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ASSESSING ORGANIZATIONS COLLABORATION READINESS
A BEHAVIORAL APPROACH

Dissertation presented at the Faculty of Sciences and Technology of the New University of Lisbon to obtain the degree of Doctor in Electrical Engineering, specialty of Robotics and Integrated Manufacturing, held under the guidance of Professor Luís Manuel Camarinha de Matos.

LISBOA
2009

ACKNOWLEDGEMENTS

It is generally accepted that making a PhD is a very hard work, and that some of its phases require an effort, of almost superhuman nature, determination, will and faith. The quest for the satisfactory answers to the research questions and facing sudden adversities, manifested collaterally in the form of severe effects in the physical and mental health of the researcher, including a proudly bald head. As the supervisor many times told us, “a PhD is also a psychological resistance test”.

The successful achievement of this thesis’ goals would not be possible without the help of several people that very kindly supported me during the walk through this frantic time. Without more delays, I want to thank the very much appreciated help received from the following people and entities:

To Professor Luis Camarinha-Matos, supervisor of this thesis, who provided me a continuous and intense support and help during the work, namely at the scientific guidance, logistic, material, intellectual and mental levels. His continuous psychological pressure exerted over me was a determining factor for finishing the work.

To Faculty of Sciences and Technology which provided me the resources that were necessary for undertaking the thesis, and on which I am proud to work as a staff.

To Uninova, which provided me valuable resources for the research work.

To Fundação da Ciencia e Tecnologia for the financial support provided during these three years.

To the ECOLEAD and ePAL European projects, which allowed quite beneficial interactions with international experts from the field of collaborative networks and other related areas.

To my family Rosa, Pedro and Beatriz for their support and tenderness. Even at an early age, Beatriz understood it was necessary to abdicate of her father during countless weekends.

To Patricia Macedo, for the fruitful discussions, the joint work, the friendship, and the wonderful teas with honey taken there in Mr. Carlos’.

To Tiago Cardoso, for the logistical support, friendship, and for sometimes running away to the nearest bar for a couple of beers (and you must stop smoking!).

To all other people that somehow contributed to my effort during this work.

Thank you everybody.

SUMMARY

This thesis presents an approach for assessing organizations' readiness to collaborate. This assessment is based in three fundamental aspects, namely (1) on collaboration preparedness, which aims at assessing whether a partner has adequate collaboration-related character traits; (2) on competencies fitness which is predominantly aimed at assessing how well an organization is able to use its competencies in a collaboration context; and (3) on willingness to collaborate, which is a concept applied to assess whether an organization is, or is not, really interested to engage in concrete collaboration opportunities.

The proposed approach contributes to the formation of improved collaborative networks, increasing their likelihood of success. The principal characteristic of the model lies in the fact that it follows a behavioral perspective. As such, collaboration preparedness is based on the idea of the organizations' character, traits and behavioral patterns. Competencies fitness is in turn based on the so-called soft competencies, exploring the performance influences/effects of the soft competencies on the hard ones in a collaboration context. Finally, willingness to collaborate is based on the organization's planned behavior, attitudes and intentions that are perceived in/from a partner.

The work involved in the conceptualization of readiness to collaborate includes the utilization of text data mining to discover the behavioral aspects, namely the collaboration-related organization's traits which are relevant for assessing collaboration readiness. Bayesian belief networks are proposed as a way to deal with the underlying uncertainty in assessing collaboration readiness.

A soft versus hard competencies dichotomy is used to develop the concept of competencies fitness, proposing the adjusted competencies profile and the fitness level, as the way to assess whether a partner's competencies fit in a collaboration opportunity.

The Theory of the Planned Behavior is adapted from social sciences and used in organizations in collaboration contexts. Various modeling experiments were performed to assist in the development of this readiness concept. The validation through some cases of partnerships is proposed to evaluate the underlying collaboration readiness assessment model.

SUMÁRIO

Esta tese propõe uma abordagem para avaliar o nível de prontidão das organizações para colaborarem. Esta abordagem baseia-se em três aspectos fundamentais, que são o nível de preparação para colaborar, que visa aferir se uma organização possui traços ou características adequadas para um ambiente de colaboração; o alinhamento de competências, que visa aferir até que ponto uma organização consegue utilizar as suas competências num ambiente de colaboração; e na vontade de colaborar, que visa aferir se uma organização está manifestamente interessada em participar em oportunidades de negócio concretas.

A abordagem proposta tem como objectivo contribuir para a formação de melhores redes colaborativas, correspondendo a uma maior probabilidade de sucesso. A principal característica do modelo desenvolvido reside no facto deste seguir uma abordagem comportamental. Como tal, a preparação para colaborar baseia-se em ideias assentes no carácter das organizações, em traços e padrões de comportamento. Por sua vez, o alinhamento de competências baseia-se na ideia das competências “soft”, explorando os efeitos que essas exercem sobre as competências de carácter mais “hard”, num ambiente de colaboração. Finalmente, a vontade para colaborar baseia-se no conceito de comportamento planeado, atitudes e intenções que podem ser percepcionadas num parceiro.

O trabalho envolvido na conceptualização do nível de aptidão para colaborar incluiu a utilização de mineração de dados sobre fontes bibliográficas, de forma a descobrir quais os aspectos ao nível comportamental, nomeadamente quais os traços mais relevantes em termos de colaboração e importantes para medir esse nível. Propõe-se também a utilização de redes Bayesianas como uma forma de lidar com a incerteza inerente ao processo de avaliação da capacidade para colaborar.

A utilização de uma dicotomia entre as competências “soft” e as de carácter mais “hard”, dá origem à ideia de perfil ajustado de competências e de alinhamento de competências, tendo em vista aferir se as competências de um determinado parceiro estão bem ajustadas em oportunidades de negócios específicas.

A Teoria da Acção Planeada é adaptada para ser usada num contexto de colaboração. Descreve-se também um variado número de experiências que auxiliaram no desenvolvimento do conceito de aptidão para colaborar. Recorreu-se também à utilização de alguns casos de parcerias entre organizações como forma de validar o modelo usado na avaliação da prontidão para colaborar.

SYMBOL LIST

Symbol	Description
ATB	Attitude Towards Behavior
CN	Collaborative Network
CNO	Collaborative-Networked Organization
CO	Collaboration opportunity
DVO	Dynamic Virtual Organizations
hc	hard competency
IQM	Intentions Query Mechanism
MBTI	Myers Briggs Type Indicator
MC	Motivation to comply
NB	Normative beliefs
o	organization
OCI	Organization Character index
org	organization
P	Preparedness (to collaborate)
PBC	Perceived Behavioral Control
PC	Preparedness condition
PP	Preparedness pattern
PVC	Professional Virtual Community
R	Readiness (to collaborate)
SC	Soft competency
SI	Social Influence
TPB	Theory of the Planned Behavior
VBE	Virtual Organization Breeding Environment
VE	Virtual Enterprise
VO	Virtual Organization
W	Willingness (to collaborate)
WPCO	Well Prepared to Collaborate Organization

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1 Introduction

*“If I had one hour to save the world
I would spend 59 minutes defining the problem
and one minute finding solutions”*
Albert Einstein

1.1 Stating the research question

Typically, organizations engage in partnerships as a way to together grasp new opportunities and accomplish goals which would not be achieved if working alone. In such partnerships, the involved entities work together and combine their assets in order to fulfill a number of common or compatible goals. Since the advent of ICT, and specially the growth of computer networks, the traditional ways of partnering evolved into new forms, known as collaborative networked organizations. Organizations engage in these networks as a strategy to together compete in, and protect from a market environment of growing complexity, characterized by a fierce competition and high globalization in a context of large uncertainty. In such an environment, these partnerships are seen as both providing a competitive advantage and as a survival factor. Therefore, it is of great importance that partnerships are planned in a way that increases their likelihood of success. This success depends, among other factors, on the organizations' readiness to collaborate.

The aim of this work is to address the assessment of organizations' readiness to collaborate. This is a subject that has been addressed for several years (Camarinha-Matos, Afsarmanesh et al., 2005), (Romero, Galeano et al., 2008), (Gall and Burn, 2007), (Afsarmanesh and Camarinha-Matos, 2005). Existing approaches, however, are based on models more focused on "hard" factors, such as organization's competencies, technological preparedness, ICT and networking, and adopting a variety of performance indicators. Being of a more functional and technological nature, these models do not seem to address other truly relevant issues which affect collaboration readiness. In fact, there are issues fundamentally of a more "soft nature", namely those related to the behaviors, attitudes, habits and the values of organizations, which are more adequate to

characterize an organization in a collaboration context, mainly in what concerns its readiness to collaborate.

Although such concepts start to be considered in more recent research, the topic of collaboration readiness has probably not been addressed from a proper perspective. This is due to the fact that most research does not put the focus on organizations' behavior. To illustrate the idea, when an organization considers a new partner, it has already got a general idea of some of its competencies, being its main concerns focused on whether its new partner is likely to be a good one or not, which depends to a great extent on how it will behave. Putting the focus on a more behavioral perspective breaks up from existing research, mainly focused on assessing "functional" competencies and technological performance. This new perspective raises new difficulties and opens difficult challenges, which previous approaches could not adequately handle. One of such challenges is to find an adequate way to model organization's behavior which, as this work shows, is a fundamental concept in assessing collaboration readiness. This shift towards a behavioral perspective raises the necessity for new models and assessment methods, which are able to comply with these soft aspects of organizations. As a consequence, the main research question pursued during this work is:

How to effectively model collaboration readiness?

Obtaining a satisfactory answer to this question will lead to a model for representing organizations' collaboration readiness with a corresponding assessment approach. By assuming a behavioral perspective of collaboration readiness, the proposed approach aims to bring new insights on how to increase the chances of partnership success.

It is worth to mention just at the start that the notions of collaboration readiness and preparedness might appear as similar concepts, which is often the assumption in literature, but are in fact distinct. These differences are clarified during this work.

1.2 Motivation why this is a worthwhile question

In order to understand why a model of collaboration readiness is so important, and why the approach should be focused on a behavioral perspective, it is necessary to address the very factors underlying partnerships success/failure.

First of all, it is important to notice that the overall success rate of alliances hovers near 50% (Ernst and Bamford, 2005). The reasons for such a high number of failures are varied, including competition, market turbulence, and the endogenous factors related to the partnerships and their members. Just to bring some light in order to establish a framework, a small research was performed, aimed at enquiring about which causes are referred by researchers and entrepreneurs, which led to the success or the failure of partnerships. The work involved analyzing web documents concerned with partnerships and the factors of success or failure mentioned in those documents. The obtained results are a list of factors, which are summarized in Fig. 1.1. The method to obtain this list consisted of the following steps:

- Search the WEB for documents referring partnerships' success/failure factors.
- Collect these factors and split them in two groups, one for the success and the other for the failure factors.
- Observe each factor trying to perceive a possible behavioral connotation.
- Factors from both groups with such connotation are underlined (Fig. 1.1).

A factor has a behavioral connotation whether it is more related to behavioral aspects, and less to technical, financial or managerial ones. For instance, the “establishing of attainable goals” can be considered as having a behavioral connotation, because the word “attainable” is related to the words “reasonable” and “realistic”, meaning that the partnership should together be able to establish achievable goals. Other factors, such as “decision by consensus”, “fairness” and “trust” on the positive side, and “differences in partners' values”, “criticism”, “weak partner commitment”, “worry about lost of independence” and “blaming and feeling blamed” on the negative side can also be considered behavioral factors. Lastly, “resources sharing” or “knowledge sharing” can be considered behavioral, because such acts depend on a partner's ability and willingness to share.

Factors of success

Establishing of attainable goals, unrelenting focus on the client, common purposes, common values or norms, good communication, decision by consensus, creativity, fairness, flexibility (flexible set up of VO), existence/use of adequate ICT, best use of interests, knowledge sharing, joy in working together, visible leadership, mutual needs and opportunities, organizational readiness, open and honest participation, partnershiping skills, existence of performance measurement and reporting mechanisms, resource sharing, roles fitness, skills fitness, trust among partners, willingness to commit resources and capabilities, development of social skills, trying to like your partner, compatible culture, share knowledge motivation, and trust.

Factors of failure

The absence of trust, cultural incompatibility, differences in partners' values, forgotten agreements, inefficient alliance leadership, low levels of commitment or interest, partners who don't agree on realistic roles, personality conflicts, poor communication, power struggles, relationship breakdowns, unrealistic or unclear expectations, weak partner commitment, worry about lost of independence, blaming partners and feeling blamed, criticism, feuds and competition between partners, floundering, individualism, lack of flexibility, loss of autonomy, overbearing or dominating partners, reluctant partners, rush for accomplishment, unquestioned acceptance of opinions as facts, changing priorities, drastic market changes, external forces, poorly negotiated terms, product failure, underestimating the risks and difficulties in partnering, conflicting goals, conflicting mission, and (unsuccessful) past collaboration history.

Fig. 1.1 – Factors of success and failure of partnerships obtained in partnership-related web documents

Although this list may not be exhaustive, it can be considered enough to get the idea. Due to the impressive number of behavioral factors found in the analyzed reports, an assumption can be made that probably most partnership failures are caused by behavioral factors. For instance, about 47 out of 64 of the above factors (accounting for 73%) are of behavioral nature. No existing models in the literature seem to be able to address these factors in their behavioral true nature, nor even relate them to partners' readiness to collaborate. It is for this reason that the established research question should be pursued. Although reduced in number, the remaining factors which correspond to a more "technological"/management nature are the ones that have had more attention in other research works.

1.3 Research hypothesis and goals

From the above section, a first research hypothesis for this work should be that collaboration readiness is a behavioral subject, and that an adequate modeling approach should assume a behavioral perspective. This hypothesis will be based on the concepts of organization's behavior, behavioral patterns, traits, and a number of additional factors. We basically assume that if we can predict that an organization is likely to

behave according to what it is usually expected in a good partnership, then this organization can be considered well prepared to collaborate.

The rationality for this hypothesis is based on the assumption that an organization involved in a partnership works and interacts with its peers towards the achievement of common or compatible goals, during which they manifest a variety of behaviors, according to the situations they are involved in. These behaviors tend typically to show some repetition through time. This repetition in turns leads to the formation of behavioral patterns, which can be associated to a set of identifiable traits. In this sense, traits are used to characterize the behavior of organizations. A *trait* represents a relatively stable predisposition to act in a certain way or, in other words, the preponderance for the occurrence of a certain behavioral pattern (Webber, 2006). Examples of behavioral patterns are perceived when a partner performs a reliable or friendly behavior. These traits, together, form what is referred to as character. An organization's *character* can therefore be seen as a composition of a set of traits that determine the behavior or nature of the organization.

This suggested mapping between character traits and behavior can be used to perform behavior prediction. It is here that the hypothesis being addressed in this work can be established. Given the mapping between traits and behavioral patterns, and given that using these mappings one can perform behavior prediction, it is possible to assert collaboration readiness. Basically if the predictable behavior is considered positive towards collaboration, then the readiness level increases, otherwise it decreases. This means, that collaboration readiness assessment can be performed using the concept of organization's character. It shall be noted that the intrinsic connection between character traits and behavior has traditionally been an extensive research topic in Psychology, as expressed in (Goldie, 2004) and (Webber, 2006).

A remark must be made to this readiness hypothesis. It adequately establishes a behavioral perspective for collaboration readiness. However, as explained in subsequent chapters of this work, the readiness concept must be of a composite nature. This requirement lies in the fact that, beyond behavioral preparedness, readiness to collaborate also depends on the organization's competencies, which are the competencies required in a collaboration opportunity. Without these competencies, an organization cannot be considered ready to collaborate. Readiness also depends on the organization's willingness to collaborate. The willingness concept is used here to assess whether an organization is really interested in a given collaboration opportunity. If this interest is low, then the organization's willingness to commit itself and react promptly

to partnership demands is diminished, which poses a negative effect in its readiness. This composite structure of readiness is explored in the remaining chapters, together with additional research hypothesis related to each of the readiness' constituents, namely collaboration preparedness, competencies fitness, and willingness to collaborate. In this work, incidentally, even competencies fitness and willingness to collaborate are also seen from a behavioral perspective.

The mentioned issues cannot be addressed by existing models, as they require a behavioral approach, which none have yet proposed. Therefore, this work is fully committed to explore a behavioral perspective for developing a collaboration readiness assessment model (Fig. 1.2).

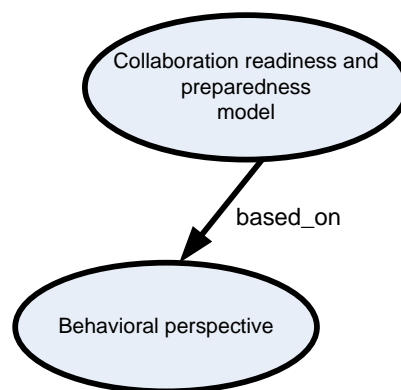


Fig. 1.2 – The adopted approach

In order to achieve the established commitment it is necessary, during this work, to perform the following steps:

- Clarify the concepts of collaboration readiness and preparedness.
- Clarify the concepts of organization's behaviors, traits, and behavioral patterns.
- Clarify the importance of a behavioral approach to collaboration readiness, and show that without considering the behavioral factors, readiness assessment is an incomplete process.
- Build a model to perform collaboration readiness, encompassing preparedness, competencies fitness, and willingness to collaborate.
- Propose a validation strategy.

As to finalize, we can relate collaboration readiness to the subject of consortia formation. In this sense, if a partnership is composed of entities well prepared to collaborate, according to the proposed readiness model, we can expect higher partnership success.

1.4 The research method

The research method for this work, which is based on the traditional scientific method, includes:

1) Establish the motivation for a collaboration readiness assessment approach

In this phase the aim is to depict the importance of collaboration readiness in the creation and success of collaborative networks. Considering the behavioral perspective mentioned before, the problem in question consists on identifying how to adequately model the concepts involved in collaboration readiness assessment.

2) Background information for collaboration readiness

During this phase, the aim is to collect enough information and evidences, which provide clues for the modeling approach pursued during this work. The analysis of relevant literature is thus conducted at this stage.

3) Formulation of collaboration readiness hypothesis

The strategy for establishing the collaboration readiness hypothesis consists of trying to establish a relation between organizations' behavioral determinants, e.g. their behavioral traits, and collaboration readiness. As mentioned before, this hypothesis is based on the assumptions that the expected behaviors can be used to assess collaboration readiness.

4) Design of the collaboration readiness assessment approach

This part involves the development of the collaboration readiness model. It starts by the clarification of fundamental concepts, e.g. the notion of organizations' behavior, behavioral patterns and traits. The research continues with the specification of each readiness's components, namely collaboration preparedness, competencies fitness, and willingness to collaborate. In specific terms, the work involved in the development of each of these components is:

Preparedness – Determination of the more important organization's traits in terms of collaboration preparedness, and the development of a corresponding traits-based collaboration preparedness assessment.

Competencies fitness – Clarification of the hard versus soft competencies dichotomy, and why it is important for partnerships. Then the development of the competencies fitness concept, and a corresponding assessment approach, are performed.

Willingness to collaborate – Clarification of this concept and its importance in partnerships. Then the corresponding assessment part is developed.

After developing each of the mentioned parts, the obtained components are combined in order to form the collaboration readiness assessment approach.

5) Model validation

The validation process involves two parts, which are the validation of the research work, and thereafter, the validation of the readiness model. Due to the difficulty in obtaining enough and more detailed information for a sufficient number of cases, some validation approaches, such as statistical ones, cannot be applied. As such, the readiness model will be applied on a few cases of partnerships using corresponding information from web documents. Rather than trying to perform full assessments, it will be shown that using the readiness model would provide a better perspective about the factors that affected the partnership in each of the considered cases.

1.5 The ECOLEAD project context

This work started within the ECOLEAD project. One of the aspects from this project more related to this work was the realization of the importance of the soft aspects in collaborative networks. During this section, an overview of this project is provided, aiming at introducing the context of this work.

1.5.1 The vision and goals of ECOLEAD project

The ECOLEAD project was launched with the aim to provide the foundations and mechanisms for establishing an advanced collaborative and network-based industry. The pursued vision was that in the near years many enterprises would be part of some sustainable collaborative networks which would act as breeding environments for the

formation of dynamic virtual organizations in response to fast changing market conditions (Camarinha-Matos, Afsarmanesh et al., 2005).

The underlying rationale of ECOLEAD was that the efficient launching and operation of virtual organizations require organizational preparedness, both in terms of VO environment and involved entities. The core research of ECOLEAD addressed three main areas (as seen in Fig. 1.3), namely VO 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.

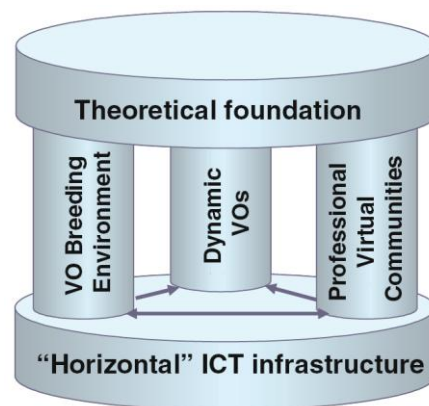


Fig. 1.3 – The ECOLEAD focus areas (Camarinha-Matos, Afsarmanesh et al., 2008)

Each of these three main areas was focused on the following aspects:

VO Breeding Environments

The aim of this focus area was to provide a substantial contribution for the VBE concept in terms of understanding and formalizing the operating principles, the infrastructures and services to support the VBE life cycle. The included actions were:

- Development of generic models and mechanisms for VBE operation - Some of the aspects addressed were the definition of working and sharing principles, the elaboration of common ontologies, partners' competencies, and value systems.
- Development of a VBE management system - to support mechanisms for the daily operation and evolution of VBEs. Some of the aspects addressed in this area are the mechanisms for: competencies management, trust management, assets management, and performance catalog management.
- Development of a VO creation framework – To support the creation of VOs within VBEs. It includes the provision of guidelines for VO configuration and

launching, collaboration opportunity identification, mechanisms for partners search and suggestion, negotiation and contracts establishment.

Dynamic VOs management

The challenges of VO management come from the temporary nature of VOs and the need of fast reaction 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 concrete actions developed for Dynamic VOs management are:

- The definition of VO performance measurement approach and assessment mechanisms.
- The VO management, coordination and supervision.
- The VO inheritance management.
- The development of generic business support e-services.

Professional Virtual Communities (PVC)

This focus area aims at leveraging the human centered management and exploitation of knowledge and value creation in a PVC, and to ensure the members' motivation, commitment and welfare. The actions for this area were the following:

- Elaboration of collaboration models and social forms.
- Development of advanced collaboration space platforms.
- Business models for PVC exploitation.

Complementarily to the above “vertical” areas, the following “horizontal” areas were also considered:

Theoretical foundation

This area is focused on the contribution to the establishment of collaborative networks as a recognized scientific discipline. The corresponding actions were:

- Establishing a formal modeling foundation for collaborative networks.
- Elaborate reference models for collaborative networks.
- Develop soft models for collaborative organizations.
- Establish the basis for combination of models.

ICT horizontal infrastructure

This area is aimed at contributing to the development of technological enablers of collaborative behaviors in collaborative networks. The actions for achieving this objective were:

- Elaboration of infrastructure reference architecture principles for Collaborative Networked Organizations (*CNO*).
- Devise new business models for the horizontal infrastructure.
- Develop generic security framework for distributed collaborative environments.

An extensive account of the achieved results can be found in (Camarinha-Matos and Afsarmanesh, 2008) and (Camarinha-Matos, Afsarmanesh et al., 2008).

1.5.2 Relating ECOLEAD and this work

This research work started to be forged during the ECOLEAD project. Since the very beginning an effort was made to establish compatibility between the thesis and ECOLEAD in terms of objectives to be achieved, namely to benefit from a synergistic effect in terms of efforts deployed and resources used.

In concrete terms, this thesis meets an action area of ECOLEAD related to the development of soft models for collaborative networks. This area was concerned both with the behavioral aspects underlying collaborative networks, and the decision making in face of incomplete and imprecise information. The work performed in this area consisted of knowledge modeling for assessing collaboration preparedness using Bayesian belief networks and Rough Sets. This research on collaboration preparedness was in fact the starting point for the collaboration readiness assessment modeling approach pursued in this thesis. The author of the thesis had a relevant contribution to this part of ECOLEAD (Camarinha-Matos and Afsarmanesh, 2008).

1.6 Structure of the thesis

The structure of this thesis is composed of the following chapters:

Chapter 1 (Introduction) – Introduction of the research question and why it is a worthwhile one.

Chapter 2 (Literature review) – Review of existing research, theory and concepts which can be related, contribute to, or even help establish the context for this research. A special effort is devoted to clarify why behavioral aspects of a human realm can be applied to organizations in a collaboration context.

Chapter 3 (The collaboration readiness model) – The collaboration readiness model is introduced. It starts by clarifying the relevant concepts related to collaboration preparedness, namely the mentioned behaviors, behavioral patterns and traits. The model description proceeds with the remaining components of readiness to collaborate, namely competencies fitness, and willingness to collaborate.

Chapter 4 (Modeling experiments) – Includes an explanation of the modeling experiments performed during the development of the collaboration readiness assessment model. For instance, one such experiment consists of determining which organizations' character traits should be observed in order to assess collaboration preparedness. Furthermore, an approach to improve such experiments into components able to be integrated into decision support systems is suggested. This is illustrated by a partners' suggestion mechanism developed during this phase. There is also a modeling experiment for competencies fitness, aimed at showing the effects of the soft competencies in the performance of hard ones in a context of a given collaboration opportunity. Finally, an experiment is performed in order to show how to assess willingness to collaborate.

Chapter 5 (Model validation) – This chapter is devoted to the description of the validation for this thesis. It starts by clarifying the difficulties of performing a validation in a work involving organizations in a collaboration context, followed by proposing an approach more adequate for this work. The validation process is twofold, firstly aiming at assessing the work performed during the research, and afterwards focalizing in validating the readiness model itself.

Chapter 6 (Conclusions and future work) – This chapter is devoted to the conclusions of this thesis. It starts with a synthesis of the research aimed at obtaining the collaboration readiness assessment model, followed by an enumeration of the contributions obtained from this research work. Finally, some alternative ways for the future improvements of this work are put on the spot.

2 Literature review

“The more we share, the more we have”.
Leonard Nimoy

The aim of this chapter is to synthesize current research related to collaboration readiness, from which open issues and useful ideas are identified and considered in the posterior phases of this research work. The chapter starts by addressing the concept of collaboration. Afterwards, the discussion proceeds to an overview of collaborative networks and the consortia formation process.

Considering that this work follows a behavioral perspective for assessing collaboration readiness, it is worth to mention relevant theories and models provided by research works from social sciences, which are aimed at characterizing people/organizations' behavior, including a synthesis of existing personality and character models.

