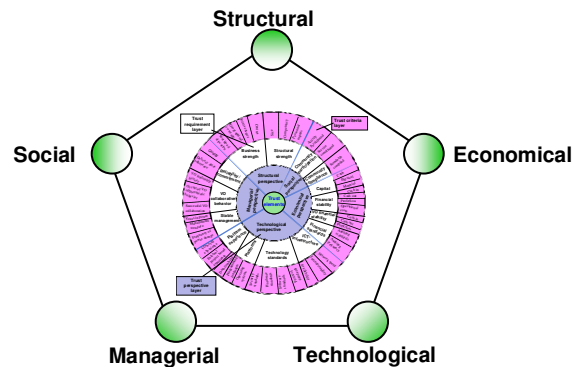


Figure 3.5: Trust perspectives pentagon for trust relationships between VBE members  
The descriptions of these elements are provided in the paragraph above and further classification is provided in Figure 3.6.

In the Trust Management (TrustMan) system developed and addressed in this dissertation (later in Chapter 6), trust related data is stored and managed in a database. The TrustMan system provides functionalities and services for supporting different actors in the VBE, in order to perform tasks related to the management of trust among organizations in a VBE, including trust level assessment, trust relationship establishment, and trust creation. These functionalities require some assistance from domain/trust experts while being applied during the operation stage of the VBE life cycle. The TrustMan system is discussed in more detail in Chapter 6.

The assessment of level of trust in a VBE member organization occurs in three different cases. Firstly (case 1), for each VBE membership applicant, its “base” trust level needs to be assessed in order to be accepted as a member of the VBE. The base trust level is the minimum threshold value of trust level, which allows a member organization to keep operating in the VBE. Secondly (case 2), periodic assessment of the base trust level for all VBE member organizations is necessary, in order to control and preserve the trust balance at an acceptable level within the VBE. Tertiary (case 3) is when *specific trustworthiness* evaluation is requested by a trustor for certain “specific” purpose, such as for inviting a VBE organization to participate in a VO, or for appointing an organization to become VO coordinator, and so on. In such cases the trustworthiness of the organization must be assessed for that specific purpose [Msanjila & Afsarmanesh, 2007a].

In Section 3.2 we analyzed the causal influences among the trust criteria for the structural perspective as an exemplification of the HICI approach. The trust criteria and related customizations of trust perspectives are also used as an example in Chapter 5 for the formulation of mechanisms for assessing the level of trust in organizations. Trust criteria, their unit of measurement and their related causal analysis result for all five trust perspectives mentioned above are further described in Table 3.2, Table 3.3, Table 3.4, Table 3.5, and Table 3.6.