As a way to better understand organizations, in order to assess their collaboration readiness, a few organizations' metaphors are introduced. The utilization of an adequate metaphor, which allows looking at organizations from a certain perspective, and suggests corresponding modeling approaches, is a determinant aspect for modeling collaboration readiness assessment.

Finally, a review of the state-of-the-art concerning collaboration readiness is provided. As mentioned before, while the concepts are introduced, an effort is made to identify useful ideas, as well as identifying open issues, which may be useful for the development of the collaboration readiness assessment model. The structure for this chapter is illustrated in Fig. 2.1.

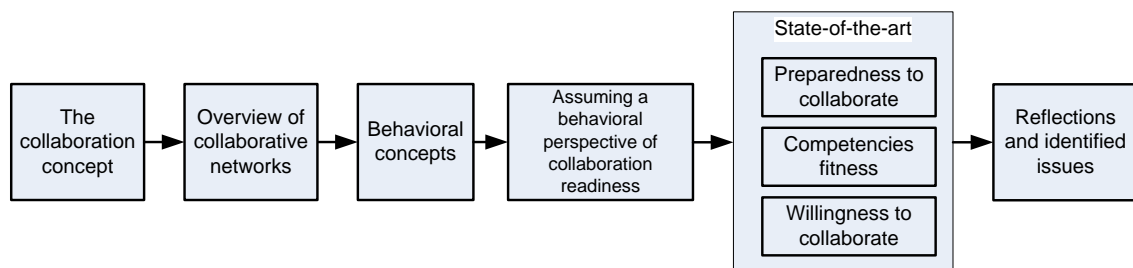


Fig. 2.1 – Structure of this chapter

In this literature review the approach is to be as much abstract and synthetic as possible. The reason for these requisites lies in the fact that collaboration readiness is a problem of an interdisciplinary nature, by essence difficult to deal with. The problem involves

the utilization of models and theories originated from diverse areas, such as Collaborative Networks, Behavioral Sciences, Management, and Knowledge Modeling areas, as later discussed in section 3.1.1. On the other hand, some concepts are used in distinct ways in different, but related, areas. For instance, the notion of organization can be observed from a point of view of distinct theories, perspectives, schools, models and metaphors. In a similar way, involved in the problem of behavior prediction are Traits Theory, Personality Psychology, and Social Learning Theories, just to name a few.

As a result, each theory or model found useful and considered as a potential contribution to model collaboration readiness may bring useful concepts, but it also brings additional layers of complexity. On top of it, is the fact that most models and theories from a social realm are presented in an informal and textual manner, making it even harder to visualize and understand the concepts. The best way to overcome these difficulties is to rely on a formalism, which can be used to represent ideas and concepts in an intuitive, straightforward way. The proposed approach is based on the utilization of semantic maps.

A semantic map can be seen as a loosely coupled web of concepts, in which links are used to connect concepts or ideas, which are related in a structural or semantic way (Van Der Auwera, 2008). Semantic maps can help to highlight relevant aspects from a textual representation into a visual, clearer, and more intuitive way. The obtained semantic map representations can then be used in the posterior phases of modeling collaboration readiness.

2.1 Collaboration and related concepts

Considering the objective of this work, specifically collaboration readiness assessment, this section is aimed at providing an overview about the notion of collaboration and some of its related concepts. Collaboration is a complex and multifaceted concept, for which a detailed description requires an extensive analysis that is out of the scope of this work. Therefore, the overview is constrained to a few fundamental aspects of collaboration, addressing collaboration both from a social and from an “industrial” (e.g. entrepreneurial and organizational) point of view. Some attention is also given to the typical problems which benefit from a collaboration strategy.

2.1.1 Establishing a meaning for collaboration

The idea of people and groups working together to achieve shared objectives is not new. But according to (IBHE, 2007), collaboration still remains a concept that is difficult to define and even more difficult to implement. The precise meaning of collaboration can be elusive, in part because it may be interchangeably used with many other terms, namely as partnerships, alliances, joint ventures, and research consortia, any of which may be different in nature.

According to Gray (Gray, 1989), collaboration is a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited resources and vision of what is possible. Collaboration is based on the simple adage that “two heads are better than one” and that one by itself is simply not good enough. Those parties with an interest in a given problem or opportunity to collaborate are termed stakeholders. They include all the individuals, groups, or organizations that are directly influenced by the actions others take to solve the problem. Each stakeholder has a unique appreciation of the problem, and the objective of collaboration is to create a richer, more comprehensive, appreciation of the problem among the stakeholders, than any one of them could construct alone.

The research in (IBHE, 2007), allowed to identify ten distinguishing characteristics of collaboration, which are synthesized in Fig. 2.2.

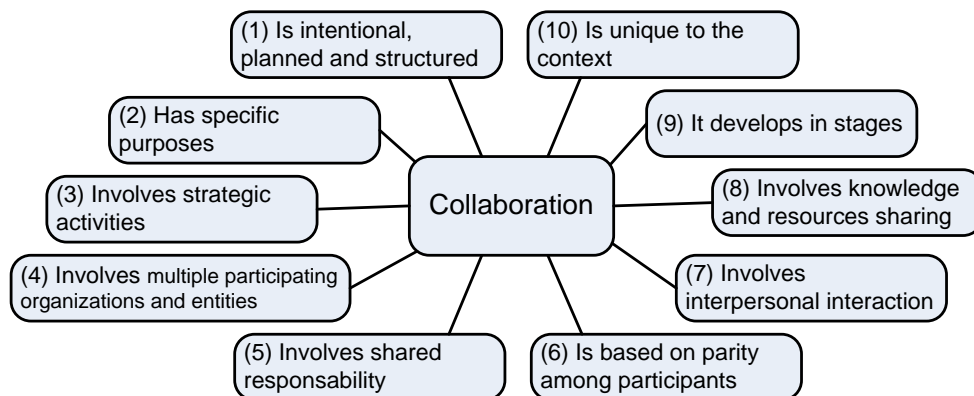


Fig. 2.2 – Establishing the concept of collaboration.

The meaning of each aspect in this figure is the following

1. Collaboration does not happen accidentally or without a specific commitment to do something. It means that there is an intentional decision to collaborate that

precedes the actual engagement in any collaborative activities, which are planned and structured in advance.

2. Organizations decide to collaborate with others to achieve objectives that are important to them and that they could not achieve by acting independently. These goals are to be clearly defined so that everyone involved will have a common understanding and shared acceptance of the aims that lead to collaboration.
3. Collaboration is not intrinsically successful as a way to achieve identified goals and objects. The success of collaboration largely depends on the appropriateness of the strategies or activities specifically designed, or chosen, by the collaborating partners to achieve these goals.
4. By definition, collaboration involves more than one organization or entity, and the challenge is to engage the “right” participants.
5. The decision to collaborate with others to achieve common or compatible goals is also a decision to share responsibility for the work, outcomes and potential risks, including the risk of failure.
6. All participants should be equals in the consortium, but this is not obligatory. In fact, there should be differentiation of roles to take advantage of different talents and perspectives. Nevertheless, the consortium should be structured and operated in ways that acknowledge and support the parity among the participants, each of whom has a stake in the outcomes.
7. Although collaboration occurs between and among organizations, its implementation involves interaction among individuals who represent those organizations. Many research works in collaboration suggest that the nature of this personal dimension is the most important factor in determining the success of the initiative.
8. Sharing of resources is a fundamental principle of collaboration and one of its primary benefits. In a time of limited resources, pooling money, time and talent can extend their impact and avoid duplication of effort.
9. Existing literature indicates that the work of collaboration or strategic alliance passes through four or five predictable stages: Creation, Operation, Evolution, and Metamorphosis/Dissolution (Camarinha-Matos and Afsarmanesh, 2006).
10. Although collaboration may be developed or replicated around successful models, the character and design of each collaboration depends on its goals, its participants, the environment and a myriad of other variables. Some of these

aspects are taken into consideration in the readiness model, by assessing willingness to collaborate.

The characteristics mentioned above are later recalled to justify the adopted approach for assessing willingness to collaborate in chapter 3. The characteristic at point 7 deserves some attention, because it is related with the issue of whether it is an organization's collaboration readiness that is being assessed, not of the individual representing it. However this aspect can only be addressed after necessary concepts are introduced later on.

2.1.2 When to collaborate

Collaboration is seen in (Gray, 1989) as a constructive approach for confronting difficult social problems, in front of the organizations' inability to provide effective and timely responses to the increasing pace at which new problems are generated. While new problems are cropping up daily, yesterday problems often go unsolved. This pileup of problems and the inability of organizations to contend with them reflect the turbulence of the environment. Under turbulent conditions, organizations become highly interdependent with others in indirect but consequential ways, and that under these circumstances, it is difficult for organizations to act unilaterally to solve problems without creating unwanted consequences for other parties and without encountering constraints imposed by others.

The situations that provide opportunities for collaborating are many and varied. They include joint ventures, settlement of (local neighborhood) disputes, environmental disputes, revitalization of economic depressed regions, and resolution of major social problems. The situations that can be better addressed by following a collaboration strategy share the characteristics in Table 2.1, which are related to the problem being addressed and to the involved stakeholders. The presented characteristics are only an illustration, because due to its multidimensionality, there is much more to mention. In addition, there are more types of situations for collaborating, according to the concrete form collaboration materializes (e.g. a collaboration agreement or a joint venture). This topic is addressed in the next section.

Table 2.1 – Situations better addressed by a collaboration strategy

Problem-related characteristics	Stakeholders-related characteristics
<ul style="list-style-type: none"> • Problems are ill defined, or there is disagreement about how they should be defined. • These problems are often characterized by technical complexity and scientific uncertainty. • Differing perspectives on the problems often lead to adversarial relationships among the stakeholders. 	<ul style="list-style-type: none"> • Several stakeholders have a strong interest in the problem and are interdependent on each other. • The stakeholders are not necessarily identified a priori or organized in any systematic way. • There may be a disparity of power and/or resources for dealing with the problems among the stakeholders. • The stakeholders may have different levels of expertise and different access to information about the problems. • Incremental or unilateral efforts to deal with the problems typically produce less than satisfactory solutions. • Existing processes for addressing the problems have proved insufficient and may even exacerbate them.

2.1.3 Collaboration in an inter-organizational context

Given that this work is about assessing organizations' collaboration readiness, it is worth to address collaboration in an inter-organizational context. Some forms of collaboration between organizations are summarized below.

Cooperation

According to Penã and Arroyabe (Penã and Arroyabe, 2002), cooperation can be defined as a formal agreement between companies, or between companies and organizations, for a stable long-term bond to exploit a specific market opportunity. Each company is responsible for its individual duties and all of them also responsible for reaching a joint objective. It involves a reciprocal, limited and progressive commitment to improve their respective performance and to acquire competitive advantages in the market. The principal characteristics of a cooperation agreement are:

- Reciprocal commitment: The partners consider real interests, either qualitative or quantitative, in the cooperation.
- Limited: The partners develop common objectives through cooperation, but they preserve their independence in their own activities.
- Reversible: partners can dissolve the cooperation agreement if obtained results are not considered satisfactory.
- Decision-making: authority and decision-making are shared.

The reasons for company cooperation can be summarized as follows:

- Reduction of the transaction costs that arise when uncertainty in the markets is high.
- Obtaining a greater volume and presence in the market by reaching agreements with competitors, suppliers and customers.
- Seeking efficiency in certain activities carried out by a company.

Strategic alliances

A strategic alliance can be seen as links formed between two or more independent companies, which choose to carry out a project or specific activity jointly by coordinating the necessary skills and resources (Penã and Arroyabe, 2002). The key parameters surrounding alliances are opportunism, necessity and speed (Dussauge and Garrette, 1995), (Iřoraité, 2009).

Under the context of a strategic alliance, the reasons for engaging in collaboration can be summarized as follows:

- Reduce the uncertainty of businesses in an age when the great growth of competition levels and economic globalization pose increasing business risks.
- The need to reduce transaction costs that have risen due to the volatility of the environments.
- The search for synergies linked to combining complementary operations (for instance, through the joint use of common sales networks, joint development of technological projects, and so on).

Consortium

A consortium is an association of two or more individuals, companies, organizations or governments (or any combination of these entities) with the objective of participating in a common activity or pooling their resources for achieving a common goal (Wiki, 2009), (Lang, 2002). Consortia are common in large construction and infrastructure projects for bridges, airports, railways. Their lowest common denominator is that they are normally formed on a project-by-project basis (Halaris, Bafoutsou et al., 2009).

The rationale behind the formation of consortia is based on four main threads, namely sharing of risks, pooled R&D, allocation of staff resources, and financial capability (Matthews, 2001).

Joint ventures

Nowadays an increasing number of firms are utilizing joint ventures for the first time to increase their strategic capabilities and global competitiveness (Lyles, 2002). A joint venture (often abbreviated JV) is an entity formed between two or more parties to undertake economic activity together. The parties agree to create a new entity by contributing with equity and sharing the revenues, expenses, and control of the enterprise. The venture can be made either for one specific project only or for a continuing business relationship.

The reasons to form a joint venture can be split by internal, competitive and strategic goals, which are shown in Table 2.2.

Table 2.2 – Reasons to form a joint venture (Lyles, 2002)

Internal reasons	Competitive goals	Strategic goals
<ul style="list-style-type: none">• Build on company's strengths• Spreading costs and risks• Improving access to financial resources• Economies of scale and advantages of size• Access to new technologies and customers• Access to innovative managerial practices	<ul style="list-style-type: none">• Influencing structural evolution of the industry• Pre-empting competition• Defensive response to blurring industry boundaries• Creation of stronger competitive units• Speed to market• Improved agility	<ul style="list-style-type: none">• Synergies• Transfer of technology/skills• Diversification

An aspect that persists in each of the above collaboration forms is that the involved companies remain independent. In this sense, they join forces in the pursuit of common goals without losing their autonomy and without abandoning their own specific interests, as illustrated in Fig. 2.3.

Lately, the increase in both market turbulence and complexity led to the appearance of emergent collaboration paradigms. These paradigms were further leveraged by newer and sophisticated ICT, opening the path for richer and inter-organizational contexts and interactions. Such richness allowed a further “virtualization” of organizations, allowing their arrangement in new forms of collaboration, which are known as Collaborative-Networked Organizations (CNO).

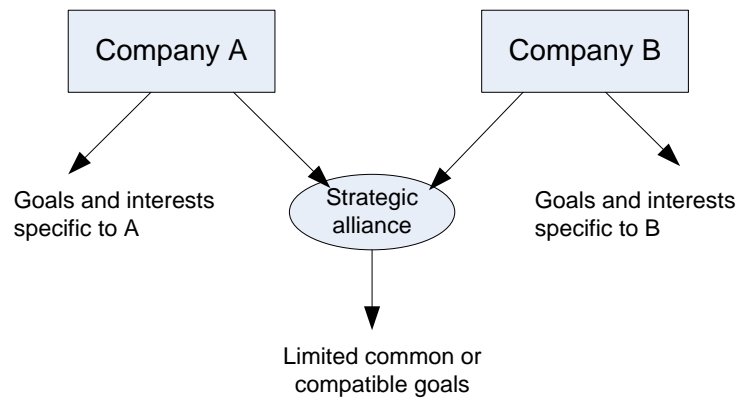


Fig. 2.3 – Companies work together without losing their autonomy. Inspired in (Child and Faulkner, 1999)

2.2 Collaborative-networked organizations

This section is devoted to provide an overview of relevant concepts concerning collaborative-networked organizations. The aim is to briefly establish the application context of this work, without being too much exhaustive. CNOs belong to another type of organizational structure, known as collaborative networks, which comprises networks involving organizations and individuals, as discussed below. Some important aspects regarding collaborative networks are shown in Fig. 2.4.

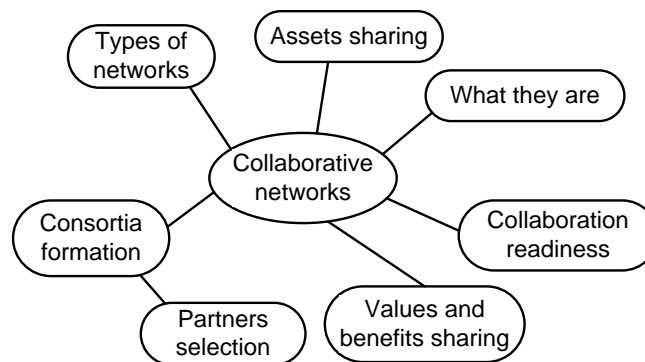


Fig. 2.4 – Important aspects associated to collaborative networks

2.2.1 What are collaborative networks

A collaborative network can be seen as a network consisting of a variety of entities (e.g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals,

but that collaborate to better achieve common or compatible goals, and whose interactions are supported by computer networks. These networks provide a basis for competitiveness, world-excellence, and agility in turbulent market conditions. They have the potential to support Small and Medium Enterprises (SMEs) in identifying and exploiting new business potential, boosting innovation, and increasing their knowledge (Camarinha-Matos, Afsarmanesh et al., 2005), (Camarinha-Matos and Afsarmanesh, 2006).

2.2.2 Existing types of collaborative networks

Collaborative networks are entering into a consolidation phase. Confirming this assumption is the number of publications already using the concepts of Virtual Enterprises (VE), Virtual Organizations (VO), and Virtual Organizations Breeding Environment (VBE), and that include other varieties, such as production or service-oriented virtual organizations, dynamic supply chains, professional virtual communities, industry clusters, professional virtual communities, and collaborative virtual laboratories. According to Camarinha-Matos et al (Camarinha-Matos, Afsarmanesh et al., 2009), most of these networks can be classified as being either goal oriented (Fig. 2.5), in which intense collaboration is practiced among partners, or long term alliances, in which interactions are not so much based on collaboration but on cooperation, as seen below in Fig. 2.6.

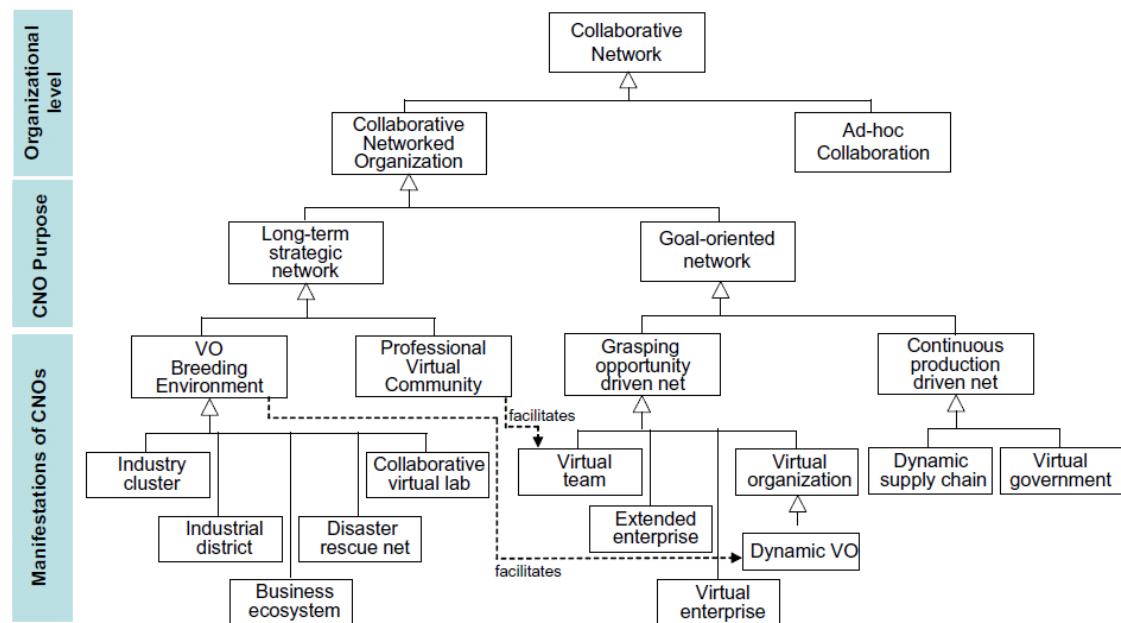


Fig. 2.5 – Examples of collaborative networks (Camarinha-Matos, Afsarmanesh et al., 2009)

A more detailed description of this ontology can be found in (Camarinha-Matos, Afsarmanesh et al., 2009). Considering only their essential aspects, some of these networks can be defined as follows:

- Collaborative network – An organizational structure that can be understood as a group of entities, namely people or organizations, which get together in order to achieve a set of common or compatible goals.
- Collaborative-networked organization – One class of collaborative networks that can be understood as an organized group of organizations that get together in order to achieve a set of common or compatible goals.
- Virtual enterprise – A Virtual Enterprise (VE) corresponds to a temporary alliance of enterprises that come together to share skills and resources in order to better respond to business opportunities, forming an interoperable network that acts as a single enterprise.
- Virtual Organization – A Virtual Organization (VO) is a network similar to a virtual enterprise. It comprises a set of independent organizations that share resources and skills to achieve its mission / goal. As opposite to a VE, this goal is not limited to profit.
- Dynamic Virtual Organization – A Dynamic Virtual Organization (DVO) is similar to a VO, but typically established in a short time, in order to achieve a sudden collaboration opportunity. This is a short-term network, which is dissolved after its purpose has been accomplished. The members are not necessarily enterprises.
- Extended enterprise –The concept of Extended Enterprise (EE) is typically applied to a network in which a dominant enterprise "extends" its boundaries to all or some of its suppliers. This type of network can be seen as a particular case of a VE.
- VO Breeding Environment – A VO Breeding Environment (VBE) represents an association of organizations that are willing to cooperate with each other on incoming collaboration opportunities and thus get prepared for that. When a business opportunity is identified by a member (acting as a broker), a subset of these organizations can be selected and thus forming a VE/VO.
- Professional Virtual Communities – A Professional Virtual Community (PVC) is a term that represents the combination of concepts of virtual community and professional community. Virtual communities are defined as social systems of

networks of individuals, who use computer technologies to mediate their relationships. Professional communities provide environments for professionals to share the body of knowledge of their professions, such as similar working cultures, problem perceptions, problem-solving techniques, professional values, and behavior. When professional communities adopt computer networks and most of the practices and tools of virtual communities, they become professional virtual communities (Camarinha-Matos and Afsarmanesh, 2005).

Another network class is the so called ad-hoc networks, which correspond to spontaneous forms of collaboration, non-business oriented, and usually taking place in the realm of virtual communities. They correspond to cases where people or organizations may volunteer to collaborate hoping to improve a general aim, with no pre-plan and/or structure on participants' roles and how their activities should proceed (Camarinha-Matos, Afsarmanesh et al., 2009).

2.2.3 The role of collaboration readiness in 'consortia formation'

As illustrated in Fig. 2.6, from the left to the right, there is an increase of importance in terms of soft issues in these networks. At the right side, the soft aspects are especially relevant, as collaborative networks involve working together for pursuing a number of joint goals.

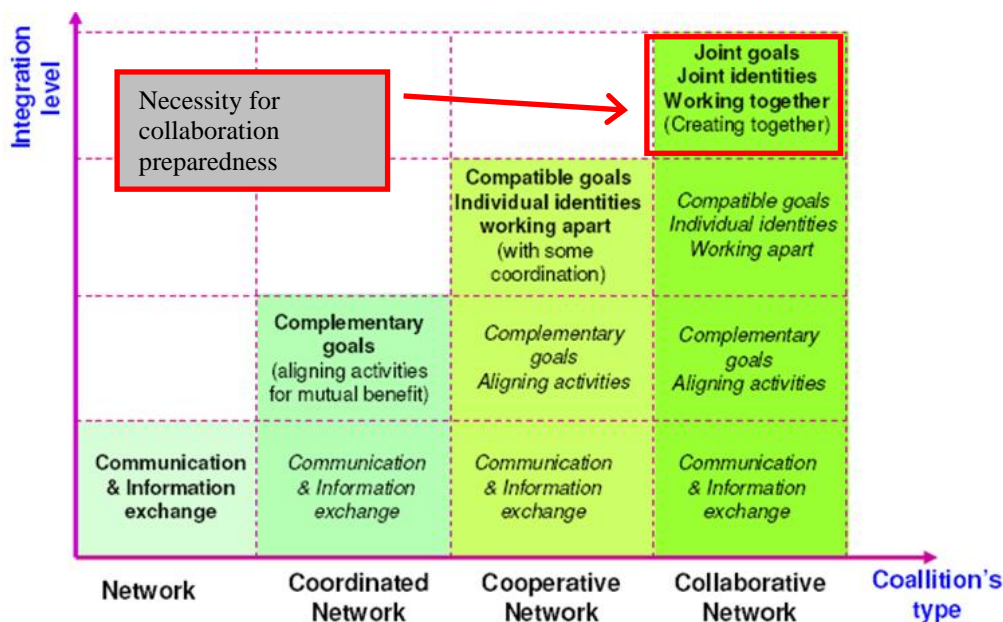


Fig. 2.6 – The several “degrees” of collaboration (Camarinha-Matos and Afsarmanesh, 2006)

Therefore, collaborative networks are the context in which collaboration readiness assessment becomes more important.

In addition, it is during consortia formation that collaboration readiness should be used. As an example, one of the processes for consortia creation is composed of a number of steps as illustrated in Fig. 2.7 (Camarinha-Matos, Silveri et al., 2005).

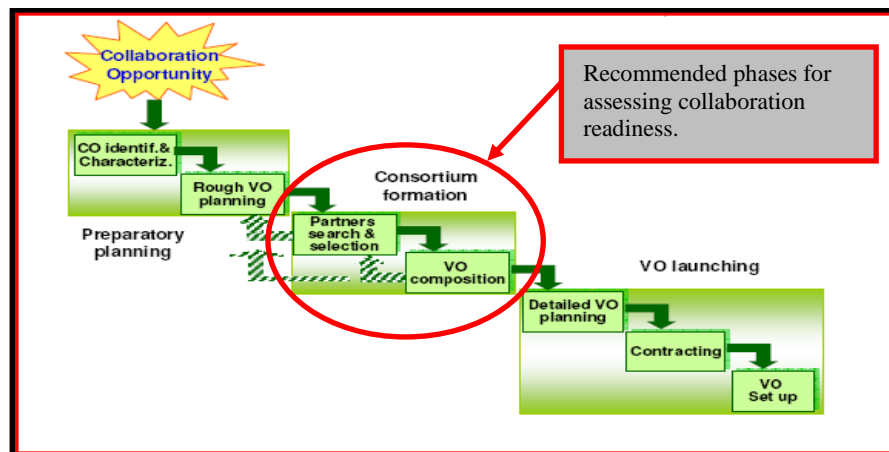


Fig. 2.7 – Importance of readiness in the VO creation process in a VBE. Adaptation from (Camarinha-Matos, Silveri et al., 2005)

For this example, the moments when collaboration readiness assessment should be performed are during the partners' search, selection and VO composition phases. For illustrating this aspect, a modeling experiment in chapter 4 describes a partners' suggestion mechanism involving collaboration readiness assessment, which selects partners for a given collaboration opportunity.

2.3 Overview of behavioral concepts

This section is aimed at providing behavior-related concepts, which are necessary as a theoretical basis for modeling collaboration readiness assessment. In this overview, such concepts as behavior, behavioral patterns, character traits, attitudes, intentions and situations are addressed (Fig. 2.8). The section also includes an overview of existing personality/character models, personality assessment, and behavior prediction.

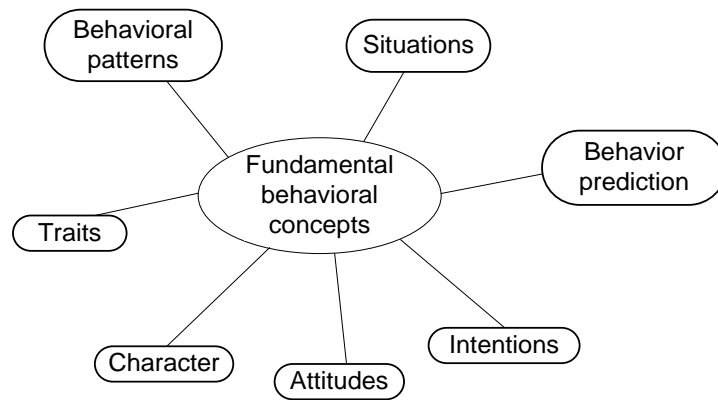


Fig. 2.8 – Fundamental behavior-related concepts

2.3.1 *Intuitive notion of behavior*

In an intuitive way, behavior can be understood as any actions performed by a human, animal, system or thing. However, this notion of behavior changes according to the field this concept is applied. For instance, a software engineer considering this concept may talk about the real-time behavior of the processes running inside a computer. An engineer in a factory may illustrate the concept saying “This cell requires maintenance... is behaving odd”. A psychologist may assess the personality profile of a person in order to characterize his/her behavior. In order to provide more insights on this concept, it is worth to recall some available definitions of behavior, which are shown in Table 2.3.

Table 2.3 – Definitions of behavior

<p>According to WordNet (WordNet, 2009), behavior can be seen as</p> <ul style="list-style-type: none"> • the manner of acting or controlling yourself • the action or reaction of something (as a machine or substance) under specified circumstances; "the behavior of small particles can be studied in experiments" • demeanor: (behavioral attributes) the way a person behaves toward other people • (psychology) the aggregate of the responses or reactions or movements made by an organism in any situation
<p>Response of an individual or group to an action, environment, person, or stimulus (Business-Dictionary, 2009).</p>
<p>Any observable overt movement of the organism generally taken to include verbal behavior as well as physical movements (dictionary-psychology, 2009)</p>
<p>The response of a component or system to a set of input values and preconditions (Veenendaal, 2006).</p>
<p>Behavior in a general sense can be understood as the actions displayed by an entity in response to its surrounding environment, or the manner in which a system of any kind, such as a gas, a subatomic particle, or ecosystem, acts or functions, especially under specified conditions (The-free-dictionary, 2009).</p>

Beyond its observed effects on the surrounding environment, behavior can also be reactive or pro-active (Bateman and Crant, 1999). The main characteristics involved in this notion of behavior, as stated by these definitions, are illustrated in Fig. 2.9.

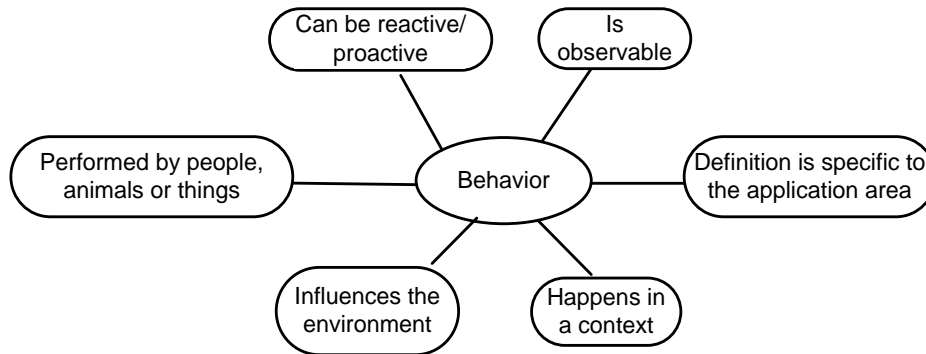


Fig. 2.9 – Involved aspects in the notion of behavior

As a remark, and at least in the context of this work, the internal processes inside a human mind, like internal introspection, emotions, moods, and feelings are not considered behaviors, for the reason that they do not cause observable state changes in the environment/situation nor on the person's "physical" condition. Of course, such internal processes can be the antecedent for starting/finishing behaviors (Fig. 2.10).

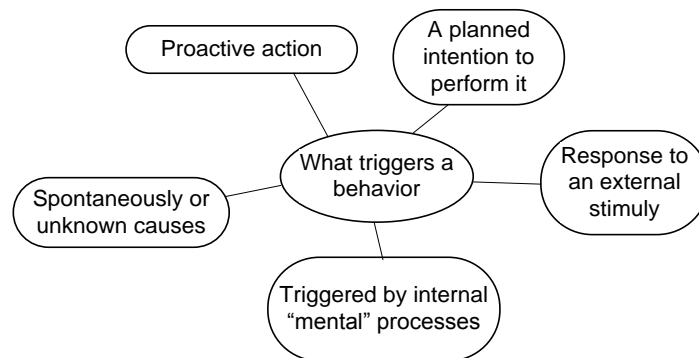


Fig. 2.10 – Some ways in which a behavior is started.

Another concept which is derived from the notion of behavior is the idea of behavioral pattern. As this concept is a fundamental one for the formulation of the collaboration preparedness hypothesis, some time is devoted to its clarification.

2.3.2 Behavioral patterns

The notion of behavioral pattern is one that is heavily used across the diverse fields of research and application, but for which an explicit or clear definition is hardly seen. However, this very concept is fundamental for modeling collaboration readiness and preparedness. Therefore, in order to put more light in this concept, an initial notion of behavioral pattern is provided, followed by some examples illustrating the idea of behavioral pattern in distinct contexts. From these examples, the relevant aspects of this concept are then obtained.

Psychologists have tried to characterize the behavioral patterns of an individual in order to explain how and why people react differently to their environment. According to the dictionary (Dictionary.com, 2009), a behavioral pattern is understood as a recurrent way of acting by an individual or group towards a given object or in a given situation. According to Eionet (Eionet, 2009), a behavioral pattern can also be understood as a relatively uniform series of overt activities that can be observed with some regularity. In addition to these two definitions, it is worth to mention that behavioral patterns are not exclusive to humans, but are instead a universal concept. This concept can be manifested in many ways and expressed by distinct types of entities. In order to perceive its generality, some examples illustrating the presence of behavioral patterns are provided below. Furthermore, these examples also constitute an attempt towards its very meaning.

Human behavioral patterns

A good way to illustrate behavior patterns in humans is through the following text which illustrates their manifestations in people's life.

"Most people realize what patterns are when they look back over their lives. OK, they find actions that they took in relationships, on a job or generally in their lives repeating over and over. They do not see the repeating process until after they have been through it several times. They do not understand why it happens. It may cycle within weeks or years. It may require a change in relationships before it happens again - but without a doubt, it does.

Patterns are typically a normal process that each person creates to make their life predictable, controllable, and less stressful. Each of us has a morning routine that helps us get to work on time. Families with children have routines that help create security and consistency for their family. All patterns help us. Some patterns reduce stress from traumatic events or painful injuries. Some patterns like smoking - are not healthy; but when you ask a smoker about why they smoke, they talk about relaxation. Some patterns are habits - others are long term problem solutions. In every case, the person is using the pattern to answer a question, produce an outcome, organize a confusing experience, or minimize stress in their life."
(Mauldin, 2006)

Behavioral patterns in animals

Behavioral patterns are also observed in animals, as illustrated by the following text.

“There are millions of different species of animals, and each species behaves somewhat differently. Nevertheless, there are common patterns of behavior exhibited by many species, and a few behavior patterns that are exhibited by all species [...] Since all species need to reproduce, eat, and try not to be eaten by someone else, they exhibit some type of reproductive behavior, foraging (eating) behavior, and defensive behavior. Over time, natural selection has also favored other behavior patterns that help species.”
(Alcock, 1989)

Behavioral patterns in countries

According to Ranis et al (Ranis, Stewart et al., 2007), distinct countries show distinct ways of behavior. A country can be categorized according to its behavior on basic human development, economic, social and political dimensions. Some countries seem to do particularly well on one dimension and less well on others, or particularly badly on one dimension and better on others. The many patterns of behavior indicate that while countries are constrained by history, culture and initial conditions, they also have choices.

In collaboration contexts

It is also worth to mention the collaboration patterns which arise in collaboration context. The list in Table 2.4 contains examples of observed behavioral patterns in a collaboration context.

Table 2.4 – Behavioral patterns in a collaboration context (OCGOV, 2009)

- Sharing information or helping others when necessary; volunteering useful information even if co-workers forget or are unable to ask.
- Regular participation in meetings
- Giving and getting others’ input into key decisions, projects, etc.
- Assisting in training others when needed
- Demonstrating flexibility and sensitivity to others’ schedules, to minimize impact to their work efficiency and time usage
- Remaining focused on work and task objective while calmly discussing and seeking to understand alternative points of view
- Giving and getting feedback about performance in a constructive manner
- Orally supporting others’ performance in a positive, supportive manner.

Collaboration patterns

In addition to the previous concept of behavioral patterns occurring in a collaboration context, it is also worth to mention the idea of collaboration patterns. In (Lonchamp, 1998), a way to model real work situations which are collaborative in nature is provided. The research work proposes generic collaborative patterns defining abstract and basic building-blocks for constructing specific models, which can be applied in recurrent situations. Fig. 2.11 provides two examples of collaboration patterns.

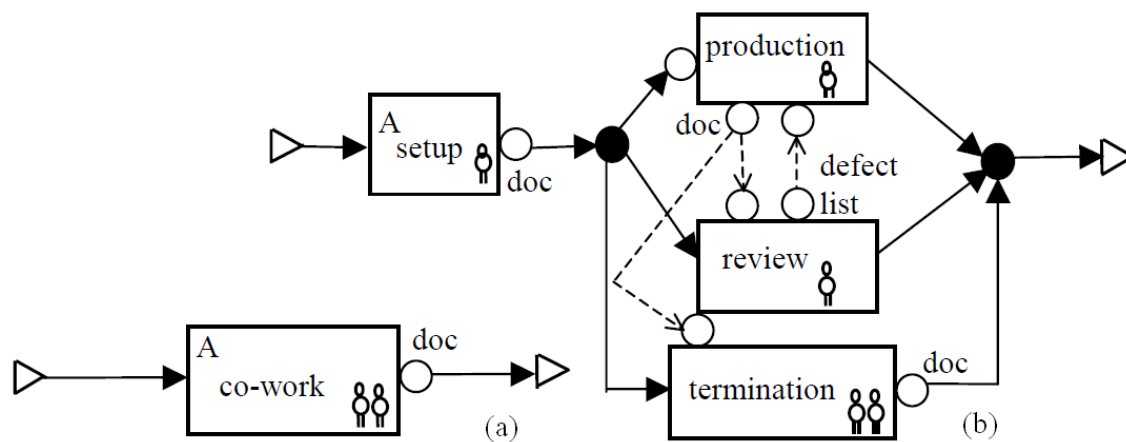


Fig. 2.11 – Collaboration patterns: (a) co-work and (b) the “production/review” pattern (Lonchamp, 1998)

Fractal patterns

A fractal can be seen as a complex geometric pattern exhibiting self-similarity in that small details of its structure, viewed at any scale, repeat elements of the overall pattern (The-free-dictionary, 2009). The importance of the fractal patterns lies in the fact that many things previously called chaos are now known to follow subtle fractal laws of behavior (MIQEL, 2006). In this sense, fractals and dynamical systems are closely related in the sense that the phase portraits of typical dynamical systems have fractal structures. For instance, fractal patterns help to classify and analyze the behavior in natural phenomena, such as the distribution of galaxies in space, the turbulence of fluids, and the branching of blood vessels, rivers and trees (Oluwade, 2005).

Fractals are unpredictable in specific details, yet deterministic when viewed as total pattern. In Fig. 2.12, the pattern of a tree begins to form when basic shapes (or behaviors) are generated according to an underlying law. The specific fractal in Fig.

2.12 is used to model blood vessels in the design of artificial tissues, such as the liver, lungs and kidneys (TRN, 2009).

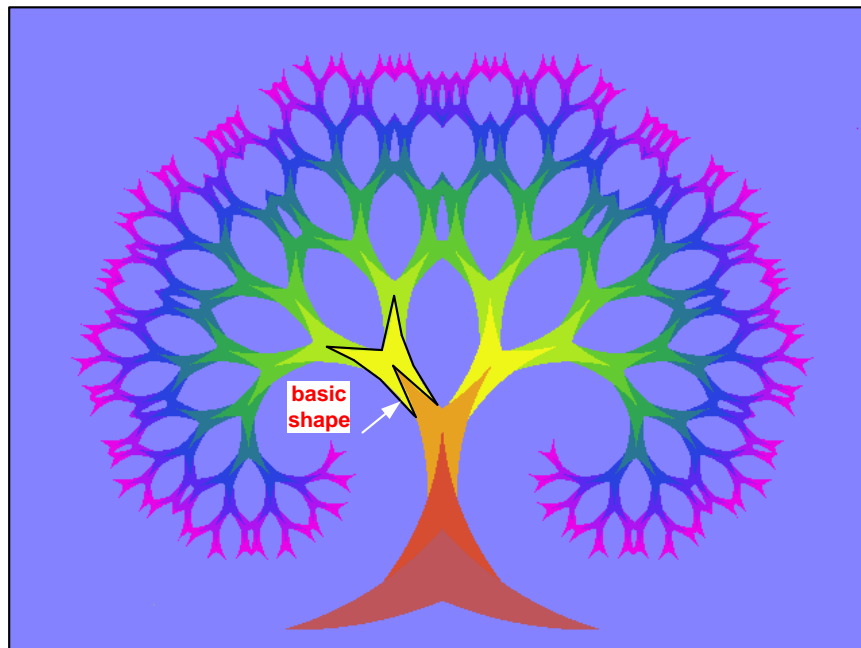


Fig. 2.12 – Example of a tree-like fractal (Fractal.org, 2009).

Setting the behavioral pattern concept

According to the descriptions of the above examples, the idea of behavioral patterns can be associated to two specific aspects: the repetition of specific behaviors and the regular manifestation of certain characteristics in the performed behaviors (Fig. 2.13).

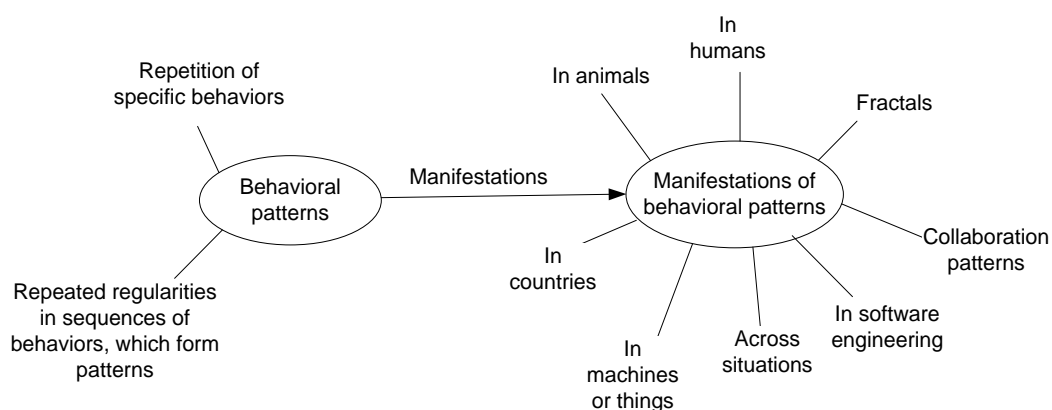


Fig. 2.13 – Notion of behavior patterns and where they can be manifested

The determination of whether or not a behavior pattern has been identified is based on this very idea of repetition. In this sense, it is expected that something identified as a behavioral pattern is likely to repeat in the future; otherwise it is not a behavioral

pattern. In other words, the successful identification of a behavioral pattern should offer the chance for behavior prediction. This possible association between behavioral patterns and behavior prediction is especially relevant in this work. The way behavioral patterns are classified is through a pre-defined number of traits, which are aggregated, leading to the idea of character/personality.

2.3.3 The concept of character/personality

The concept of character or personality is very important in this work, because collaboration readiness is based on the notion of organization's character.

There are numerous psychological personality theories, which differ in distinct ways, but most of them emphasize the unique or distinctive behavioral qualities of individuals (Table 2.5). One of such theories is the Traits Theory. This theory assumes that an individual's personality can be explained in terms of a set of psychological enduring characteristics, namely traits, which determine his or her behavior. Each trait is usually quantified on a continuous dimension, such as the "Introverted/extraverted" scale. A personality profile of an entity can then be used to predict its future behavior (Rousseau and Hayes-Roth, 1998).

Table 2.5 – Some definitions for Personality/Character

Personality is the entire mental organization of a human being at any stage of his development. It embraces every phase of human character: intellect, temperament, skill, morality, and every attitude that has been built up in the course of one's life.	(Warren and Carmichael, 1930),
Personality corresponds to an individual's pattern of psychological processes arising from motives, feelings, thoughts, and other major areas of psychological function. Personality is expressed through its influences on the body, in conscious mental life, and through the individual's social behavior.	(Mayer, 2007)
The totality of qualities and traits, as of character or behavior that are peculiar to a specific person. The pattern of collective character, behavioral, temperamental, emotional, and mental traits of a person. The distinctive qualities of a person, especially those distinguishing personal characteristics that make one socially appealing.	(Answers-Corporation, 2009)
Relatively stable, consistent, and distinctive set of mental and emotional characteristics a person exhibits when alone, or when interacting with people and his or her external environment.	(Business-Dictionary, 2009)
A character corresponds to the sum total of a person's behavioral traits, history, reputation in community, and values.	(Business-Dictionary, 2009)

It is worth to mention some existing models of character/personality used to characterize people's behavior. The presentation of these models provide a ground for the above concepts and serve also as theoretical inputs for the development of the collaboration preparedness assessment approach.

2.3.4 Existing personality models

There are many personality models. Many of them consist of a number of dimensions, in which each dimension in turn aggregates a number of traits. Some of these models are presented in Fig. 2.14 and detailed in Table 2.6.

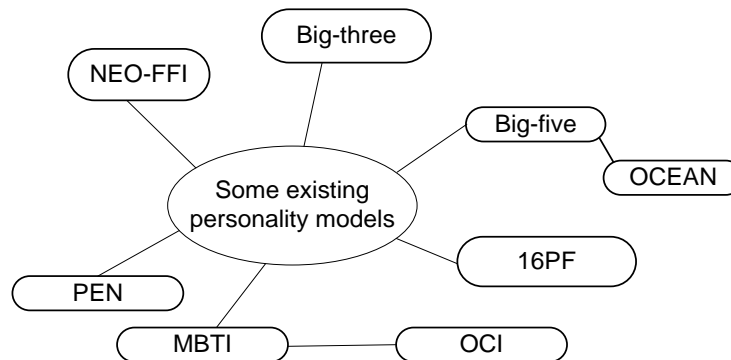


Fig. 2.14 – Examples of personality models found in related research

A consensus which seems to have arisen among researchers, regarding existing personality models, is that there are about five higher level factors of personality, namely extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. Each of these factors represents aggregations of traits that correlate together. These dimensions have come to be known collectively as the Big-Five factors of personality (Paunonen, 1998).

The big-five is not a theory of personality *per se*, but rather is a model of personality based on some fifty years of research analyzing the words individual's use to describe themselves and others. After Factor Analysis, these "personality traits" align along the mentioned five dimensions, hence the model's name. Although it is not a theory in itself, the model has generated several trait theories (Kowert and Hermann, 1997). Annex 1 provides a more detailed description about the big-five personality model.

Table 2.6 – Existing personality models (P: for people; O: for organizations)

Personality/ character model	Main dimensions	Target
Big-five	Extraversion/Surgency, Agreeableness, Conscientiousness, Emotional Stability, and Intellect/Openness. It is based primarily on factor analyses of adjectives. (Goldberg, 1999), (Goldberg, Johnson et al., 2006)	P
OCEAN	Extraversion, Agreeableness, Conscientiousness, Neuroticism, Openness. It is based on factor analyses of questionnaires. (McCrae and Costa, 1996)	P
MBTI	Extraversion /Introversion; Sensing/Intuition, Thinking /Feeling; Judging /Perceiving. (Myers, 2009)	P
OCI	Same dimensions as MBTI but applied to organizations. (Bridges, 2000)	O
NEO-FFI	Based on OCEAN scale. (Costa and McCrae, 2009)	P
16PF	Warmth, Reasoning, Emotional Stability, Dominance, Liveliness, Rule Consciousness, Social Boldness, Sensitivity, Vigilance, Abstractedness, Privateness, Apprehension, Openness to Change, Self-Reliance, Perfectionism, and Tension. (Cattell and Mead, 2008)	P
Chun's organizations' ethical character scale	Integrity, Empathy, Courage, warmth, Zeal, Conscientiousness (not included in Fig. 2.14, which contains stable models. This one is the result of very recent research work). (Chun, 2005)	O
The big-three	Extraversion, Neuroticism, and Psychoticism. (McCroskey, Richmond et al., 2004)	P

2.3.5 Relation to behavior prediction

Behavior prediction is a fundamental aspect in the formulation of the collaboration preparedness hypothesis. As mentioned before, behavior prediction is intrinsically connected to the concept of behavioral pattern. As previously established, behavioral patterns can be either associated to the repetition of specific behaviors, or to the repetitive presence of behavioral characteristics in an entity's behavior. Therefore, by being regular and repetitive, it is natural to think that they will subsist in the future. If that is true, it is possible to predict the behavior of an entity, be it a human, animal or thing. On the other hand, each behavioral pattern is characterized through corresponding traits, which are in turn related to the behavioral dimensions of the personality or character models. By looking at a personality profile of a person, it is possible to understand his/her behavior and predict how he/she is likely to behave in the future. Therefore, personality or character can be used to perform behavioral prediction (Fig. 2.15).

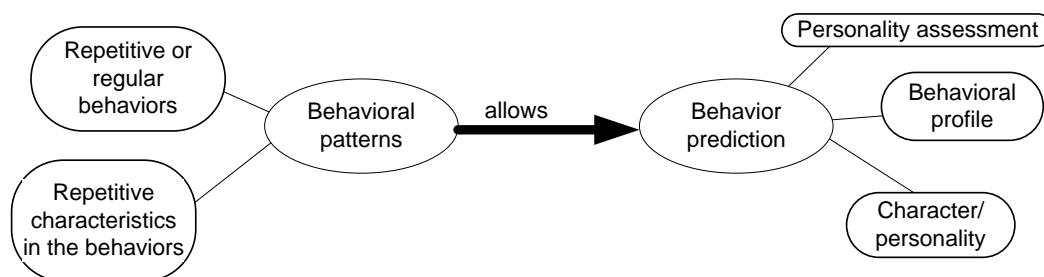


Fig. 2.15 – Involved aspects in behavioral prediction

The research from Paunonen (Paunonen, 1998) shows these concepts, namely behaviors, behavioral patterns and traits, organized in a hierarchical way, as illustrated in Fig. 2.16. Starting from the lowest level of the hierarchy, several specific responses or narrow behaviors of a person define habitual response patterns, or behavioral patterns. Several regular response tendencies, in turn, combine to form what is called as personality trait. The combination of these lower level traits constitutes what is usually considered a broad factor or dimension.

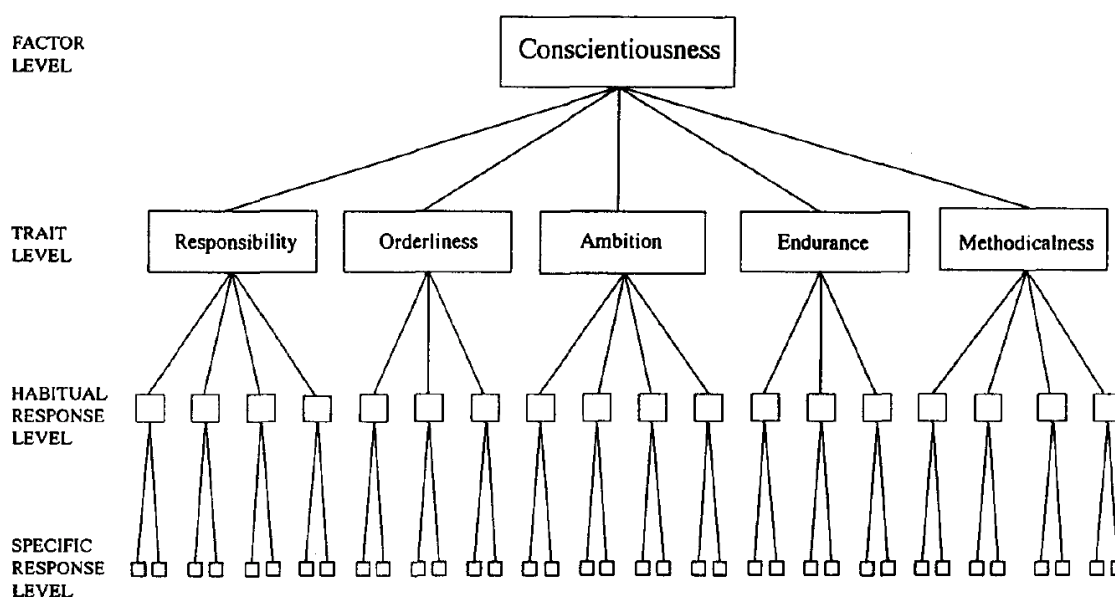


Fig. 2.16 – A hierarchical, nested, model of personality organization (Paunonen, 1998)

The example of the figure is a simplification, as it only shows the partial structure of only one personality factor, namely conscientiousness, of the big-five structure. The example is also a simplification, because it represents a nested model of personality, in which each component at each level of the hierarchy is connected to one and only one component above it. But this exclusivity is considered unrealistic because as a general rule: “a personality trait could have theoretical and empirical associations with more than one personality factor” (Paunonen, 1998).

It is also worth to illustrate through examples how behavior, behavioral pattern, and traits are related to each other. This is provided in Table 2.7.

Table 2.7 – Examples of behavior, behavioral patterns and traits correspondences.