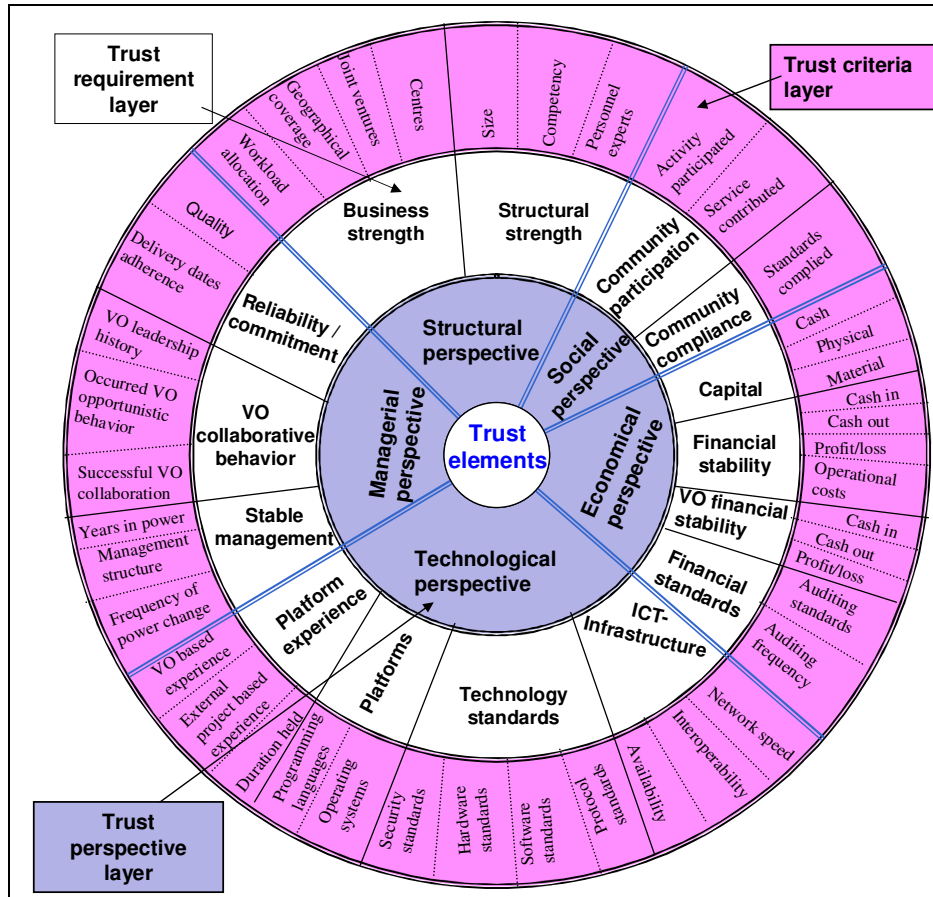


Figure 3.6: The wheel of general trust elements for VBE member organizations  
 The descriptions of these elements are provided in Table 3.2, Table 3.3, Table 3.4, Table 3.5, and Table 3.6. The classification of layers is based on the levels of measurability of trust elements as shown in Figure 3.1.

For the first two cases above (assessing base level of trust for a potential VBE member and a VBE member organization), the assessment of level of trust is based on a so-called set of *base trust criteria*. This set of base trust criteria is identified by the VBE administrator usually a priori to the establishment of the VBE, is announced to all VBE member organizations for transparency reasons, and is used for the assessment of their base level of trust.

For the third case, the evaluation of specific trustworthiness will be based on the so-called set of *specific trust criteria* identified by the trustor organization. Both the specific and the base trust criteria represent a subset selected among the list of *general set of trust criteria (VBE pool of trust criteria)*. Figure 3.6 shows the set of general trust criteria in the form of a wheel representing the three layers of trust perspectives, trust requirements, and trust criteria. As such, it illustrates the general trust criteria identified for VBE member organizations in respect to trust requirements and trust perspectives. Please note that, whenever needed, the general set of trust criteria for a VBE can be updated or extended by the domain experts with the help of

trust experts. Please also note that the base trust criteria usually constitute a subset of the general set of trust criteria, as selected by the VBE administrator for this purpose. The selection of trust criteria made by the VBE networks that have been used to demonstrate our results is presented in Section 6.6.2.

#### A. Trust criteria subordinated to social perspective

Trust in an organization related to social aspects is needed to maintain the organization's moral acceptance within the market and within the society. In Section 2.3.6 we addressed the social aspects of trust in relation to establishing collaboration between organizations. Figure 3.6, among others, presents a set of trust criteria related to the social perspective. Table 3.2, presents the description for each trust criteria of the social perspective.

Table 3.2: Description of trust criteria related to social perspective

Trust criteria	Description
<b>Activities participated</b> (AP, measured in: # of activities)	Societies in which organizations operate their businesses do have some activities that enable each specific society to achieve certain goals that maintain smooth continuity. Such activities may include: voluntary cleaning of the surroundings, voluntary participation in emergencies (such as providing support to people on earthquake disaster), voluntary support for sporting events, etc. Although participating in these activities does not directly influence the performance and profit of organizations, it enhances the social trust of the community. This encourages the society to support the organization and thus sustain its continuity, for example, by purchasing its products/services, supporting its operations, and so on.
<b>Services contributed</b> (SC, measured in: # of services)	Various services are needed within a society to maintain the balance of life in the community and ensure the survival of the society such as related to the provision of health, education, etc. Organizations can enhance their trust on the basis of social aspects by supporting, contributing and facilitating the realization of such services. For example, contributing to disabled schools, providing support for students' transport, contributing to the purchase of medicine for outbreaks of diseases, etc.
<b>Complied Standards</b> (CS, measured in: # of standards)	Every society maintains certain standards with which each organization operating within the community must comply. Common ones include: environmental standards, financial standards, cultural standards, etc. Such standards can influence the organization's trustworthiness in the eyes of the society and compliance with these standards shows how organizations perceives themselves as part of and belonging to the respective society.