Behavior	Behavioral pattern	Corresponding traits
Regularly delay in start/finishing assigned tasks	Lazy behavior	laziness
Regularly meets the deadlines	Reliable behavior	Reliability
Does the right things at the right times	Reliable behavior	Reliability
“The services provider usually meets my requisites and has always handled sudden issues”	Trustworthy behavior	trustworthiness
Development of novel things	Innovative behavior	Innovativeness, Creativity...

The subjects of this section are recalled in chapter 3 for establishing the organizations’ collaboration preparedness hypothesis.

2.3.6 Traits-situation behavioral prediction

Until now traits were said to correspond to enduring behavioral characteristics which remain constant over time. Another theory, the Social Learning Theory proposed by Albert Bandura (Bandura, 1977), considers how the characteristics of the situations influence people’s traits and behavior. In this sense, the question of whether to use traits in behavioral prediction is related to the issue of knowing whether they remain consistent over time and across situations. As stated in the previous sections, the trait-related theories assume that traits represent people’s predispositions to behave consistently, no matter the situation. But Social Learning Theory, which follows a more social-cognitive perspective (Bandura, 1977), assumes that an individual’s personality is modified by each situation, which is viewed as a learning experience (Fig. 2.17).

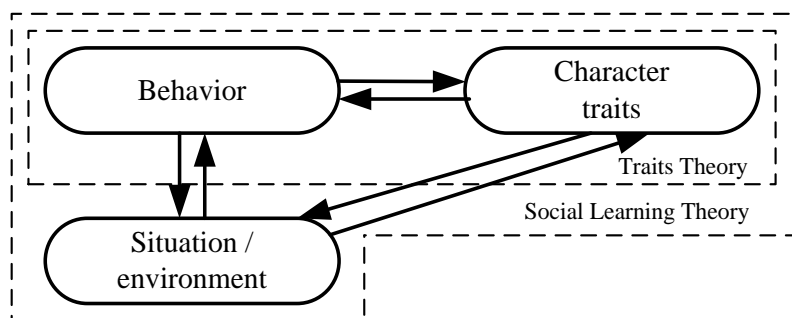


Fig. 2.17 – Relation between traits theory and social learning theory

In the long term, a person's behavior varies depending on the specific characteristics of situations, considering the individual's appraisal to these situations and reinforcement history (Rousseau and Hayes-Roth, 1998).

In a collaboration context, if each collaboration opportunity is viewed as a learning experience, either positive or negative, the involved organizations, in time, have their traits modified to a more/less preparedness to collaborate state. Inside a VBE, the partners' membership should in principle provide positive reinforcement history, turning each organization more prepared to collaborate in the upcoming collaboration opportunities. If a consortium is created without consideration for the partners' preparedness to collaborate, then even a minor problem, or even small divergences in the viewpoints, may create harmful situations for the partnership. This can be illustrated through the Model of Reciprocal Determinism [(Bandura, 1983), (Cooper and Phillips, 1997)], showing how a situation degenerates in an environment that undermines collaboration and prematurely terminates a partnership (Fig. 2.18).

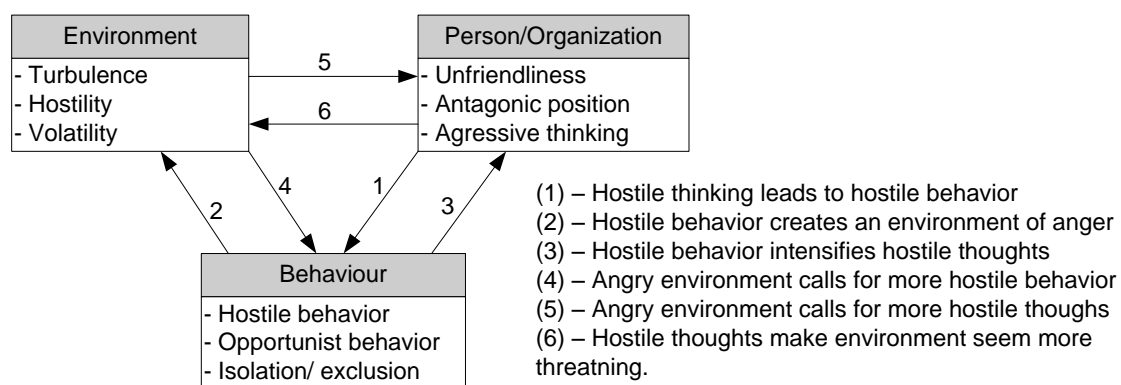


Fig. 2.18 – Degeneration of a network into a disrupted environment. Inspired in (Gayton, 2009)

2.3.7 Personality model versus personality profile

It is also important to establish the distinction between a character/personality model and a personality profile. Basically, a personality model represents an abstract characterization of human behavior that is generic to all individuals. As mentioned before, this model corresponds to a structure composed of several traits, which are aggregated in specific dimensions. The association between traits and dimensions is usually weighted with the so called factor loadings, which are numbers that establish the correlation between the traits and their corresponding dimensions.

A personality profile, on the other hand, corresponds to a concrete characterization of a single individual. The personality profile corresponds to a structure of traits and dimensions, as for personality models, but instead of factor loadings, this time each of these traits and dimensions are assigned with concrete values, according to the behavioral characteristics of a person. These values are specified using a scale containing numbers from the set {*very low, low, average, high, and very high*}. The process of characterizing a person's behavior, from which the personality profile is obtained, is called personality assessment (Matthews, Deary et al., 2003), (John and Srivastava, 1999) and (Goldberg, 1990).

2.4 Towards a collaboration readiness behavioral perspective

As mentioned in chapter 1, the factors which mostly contribute to partnerships' success/failure are of behavioral nature. The question to answer here is whether a behavioral perspective based on the concept of organization's character can be the basis to model collaboration readiness and preparedness.

One way to obtain an answer to this question is to analyze the several metaphors and perspectives currently applied to organizations.

2.4.1 The several perspectives of an organization

The notion of organization is varied and a specific definition largely depends on the aspects and issues that need to be addressed. Each model of organization serves its own purposes. There is no universal and effective way of defining or modeling an organization, which could simultaneously comply with the financial, management, market and manufacturing aspects of an organization, just to name a few. The following definition is just one example, which is compatible with the needs of this work, but not completely.

Definition 2.4.1 (Organization) – A social unit of people, systematically arranged and managed to meet a need or to pursue collective goals on a continuing basis. All organizations have a management structure that determines relationships between functions and positions, and subdivides and delegates roles, responsibilities, and

authority to carry out defined tasks. Organizations are open systems in that they affect and are affected by the environment beyond their boundaries (Business-Dictionary, 2009).

Several types of organizations have been conceived in Organizational Sciences, namely the mechanical, organic, or systemic organizations, each one addressing particular issues of an organization's life. According to Bridges (Bridges, 2000), the best way to determine how an organization should be observed is to use an adequate metaphor. The selection of the right metaphor will eventually determine how an organization is conceived, created and managed.

2.4.2 Visiting some metaphors

According to Bridges (Bridges, 2000), the theories and explanations for organizational life are based on metaphors. These metaphors lead to see and understand organizations in distinct yet partial ways, allowing to highlight certain properties and interpretations, while forcing others into a more background or secondary role. This kind of thinking is relevant for an adequate understanding of organizations, “which are seen as complex and paradoxical phenomena that can be understood in many distinct ways”, and that many of the taken-for-granted ideas about organizations are metaphorical, even though people might not recognize them as such.

For instance, organizations are frequently seen as if they were machines designed to achieve predetermined goals and objectives, and which should operate smoothly and efficiently. As a result of this thinking, people often attempt to organize and manage them in a mechanistic way, forcing their “human” or soft qualities into a secondary role. As argued in the research work in (Bridges, 2000), these human-qualities play a great deal in an organization's life. That is such as for collaboration.

Pursuing this idea, some metaphors for organizations are described in Table 2.8. A more detailed description of these metaphors can be found in (Bridges, 2000), (Gareth, 1986), and (Barrett, 1998).

A metaphor from this table, namely “the organization seen as a living entity”, is next highlighted, as it seems to provide the answer to the initial question, which is concerned with whether to adopt a behavioral perspective for modeling collaboration readiness. As stated in (Barrett, 1998),

“When an organization begins to care about the collective good, we enter in the realm of spiritual values. Values such as trust, honesty, integrity, compassion, and sharing become very important. Organizations that operate with these values cannot be described as machines. They are living entities. They have physical, emotional, mental, and spiritual needs. Organizations that recognize themselves as living entities know that to achieve optimal health they must balance all of these needs.”

These very words suggest a deeper look into this metaphor. Therefore, a more detailed description of the organization as a living entity metaphor is provided in Annex 2. It is recommended to read now this annex, because this metaphor is eventually the right one to use in this work.

Table 2.8 – Available metaphors for organizations

Metaphor	Notion
Organizations seen as machines	When organizations are seen as machines, there is the tendency to design and manage them as machines made up of interlinking parts, each playing a clearly and definite role in the functioning of the whole. While at some times this can prove highly effective, at others it can have many unfortunate results (e.g. adopting the same behavior for determined contexts, without attempting to predict the necessity for sudden contingencies).
Organizations seen as organisms	In this metaphor, the attention is focused on understanding and managing organizational “needs” and environmental relations. Usually, organizations may be seen as belonging to different species, and that each species is suited for coping with the demands of distinct environments. Examples of such species are enterprises and non-governmental organizations. Using this metaphor, people are encouraged to understand how organizations born, grow, develop, decline, and die, in a “biologic” way. Using this metaphor also allows to consider the relations between species, and the evolutionary patterns found in the inter-organizational ecology.
Organizations seen as brains	This metaphor draws attention to the importance of information processing, learning, and intelligence. Using a brain metaphor, allow people see an organization as a kind of information processing computer and as a hologram. These images, especially the later, highlight important principles of self-organization for designing organizations, in which a high degree of flexibility and innovation is needed.
Organizations seen as cultures	In this metaphor, organizations are seen to reside in the ideas, values, norms, rituals and beliefs that sustain organizations as socially constructed realities. This focus provides another way of managing and designing organizations through the values, beliefs, and other patterns of shared meaning that guide organizational life.
Organizations seen as political systems	The political metaphor is more concerned on different focus of interest, conflicts and power. In this metaphor, organizations are seen as systems of government drawing on various political principles to legitimate different kinds of rules, as well as the detailed factors shaping the politics of organizational life.
Organizations seen as “physical prisons”	Another interesting metaphor is the idea that organizations are “physical prisons”, where people become trapped by their own thoughts, ideas, and beliefs.
Organizations seen as a living entity	In this metaphor, organizations are seen in a perspective which gives more relevance to their soft-side. As such, organizations are considered in terms of their physical, emotional, spiritual, and mental well-being.

Furthermore, the author’s own words in this case seem to be the best way to provide a better insight into this metaphor. The principal characteristics from this metaphor are illustrated in Fig. 2.19.

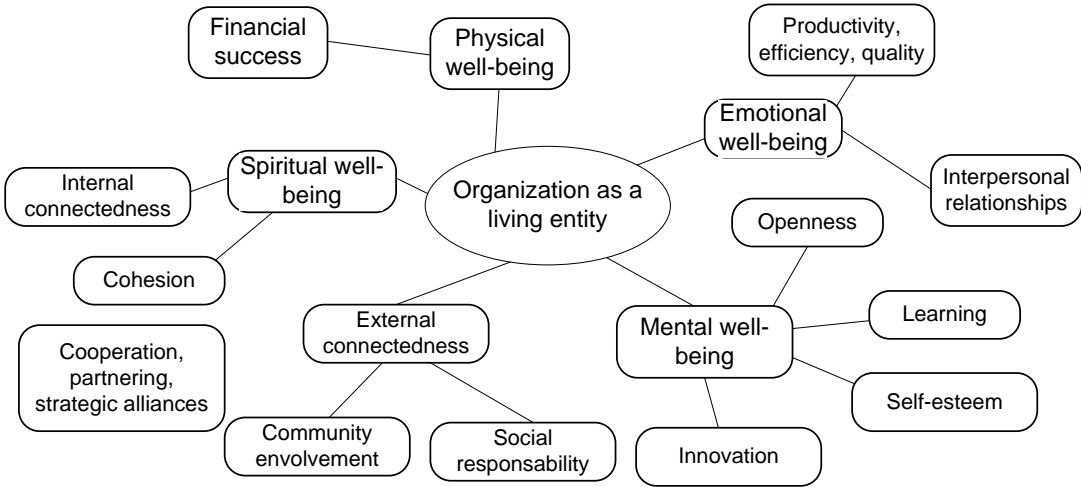


Fig. 2.19 – An organization seen as a living entity

By considering this metaphor, the impression that remains is that it is possible to observe an organization similarly to a person, because it seems that in principle, both types of entities have physical, emotional, mental, and spiritual needs. Given this similarity, although within some limits, it is possible to characterize the behavior of an organization, in a similar way to a person (Fig. 2.20). This is an important assumption taken from this literature review, as it justifies modeling collaboration readiness and preparedness, following a behavioral perspective, based on the concept of organization’s character. This is a subject addressed in more detail in chapter 3.

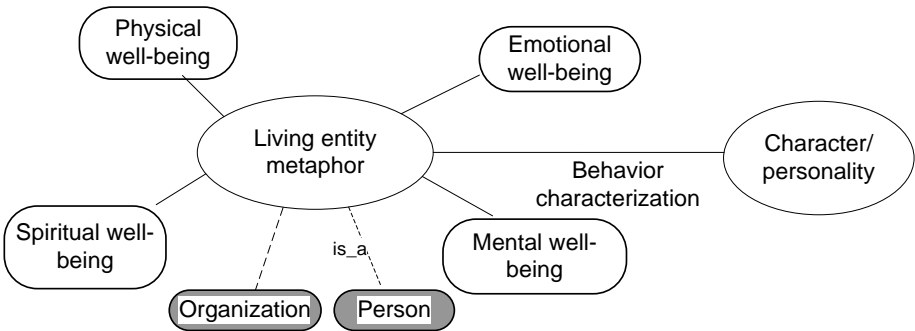


Fig. 2.20 – Taking organization as a living entity provides ground to a character-based behavior characterization

Given this assumption, it is time to explore the organization’s character concept.

2.4.3 Taking the organization's character concept

According to Bridges (Bridges, 2000), organizations differ in their size, structure, and purpose, but they also differ in character. A play-it-safe, old-line manufacturing company has a very different character from a new start-up software company. They differ in the same way as two individuals do. And the characters of both the manufacturing and the software company differ from that of a state university, a community hospital, or an architectural firm.

An organization's character represents the personality of an individual organization. It corresponds to the DNA of the organizational *life form*. It is the organization's character that makes it feel and act like itself. Organizational character varies greatly and subtly. In one sense, there are as many characters as there are organizations. But those infinitely varied differences can be profitably grouped into a small number of categories, usually referred as traits. As with people's personality, organizations' character can be established with a fair degree of objectivity. For instance, the Organizational Character Index (OCI) does for organizations what the Myers-Briggs Type Indicator (MBTI) does for people (Bridges, 2000).

Where does organization character come from?

The character of an organization is originally set by its founder. The line of business has also a deep influence, e.g. like in security, religious, or educational work. The same applies for finance, manufacturing, entertainment, engineering and social services. Sometimes, the dominance of one or two functions in an organization's history can shape the character of the whole company. The business itself causes a generic and very deep influence in organization's character. The employees also contribute to an organization's character. The final source of organization's character is its subsequent leaders.

Another factor in organization's character is its history. Indeed, some organizations have long tradition while others don't. If a company has never had an unprofitable quarter in three decades, or if it had to struggle back several times from the edge of bankruptcy, its character may be affected accordingly (Bridges, 2000).

A related concept, organizational memory also contributes to the formation of an organization's character. According to Stein (Stein, 1995), organizational memory is the means by which knowledge from the past is brought to bear in present activities, thus

resulting in higher or lower level of organizational effectiveness, which can be considered an organization's trait. These aspects are illustrated in Fig. 2.21.

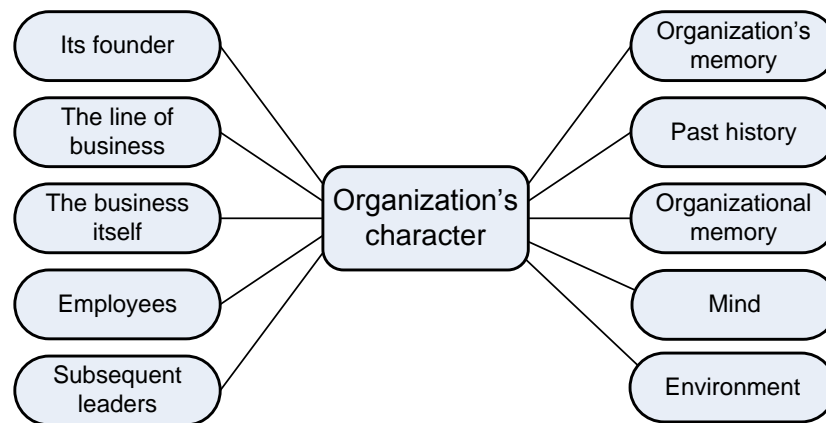


Fig. 2.21 – Aspects contributing to the formation of organization's character

The best way to understand and illustrate how an organization can be characterized by a character is through an example. In this case, the chosen example consists of setting the character profile of organizations that are considered well prepared to collaborate. This is made with the OCI (Organization Character Index) model. Before proceeding to it, it is necessary to provide a brief description of this model.

The OCI model

The OCI is based on four pairs of opposing tendencies. As adapted from the human realm to the organizational area, those dichotomies are the following:

- **Extraversion (E) or Introversion (I)** – the organization's orientation, the location of its reality (its inner or outer boundaries), and the source of its energy. Is the organization primarily outwardly oriented toward markets, competition, and regulations (Extraverted), or is it inwardly oriented towards its own technology, its leaders' dreams, or its own culture (Introverted)?
- **Sensing (S) or Intuition (N)** – how it gathers information, what it pays attention to, how it "perceives". Is the organization primarily focused on the present, the details, and the actuality of situations (Sensing), or on the future, the big picture, and the possibilities inherent in situations (Intuition)?
- **Thinking (T) or Feeling (F)** – it is the way of processing information, its manner of judging situations, its way of making decisions. Does the organization do these things by an impersonal process so that decision making happens on the

basis of such principles as consistency, competency and efficiency (Thinking), or through a personal process that depends on the values such as individuality, the common good, or creativity (Feeling)?

- **Judging (J) or Perceiving (P)** – does the organization tend to deal with its external world through one of the judging functions (Thinking or Feeling), or through one of the perceiving functions (Sensing or Intuition)? Organizations in which Judging predominates prefer to reach firm decisions, define things clearly, and get closure on issues. Organizations in which Perceiving predominates are always seeking more input, preferring to leave things loose, or opting to keep their choices open.

2.4.4 The character for good collaboration preparedness

In the tables below, the character profile of an organization well prepared to collaborate is presented. The tables are inspired in (Bridges, 2000). Inside each table, a number of items can be selected (with a “check symbol”), according to the best characteristics of an organization well prepared to collaborate. The assessment is based on a consensual discussion between several people related to the areas of collaborative networks.

The Extraverted and Introverted traits

Table 2.9 constitutes a summary of the characteristics of Extraverted versus Introverted organizations. On the basis of these descriptions, would one say that a Well Prepared to Collaborate Organization (WPCO) is Extraverted (E) or introverted (I)?

Table 2.9 – Typical Behaviors of an Extraverted versus Introverted organization (‘✓’ – item is selected; ‘✓?’ – item might be important)

Extraverted organizations	Introverted organizations
Have open boundaries ✓	Have closed boundaries
Allow access to decision making ✓	Prevent access to decision making
Collaborate on decisions ✓	Reach consensus after a decision is made
Act quickly	Respond only after study
Experiment with several possible lines of action	Explore options in detail, then try one line of action
Trust oral communication ✓	Trust written communication ✓?
Encourage interdepartmental cooperation ✓	Experience interdepartmental distrust
Turn outside for guidance ✓	Insist guidance must come from within
Seek assistance when in trouble ✓	Circle the wagons when in trouble
Invite outsiders to celebrations ✓	Keep celebrations “in the family”
Have as a motto “The answer is out there – we just have to find it” ✓	Have as a motto “The answer is within – we just have to figure it out”

The Sensing and Intuitive traits

Similarly to E and I, it is possible to characterize Sensing versus Intuitive organizations. On the basis of the descriptions presented in Table 2.10, can a WPCO be classified as Sensing (S) or Intuitive (N)?

Table 2.10 – Typical Behaviors of a Sensing versus Intuitive organization

Sensing organizations	Intuitive organizations
Are at their best with detail	Are at their best with the big picture
Can handle masses of data	Can spot emerging trends ✓
Prefer solid routines	Are a little careless about routines ✓
Prefer incremental change	Prefer transformational change ✓
Make improvements	Change “paradigms” ✓
See intuitive organizations as lost in the clouds	See sensing organizations as stuck in the mud.
See the future as an extension of the present	Believe the future can be created ✓
Emphasize targets and plans ✓?	Emphasize purposes and vision ✓
Trust experience and authority	Trust insight and creativity ✓
Tend to organize functionally	Often use cross-functional teams ✓
Have as a motto “Change the structure”	Have as a motto “Change the belief systems” ✓

The Thinking and Feeling traits

Thinking or Feeling refers to the different ways in which organizations make decisions. Thinking organizations attack problems with an arsenal of business, professional, scientific and/or moral principles. Is a WPCO more Thinking (T) or feeling (F) type?

Table 2.11 – Typical Behaviors of a Thinking versus Feeling organization

Thinking organizations	Feeling organizations
Make decisions based on principles ✓?	Make decisions based on values ✓
Think in terms of rules and exceptions ✓?	Think in terms of particular human situations
Value what-is-logical	Value what-we-care-about ✓
Emphasize the objective ✓?	Emphasize people ✓
Believe criticism leads to efficiency	Believe support leads to effectiveness ✓
Encourage employees to live up to exceptions	Encourage employees to do their best ✓
Are a social machine ✓?	Are a social community ✓
Have as a motto “Do the right (or intelligent) thing”	Have as a motto “Work well together” ✓

The Judging and Perceiving traits

Judging (J) organizations are good at making decisions, but Perceiving (P) organizations are more open, dealing better with the external world, gathering information and good also at monitoring and evaluating progress. Which of these traits should a WPCO have?

Table 2.12 – Typical Behaviors of a Judging versus Perceiving organization

Judging organizations	Perceiving organizations
Drive towards decisions	Keep options open and seek more information ✓
May be weak in information gathering	May be weak in decision making
Set clear, specific standards ✓?	Set general standards ✓
Define lots of things in detail	Leave many things vague and undefined ✓
Are often moralistic	Are loose and fairly tolerant ✓
Have as a motto “Fish or cut bait”	Have as a motto “Don’t miss an opportunity” ✓

The obtained profile

Considering the selected descriptions in the above tables, the profile of an organization well prepared to collaborate would be of the type

E	N	F	P
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Therefore, according to the OCI model, and the characteristics selected in the previous tables, organizations well prepared to collaborate will have a character portrayed as extraverted, intuitive, feeling, and perceiving.

As the discussion is still taking place at a metaphorical level, let us give a bit more latitude to our imagination. In practice, an organization has values on both sides of the considered four pairs. This means that, for instance, it can be extraverted in some aspects, and introverted in others. Therefore, we can assume that organizations have scores on both sides of the four opposite pairs, namely on “Extraverted/Introverted”, “Sensing/Intuitive”, “Judging”/“Perceiving” and “Thinking/feeling”. In order to distinguish more clearly the weight of each trait, instead of 4 opposite pairs, 8 traits can be considered. Let us also admit that from the items selected in the previous tables, it is possible to assign a percentage value to each of these traits. Using these values, the character of an organization well prepared to collaborate can be portrayed as a web chart, as illustrated in the left side of Fig. 2.22.

Considering the selected items in the above tables, the better the shape resembles a star, the better the preparedness to collaborate. Therefore, this star represents the character of organizations that are able to collaborate in almost every circumstance. It can be seen as the rising star of the best partners. Such organizations, displaying its shining star, will continuously attract partners and corresponding new opportunities. If necessary, the best analogy to derive from this “image” would be an organization with high reputation.

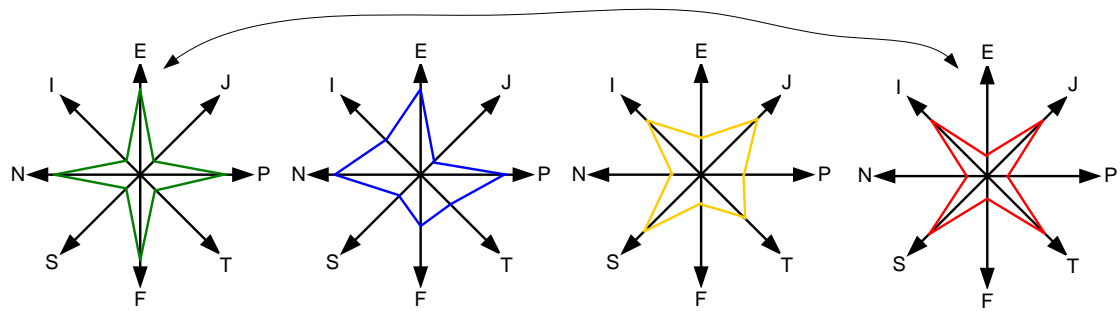


Fig. 2.22 – Examples of organizations’ character profiles using the OCI scale. The “ideal” profile of a WPCO is at the left side

There is another star on the opposite side, the laying star (it is laying on two legs), which represents the characters of organizations not able to collaborate in any circumstance. This does not mean that organizations of this character are not successful. These organizations have characters of more introverted and conservative nature, which can be adequate in some market environments.

In other words, the left star represents the character of organizations that are good at collaborating. The right one represents organizations that are more successful working alone. In a hypothetical situation, if two organizations characterized with these two opposite characters were joined in a collaboration situation, odds would be that the partnership would not go far. The other shapes represent intermediate cases of these two extremes.

2.5 The collaboration readiness concept

The objective of this section is to provide an overview of the collaboration readiness concept, as it emerges from related research. This is made following the sequence which is illustrated in Fig. 2.23, namely observing the readiness, and each of the its constituents, in terms of their meaning, work already done, and aspects that are still missing.

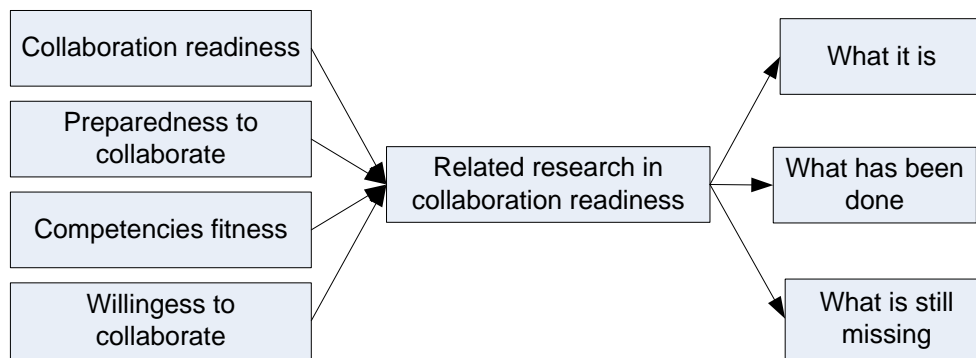


Fig. 2.23 – Proposed way to study the related research of collaboration readiness
(inputs: the involved aspects; outputs: the points to achieve)

There is plenty of research works concerning consortia formation, competencies, and performance assessment, which are related to collaboration readiness. The aim here is not to provide an exhaustive description all these aspects, but rather to provide enough indications of a shift from a technological-based collaboration readiness assessment to a more soft-based one.

2.5.1 What is collaboration readiness and preparedness

As mentioned before, collaboration readiness aims at assessing how well an organization is likely to perform in a partnership. Collaboration readiness includes preparedness, competencies fitness, and willingness. Collaboration preparedness, as part of readiness, is the element more focused on the behavioral aspects related to the act of collaborating.

In a context of collaborative networks, the measurement of collaboration readiness is an idea which matured from previous ideas related to partners' selection in consortia formation. As described below, previous research which more or less directly considered this concept, started to address readiness by considering the competencies and resources a partner was willing to bring to a consortium. It was only in more recent research works that aspects of a more soft nature started to be considered for assessing the ability of a partner to perform well in a partnership.

Resources- and competencies-based capability assessment

There have been plenty of research works on partners' selection for collaborative networks. Initial approaches were mainly focused on partners' skills, capacities, and resources to be shared. For instance, (Gupta and Nagi, 1995) developed a Decision

Support System for the selection of manufacturing partners in which the selection criteria consider a variety of partners' attributes, including quality, price, delivery, production, management, and other enterprise services (e.g., packaging ability, R & D). The selection is performed by a genetic-algorithmic search approach, providing nearly optimal groups of manufacturing partners.

Another example is found in (Mowery, Oxley et al., 1998), which relies on a resource-based view of enterprises emphasizing the role of partners' technological capabilities. Patent citation data and statistics were used as measures of enterprise-specific technological capabilities, which were then used to determine eventual technological overlaps between these firms. Partners' selection is derived from the measurement of these overlaps. (Chu, Tso et al., 2000) established the premise that partners' selection is strongly coupled to the product design process for a new product or business opportunity. As such, they proposed a Group Technology-based approach for partners' selection, which is mostly driven by "hard" factors such as cost, time, quality, and enterprises' financial stability.

In (Viswanadham and Gaonkar, 2003) a mixed-integer programming model for partners selection in a supply-chain context is suggested, in which participants share information on their capacities, schedules, and cost structures. Based on this information, the decision model addresses the partner's selection problem in terms of profit maximization, while considering various manufacturing and logistics constraints.

In (Fischer, Jähn et al., 2004), the virtual enterprise model is based on the concept of aggregation of small performance units called competency cells. The methodology, formulated as an optimization problem, chooses the most capable competency cells according to the core competencies. The optimization conditions consider such factors as time saving, similarity between needed and candidate's competencies, delivery date and its probability, and costs.

According to Camarinha-Matos et al (Camarinha-Matos, Silveri et al., 2005) and (Camarinha-Matos and Oliveira, 2006), finding the right partners and establishing necessary conditions for starting a collaboration process is seen to be a costly process both in terms of time and effort, which affects a required agility in the consortia formation process. The identified obstacles include the lack of information, lack of common collaboration infrastructure, and above all, the lack of preparedness of organizations to join the collaborative process. The ECOLEAD approach proposes the membership to a VBE as a way to increase preparedness to collaborate, as well as the desired agility. This preparedness is based on the use of the VBE's common

interoperable infrastructure, common operating rules, and common cooperation agreements, among others, as well as establishing a base level of trust among the organizations (Camarinha-Matos and Afsarmanesh, 2006). The membership to a VBE provides a number of advantages that are mentioned in Fig. 2.24.



Fig. 2.24 – Reasons to join a VBE (Camarinha-Matos, 2006)

A natural context for considering collaboration readiness is in partners' selection situations. As stated in the research work described in (Crispim and Sousa, 2007), these situations include the formation of a consortium for an emerging market opportunity, when it is necessary to perform a reorganization of an existing consortium by adding/expelling some members, or even when a reassigning of roles and tasks are necessary for better coping with new market circumstances. The mentioned research work proposes an approach to rank VE configurations using an extension of TOPSIS^{*} with fuzzy logic, improved through the application of Tabu Search[†]. The mechanism that determines the VE configuration is modeled as a multi-criteria decision problem, which considers as inputs a number of project-specification information, namely activities, resources, precedences and durations. Some of the considered attributes are of soft nature, namely the attitude towards risk, the market entrance, the capability, and partnership experience, which are specified with linguistic data. Beyond facilitating the

^{*} a Technique for Ordering Preferences by Similarity to an Ideal Solution (TOPSIS)

[†] A meta-heuristic used to forbid certain movements in a search problem, in order to discover distinct solutions

expression of preferences, these variables are handled by corresponding fuzzy representations, which allow establishing ambiguous or imprecise preferences.

What is missing in resources-based approaches

Collaboration readiness and preparedness, as stated by previous research works, requires improvement. They fundamentally rely on the resources, infrastructures and common cooperation agreements that are available to facilitate the creation of VOs. Although the availability of cutting-edge ICT, good consortia creation mechanisms, or even well established guidelines are necessary elements for the success of collaborations, they are not enough. The reason lies in the fact that partners not prepared to collaborate, in a behavioral sense, are likely to remain unprepared even if the conditions change, like becoming members of VBEs. An organization that is not able to develop desirable collaboration-related behavioral patterns, is likely to affect the joint effort.

Considering soft aspects

Recent works started introducing new factors leading to the consideration of soft aspects in collaboration readiness. For instance, in (Holtbrügge, 2004), the cultural and strategic compatibility of partners are seen as a particularly important criterion for partners' selection. A scoring model for partner analysis is proposed, in which several aspects are considered, such as the state of cooperation, e.g. harmony among partners, morale, adaptativeness, and learning.

In (Jarimo, Ljubi et al., 2005) the process of partners' selection is defined as a multi-attribute decision-making problem, in which a hierarchy of attributes is used to characterize partners. These attributes include elements such as expertise, resources, performance indicators, competencies, and the economical situation of a partner. But it also considers the "network preparedness", in which the business culture, competition, trust, intelligence, motivation, and the infrastructure of a partner are characterized.

The work of (Camarinha-Matos and Abreu, 2005) proposes an approach for benefits analysis in collaborative processes for networks of enterprises and introduces the notion of past performance as a criterion for future selection. By observing the history of benefits-flow between partners, it is possible to create indicators that can be used to assert partners' collaboration levels, which can be used to select/search partners for

future collaboration situations. An interesting feature of this work is that it involves concepts from the Social Networks area.

An extremely important enabler of collaboration is trust. In (Blomqvist, Hurmelinna et al., 2005), the research is focused on the roles of trust and contracts. They examine the potential for balancing trust and contracting, affirming that contracts alone cannot guarantee successful collaboration, but that the contracting process could be purposefully used to increase mutual understanding, learning and trust. In this sense, trust both complements contracts and is a threshold condition for collaboration.

The work described in (Msanjila and Afsarmanesh, 2008) introduces the notion of rational trust in the context of VO breeding environments. Through the definition of a number of trust criteria based on observable / measurable facts, the method allows establishing a relative grading of trustworthiness among enterprises, which can provide a useful indicator for partners' selection.

In (Haller, 2008) a trust management approach based on a Bayesian reputation system is proposed to help choosing more reliable partners. In this research, reputation is taken as a trust measure, aggregated from a multiple independent trust sources. On the basis of these measures are elements such as financial, organizational, and operational aspects of network members, including external and third party entities.

There is now an increasing trend in research towards incorporating aspects of "soft nature" in partners' selection. Nevertheless, existing research on collaboration preparedness, based on soft aspects, mainly those works exploring a behavioral dimension, seem to be still scarce. One contribution in this direction is, for instance, provided in (Camarinha-Matos and Macedo, 2007), which establishes a dependency of the joint behavior from the underlying value systems prevalent in the network. In (Westphal, Thoben et al., 2007) the problem of collaboration performance is addressed using aspects such as flexibility, reliability and commitment, which can be considered traits of an organization's character. In (Romero, Giraldo et al., 2007) the definition of guidelines for governance rules and bylaws for behavior regulation is attempted. In (Conte, Santoro et al., 2004), a collaboration readiness methodology composed of motivation, capability and interoperability assessment is presented.

What is still missing

As it has been seen, initial approaches to model collaboration readiness lack fundamental aspects, which are essential for a reliable assessment. These approaches hardly consider a behavioral perspective.

Therefore, to our knowledge, establishing a firm commitment to follow a behavioral perspective for assessing collaboration readiness and preparedness is a novel idea. Supporting this claim is the fact that existing research for collaboration preparedness does not exist in substantial amount and those addressing soft aspects of collaboration are even scarcer.

2.5.2 Competencies assessment

In order to start with the issues of competencies in collaboration, it is necessary to adequately clear out the notion of competency, and afterwards establish a distinction between soft and hard competencies. This distinction is fundamental for the competencies fitness approach developed in this work.

What are competencies

Competencies are a complex concept. In order to rationalize this complexity, competencies are only considered in a collaboration context, being the focus of discussion put more in their combination, than to conceptualizing them in a broad sense. According to Ermilova and Afsarmanesh (Ermilova and Afsarmanesh, 2007), there is no consensus on the definition of competency. Existing literature usually associates it with a range of tangible characteristics such as resources and products, as well as intangible characteristics such as knowledge and motivation. As such, competencies have been traditionally defined as the set of knowledge, skills, and attitudes required in the performance of a certain process under some specific constraints. The work from (Draganidis and Mentzas, 2006) shows several definitions of competencies. As a sum up of these definitions, they consider competency as a combination of tacit and explicit knowledge, behavior and skills that provides the potential for effectiveness in task performance.

What has been done

The Competencies subject has been studied during the last decades, using diverse approaches and for distinct purposes. For instance, in Human Resource Management research, competencies are studied from the point of view of *Job Competencies* in which they are considered as technical skills to perform job activities. In the last decades, some authors initiated a new approach to competency management, introducing the importance of some behavioral characteristics for the proficiency of professional careers (McClelland, 1973). The term *soft competencies* was defined as “personal behaviors or attitudes”. Diverse authors defended that soft-competencies are complementary to technical competencies, and that they are of great importance in human resource management (Dainty, Cheng et al., 2005), (Dubois, 1993).

In (Prahalad and Hamel, 1990) a model for competency management in organizations called “Core competency notion” is proposed in order to support strategic planning and provide means for achieving better synergies among the various organization’s business units. Another contribution to this issue was provided by (Javidan, 1998) proposing an extension to the core competency notion, where the concepts of resource and capabilities are included in the core-competency model. He proposed also, a method based on the discussion of eight structured questions that help managers to identify the company’s core competencies and capabilities in a systematic and methodical way.

In recent years, the collaborative networks community developed some work related to competency management in a collaborative context. Molina and Flores (Molina and Flores, 1999) proposed a core-competency model for the manufacturing clusters. The basic idea of this model is to match the tasks defined for a new Virtual Organization against the constituent skills provided by the cluster of organizations. Another model for competency analysis in collaborative context, called s-a-r-C model, was introduced by Boucher and Lebureau (Boucher and Lebureau, 2005). This model supports the idea that competencies usually increase in networked organizations as a consequence of the interaction between tasks, human resources and material capabilities. Odenthal and Peters (Odenthal and Peters, 2006) further developed the concept of competency profiles in collaborative environments, proposing a method to generate target competency profiles in a Virtual Enterprise. These target profiles are based on the allocation of competencies to activities and where each set of activities correspond to a specific task. Recently Ermilova and Afsarmanesh (Ermilova and Afsarmanesh, 2008)

developed a competency model specific to competencies management in Virtual Organizations Breeding Environments (VBEs). This model is called the “4C-model” and considers four fundamental components of competency: “Capability”, “Capacity”, “Cost” and “Conspicuity”.

Another important aspect is related to the operationalization of competencies, which are usually seen as more abstract concepts considered at the management and strategic levels. For instance, these competencies need to be materialized in the form of corresponding functional constructs inside a manufacturing environment. In this sense, the research work described in (Carmo-Silva, Alves et al., 2007) proposes a POMS* design methodology combined with the utilization of distributed sources of design services, available in a distributed community, for the reconfiguration of manufacturing systems, according to new products’ requirements. This approach could be used to map (at high-level) the partners’ competencies into the (low-level) design information, which leads to the reconfiguration of a manufacturing system for a new product.

What is still missing

Although the soft competencies concept has been addressed in related fields, as just explained, our perception led us to conclude that, in spite of the potential value and benefits it could bring, the subject of soft versus hard competencies has so far received little attention in collaborative networks.

Moreover, the mentioned research works do not address the fundamental idea in this dichotomy, which is related to the effects of soft competencies on the hard ones in a collaboration context. In this sense, the competencies assessment should not only assess whether a partner has a certain (hard) competency, but also to know how well the partner is likely to use its competency. This is one of the points explored in chapter 3.

2.5.3 The willingness concept

What it is

Willingness to collaborate is related to the partner’s attitudes and intentions towards concrete collaboration situations. It depends on a variety of aspects, which are basically related to the partner’s very interests in participating in a given a partnership. These

* Product oriented manufacturing systems.

interests may be to get increased profits, achieve new markets, or obtaining some competitive advantages.

What has been done

At first sight, willingness to collaborate should have had more attention by collaborative networks researchers, given its potential importance for partnerships success. A more generic problem, namely willingness to perform a behavior is already a common subject in human behavior studies. But such is not the case in collaborative networks, as the research works addressing organizations' willingness to collaborate are scarce.

An example of such a research is (Anderson, Martin et al., 1998) where willingness to collaborate is defined as a new communication trait. As such, willingness to collaborate is positively related to a number of traits, such as willingness to communicate, argumentativeness, verbal aggressiveness, interpersonal communication competency, and a relaxed, friendly and attentive communicator style. In (Claudia and Michael, 2002), the influence of organization's corporate culture and perceived culture of a particular partner is analyzed, in order to undertake a shift from a transactional buyer-seller relationship to an intensified collaboration. If there is fitness between own and peer's culture, then willingness to cooperate increases.

In (Raban and Rafaeli, 2007) it is described a way to experimentally investigate aspects of the willingness to share information online. For instance, this research found that the ownership of information is a determinant factor in the sharing behaviour, in which sharing was higher for privately owned expertise than for organizationally owned content.

Other works could be mentioned here, but are not related to collaboration. For instance, the research in (Corral, 2001) is concerned with a firm's willingness to engage in innovation. The same researcher reuses this idea to research about the organization's willingness to adopt cleaner technologies (Corral, 2003).

What is still missing

Although being a concept used for human behavior analysis, in terms of collaborative networks, this aspect seems an issue that is still open.

2.6 Reflections and identified open issues

The principal result from this literature review was the establishment of an adequate ground, in terms of existing theories and models, which allows applying a behavioral perspective for assessing collaboration readiness.

An aspect that was mentioned in Fig. 2.2 (the 7th aspect) that collaboration between organizations involves personal interaction among individuals who represent these organizations. The problem is to ensure that during the collaboration preparedness assessment of a given organization, it is the character of the organization that is being used, not of the person(s) who represent it. Although it seems a relevant aspect at start, it may not be that important. Let us consider a person who represents an organization fully committed to collaboration in a long term fashion. While interacting with partners if the individual adopts a posture fully compliant with the represented organization, then the organization's character is expressed through the person's behavior. Both the person and his/her organization aims and behavior are in consonance. If the person does not represent adequately the organization's wishes to collaborate, the management will generally become aware of it, either through direct observation or alerted by its peers. In this case, the person is instructed to change his/her dissonant attitude, or is replaced by another one able to better express the organization's interests. In both situations, what prevail in the long term are the interests, attitudes, wishes and behaviors of the organization, not of the individual representing it. As a way to reinforce the idea of organizations' character, and not a person's personality, the subsequent sections use the more generic term character, instead of personality, which can be more semantically associated to people than to organizations.

According to what was said during this chapter, an aspect that turns up is that collaboration preparedness has been researched under a more technological perspective, and that only recently some soft issues started to be considered. When an organization establishes a partnership with a peer, both already have an idea on each one's capacities and skills. As much as important as competencies, it is to know how well they are likely to behave in a partnership. Therefore, rather than following a functional or technological approach, the work is more focused on a behavioral perspective of collaboration preparedness, because such a technological/functional/resources based assessment is just not enough to handle the soft aspects that are of great influence in the success of partnerships.

Existing research is more focused on assessing competencies the partners bring to partnerships. However, a fundamental aspect that has not been considered yet is that beyond assessing competencies, it is also important to know whether partners are able to effectively use these competencies in a collaboration context.

Willingness to collaborate seems to be a forgotten, or yet undiscovered, topic in collaborative networks. This assumption is based on the little research found concerning willingness to collaborate. The relevancy of willingness is that, although a partner possesses great competencies and resources useful in a given collaboration opportunity, it is necessary to assess its interest to participate first-hand. In this sense, there are a lot of reasons for an organization to decline an offer. Even when the partner showed interest and engaged into the partnership initially, it may wish to quit afterwards, causing undesired effects on the partnership.

3 The collaboration readiness model

"All models are wrong but some are useful"
George E.P. Box

This section introduces the proposed collaboration readiness model. According to the hypothesis previously established, a behavioral approach is pursued. Such approach involves the combination of a variety of concepts, which come from several disciplines. These concepts, such as organization's values, behaviors, character traits, attitudes, and intentions are among the ingredients used in modeling collaboration readiness, and their corresponding meaning and purpose are therefore explained in this section.

Although several of the involved concepts come originally from the social sciences area, the strategy is to follow an "integrative view", combining such concepts with methods and tools offered by the computer engineering areas, such as knowledge discovery and modeling, text data mining and formal models. As a result, various concepts of the social realm appear here *dressed* in a more formal notation, not commonly observed in their original areas. This integrative view is exercised during the various stages of the readiness model description.

The proposed model is intended to be formalized at an abstract level, keeping here only its core elements, described in a skeletal and formal way. Its working parts, functional or behavioral ingredients (or using an analogy, its muscles and flesh) are presented in a later chapter devoted to modeling experiments. This strategy allows first specifying readiness in a way as generic and open as possible. Its practical use (or its instantiation) needs to consider the specificities of each situation. The practical aspects are addressed during the modeling experiments, and the application of the model to illustrative cases. These cases will also help perceive something that is worth mentioning at this stage. Although a formal exposition of readiness and its related concepts is attempted, this model is intended to be used in a straightforward way. In order to especially ensure this requirement, a representation of a readiness canonical model is also proposed. This canonical form is intended to give a touch of easiness, desirable in handling both simpler and complex situations.

The structure of this chapter is illustrated in Fig. 3.1.

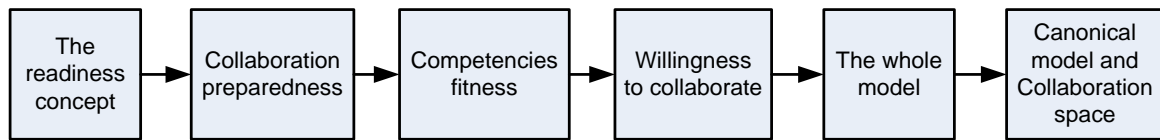


Fig. 3.1 – Structure of this chapter

3.1 The meaning of readiness

The word readiness, according to the Oxford Dictionary of English (Oxford, 2003), refers (1) to the state of having been made ready or prepared for something; (2) the willingness to do something; (3) and the quality of being immediate, quick and prompt. Following this definition, an organization could be considered ready to collaborate if it is prepared and willing to work in collaboration for the achievement of common goals, performing tasks in an accurate and reliable way. This readiness concept should cover several aspects, ranging from the technological and economical to the behavioral and social ones.

Digging further into this notion, collaboration readiness can be based on three fundamental aspects, which can be named as collaboration preparedness, competencies fitness, and willingness to collaborate. The role of each of these elements is as follows:

- Collaboration preparedness (*P*) – aims at addressing an organization's behavioral aptitude for collaboration.
- Competencies fitness (*C*) – aims at addressing an organization's capability to use its competencies in specific collaboration situations.
- Willingness to collaborate (*W*) – aims at addressing an organization's interest, commitment and will to engage in concrete collaboration situations.

These three aspects of readiness are all necessary for even a sufficient and basic collaboration readiness assessment, which is well illustrated by the pictogram in Fig. 3.2. Such necessity is based on the following reasons:

1. An assessment just based on competencies does not provide any information about a partner's behavioral preparedness to collaborate, nor whether it is interested in engaging in a specific collaboration opportunity.

2. An assessment just based on behavioral preparedness does not provide information about which competencies the partner is able to exercise in a specific collaboration. Furthermore, even when a partner has a high grade on preparedness, it is not possible to know whether it is really interested in engaging in a particular collaboration opportunity.
3. Assessing willingness to collaborate is very important, but such aspect alone does not provide information that can be achieved during preparedness or competencies fitness assessment.

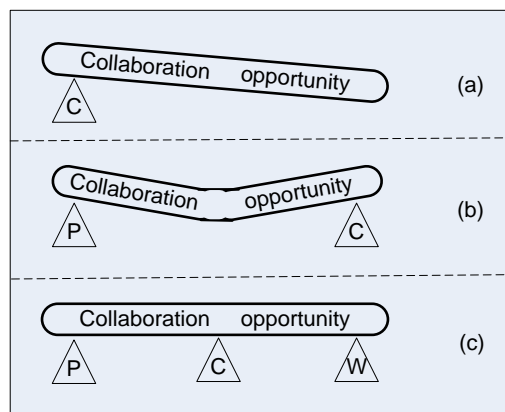


Fig. 3.2 – Establishing the need of using several dimensions in readiness to collaborate.
(C: competencies, P: preparedness and W: willingness)

The very idea of collaboration preparedness lies on the idea of behavioral patterns. These patterns are latent characteristics that may be perceived on the specific behaviors developed by a partner during collaboration. For instance, a pattern of reliability is identified when it is perceived that a partner usually undertakes its assigned activities in a reliably way.

It is also worth to mention that although the term competencies fitness suggests a classical approach for competencies assessment, such is not the aim of this work. As further explained in section 3.3, competencies fitness is here considered more from the behavioral side. In this case, what matters is not particularly assessing a partner's ownership of specific competencies, but whether this partner is able to perform them in a given collaboration situation.

The importance of willingness to collaborate assessment lies in the necessity to perceive a partner's attitudes and "true" intentions towards a concrete collaboration opportunity. If this partner is not really interested, then regardless of the signed agreements, its effective commitment, effort and performance is potentially lower.

As mentioned above, in this work it is proposed that the notions of preparedness, competencies fitness, and willingness are combined together to form the concept of readiness as illustrated in Fig. 3.3, synthesizing the main aspects involved in the assessment of an organization's ability to participate in collaborative networks.

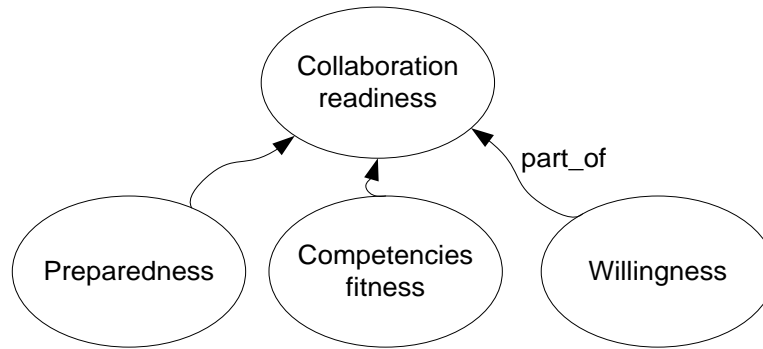


Fig. 3.3 – The collaboration readiness concept

As such, it is possible now to establish a definition for the concept of collaboration readiness. This definition is purposefully made as simple and abstract as possible. It corresponds to the very idea, and essence, of this work. This concept is ultimately a behavioral one, because even its competencies side shares this behavioral characteristic. As mentioned before, the focus of competencies assessment, in the scope of this approach, is not particularly assessing a partner's specific competency, but its ability to perform it in collaboration, being this ability also of behavioral type.

Definition 3.1.1 (Collaboration readiness) – A concept that refers to an organization's preparedness to collaborate, willingness to engage in joint work, and with the quality of being immediate, effective and prompt in a collaboration scenario. It can be formally specified as a tuple $R=(p, c, w)$, in which

- p – represents an organization's preparedness level specified using an adequate scale, which can be numerical (e.g., 0-100%) or qualitative (e.g. {low, medium, high}).
- c – represents an organization's competency fitness level according to the requirements of a concrete collaboration opportunity. It expresses how effectively an organization uses its competencies in a given collaboration situation. It can also be specified by either a numerical or qualitative scale.
- w – represents an organization's interest, commitment level, or intention to collaborate in a collaboration opportunity, with a value specified as in the previous cases.

These three dimensions of collaboration readiness are the subjects of study in the remaining of this chapter.

In order to do that, it is necessary to establish which theoretical inputs can be considered for their definition and corresponding integration in the whole structure of the readiness concept, which is also shown later in this chapter.

3.1.1 The theoretical inputs for collaboration readiness modeling

In order to develop the collaboration readiness concept, it is necessary to establish which auxiliary concepts are necessary to use. Considering the behavioral approach followed in this work, these concepts ought to be also from a behavioral realm. A first attempt is to consider the open issues already referred, namely:

- Find an adequate way to model organization's behavior.
- Define organization's behavioral patterns, traits and character.
- Perceive when a partner might be interested to engage in a collaboration opportunity.
- Adequately address the issue of competencies, in the specific context of collaboration.
- Consider the distinct situations and corresponding implications in readiness.

The models which might potentially contribute to this purpose come from several areas, which are illustrated in Fig. 3.4. As previously referred, this diversity of input models reinforces the multidisciplinary nature of this work.