#### B. Trust criteria subordinated to economical perspective

A large set of trust criteria related to economical perspective needs to be considered to support the creation of trust in organizations to smoothen their collaboration. In Section 2.3.6 we introduced the economical aspect of inter-organizational trust. We also show in Figure 3.6 the trust criteria for the economical perspective in Section 3.3. Below in Table 3.3 we present a description for each trust criterion for the economical perspective.

Table 3.3: Description of trust criteria related to economical perspective

Trust criteria	Description
<b>Cash capital (CC)</b> , <i>measured in: Euros</i>	In finance and accounting, capital refers to financial wealth especially that is used to start or maintain a business. In economics, capital refers to the physical assets that are used in relation to labor and other inputs in order to produce products and services. In business, the term capital refers to the money that is available for investment. Here, we refer to cash capital as the amount of money available to an organization that can be or has been invested in its businesses.
<b>Physical capital (PL)</b> , <i>measured in: Euros</i>	In general, physical capital refers to any non-human asset made or adopted by humans (excluding money) and then used in production. Often, it refers to economic capital in some combination of infrastructural capital and natural capital, such as machinery, equipment, buildings and land, acquired by an organization and applied in its businesses.
<b>Material (Operational) capital (MC)</b> , <i>measured in: Euros</i>	Otherwise known as working capital, this refers to current assets minus current liabilities. Operational capital is a measurement of the number of liquid assets an organization has and those it can use in order to build its business. In general, companies that have a high operational capital can be more successful as they have the power to improve their operations.
<b>Cash in stability (CI), cash out stability (CO), and profit/loss</b> (all three criteria <i>measured in: Euros</i> ):	Cash in refers to the amount of money that is received as a result of the daily business conducted by an organization. Cash in stability refers to the balance of the money that flow into the organization at a given period of time and the opposite of this is the <i>cash out stability</i> , which refers to the balance of the money that flow out of the organization. The difference between the cash in and the cash out gives the <i>profit/loss (net gain)</i> of the organization.
<b>Operational costs (OC)</b> , <i>measured in: Euros</i>	Operational costs are the daily expenses that an organization incurs in order to maintain its operations and thus these costs are usually subjected to specific opportunities.
<b>VO cash in (VCI), VO cash out (VCO) and VO related profit/loss</b> (all three criteria <i>measured in: Euros</i> )	These are similar to cash in, cash out and profit/loss respectively as described above, however, these refer specifically to achievements with respect to participations in VOs.
<b>Auditing standards (AS)</b> , <i>measured in: # of standards</i> ) and <b>auditing frequency (AF)</b> , <i>measured in: # of times per year</i> ):	an audit is an evaluation of an organization's financial performance that is carried out by competent, independent, and unbiased professionals known as <i>auditors</i> . The aim of an audit is to make an independent assessment based on a management's representation of their financial transactions using the organization's financial statements. The audit is also a means to ensure that the operational effectiveness of the internal accounting system is in accordance with approved and accepted accounting standards, statutes, regulations, or practices. Auditing frequency refers to the number of times that auditing must be done in certain period such as in one, two of five years.



### C. Trust criteria subordinated to technological perspective

There are a number of trust criteria that organizations must examine and consider when seeking to enhance their technological related trustworthiness as shown in Figure 3.6. Below, in Table 3.4, we describe the trust criteria related to the technological perspective.