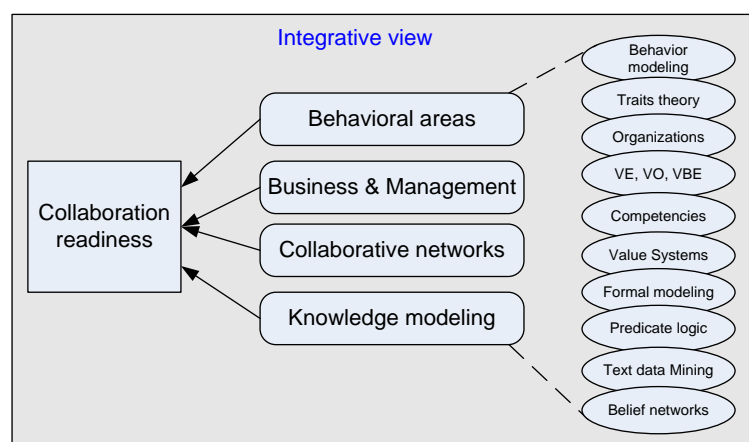


Fig. 3.4 – The theoretical inputs for the collaboration readiness model

These inputs suggest that the proposed collaboration readiness model will be a complex one, and difficult to use. A useful strategy to deal with the subjacent complications arising from this variety of inputs is to place each readiness auxiliary concept at an adequate level of abstraction. The first part, described in this chapter, is more skeletal and formal, meaning that what matters now is to define what each part of the readiness model is. The second part is tied to the modeling experiments described in chapter 4, and takes care of the corresponding semantics, taking in consideration the concrete situations, in which the model is going to be used. This two-level approach also contributes to maintaining the model as abstract, flexible and open as possible.

3.1.2 How to model behavior

A first step to behavior modeling for CNOs starts with the very definition of the behavior concept, which is an old, generic and subjective concept. Recalling one of the definitions from chapter 2, behavior in a general sense can be understood as the actions displayed by an entity in response to its surrounding environment, or the manner in which a system of any kind, such as a gas, a subatomic particle, or ecosystem, acts or functions, especially under specified conditions (the free dictionary, 2008).

Considering this notion of behavior in a context of collaborative networks, it could be defined as the way in which an organization acts or conducts itself and toward others; the way it behaves in response to relevant events or situations, in a collaboration context. But even in this context, such a definition is quite general and does not fulfill what is necessary to perform collaboration readiness assessment. In fact, modeling behavior is a difficult matter, for which a general and comprehensive solution is difficult to provide. Therefore, instead of looking for very general definitions, the subject of modeling behavior should take in consideration concrete intentions and objectives. For instance, the way behavior is modeled depends on whether it is necessary to perform control, manage, or supervise a system of any kind, to perform regulation, to predict future behavior, or just describe it.

Each of these intentions requires a specific behavior modeling approach. Some of these approaches are illustrated in Table 3.1. The basis for the construction of this table was to consider the situations in which each modeling approach can be well applied, according to the behavior modeling intentions. For instance, the management of a collaborative project can be made using business processes modeling or workflow languages (Hodík, Vokíněk et al., 2009). For prescribing behaviors it is enough to assign roles (HOGG, 1996). The contents of Table 3.1 are incomplete and some entries

can even be arguable, being the aim only to show that the issue of modeling behavior is tied to the specific modeling purposes. A summary of some methods commonly used to represent system behavior, in an engineering realm, is in (Karangelen and Hoang, 1994).

Table 3.1– How to model behavior

Used for behavior	Behavior Modeling approaches										Personality / character
	Informal text	State/event based	Probabilistic models	Roles assignment	Rules-based	Qualitative modeling	Neural computing	Algebraic models	Business processes & WF	Governance rules	
Description	×							×	×	×	×
Prediction			×		×		×				×
Prescription	×			×						×	
Control		×			×	×	×	×			
Regulation				×						×	
Management		×							×		
Supervision		×	×			×			×		

The question now is which of the above behavior modeling approaches is better suited for use in collaboration readiness assessment. The criterion to choose one can be based on the rationale for performing collaboration readiness assessment. This assessment is intended to predict whether an organization will develop desirable behavioral patterns in a collaboration context. Therefore, it is necessary to adopt an approach to model behavior that is of predictive nature. The approaches in Table 3.1 which support behavior prediction can be based on rules-based, probabilistic, qualitative or neural-computing models. As described in chapter 4, in which the modeling experiments are presented, the prediction of organizations' behaviors is based on a probabilistic model, namely the Bayesian Belief Networks. As mentioned in chapter 2, the personality/character concept is used to make their behavioral characterization.

3.2 Modeling preparedness to collaborate

The concept of preparedness to collaborate is intended to represent the organization's behavioral predisposition to develop desirable behaviors in partnership contexts. The

approach to assess preparedness is based on a collaboration preparedness hypothesis, which is presented later on. This hypothesis establishes a relation between behavior prediction and collaboration preparedness, based on the character traits of an organization.

3.2.1 *Readiness versus preparedness*

An aspect that is important to clarify is the difference between preparedness and readiness. Although they seem similar and are used indistinctly by some authors, they refer to distinct meanings and contexts. As illustrated in Fig. 3.5, preparedness is a concept more used in a long-term perspective, representing an organization's aptitude to collaborate (sometime in the future), being this aptitude relatively stable through time. In the mentioned figure, an organization is considered more prepared if it passes a selective process to join the VBE, or by just being inside that VBE it learns to become more prepared. Readiness, on the other hand, is applied in the specific situations of sudden or emergent collaboration opportunities. Readiness represents an organization's condition of being ready, capable, and willing to engage in a corresponding consortium, also owning necessary competencies, during the period provided by the window of opportunity associated to the collaboration opportunity (CO).

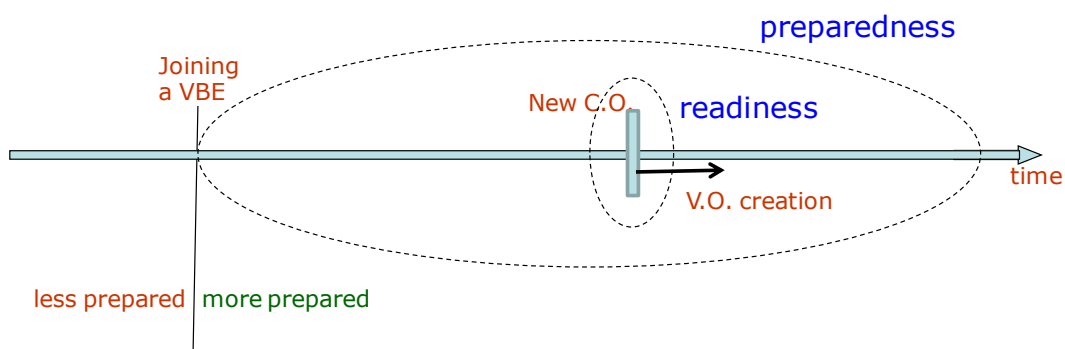


Fig. 3.5 – Readiness versus preparedness

3.2.2 *The collaboration preparedness hypothesis*

The collaboration preparedness hypothesis can be stated from the assumptions assumed in section 1.3 in terms of the established research hypothesis. Recalling these assumptions, in a collaboration context organizations interact with each other for achieving the common or compatible goals and that during these interactions they manifest a variety of behaviors, which tend to repeat through time, leading to the manifestation of behavioral patterns. As mentioned before, these patterns can be associated to identifiable traits, which as later specified, represent relatively stable

predisposition to act in a certain way. In an aggregated way, these traits form what is referred as character. This leads to the definition of organization's character as a composition of a set of traits, which determine the behavior of an organization. This underlying mapping between character traits and behavior can be used to perform behavior prediction. For instance, it is possible to predict, for a given extent, whether an organization is likely to develop trustworthy or reliable behavior knowing some of its traits. From this correspondence between traits and behaviors, the collaboration preparedness hypothesis can be formulated as follows:

h1:	The collaboration preparedness hypothesis
The behavior of an organization can be predicted to some extent, given the knowledge of some of its character traits. If collaboration preparedness is related to de manifestation of adequate collaboration-related behavioral patterns, then an organization's preparedness to collaborate can be accessed from its character traits.	

The rationality for assessing collaboration preparedness can be stated as follows:

- If the predicted patterns are seen as favorable to collaboration, then the perception of preparedness increases to a more positive level.
- If these patterns are mostly positive, then in terms of its character the organization is considered prepared to collaborate.
- On the opposite side, if these patterns are considered undesirable or unfavorable to collaboration, then the preparedness decreases to a more negative level.
- If these patterns are mostly negative, then in terms of its character the organization is considered not prepared to collaborate.

In order to develop this hypothesis, it is first necessary to introduce a number of concepts, namely the concepts of organization's behavior, trait, and character. Afterwards, a number of axioms to assess collaboration preparedness are established.

3.2.3 The concept of organization's character

The first concept that is necessary to model is exactly the concept of behavior. This concept was already intuitively established in this chapter, as anything an organization does involving reactive responses and proactive actions during interaction with its environment and its peers. Now it only matters its formal notation, which corresponds to the following definition:

Definition 3.2.1 (Organization's behavior) – The way in which an organization acts or conducts itself and toward others; the way it behaves in response to a particular event or situation. It can be formally specified as the set $B=\{b_1, b_2, \dots, b_n\}$, in which

- b_i corresponds to a short representation of $b_i(s_t) = s_{t+1}$, which abstractly corresponds to an operation, function, task, activity, plan, or process, which changes the situation (environment or context) condition from states 2^{s_t} to states $2^{s_{t+1}}$. The element 2^{s_t} represents the power set^{*} of S_t .
- $s_t \in \{(sv_t, v_{t,k}) | sv_t \in SV, v_{t,k} \in V_t\}$, corresponds to a state in the form of a state variable and a corresponding value, to represent the endogenous or exogenous effects of that behavior in the entity performing it, or in its surrounding environment.
- $SV=\{sv_1, sv_2, \dots\}$ – stands for relevant abstract state variables describing the status of the entity's situation or environment. These variables can be of elementary or composite structure.
- $V_t=\{v_{t,1}, v_{t,2}, \dots\}$ – stands for the values each state variable can assume.

This notion of behavior, and its effects on the situation or context, is illustrated in Fig. 3.6. In other words, it illustrates the idea of a behavior being performed through time, and the corresponding effects being represented by the change in values of the state variables representing the situations at instant times $t_1, t_2 \dots t_m$. An example of a behavior, using this definition, can be represented by state variables representing the started/finished states of the activities in a collaborative business process.

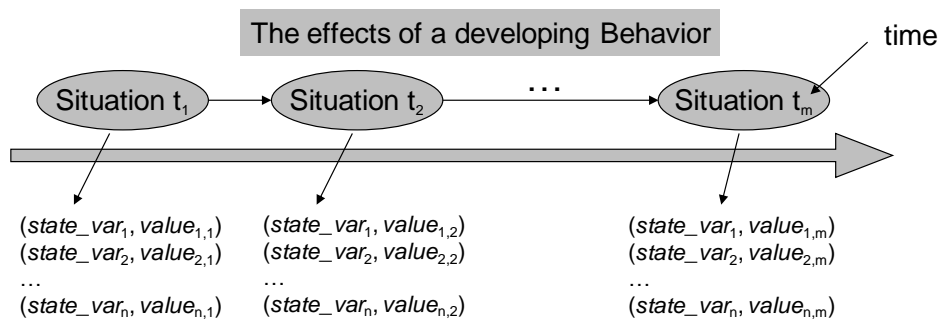


Fig. 3.6 – A behavior performed by entity(ies) and corresponding situation states

For instance, the following negative or non-beneficial behaviors, presented in Table 3.2, were identified as having occurred in inter-organizational relationships (Muskin, 2000).

^{*} If $A=\{1,2,3\}$, then $2^A=\{\{\},\{1\},\{1,2\},\{1,2,3\}\}$

Table 3.2 – Non-beneficial inter-organizational behaviors

Behaviors	Short description
Conflict of interest	Incompatible affiliation between organizations, which has the potential of causing an unmerited flow of benefits .
Bribery	Offering something, which causes unmerited benefits.
Purposefully misleading or false statements	Which is benefic to one organization, but resulting in a business behavior that is harmful to another organization.
Appropriation of intangibles	Any unauthorized taking of ideas, information, design, processes, secrets or other intangibles belonging to an originally possessing party.
Non-performance of agreements	Expectations and commitments not met by a partner, without an agreement of substitute provisions.
Commitments beyond ability to perform	Failing to perform on acceptable performance standards; irresponsible announcement of “technological” capabilities.
Exploitation of relative power	An organization uses its position to induce behavior contrary to the reasonable interests of a party exposed to this power.
Favoritism	Activity carried by one organization, in result of some “non-business” relationship, and which favors one organization over another of greater merit.

By contrast, the observation of the following behaviors is beneficial for collaboration:

- Strong effort put in undertaking assigned “business” processes.
- Adhesion to established governance rules.
- Following agreed strategies and protocols.
- Sharing assets and exchanging knowledge.
- Promoting a team-spirit among participating organizations.

Many times, the focus may not be on the behaviors, but on their effects. This approach of stating a behavior with *Definition 3.2.1* allows modeling these effects in terms of relevant state variables. For instance, state variables can be adequately used to model both the beneficial or negative effects of the behaviors exemplified above, such as to the appropriation of intangibles or non-performance of agreements.

Definition 3.2.2 (Organization’s behavioral patterns) – Behavioral patterns correspond to the repetition of specific behaviors (such as the continuous engagement in innovative activities) or the occurrence of regular behavioral characteristics in organization’s behaviors (such as when an organization performs trustworthy or reliable behaviors). For the modeling purposes of this work, it is enough to specify these patterns by a set $BP=\{bp_1, bp_2, \dots\}$ of behavioral patterns, which are considered relevant in a given context (such as in collaboration). In order to be considered behavioral patterns, such repetition of behaviors or the mentioned regularities, are expected to continue in the future.

For instance, an organization that delays its works and duties, though it may be concentrated in other more important activities, might be classified as showing a lazy behavior. If it fails/misses assigned jobs, it might be classified as performing unreliable behavior. As illustrated in Fig. 3.7, behavioral patterns are characteristics which can be perceived in the organization's performed behaviors. In this figure, these behaviors assume the form of the activities in an organization's business processes. For instance, the third behavior can be characterized as reliably and trustworthy, but not innovative. According to *Definition 3.2.1*, these activities can be considered behaviors, because they cause changes in situations' states during the time of their occurrence.

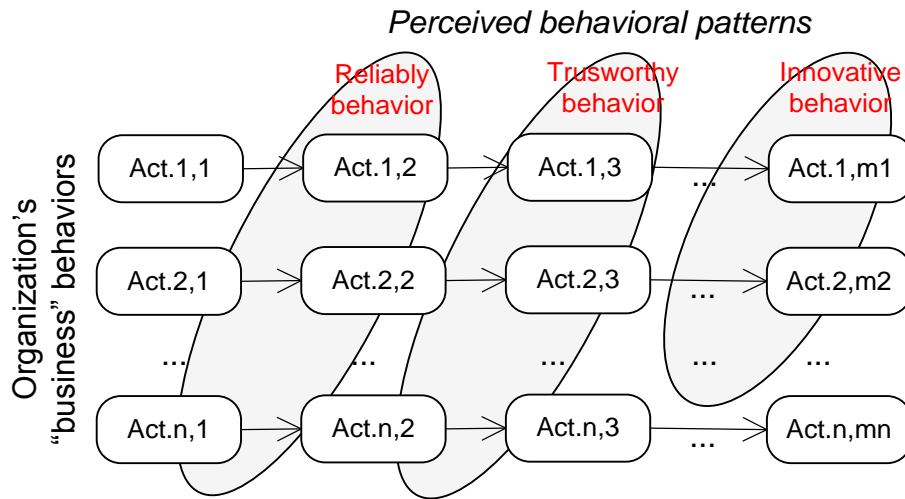


Fig. 3.7 – Illustration of behavioral patterns as latent characteristics in the concrete behaviors, represented as sequential linked activities (act: activity: arrow:sequence)

Definition 3.2.3 (Organization's Traits) – An organization's traits can be viewed as organization's relatively stable predispositions to act in a certain way. They can be specified as a pre-defined set $Tr = \{tr_1, tr_2, \dots\}$ of traits, which are associated to the manifestation of habitual behavioral patterns.

Examples of such traits could be reliability, adaptability, empathy, creativity. Although they are connected, it is necessary to distinguish behavioral patterns and traits. As mentioned before, behavioral patterns can be seen as latent characteristics perceived in the behaviors performed by organizations. A trait, on the other hand, is associated to the manifestation of habitual behavioral patterns. The former is used to characterize behaviors, and the latter is used to characterize organizations.

These concepts are not of deterministic nature. For instance, an *unreliable* organization might develop reliable behavior if it receives an overwhelming incentive, or is strongly compelled to it by circumstances. Therefore, this temporary pattern should not be understood as an indication of the reliability trait, because as soon as these particular circumstances cease its influence over the organization, it resumes to its previous unreliable behavior. On the other hand, an organization characterized by its friendliness, might not develop friendly behavior in front of threatening situations, or more “aggressive” entities.

Fig. 3.8 illustrates how these concepts can be associated to form an organization’s character, which is introduced shortly below. It shows that more than one pattern can be perceived in a behavior, and that a behavioral pattern may be connected to the combination of several traits, such as the innovative behavior illustrated in previous figure, which requires that behaviors can also be characterized as challenging and risk-taking (Kleysen and Street, 2001).

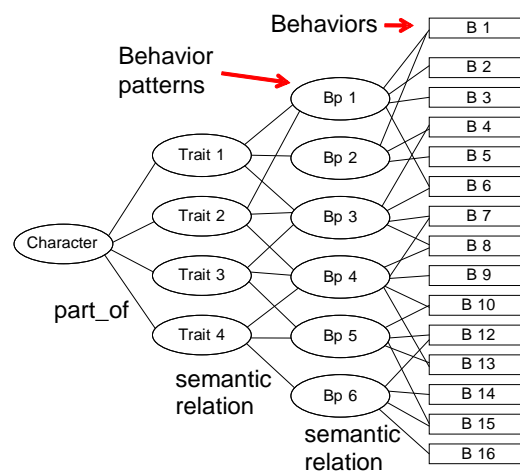


Fig. 3.8 – Relationship between traits, behavioral patterns and behaviors.

According to the previous definitions, the difference between behaviors, behavioral patterns, and traits can be stated as follows:

- Behaviors correspond to any acts (activities, tasks, processes...), which can be observed and cause (relevant) changes in situations’ states, such as the start/finish of activities.
- Behavioral patterns correspond to either the repetition of specific behaviors, or the occurrence of regular characteristics that can be perceived in these behaviors, such as perceiving a “*reliable*” and/or a “*friendly*” behavior.

- Traits are used to characterize the organizations' habitual patterns of behaviors. Examples of traits can be an organization's integrity or empathy. For instance, a more/less degree in an organization's empathy trait may influence the performance of more/less friendly behavior.

As in human behavior modeling, the traits of an organization can be grouped into common factors or behavioral dimensions. As mentioned in chapter 2, an example of such a model for humans is the “big-five” personality model (Goldberg, 1990). The rationality for clustering the traits into dimensions is due to the fact that certain traits are correlated and that together refer to more abstract behavioral characteristics, which can be used to describe an organization's behavior at the most abstract level.

Definition 3.2.4 (Organization's behavioral dimensions) – Organization's behavioral dimensions, or super traits, correspond to groups of traits that correlate together. They can be specified by a set $D = \{d_1, \dots, d_n\}$. These dimensions are usually determined by a process based on Factor Analysis (an example provided below).

Definition 3.2.5 (Organization's character) – An organization's character can be seen as a composition of traits (*Definition 3.2.3*), which are organized in a set of broader dimensions (*Definition 3.2.4*). An organization's character can be modeled as a tuple $OC = (D, Tr, A)$, in which

- $D = \{d_1, \dots, d_n\}$ – is the set of broad behavioral dimensions (*Definition 3.2.4*).
- $Tr = \{tr_1, \dots, tr_m\}$ – is the set of traits (*Definition 3.2.3*).
- $A = \{(d_i, t_j, c_{ij}) \mid d_i \in D, t_j \in T, c_{ij} \in [-1.0, 1.0]\}$ – establishes the strength of the association between dimensions and traits, through the specification of correlations coefficients (Costa and McCrae, 1995).

The concept of organization's character and the relationship between the involved concepts are illustrated in Fig. 3.9a. These dimensions are usually visualized in a web chart representation (Fig. 3.9b).

This form of specifying an organizations' character is similar to the ones used in traits theory and personality assessment, in which people can be characterized by a number of traits, and that these traits together refer to a single set of behavioral dimensions. As mentioned in section 2, for people, this assessment is usually performed

using questionnaires, which are then translated into scores on the behavioral dimensions (Goldberg, Johnson et al., 2006).

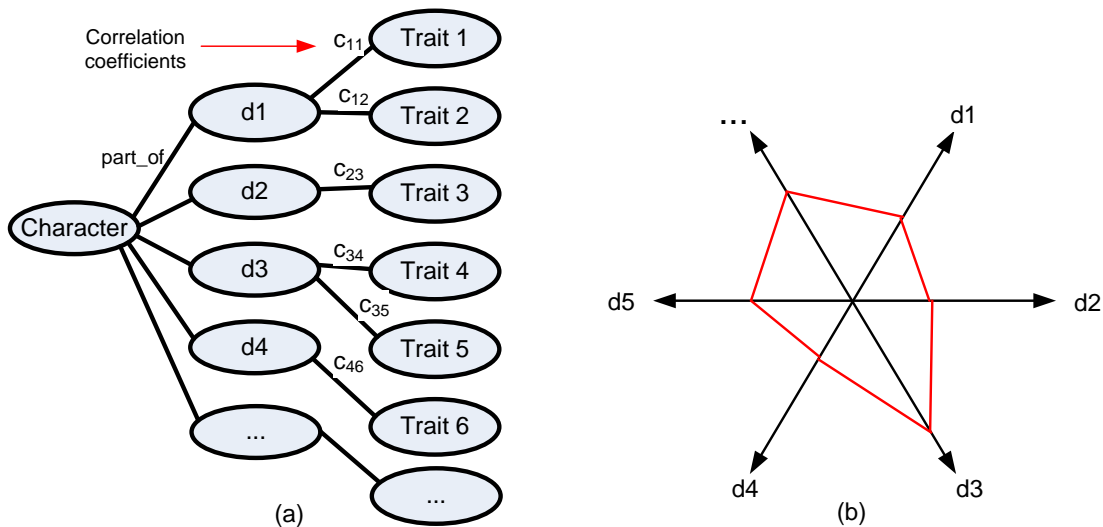


Fig. 3.9 – (a) The organization's character concept; (b) a representation using a web chart

In Fig. 3.10 there is an example of an organization's character model, which follows the structures specified in the definitions just presented. This model addresses a more ethical perspective of an organization's behaviors. The left side of the figure shows the mentioned dimensions, and the right side shows the corresponding traits.

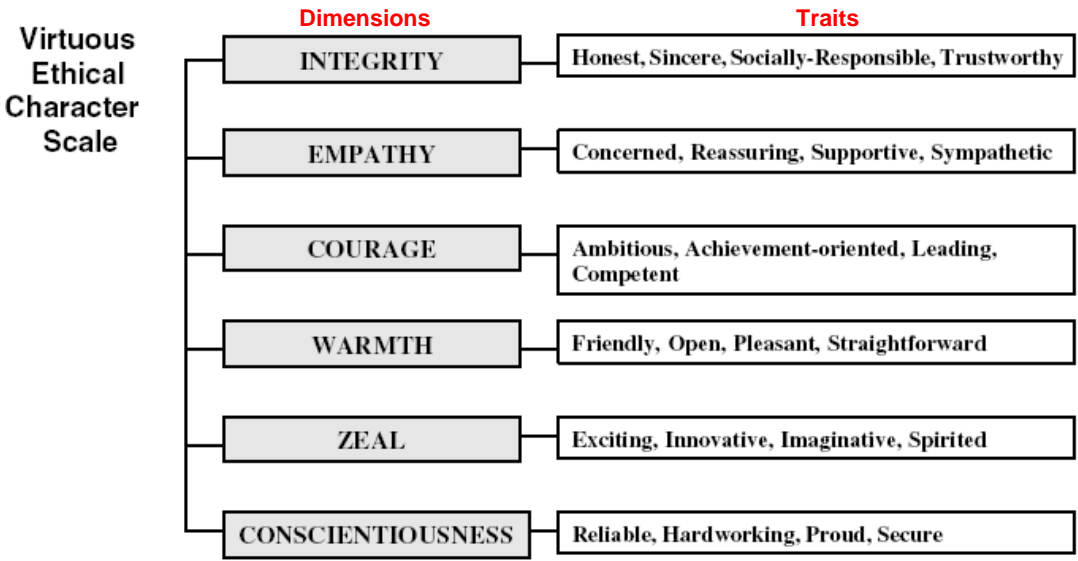


Fig. 3.10 – An example of organizations' character model (Chun, 2005)

Definition 3.2.5 specifies an abstract representation of an organization's character as a composition of behavioral dimensions, traits, and corresponding correlation coefficients. It is also necessary a way to characterize concrete organizations' characters, namely the character profiles of organizations.

Definition 3.2.6 (Organization's character Profile) – An organization's character profile can be seen as concrete set of trait values which is used to characterize a given organization. It can be modeled as a tuple $OCP=(o, I_D, I_T, M)$, in which

- o - identifies the organization being characterized.
- $DV = \{(d_i, v_i) \mid d_i \in D, v_i \in [0.0, 1.0]\}$ – is the dimension set constituted of tuples, each one composed of a behavioral dimension and a corresponding value.
- $TV = \{(t_i, v_{i,k}) \mid t_i \in T, v_{i,k} \in V_i\}$ – is the trait set constituted of tuples, each one composed of a trait and a corresponding trait value.

Additionally, it may also be relevant to specify the mechanism used to obtain the profile, such as an interview or a questionnaire. These two definitions are used in next section for assessing collaboration preparedness. An example of a character profile for a given organization is illustrated Fig. 3.11. Each dimension on the left side corresponds to the combination of the values of its corresponding traits in the right side. As mentioned before, the character model is from (Chun, 2005).

The character profile in Fig. 3.11 is arranged with the seven dimensions presented on the left, followed by the 28 trait scales grouped by corresponding dimensions. As in NEO-PI-R character profiles), this arrangement is intended to suggest a particular strategy of interpretation: to firstly attend to the broad dimensions, then to the details within each dimension. This sequence is intended to facilitate rapid understanding (Costa and McCrae, 1995). For instance, this profile represents a character of an organization which is average in Warmth and high in Conscientiousness dimensions. Contributing for a higher rank in the Conscientiousness are the traits secure, hardworking and reliable.

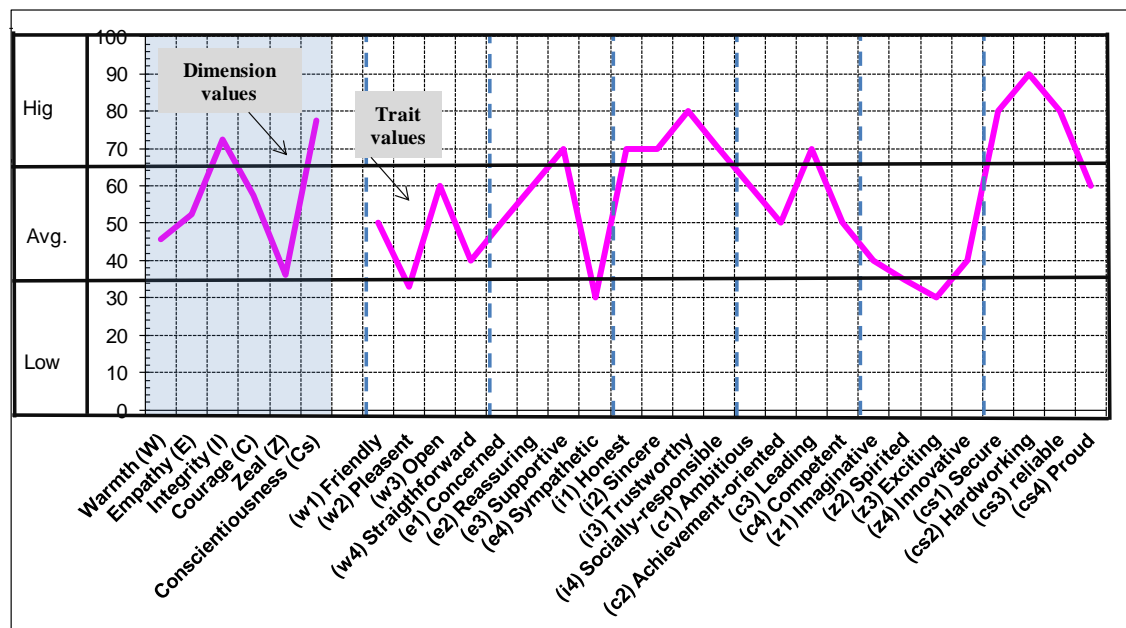


Fig. 3.11 – An example of organizations' character profile, with dimensions (W: warmth, E: empathy, I: integrity, C: courage, Z: zeal, Cs: Conscientiousness) on the left side and the corresponding traits on the right side (W is related to {w1, w2, w3, w4}); horizontal scale corresponds to the dimensions/trait values

The distinction between a character model and a character profile, in terms of structure, is best portrayed if both are represented as Entity-Relationship diagrams. In terms of utility, a character model is used as an abstract representation of all organizations' characters (Fig. 3.12a); a character profile is used to represent a concrete character of a given organization (Fig. 3.12b). Without the former, a character profile could not be interpreted. In human's realm, for instance, people who are sociable tend also to be talkative, which is information that is held in a human's personality/character model.

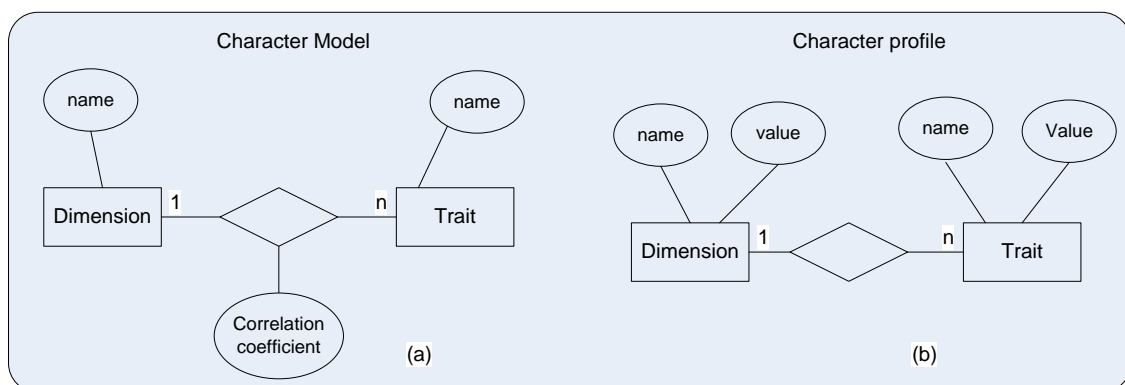


Fig. 3.12 – Distinction between character model and character profile: (a) model which represents organizations character; (b) character profile for a single organization

3.2.4 Assessment of collaboration preparedness

Collaboration preparedness assessment is based on the previously presented preparedness hypothesis, which establishes that collaboration preparedness assessment could be performed based on the organizations' character. In order to develop this assessment, it is necessary to introduce the concept of character-related collaboration preparedness pattern.

Definition 3.2.7 (Required collaboration preparedness pattern) – A required collaboration preparedness pattern (*PP*) specifies which traits, and to which extent, an organization's character profile should have in order that the corresponding organization can be considered prepared to collaborate. A preparedness pattern is specified by a set *PC* of preparedness conditions. Each preparedness condition is a tuple specifying the required or desired value for a character trait in a given profile. The set *PC* can be specified as $PC = \{ (t_i, op_i, v_{i,k}, b_i) \mid t_i \in T, v_{i,k} \in V_i, op_i \in OP, b_i \in [0,1] \}$, in which

- t_i - is the trait name.
- $v_{i,k}$ - is the trait value, such that $v_{i,k} \in V_i$.
- op_i - is the operator used for comparing the values of degree of belief b_i .
- b_i – corresponds to a belief, or subjective probability, that $op_i(t_i, v_{i,k})$ is true.

As an example, a required preparedness pattern would be represented by the following set $PC = \{(\text{reliable}, '>=', \text{high}, 0.7), (\text{imaginative}, '\text{above}', \text{fair}, 0.8)\}$, which corresponds to inferring $P(\text{"reliable"} \geq \text{high}) \geq 0.7$ and $P(\text{"imaginative"} \text{ above } \text{high}) \geq 0.8$.

The required preparedness pattern can be represented as a threshold line in a character profile, as illustrated in Fig. 3.13. This allows a visual contrast between actual traits in the organization's character profile and trait values specified in the collaboration preparedness pattern, which corresponds to the target, desired, adequate or recommended traits for a partner in a given collaboration.

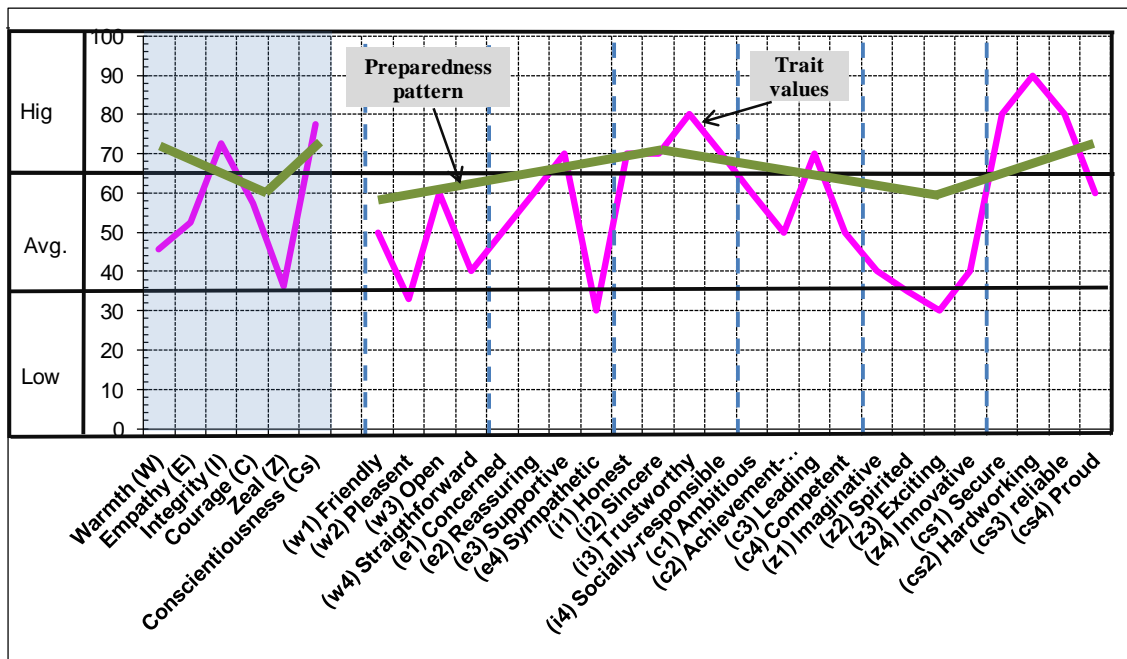


Fig. 3.13 – Comparing an organization’s character profile with a required preparedness pattern for assessing preparedness to collaborate

The way collaboration preparedness assessment can be performed is illustrated in Fig. 3.14

Fig. 3.14. An adequate assessment method or mechanism (as suggested in *Definition 3.2.6*), uses the abstract organization’s character model, the required preparedness pattern, and the organization’s character profile in order to obtain the collaboration preparedness level of the organization being assessed. In more concrete terms, the assessment tries to determine whether the organization has got the traits specified in the collaboration preparedness pattern (*Definition 3.2.7*), at the required values in order to be classified as prepared to collaborate.

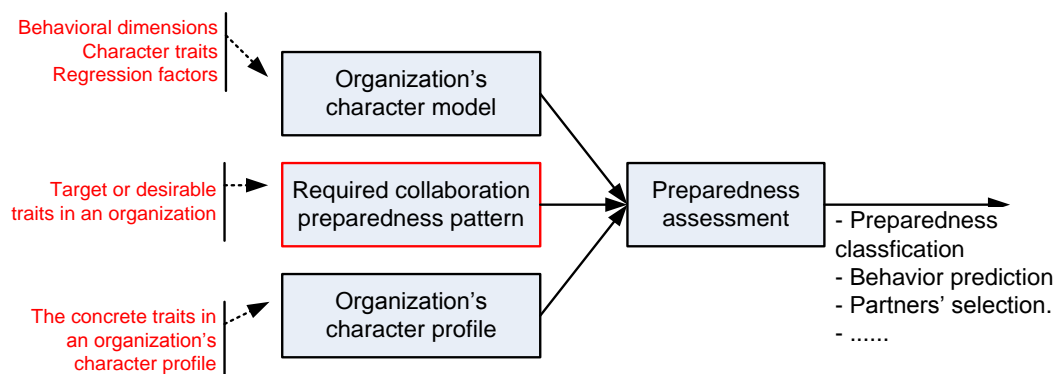


Fig. 3.14 – Assessing collaboration preparedness

This assessment process can be modeled by the following axioms:

Axiom 3.2.1 (Organization's collaboration preparedness) – A given organization *org* is considered prepared to collaborate according to a given set of character-related preparedness conditions *PC* of a required collaboration preparedness pattern *PP* (*Definition 3.2.7*), if the organization's character profile complies with each of the preparedness conditions *PC*.

$$\forall_{org} \forall_{PP} (is_prepared(org, PP) \leftarrow \forall_{pc} (belongs(pc, PP) \rightarrow complies(pc, org)))$$

The predicate '*complies*' verifies whether the organization's character is in accordance with the preparedness condition *pc* specified in the required preparedness pattern *PP*.

The next axiom establishes whether a *VO* is considered prepared to collaborate, which means that by the previous axiom, all its members are considered prepared to collaborate. This can be specified as:

Axiom 3.2.2 (VO preparedness to collaborate) – A given *VO* is prepared to collaborate according to a required collaboration preparedness pattern *PP* if all the *VO*'s members are considered prepared to collaborate.

$$\forall_{VO} \forall_{PP} (is_prepared(VO, PP) \leftarrow \forall_{org} (belongs(org, VO) \rightarrow is_prepared(org, PP)))$$

It shall be noted that often there is not enough information to perceive and characterize an organization's character profile. This fact results from traits that might be unknown, or characterized with imprecision/vagueness. This lack of knowledge increases the uncertainty of the collaboration preparedness assessment. This raises the necessity for an assessment of a probabilistic nature. These aspects are illustrated by an application example in the chapter on modeling experiments.

3.3 Competencies fitness assessment

It is now time to develop the second component of the collaboration readiness concept, which is competencies fitness. This concept aims at assessing how well the

competencies a partner brings to a partnership, fit to the necessities of that partnership. As for preparedness, we address the issue of competencies fitness from a behavioral perspective. Although it is important to address competencies in functional or technological terms, the most important aspect is not so much to assess whether an organization can provide a specific number of competencies, but rather to perceive whether this organization will be able to effectively develop/apply its competencies inside a collaboration context. Considering this aspect, competencies fitness is also dependent on behavioral aspects. In order to deal with these aspects, the competencies model described below is based on a behavioral “soft versus hard” competencies dichotomy. As explained in the next sections, this dichotomy helps understand the effects of the soft competencies in the effective use of the hard competencies.

3.3.1 Establishing the framework

In partnership formation, competencies’ assessment is usually done in order to determine the suitability of potential partners regarding a given collaboration opportunity, and to establish which activities should be assigned to which organizations, in an effort to build the best consortium with an increased chance of achieving the desired goals. Such competencies’ assessment inform about the organizations capability to perform a number of related tasks, activities or processes. However, it usually happens that many competencies are typically tuned for an organization working as a single entity in a regular market-like environment. Although competencies specification might be accurate for such environment, either the same or similar specifications might not be enough in a collaboration context. This comes from the fact that a collaboration process has its specific requirements, to which organizations must be able to comply, or otherwise their performance inside the partnership is affected. In order to comply with collaboration-related requirements it is necessary that organizations are able to perform other type of competencies. While the traditional notion of competencies is more functional and technical, the concept needed here is of a more behavioral nature. As such, the more technological type of competencies can be referred as hard competencies, and the more behavioral ones can be referred as soft competencies.

Previous works concerning competencies in collaborative networks were predominantly focused on hard competencies (Javidan, 1998), (Molina and Flores, 1999), (Odenthal and Peters, 2006), and (Ermilova and Afsarmanesh, 2008). With the model proposed here, the aim is to address the performance effects of the soft

competencies on the hard ones, within a collaboration context. The duality between soft and hard competencies is observed from a behavioral perspective, which also considers the very values of an organization, its traits, and the activities performed at a more functional and technical level. Thus, a modeling approach is proposed combining both hard and soft competencies. The assumption is that considering these aspects in the partners' competencies assessment provides a broader and more accurate perception of partners' capabilities, and that such vision of capabilities allows an improved assignment of roles and activities inside networks. This assignment in turn leads to the formation of more effective consortia. This can be summarized by the following hypothesis:

h2:	Competencies fitness assessment
In a collaboration context, the use of hard competencies is affected by a partner's ability to perform soft competencies. If we consider the effects of the soft competencies over the hard ones, then it is possible to perceive how well a partner uses its hard competencies in partnerships.	

In order to verify this hypothesis, a number of concepts are both identified and specified below, namely the concepts of Extended Competencies Model, the Adjusted Competency Model, and Adjusted Competency Level.

3.3.2 Competencies assessment model specification

In order to establish our approach and analysis, it is important to mention that the aim is not to specify a complete and very detailed competencies model, but as mentioned before, to address the soft competencies performance effects. As such, the adopted approach is to define an abstract model, maintaining the compliance with existing competency models, but allowing the integration of the findings from this research.

The meaning of competency, according to the Cambridge dictionary, corresponds basically to the ability to do something successfully or efficiently (Oxford.Dictionary, 2003). In a similar way, an organization that is considered competent on a certain domain has got the necessary ability, knowledge, and skills to perform the corresponding tasks towards achieving specified goals (McClelland, 1973).

As mentioned before, competencies can be either of hard or soft nature. An example of hard competency can be anything associated to the achievement of a concrete outcome, such as producing a car's motor or painting a ship. A soft-competency is more behavioral and allows achieving more abstract outcomes. For instance, the ability to

share knowledge, which is an example of a soft competency, can provide as outcome stronger ties between partners. In order to establish an adequate framework for a collaboration context, this dual notion of competencies must be considered inside a behavioral space, which encloses the whole organization's behavior. In this space, activities associated to a competency can also be considered as a performed behavior. A soft competency is related to more abstract behaviors, and a hard competency is related to more concrete ones. This space, as illustrated in Fig. 3.15, which starts from the very values of an organization and spans to the activities and tasks performed at a technical and functional level.

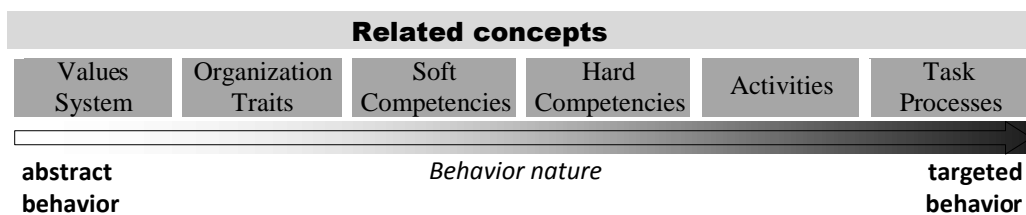


Fig. 3.15 – Behavioral space containing the key concepts involved in organization's competencies assessment

Value systems are related both to the purposes of an organization and its roles inside society. The behaviors developed by organizations should, in principle, be in accordance with its values, and their influences are propagated to the lower technical and functional behavioral levels*. Principles of ethics and code of conduct are also of great importance in collaborative networks [(Hall, 1995), (Macedo, Sapateiro et al., 2006)]. Next to the values, there are organization traits, which are also values, but with a more concrete connotation to organizations' behaviors. These traits can be perceived from the behavioral patterns that arise from the behaviors performed by organizations. For instance, an organization may be classified as reliable because it has usually performed in a very reliable way, and can be considered friendly if it usually reveals friendly attitudes. This organization could therefore be characterized as owning the traits of reliability and friendliness.

Soft competencies come next to traits. This "proximity" is related to the fact that soft competencies are more abstract, as opposite to the hard ones, which are connected to more targeted type of behaviors. The ability to develop soft competencies is in accordance to the mentioned organizations' traits. For instance, if an organization is capable of building consensus on a conflicting situation, which is an example of a soft

* One can imagine a 'green' enterprise adopting renewable energies and performing recycling in its manufacturing system.

competency, that might be due to its empathy and openness, which are examples of traits.

Going further through the considered behavioral space, we can find the hard competencies concept. Such type of competencies is associated to the specific skills, functions, activities, and knowledge, used to achieve specific goals and outcomes, establishing the association to the mentioned more technical and functional nature.

These concepts can be represented using a formal notation, using the concepts mapped in the mentioned behavioral space.

The first definition to state is the very concept of competency. This is a concept heavily studied in the human resources areas, for which many definitions are provided. The work from (Draganidis and Mentzas, 2006) shows a collection of these definitions. From the performed research, they came up with a definition of competency, which they state as:

“A competency is a combination of tacit and explicit knowledge, behavior and skills that gives someone the potential for effectiveness in task performance.”

In the context of this work, it is necessary to state a definition of competency that is congruent with the concepts introduced in this work, because of the assumed behavioral perspective and the distinction between soft and hard competencies. Let's consider for subsequent modeling a set of organizations $O=\{o_1, o_2, o_3, \dots\}$.

Definition 3.3.1 (Organization's competency) – A competency can be understood as an organization's behavioral ability to perform acts, activities, tasks, or processes aimed at achieving a specified number of outcomes.

This definition is intentionally as abstract and open as possible, not mentioning aspects such as knowledge, skills and capabilities, in order to maintain its compliance with most of existing definitions. Depending on the nature of these outcomes, a competency can be of the type soft or hard.

Definition 3.3.2 (Organization's Soft Competency) –Can be understood as a general aptitude to perform a behavior (e.g. the ability to exchange knowledge), which is beneficial for the achievement of the outcomes and goals associated to the performance of a hard competency.

For modeling the remaining concepts, let us consider the set of soft competencies $SC=\{sc_1, sc_2, sc_3, \dots\}$, in which each element sc_i stands for a soft competency.

The following definition introduces the concept of hard competency, which is built upon the *4C* competence model described in (Ermilova and Afsarmanesh, 2008)

Definition 3.3.3 (Organization's Hard Competency) –A hard competency represents an organization's capability to run activities, tasks or processes, which allow achieving concrete outcomes or goals. It can be specified as a tuple $hc=(C_1, C_2, C_3, C_4)$, such that:

- C_1 represents the competency capability information in terms of the processes and activities an organization can perform.
- C_2 represents the capacity information, used to represent the free capacity of related resources, and to specify quantitative values of capabilities, such as a production rate (e.g. units/day).
- C_3 represents cost information of products/services that are related to the organization's capability C_1 .
- C_4 represents the conspicuity, i.e. information used as a mean to validate and certify the organizations' capabilities. This information can take the form of certifications, licenses, or recommendation letters.

For modeling the remaining concepts, let us consider the set of hard competencies $HC=\{hc_1, hc_2, hc_3, \dots\}$.

The following definition introduces the extended competency model concept, which results from the combination of an organization's traits, observed behaviors, and both the hard and soft competencies specified in the previous definitions. The observed behaviors are important here, as they are associated to previous manifestations of soft competencies.

Definition 3.3.4 (Organization's Extended Competencies profile) – is defined as a tuple (o, OT, OB, HCL, SCL) , where:

- o – represents a given organization, such that $o \in O$.
- $OT = \{(tr_i, v_i) \mid tr_i \in Tr, v_i \in \{low, average, high\}\}$ are the organization's traits.

- $OB = \{(b_i, v_i) \mid b_i \in B, v_i \in \{low, average, high\}\}$. The b_i represents an organization's repeatable observed behavior, which can be associated to a soft competency manifestation.
- $HCL = \{(hc_i, l_i) \mid hc_i \in HC, l_i \in [0,100]\}$. The value of l_i represents the hc_i competency level; the set HC is assumed as in *Definition 3.3.3*.
- $SCL = \{(sc_i, l_i) \mid sc_i \in SC, l_i \in \{low, average, high\}\}$. The level l_i indicates the level of the soft competency sc_i .

The hard competency level in this definition can result from an aggregated evaluation of the hc_i information that is embedded in its $4C$ elements described in *Definition 3.3.3*. In the above definition, it has a numeric value to reflect functional or technological capability. As opposite, the scale of values for the soft is of linguistic type (e.g. 'low', 'average' or 'high' values), to reflect more abstract, not that easily to quantify values. Nevertheless, it is possible to translate competency levels values from linguistic to numeric and vice-versa (Herrera, Herrera-Viedma et al., 1996). This conversion is even necessary in subsequent sections of this chapter.

Taking this into consideration, a corresponding relation $hcLevel: O \times HC \rightarrow [0,100]$ can be defined, which obtains an aggregated competency level value from the information embedded in the $4C$ elements. In addition, the relation $scLevel: O \times SC \rightarrow \{low, average, high\}$ obtains the soft competency level for a given organization. The computation of these levels is further explained in the competencies assessment.

A collaboration opportunity (CO) can be related to the competencies that are necessary for its fulfillment. These competencies are usually of the hard type, but soft competencies are also important. For instance, certain activities associated to a hard competency might require intensive knowledge exchange. In this case, only partners that have such soft competency can assume these activities.

Definition 3.3.5 (Competencies requirements of a Collaboration Opportunity) – Can be specified as a tuple $CRCO=(co, RC)$ where:

- co identifies a specific collaboration opportunity.
- $RC=\{(hc_i, sc_j, q_{ij}) \mid hc_i \in HC, sc_j \in SC, q_{ij} \in \{low, medium, high\}\}$, establishes that an hard competency hc_i requires a certain level q_{ij} of a soft competency sc_j for its performance (e.g. the ability to exchange knowledge).

In addition, we can consider a relation named *reqLevel*, formally specified as $reqLevel: HC \times SC \times CO \rightarrow \{low, medium, high\}$, which obtains the soft competency level required by a hard competency needed in a given *CO*, from the information characterizing that *CO*.

The next concept corresponds to the definition of the adjusted competencies model.

Definition 3.3.6 (Organization's adjusted hard Competencies profile) – Represents an organization's adjusted competency levels, in which these levels are adjusted for the effects of the soft competencies on the hard ones, taking into consideration the information provided by the extended competencies model (*Definition 3.3.4*) and the requirements of a given collaboration opportunity (*Definition 3.3.5*). An adjusted competency model can be specified as a tuple $ACP=(o, AHC, co)$ where

- *o* - is a given organization, such that $o \in O$.
- *co* - identifies a specific collaboration opportunity.
- $AHC=\{ \{(hc_i, al_i) \mid hc_i \in HC, al_i \in [0,100]\} \}$, such that al_i represents the adjusted hard competency levels.

The adjusted competencies model is instantiated whenever there is a concrete *CO* establishing both hard and soft competencies requirements. In such a case, the adjusted model is fed with both the information in the extended model and the *CO* requirements, in order to compute adjusted competency levels, providing better information concerning an organization's effective capacity to use its hard competencies in such collaboration opportunity. This is the subject of the next section.

3.3.3 Competencies assessment

The assessment of competencies includes the evaluation of both soft and hard competencies. The aim of this assessment is to obtain the information of an organization's soft competencies (Fig. 3.16a), in order to be further used in the determination of the adjustment of hard competency levels, according to the soft competencies requirements of a given collaboration opportunity (Fig. 3.16b).

The information required for the soft competencies evaluation can be obtained from several sources, as explained below. The hard competencies of an organization are the information that is specified in the 4C elements provided by the organization, which is supposedly available. The rationality for this assumption is based on the fact that,

whenever an organization wishes to join a consortium, it delivers a statement describing its best competencies, aiming at obtaining a favorable qualification.

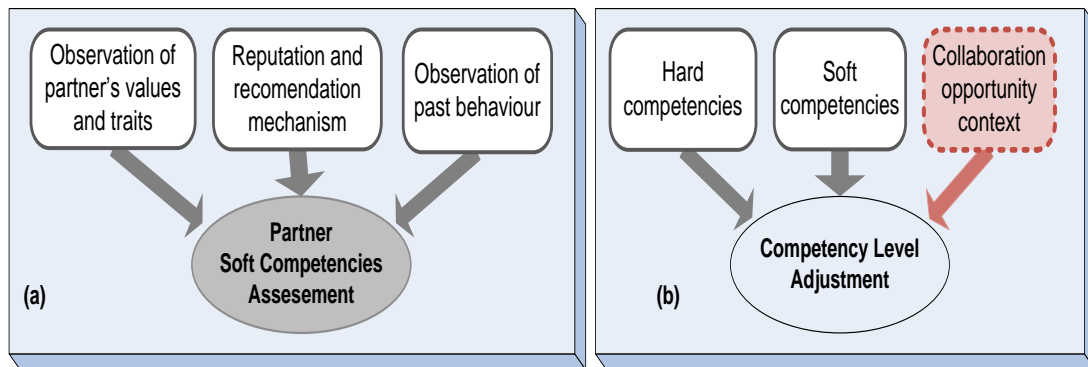


Fig. 3.16 – (a) Soft-Competencies assessment; and (b) hard competencies levels adjustment.

In the context of this approach, competencies assessment, more concerned with competencies levels, is distinct from competencies fitness, which is more concerned with the fitting between partners and necessities. Competencies fitness is a subject handled in a subsequent section.