Table 3.4: Description of trust criteria related to technological perspective

Trust criteria	Description
<b>Network speed (Broadband)</b> (NS, measured in: megabytes per second)	In computer networks this refers to the rate of data transfer supported by a network connection such as the internet, local area network, etc. In order for organizations to match the need for fast and efficient communication, as well as the rapid exchange of information, they must possess and maintain reasonable bandwidth for their computer network.
<b>Interoperability (IB)</b> , measured in: # of systems)	With respect to software, the term interoperability is used to describe the capability of different systems to exchange data via a common set of procedures, and to read and write in different formats and use different protocols. Organizations must possess interoperable systems and technologies to facilitate the setup of collaborations.
<b>Availability (AV)</b> , measured in: % of time)	Refers to the proportion of time that a system is in a functioning condition. Systems and computer networks of an organization that participate in collaboration must advocate high availability.
<b>Protocol supported (PS)</b> , measured in: # of protocols)	Refers to a set of guidelines that are used to guide communication between organizations through the use of an ICT infrastructure. Several communication and computing protocols are being used in today's world. Organizations are now confronted with heterogeneous protocols and must therefore be prepared to comply with as many of these as possible.
<b>Software standards (SS)</b> , measured in: # of standards)	Standards enable heterogeneous software to interoperate. Organizations must ensure that their systems are developed based on established standards and must conform with as many of these as possible.
<b>Hardware standards (HS)</b> , measured in: # of standards)	Unless applied in hardware, these standards are able to limit interoperability among technologies such as machines and other equipments. Organizations must be careful when purchasing hardware components or when manufacturing those components. They must conform to the available and specified hardware standards in order to optimize communications and collaboration with other organizations.
<b>Security standards (SC)</b> , measured in: # of standards)	These standards are becoming more fundamental due to the fact that sensitive information is now frequently exchanged on the internet and stored on computers that can be accessed remotely. Security standards in relation to organizational systems have become fundamental to organizations to guarantee both the confidentiality and the privacy of stored and exchanged information.
<b>Operating systems (OS)</b> , measured in: # of operating systems)	An operating system (OS) is a software program that manages the hardware and software resources of a computer. An OS performs basic tasks, such as controlling and allocating memory, prioritizing the processing of instructions, controlling input/output devices, facilitating networking and managing files. Operating systems have an important role in relation to both external communication and data sharing between

Trust criteria	Description
	organizations. Thus, organizations shall be prepared to apply any standard OS whenever it is a requirement for setting up the collaboration.
<b>Programming languages</b> (PL, measured in: # of languages)	A programming language is an artificial language that is intended to be used for controlling the behavior of a machine (often a computer). Like human languages, programming languages use syntactic and semantic rules to define meaning. They facilitate communication relating to the task of organizing and manipulating information, and many of these provide a way to accurately express algorithms. Programming languages adopted by organizations influence the chance to share and exchange technical and programming information, such as programming codes, with other organizations.
<b>Experience in applying the technology in VOs</b> (VO projects – VP, measured in: # of projects per year)	Technology can most broadly be defined as the material entities created by the application of mental and physical effort to nature in order to achieve certain values. An organization can demonstrate their capabilities related to using specific technology by showing its past experience with that technology in applying it in previous collaboration.
<b>External project applied</b> (EP, measured in: # of projects per year)	Organizations also participate individually in other businesses. For example, each organization may perform its daily activities serving its customers using the technologies it owns. The experience gained in such activities – once proved – can be used to show its experience with such technologies.
<b>Duration held</b> (YH, in: # of years)	This refers to the number of years that an organization has owned and has been using a certain technology.

#### D. Trust criteria subordinated to managerial perspective

A number of trust criteria related to the managerial perspective are shown in Figure 3.6. Below, in Table 3.5, we provide a description for each trust criterion.

Table 3.5: Description of trust criteria related to managerial perspective

Trust criteria	Description
<b>Management structure</b> (MS, measured in: # supported structure)	Various types of management structures are currently practiced in different kinds of organizations. The decision as to which management structure to implement is mainly linked to the purpose of an organization's existence and the nature of its business processes. In the literature, management structure is in fivefold, namely: simple structure, machine bureaucracy, divisionalized form, professional bureaucracy, and adhocracy. See further description in [Mintzberg, 1992]
<b>Years in power</b> (YP, measured in: # of years) and <b>frequency of power change</b> (FP, measured in: # of years per term)	The number of years a manager can stay in power in an organization depends on many factors, such as the nature of organization (business, educational, government, etc.), surrounding society (culture, country rules, etc.), the operating rules of the organization, etc. The frequency of power change influences: the level of experience that can be attained by managers, the possibility of exchanging power and the chance of learning from each other's leadership. Business organizations need highly experienced administration and therefore, allowing the managerial team

Trust criteria	Description
	to remain in power for a relatively long period is highly preferable.
<b>Opportunistic behavior (opportunistic occurred – OO, measured in: # of opportunistic events)</b>	Refers to an ungentle action taken by an organization for the purpose of benefiting unethically more than others (e.g. quitting the collaboration once the organization has achieved its own goals or if the risks are expected to arise). In competitive environments, this seems natural because the focus of organizations is to acquire customers without considering long-term relationships with others. In collaboration, however, organizations must collaborate with others in order to jointly respond to opportunities. Therefore, opportunistic behaviour in collaborations is discouraged.
<b>Successfully VO collaborations (SV, measured in: # of projects)</b>	An organization can improve in relation to both its experience and its performance by participating in as many VOs as possible. The trustworthiness of organizations is assessed to support the selection of the most trustworthy organizations to invite into the VO. This indicates that an organization which frequently participates in VOs has been assessed trustworthy by different trustors.
<b>VO participation as organizer/leader (VL, measured in: # of projects led)</b>	Previous VO participations as a leader indicate that the organization has been perceived trustworthy by other VO partners. Organizations are encouraged to participate in collaborative activities as leaders or organizers in order to enhance their managerial trustworthiness.
<b>Quality of products/services achieved (QA, measured in: # of projects)</b>	The quality of products and services that each organization delivers to customers for each project not only ensures customer loyalty, but may influence the decision made by those customers to accept offers that the organization makes on future occasions. Therefore, organizations must ensure that they produce products or provide services that meet the quality demanded by the customers.
<b>Adherence to delivery dates (AD, measured in: # of projects)</b>	Organizations should make sure that they adhere to delivery deadlines for each project agreed by the customers.

### E. Trust criteria subordinated to structural perspective

The structural perspective is in detail described in Section 3.2 and its subordinate trust criteria are shown in Figure 3.6. Trust criteria for this perspective are described below.

Table 3.6: Description of trust criteria related to structural perspective

Trust criteria	Description
<b>Size of an organization (measured in: # of employees)</b>	Refers to the number of people employed by the organization. Increase in number of employees indicates the availability of human resources that can be allocated when collaboration opportunities are brokered. The readiness of organizations to quickly act on emerging opportunities due to the availability of human resources enhances the structural trustworthiness of the organization.
<b>Geographical coverage (measured in: # of regions)</b>	Refers to the number of regions, such as cities, zones, states, countries and continents, in which an organization operates its businesses. As the

Trust criteria	Description
<i>in: # of cities)</i>	coverage increases, the organizations enhance their connections with others, which may ease the establishment of the trust relationships that are needed to smoothen the intended collaboration.
<b>Competences</b> (measured in: # of different competencies)	Competency influences the performance of an organization and it is currently a fundamental requirement for collaboration. An organization that possesses a number of different competencies has a better chance of sharing and complementing competencies with other organizations. This can lead to daily interactions between organizations which in turn enhances their trustworthiness.
<b>Personnel expertise</b> (measured in: # of experts in organization's businesses)	Refers to the available personnel skills and knowledge in different areas/domains that can be applied in emerging collaboration opportunities. As an organization acquires more experts, its structural trustworthiness improves, which may lead to more invitations to participate in VOs.
<b>Joint ventures</b> (measured in: # of organizations)	Refers to other partners, such as agents, alliances, and so on which are able to represent the organization in its business. Such joint ventures are now common, for example, among flight companies, where passengers who buy tickets from a different company may find themselves flying with another company. These types of joint ventures indicate a certain level of reliability of the company in its businesses and also in its trust with respect to previous cooperation.
<b>Centres</b> (measured in: # of centres)	Refers to the number of offices, service delivery points, production centres, branches, etc., of an organization. The number of centres indicates how distributed the organization is and how easily it can deliver products/services to its customers.
<b>Workload allocation</b> (measured in: # of specified unit)	Refers to the <i>maximum level</i> that an employee of a certain organization can be exploited. The level of workload varies depending on the domain, business environment, legal system, and so forth. E.g. the workload of doctors in medical organizations is typically measured in terms of "the number of patients to which a single doctor can attend in a day", while the workload of employees in a business organization is typically measured in terms of "the number of hours that each employee must be at work". Similarly in the manual production/processing businesses, this can be measured in terms of the amount or number of items produced per day.

### 3.3.2 Trust elements for creation of trust from members towards the VBE administration

The trust of a VBE member organization towards the VBE administration must be created and maintained in order to enhance the interests and loyalty of the member with respect to the VBE establishment, a trust which in turn also increases its active involvement in VBE's activities. In this thesis we have identified four trust perspectives that together represent the primary aspects of this trust objective and can be used to create trust in a VBE member organization towards a VBE administration (Figure 3.7) where the detail inside this figure is represented in Figure 3.8 [Msanjila & Afsarmanesh, 2007a]. As such, the approach suggests that the VBE member organization should be able to access the necessary information related to these four trust

perspectives. Figure 3.8 shows the general trust criteria for trust between the VBE member and the VBE administration.

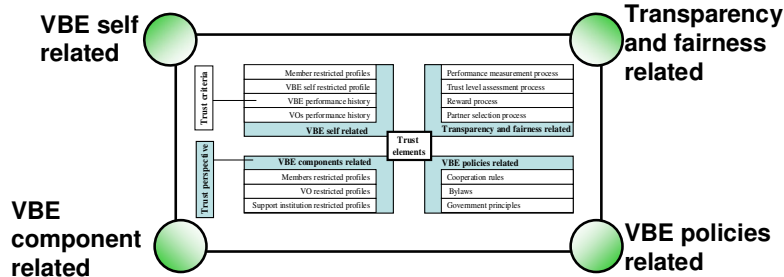


Figure 3.7: Rectangle of trust perspectives for trust in members to the administration. The descriptions of these elements are provided below and further classification is provided in Figure 3.8.

Furthermore, a VBE member organization needs to be convinced that the VBE administration is trustworthy in order to join and remain active in the VBE. For example, since VBE member organizations continuously compete to win an opportunity to participate in VOs that are configured within the VBE, they must be convinced that the VBE administration is impartial and that the selected member organizations for each VO are chosen on the basis of their qualifications. Below we address four trust perspectives for this trust objective and provide the subordinate trust elements under each trust perspective as shown in Figure 3.8.

i) **VBE policy related perspective:** VBE policy addresses the plan of action that guides VBE decisions and activities. Policies can be understood as political, management, financial, and administrative mechanisms for reaching explicit goals. For VBE environments, the main aspects related to trust, and the policies that must be accessible to member organizations are illustrated in Figure 3.8.

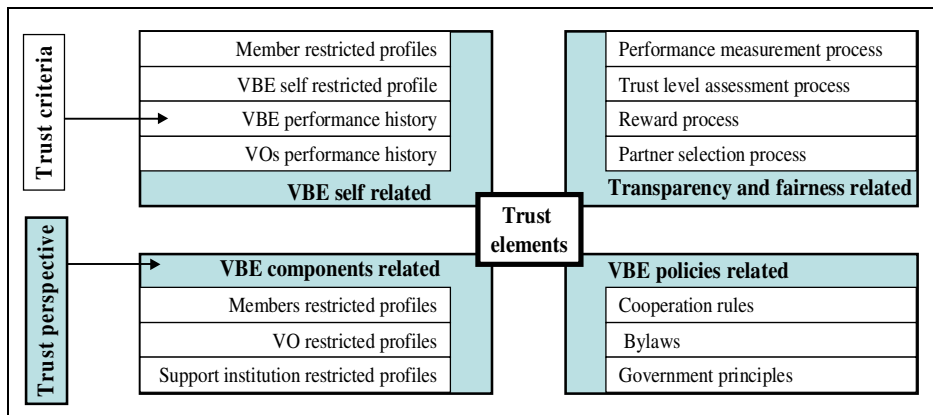


Figure 3.8: Rectangle of trust elements for trust in members to the administration. This figure shows a classification of trust criteria per perspective for the objective of creating trust from members to the administrator as described in this section.

ii) **Transparency and fairness related perspective:** A VBE administration must be transparent and fair to all VBE member organizations. In particular with respect to some of the main transparency issues that are sensitive here and refer to the steps taken or activities

performed during the entire process of assessing the level of trust in member organizations and measuring their performance, which in turn is a key source of trust related data. Fairness refers to the fact that as much as possible should constitute a formally unified reasoning mechanism and approach in relation to the decisions made in the VBE, and that all aspects are as “rational (fact-based)” as possible. For this purpose, information about trust elements ( Figure 3.8) must be accessible by all VBE members.

*iii) VBE component related perspective:* The VBE component-related perspective refers to the components that constitute the VBE. The main component of the VBE is its member organizations and its VOs. Another component of the VBE constitutes the supporting institutions. A VBE member organization that wants to assess the trustworthiness of the VBE and its administration will need the information related to the VBE structure and its components. The organization can be provided with information for three trust elements for this perspective, as represented in Figure 3.8.

*iv) VBE-self related perspective:* When it comes to trusting the VBE, member organizations must also be provided with information that will serve to build a positive picture of the VBE as a whole. Here the relevant information needs to address the performance of VOs and other information about VBEs that are restricted for its members, as in Figure 3.8.

### 3.3.3 Trust elements for creation of trust from external stakeholders towards the VBE

This section addresses another main VBE trust objective, namely the creation of trust between external stakeholders and the VBE. By external stakeholders we refer to the two kinds of actors, namely a potential organization that aims to become a VBE member, and a customer that aims to either buy VBE products or recommend the VBE for a bid made for a collaboration opportunity. There are two ways that lead to an organization becoming a member in the VBE. Firstly, when the respective organization finds the VBE an essential environment for its businesses, and thus submits an application for membership. In this case, in addition to other assessments such as competency compliance, the new membership applicant will be assessed to analyze whether it meets the required base trust level. This manner of becoming a VBE member and the required trust level assessment is addressed in Chapter 5. Secondly, when a VBE identifies gaps, such as the necessary competencies, it might search for some external competent organizations in the market to invite. Therefore, the process of such an organization becoming a VBE member is initiated by the VBE itself by means of invitation. Nevertheless, in both cases organizations will need to create trust for the VBE and its suitability for their businesses.

Similarly, customers must also be supported to trust the VBE establishment. The VBE operates in a common market where there might be other competitor VBEs and even individual powerful companies. To pursue the customer to either buy VBE products or recommend the VBE for a collaboration opportunity, the customer must be convinced about the trustworthiness of the VBE. To support the achievement of this trust objective, we identified three trust perspectives in our research that external stakeholders can assume as primary aspects when building trust in the VBE. External stakeholders must be provided with information based on preferred trust perspectives as shown in Figure 3.9 where the detail inside this figure is represented in Figure 3.10.

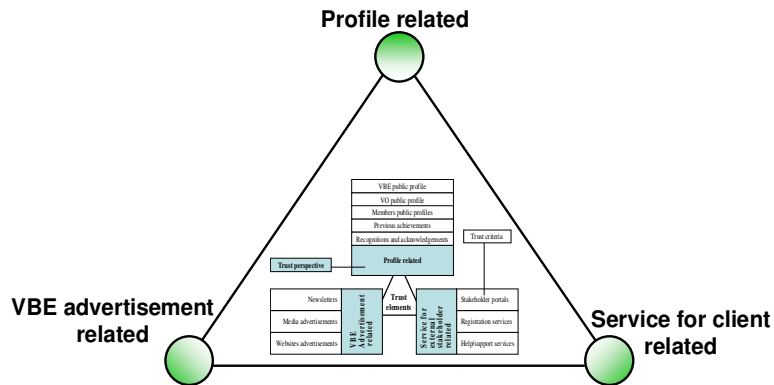


Figure 3.9: Triangle of perspectives for creating trust of external stakeholders to the VBE. The descriptions of these elements are provided in following paragraphs and further classification is provided in Figure 3.10.

Therefore, in order to accept the invitation to join or decide to apply for membership, the organization will need to trust the VBE. Moreover, in order to select the VBE (e.g. when a customer wants to provide a tender or needs to accept the VBE for a business opportunity), customers will need to trust the VBE. We recommend providing these external stakeholders with the information related to the three specific trust perspectives described below, and also summarized in Figure 3.10:

*i) Profile related perspective:* This information will enable the external stakeholder to understand the constituents of the VBE and its related competencies. It includes: (1) VBE public profile including list of members and list of VOs, (2) VO public profile including partners and VO performances, (3) VBE members' public profiles, (4) Previous VBE/VO product/service recognitions, and (5) Specific previous VBE/VO achievements.

*ii) VBE advertisement related perspective:* As in the normal business world, VBES will also advertise their products and services (offered through VOs) to the market. Information on advertisements that are usually made can indicate the capability of the VBE to support its members for business opportunity brokerage and also its capability to reach its customers. Such information can include the following: (1) Copy of advertisements in the media, (2) Link of advertisements in websites, and (3) Newsletters.

*iii) Service for client related perspective:* An external stakeholder, such as a customer, can be convinced to trust the VBE on the basis of the availability of services that it needs and the quality or comprehensiveness of the support that will be provided when acquiring these services. This includes: (1) Member or customer portal, (2) Membership or customer registration functions and (3) Help or support services.

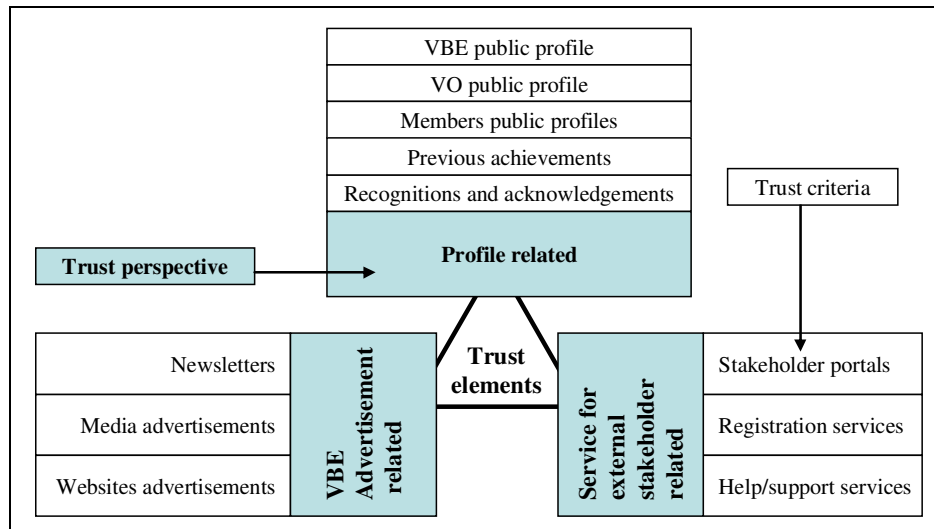


Figure 3.10: Triangle of elements for trust in external stakeholders to the VBE

*This figure shows a classification of trust criteria per perspective for the objective of creating trust from external organizations to the VBE as described in this section.*

### 3.4 Chapter discussion and conclusion

This chapter presents the HICI approach, which is used to identify trust elements for organizations. HICI constitutes three stages that address: the identification and characterization of trust elements, analyzing the impact of relations between trust elements and the performance of organizations (and thus addressing their levels of trust), and analyzing the causal influences between the trust criteria, the known factors and the intermediate factors.

By involving industrial VBE networks at the requirement analysis stage as well as applying the HICI approach, we were able to identify and characterize a set of general trust elements. A set of generic trust elements for organizations is presented in this chapter. These trust elements are categorized into their three respective main trust objectives as characterized by applying the HICI approach, namely for the building trust from: (1) a member organization towards other member organizations, (2) a VBE member organization towards the VBE administration, and (3) an external stakeholder towards the VBE and its administration.

This chapter has thus addressed two main research questions introduced in Section 1.5. It addressed the main research question MRQ1 by presenting the approach for identifying and analyzing trust elements for organizations. It addressed MRQ3 by introducing concepts regarding a multi-criteria-based approach for assessing level of trust in organizations. It further addressed MRQ3 by presenting the causal analysis approach which is applied to formulated mathematical equations. The formulated equations are further applied to the development of mechanisms for assessing trust level of organizations (Chapter 5). In Chapter 7 an integrated overview is presented of how all research questions of Section 1.5 are addressed in this thesis.

In response to the research questions as mentioned in the above paragraph, this chapter provides two key contributions of this thesis, namely: (i) the proposition of the systematic



approach (HICI) for identifying, characterizing and analyzing trust elements for organizations, and (ii) the presentation of the comprehensive general set of trust criteria for organizations. We have also addressed the characterization of performance data in terms of trust criteria, which is the main input data to the assessment of trust level of organizations (see Section 3.2.2). Based on this characterization it is possible to identify specific trust criteria whose values must be improved to enhance the trust level of a particular organization. The modeling of classes for the identified trust elements is presented in the next chapter (Chapter 4). The analysis of inter-relations among trust criteria in terms of causal influences, whose results provide a base for the formulation of mechanisms for assessing trust level of organizations, is presented in Chapter 5.