3.3.4 *Hard competencies assessment*

As shown during the literature review, the topic of hard-competencies assessment is one of the topics heavily addressed in collaborative networks. Consequently, this work does not focus on establishing the detailed processes of assessing them. Regarding this aspect, the discussion in this part of the work is firstly focused on the study of the synergistic effects of combining distinct competencies in a collaboration context. Afterwards the work is more focused on assessing whether a consortium has got a combination of hard competencies which fulfils the needs of a collaboration opportunity.

As illustrated in Fig. 3.17, one of the primary reasons for the engage in collaboration is for the sake of combining each partner's competencies. An organization alone may not have the necessary competencies (Fig. 3.17a), or they may not be inadequate (Fig. 3.17b). Establishing a consortium requires an adequate combination of partners, which jointly provide the necessary competencies to satisfy the collaboration opportunity (Fig. 3.17c).

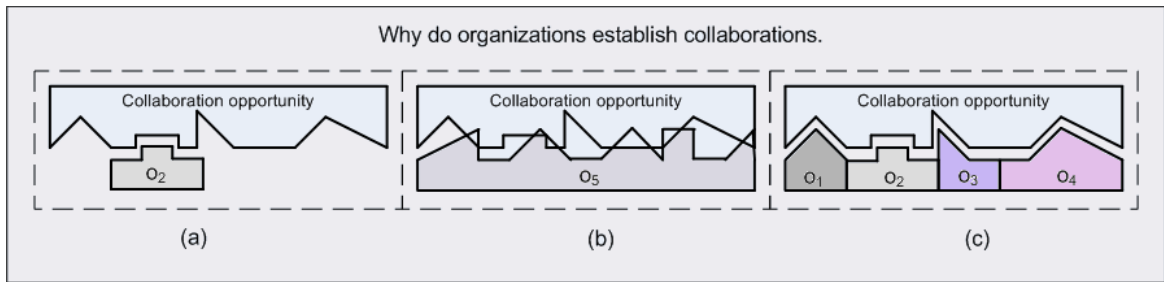


Fig. 3.17 – Why establishing a consortium: (a) single organization with insufficient capacity, (b) single organization with inadequate competencies, and (c) a consortium owning the necessary competencies and capacity

A necessary condition for an organization to be considered a potential partner is that it owns required hard competencies, which other partners already considered for the consortium do not offer. Therefore, the role of the hard competencies assessment is to determine whether partners own such hard competencies, which are required in a collaboration opportunity. An organization can be a potential partner if it has got competencies matching the collaboration opportunity (Fig. 3.18). In this figure the elements of the set $\{o1, o2, \dots\}$ represent organizations, the set $\{hc1, hc2, \dots\}$ represent competencies, and each rectangle stands for an organization and the corresponding hard competencies the organization is willing to provide.

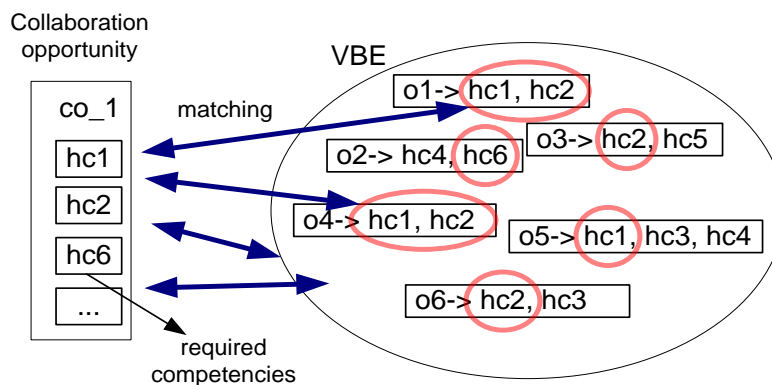


Fig. 3.18 – Matching between the required competencies in a CO with the competencies provided by organizations

As mentioned before, the determination of what are these hard competencies, and at which level, is provided by existing models, such as the 4C approach mentioned before. This aspect is out of scope of this work, because as mentioned before, the goal here is to assess the effects of soft competencies on the hard ones.

The following axiom establishes the hard competencies assessment used in this research.

Axiom 3.3.1 (Hard competencies assessment) - A *VO* satisfies a given *CO* if for any required hard competency *hc*, there is a corresponding organization *o* that provides it.

$$\forall_{VO} \forall_{CO} (\text{satisfy}(VO, CO) \leftarrow \forall_{hc} \exists_o (\text{requires}(hc, CO) \wedge \text{member}(o, VO) \wedge \text{provides}(o, hc)))$$

This predicate assesses whether a VO can fulfill the necessities of a collaboration opportunity or not. It cannot assert if partners are able to use effectively their hard competencies in such a collaboration context. This aspect is addressed in soft competencies assessment.

3.3.5 *Soft competencies assessment*

Before assessing the mentioned effects of the soft competencies over the hard ones, it is firstly necessary to know which soft competencies an organization has got. But this is not a very easy job, due to the intrinsic subjectivity and underlying ambiguity that characterizes these concepts. For instance, it is not straightforward to provide a percentage value for a soft competency related to the ability to lead a consortium composed of autonomous and conflicting parties. Consequently a qualitative scale is adopted. The adopted approach to obtain the information about an organization's soft competencies is to rely on:

- Perception of organizations' traits. For instance, the capacity to build consensus on a conflicting situation depends on organization's traits, such as diplomacy and honesty.
- Receiving advice from a trustworthy partner, who informs about third parties competencies.
- Observation of past behavior, which was characterized as a successful or unsuccessful manifestation of a soft competency.

The observation of past behavior is, amongst the mentioned ones, the most reliable way to perceive soft competencies. If, for instance, a partner was observed to engage on knowledge sharing on a situation that provided positive outcomes, then it is likely that

this partner is willing to engage in such a behavior again in the future. However, if the outcomes were not satisfactory, the partner might be less prone to repeat that behavior. The information concerning past behavior can be obtained, for instance, from a history repository of a *VBE*, assuming that such information could be collected.

Axiom 3.3.2 (Soft competencies assessment) - the process that takes an organization's traits, recommendations from experts and observed behavior, in order to infer a level for a given soft competency. This process can be represented by the following logical sentence:

$$\forall_o \forall_{sc} (observed(o, sc, level) \vee recommended(o, sc, level) \vee traits(o, sc, level) \rightarrow scLevel(o, sc, level))$$

In the above sentence, the predicate 'observed' tells us whether a partner was seen performing the soft competency *sc* before, the predicate 'recommended' provides the *sc* level as supplied from a trustworthy advisor, and the predicate 'traits' infers that level from observing the organization's character traits. The variable 'level' is considered free in this sentence, because it is not bound by any of the existential or universal quantifiers.

The order in which each predicate appears is intended to model the fact that there is precedence between traits-inferred, recommended, and observed behavior. As such, advisor's recommendations are more important than traits perception, and observed behavior overlaps both recommendations and traits. The partners' perceived reputation, which can also be used in order to perceive the soft competencies levels, can be considered as (indirectly) observed behavior.

3.3.6 *Hard competencies levels adjustment*

As illustrated in section 3.3.3 (Fig. 3.16b), the hard competency levels adjustment is a process which receives as inputs the soft and hard competency levels (from *Definition 3.3.4*), and the requirements of a given CO, in order to obtain adjusted values for adjusted hard competency levels. As mentioned before, these levels provide more accurate information about the partners' potential performance for the actual CO.

Definition 3.3.7 (The adjusted hard Competency Level) – represents a value obtained with a function $adjLevel: O \times HC \rightarrow [0, 100]$, which for a given organization o_i , calculates the adjusted level for its hard competency hc_j , according to the soft competencies owned by the organization, and the ones required by a given collaboration opportunity co . The adjustment function can be specified as:

$$adjLevel(o, hc, co) = \underbrace{hcLevel(o, hc)}_{\text{Original level}} \times \underbrace{\frac{1}{\#(SC_{co, hc})} \times \sum_{n=1}^{\#(SC_{co, hc})} \left[\frac{scLevel(o, sc_n)}{reqLevel(co, sc_n, hc)} \right]}_{\text{Adjustment factor (adjFactor)}}$$

where:

- $hcLevel$, gives the original organization's hard competency level, as previously established.
- $o=o_i$ and $hc=hc_j$ for a better function understanding.
- $SC_{hc, co}$ corresponds to the set of soft competencies that are required in the performance of hard competency hc , in the context of the actual CO . The expression $\#(SC_{hc, co})$ represents the size of this set.

The adjustment factor ($adjFactor$) of the above equation is precisely the element that considers the effects of the soft competencies over the hard ones for the concrete context of the provided collaboration opportunity. It moderates or leverages the partner's capacity accordingly to its ability to use the soft competencies required in the mentioned context. Other equations tailored for concrete situations can also be used. For instance, the way $adjLevel$ is applied depends on the context of the distinct cases of collaborative networks. In order to understand why, let us consider the following collaboration-related soft competencies:

- Ability to perform tasks in a collaborative way
- Ability to share resources and knowledge
- Ability to lead a group of autonomous organizations, possibly with conflicting interests and goals
- Ability to do consensus-based decision-making.

For a single enterprise operating in the market, in which its interactions are mostly transactional, all that matters are hard competencies, with little consideration for collaboration-related soft competencies. This can be modeled as:

$$\#(SC_{co,hc})=0 \Rightarrow \text{adjLevel}(o,hc,co) = \text{hcLevel}(o,hc)$$

In an Extended Enterprises (EE) most of the business interactions are controlled by a dominant partner (Camarinha-Matos and Afsarmanesh, 2006). Nevertheless, the involved entities are autonomous, which requires a greater level of multilateral coordination. A VE/VO, in turn, is essentially constituted by autonomous organizations, which make decisions on a consensus basis (Camarinha-Matos, Afsarmanesh et al., 2008), and the interactions are mostly collaborative. In this case, there is a higher need for collaboration-related soft competencies. As a result, the adjustment level for these two cases can be modeled as:

$$\#(SC_{co,hc}) > 0 \Rightarrow \text{adjLevel}(o,hc,co) = \text{hcLevel}(o,hc) \times \text{adjFactor}$$

In the case that an organization is invited to join a Virtual Organizations Breeding Environment (VBE), as there is no concrete collaboration opportunity to fulfill, there is no need to consider hard competencies requirements at that time (the *nil* values in the expression below). Here, the focus is predominantly put on the organization's soft competencies, and the main concern is to assess its preparedness to participate in future partnerships. This case can be modeled as:

$$\#(HC_{co})=0 \Rightarrow \text{adjLevel}(o, \text{nil}^*, \text{nil}) = \text{adjFactor}.$$

There are specific cases of VBEs, which might specialize on certain industries, such as biotechnology or energy-related. In these more concrete cases, it may be necessary to consider the candidates' hard competencies, almost with the same importance as in a given collaboration opportunity, being the adjusted level determined by the expression $\text{adjLevel}(o, hc, \text{nil})$.

These cases can be arranged in a scale, in which they are ordered by their growing needs for soft competencies, as illustrated in Fig. 3.19. Considering these cases, the resulting expression for the adjusted level calculation is given by:

$$\text{adjLevel}(o, hc, co) = \begin{cases} \text{hcLevel}(o, hc) \times \text{adjFactor} & \Leftarrow \#(SC_{co,hc}) > 0 \\ \text{hcLevel}(o, hc) & \Leftarrow \#(SC_{co,hc}) = 0 \\ \text{adjFactor} & \Leftarrow \#(HC_{co}) = 0 \end{cases}$$

* Nil corresponds to a non specified value.

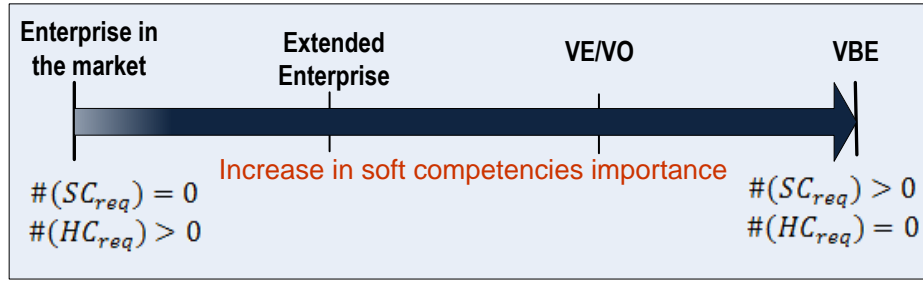


Fig. 3.19 – Soft Competencies importance according to network type.

An example in chapter 4 illustrates how to use the adjusted hard competency level concept. The competency adjustment level function is useful to define the competencies fitness concept, which is described in the next section.

3.3.7 The concept of fitness level

The competencies fitness level is a concept that can be used to determine which partners better fit in a collaboration opportunity. This concept can be applied to achieve several outcomes, some of which are:

- The fitness level of a potential partner regarding a given collaboration opportunity.
- Suggestion of which partner is better suited for providing a certain competency in a collaboration opportunity.
- For a given partner, determination of the competency in which it might potentially present the best performance.
- As the previous one, but the competency with potentially worst performance.

The way competencies fitness is assessed is based on the concept of adjusted competency level presented in previous section. Some concepts introduced in the previous definitions adopt a matrix notation in this section, in order to perform necessarily matrix algebra, and to efficiently represent the competencies profiles of several organizations simultaneously.

Definition 3.3.8 (Hard competencies matrix - HCM) – A hard competency matrix is a matrix composed of n organizations and their corresponding m hard competencies (Definition 3.3.3). The shape of this matrix is

$$HCM = \begin{bmatrix} hc_{1,1} & hc_{1,2} & \dots & hc_{1,m} \\ hc_{2,1} & hc_{2,2} & \dots & hc_{2,m} \\ \dots & \dots & \dots & \dots \\ hc_{n,1} & hc_{n,2} & \dots & hc_{n,m} \end{bmatrix}.$$

Each element in this matrix represents an organization and a corresponding hard level competency. For instance, $hc_{2,1}$ represents the hard competency level provided by organization o_2 in terms of hard competency hc_1 .

Definition 3.3.9 (Soft competencies matrix - SCM) – A soft competencies matrix is a matrix composed of n organizations and their corresponding m soft competencies (Definition 3.3.2). The shape of this matrix is similar to the previous definition.

In order to ease the understanding of the concepts, the following matrixes are provided as an example:

- HCM matrix composed of organizations $O=\{o_1, o_2, o_3, o_4\}$, and 5 corresponding hard competencies $HC=\{hc_1, hc_2, hc_3, hc_4, hc_5\}$. Each cell represents an organization, and a corresponding hard competency level. For instance, $HCM(2,3)=20$, which corresponds to the level of hard competency hc_3 for organization o_2 .

$$HCM = \begin{bmatrix} 20 & 80 & 95 & 70 & 30 \\ 30 & 70 & 20 & 40 & 50 \\ 95 & 75 & 40 & 20 & 30 \\ 70 & 65 & 40 & 90 & 25 \end{bmatrix}$$

- It was mentioned before the necessary to convert soft competencies levels from linguistic to numeric. The SCM of soft competencies $SC=\{sc_1, sc_2, sc_3\}$ for the considered organizations is therefore:

$$SCM = \begin{bmatrix} 80 & 20 & 50 \\ 80 & 0 & 30 \\ 30 & 30 & 50 \\ 80 & 30 & 0 \end{bmatrix}$$

- A competencies requirement matrix for a given collaboration opportunity co_1 , according to Definition 3.3.5:

$$reqSC(co_1) = \begin{bmatrix} 20 & 70 & 30 \\ 30 & 40 & 50 \\ 50 & 30 & 20 \\ 95 & 20 & 30 \\ 70 & 90 & 25 \end{bmatrix}$$

Therefore, taking them together, the value v_{ij} of line i and column j corresponds to each tuple (hc_i, sc_j, q_{ij}) in *Definition 3.3.5*. For instance, this matrix states that that hard competency hc_4 should be assumed by a partner that has got a level of 95% for soft competency sc_1 , i.e. it corresponds to the tuple $(hc_4, sc_1, 95\%)$ in the mentioned definition.

Definition 3.3.10 (Adjusted Competencies matrix - *adjCM*) – An adjusted competencies matrix is a matrix that stores the values of the adjusted competencies levels for a given number of organizations and a collaboration opportunity co_1 , according to *Definition 3.3.6*. Each element is therefore obtained by $adjc_{ij} = adjLevel(o_i, hc_j, co)$.

For the considered example, applying the adjusted level equation, this matrix is:

$$adjCM(co_1) = \begin{bmatrix} 40 & 111 & 151 & 82 & 34 \\ 50 & 76 & 21 & 25 & 39 \\ 114 & 69 & 55 & 23 & 28 \\ 103 & 74 & 35 & 70 & 12 \end{bmatrix}$$

For the subsequent definitions, let us assume a function $line(i, M)$, which yields the line i of a given matrix M , and a function $column(j, M)$, which yields the column j of a matrix M . For any matrix M , the value contained in a cell (i, j) is provided by $M(i, j)$.

Particular cases of the above definitions are the following:

- Hard competencies profile of an organization o_i can be specified as the matrix $line(o_i, HCM) = [hc_{i,1} \quad hc_{i,2} \quad \dots \quad hc_{i,m}]$, which corresponds to the hard competencies information specified in *Definition 3.3.4*.
- An adjusted competencies profile can be represented by the matrix $line(o_i, ACM) = ([adjc_{i,1} \quad adjc_{i,2} \quad \dots \quad adjc_{i,m}]$.
- The fitness levels for a given organization, in relation to a collaboration opportunity can be obtained by the matrix $line(o_i, CFM) = ([adjc_{i,1} \quad adjc_{i,2} \quad \dots \quad adjc_{i,m}]$.

- The competency levels of each organization for a given hard competency is $\text{column}(\text{hcj}, \text{ACM}) = [\text{adjc}_{1,j} \quad \text{adjc}_{2,j} \quad \dots \quad \text{Adj}_{3,j}]^T$.

Definition 3.3.11 (competencies Fitness matrix - CFM) – A competencies fitness matrix is a matrix, which results from the subtraction between the *HCM* (Definition 3.3.8) and the *ACM* (Definition 3.3.10). In other words, *CFM* results from the matrix operation $CFM = \text{adjCM} - HCM$.

The CFM allows observing the discrepancies between an organization's original hard competencies and adjusted levels for a given collaboration opportunity. For the considered example, this corresponds to:

$$CFM(co_1) = \begin{bmatrix} 20 & 31 & 56 & 12 & 4 \\ 20 & 6 & 1 & -15 & -11 \\ 119 & -6 & 15 & 3 & -2 \\ 33 & 9 & -5 & -20 & -13 \end{bmatrix}$$

Each value in this matrix poses implications for partners' selection. For instance, $CFM(3,3)=+3$ means that there is a good fitness between partner o_3 and its hc_3 regarding the collaboration opportunity co_1 . For organization o_4 and its hard competency hc_4 we have that $CFM(4,4)=-20$, meaning that this partner is not adequate to use its competency hc_4 in the referred collaboration opportunity. The case of $CFM(1,3)=+56$ can be interpreted as an example of excessive adjusted competency level, which means that partner o_1 is able to assume a more demanding competency in the context of the actual co_1 . The information about fitness levels can be better observed using the next definition.

Definition 3.3.12 (“Organization-CO” fitness) – Represents the fitness levels of an organization's competencies in relation to the requirements of a collaboration opportunity. Given a competencies fitness matrix *CFM*, these levels can be obtained by the expression $\text{fitness}(o_i, co_j) = \text{line}(CFM, o_i, co_j)$

For instance, taking organization o_2 , its fitness levels are $\text{line}(CFM, o_2, co_1)$, which corresponds to the matrix $[20 \quad 6 \quad 1 \quad -15 \quad -11]^T$, which can be represented as:



Fig. 3.20 – Fitness of partner o_2 's competencies according to co_1 . Much below zero: inadequate; much above zero: excess; and near zero: good fit

The idea of fitness is illustrated by the fact that adjusted versus original competencies levels should be positive, but near the zero level, that is, the way to see these fitness levels is similar to a healthy person which is considered not too fat nor too thin, therefore having optimum weight. In other words, many people like to be thin, but not too much. Therefore, the difference between a person's actual weight and the healthy weight for his/her age should be near zero. In Fig. 3.20, this idea corresponds to the fitness levels of hc2 and hc3. If there is a significant deviation to the negative side, like for competency hc4, it means that o_2 might not perform well on this competency during the co_1 . If on the other side, the value is significantly positive, like in hc1, then it means that o_2 might be too good for this competency. It allows considering the decision to assign this partner to more demanding activities, if there are any. In the particular case illustrated in Fig. 3.20, o_2 may be assigned to hard competencies hc2 and hc3, which correspond to a better fit. That, however, also depends on the assessments made for the remaining partners involved in the collaboration opportunity.

Axiom 3.3.3 (Organizations-Competencies Assignment - OCA) – Given a competency fitness matrix (CFM), the organizations-competencies assignment is provided by the following rule:

$$\begin{aligned} \forall_{hc_j} \forall_{CFM} (OCA(o_i, hc_j) = 1 \leftarrow & (level = value(CFM, o, hc_j) \wedge \\ & level = \min(column(hc_j, adjCM)) \wedge \\ & level > 0)) \end{aligned}$$

In this axiom, the predicate ‘ $value(CFM, o_i, hc_j)$ ’ retrieves from the competencies fitness matrix CFM the fitness value o_i in terms of hc_j ; the predicate $column(hc_j, ACM)$ retrieves the column corresponding to the fitness values of all organizations in terms of hard competency hc_j ; finally the ‘ min ’ function selects the value of the retrieved column. Each organization o_i is assigned a hard competency hc_j , provided that the corresponding fitness value is above zero.

For the given example, this corresponds to the matrix:

$$OCA(co_1) = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

This means that this matrix suggests that, in the context of co_1 , o_1 should offer competencies $\{hc_1, hc_5\}$, o_2 should offer $\{hc_2, hc_3\}$ and that o_3 should offer $\{hc_4\}$.

3.4 Willingness to collaborate

The concept of willingness aims at addressing organizations’ intentions towards a collaboration opportunity, trying to express an organization’s interest, expectations, desire or disposition to collaborate. Assessing willingness helps to perceive how an organization is likely to commit to a partnership. Not performing such assessment is a risky situation. For instance, if it happens that an organization accepts the invitation, but afterwards it does not identify itself with the situation, it might turn less committed to the partnership and its performance is likely to decrease. A lower commitment might be caused by an organization not perceiving that the collaboration opportunity does not favor, or is not in agreement with its interests and goals. Perhaps it also perceives unbearable risks, or simply feels that its expectations are not met. This corresponds to typical cases of cognitive dissonance, where the situation is in contradiction with the organization’s values, interests and goals, and that might cause a change on its attitudes from openness to resistance against the situation.

Neither preparedness nor competencies fitness are able to address partner’s intentions towards concrete collaborations. This is why it is necessary to consider this concept of collaboration willingness. A corresponding assessment tries to observe the

partner's interests, goals and expectations it creates in face of a concrete collaboration opportunity, in order to perceive its intentions towards that collaboration opportunity. These interests might include, for instance, the access to new markets, access to peer's resources, complementing competencies and skills, sharing market risks, or increasing benefits. A low score on willingness informs that an organization feels uneasy, perceives important concerns, or is not interested in certain aspects of the the collaboration opportunity. For instance, an academic institution might be interested to engage in a collaboration initiative for the purposes of knowledge creation, patent granting, or receiving royalties, but might not be willing to actively participate in the production and commercial phases of a product.

The suggested model for collaboration willingness assessment is based on the Theory of the Planned Behavior (Ajzen, 1991), in order to address partner's attitudes towards a given collaboration opportunity and predict its intention or willingness to collaborate.

3.4.1 Willingness versus preparedness

As explained before, preparedness and willingness may be based on common factors, as they are both behavioral concepts, but represent completely distinct concepts. While the former is focused on assessing behavioral traits related to collaboration preparedness, the later is concerned with partner's attitudes and intentions towards concrete collaboration situations. For instance, given a collaboration opportunity, for which best prepared partners were chosen, the partnership might still fail. Being prepared to collaborate, owning good working and collaboration habits, together with required competencies, might be the avatar of the "Partner". But if this partner is weakly committed, if it cannot "identify" itself with the *CO*, if it feels that its interests are not being considered, if there is dissonance between its individual and shared goals, or if it feels low empathy from/towards its peers, then this partner's performance is likely to be (much) lower than expected.

Willingness measures partner's attitudes in relation to a concrete collaboration opportunity or situation. If this partner perceives the situation as not attractive, it takes an attitude of resistance towards it. If it perceives that one of its long-term strategic partners is not participating, it might not feel like joining itself. It might perceive that its peers do not share its values, so it does not want to get in. It can even depend on the actual organization's workload, either in deficit or in excess. All in all, an organization might be well prepared to collaborate, and it would in other situations, but given the

actual circumstances, it does not manifest a great interest in joining the consortium. Its willingness to collaborate is low.

Preparedness is more linked to the idea of trait and behavioral patterns, which are quasi-“stable” properties of organizations, while willingness is more “volatile” and linked to the concrete collaboration opportunities and situations.

3.4.2 Willingness versus motivation

Another distinction that can be established is between willingness and motivation. Willingness comes from the inside of an organization. It tries to evaluate its very feelings, attitudes, and intentions in front of a concrete collaboration opportunity, which eventually corresponds to a higher, or lower, desire to engage. Motivation, on the other hand, corresponds to the result of an external act or process of motivating or being motivated. It corresponds to a stimulus, incentive, persuasion or incitement towards inducing a behavior. Motivation comes from the outside, such as when an organization has been motivated to develop some steps or actions (e.g., incentives to diversify or invest abroad).

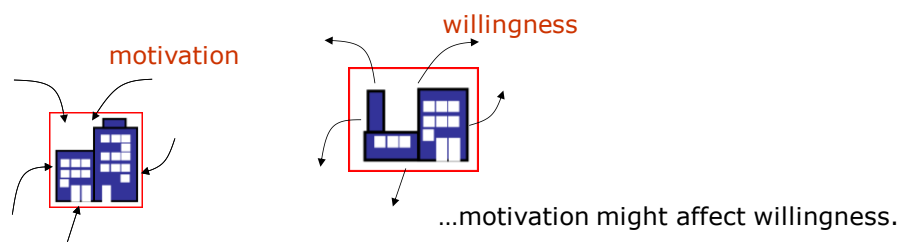


Fig. 3.21 – Motivation versus willingness

3.4.3 Modeling willingness to collaborate

As mentioned before, willingness to collaborate is concerned with assessing partner’s attitudes and intentions towards concrete collaboration situations and thus it is implicitly a behavioral concept. The research hypothesis can be state stated as follows:

h3:	Willingness to collaborate assessment
Willingness to collaborate expresses to which extent an organization is interested in a given collaboration opportunity. According to existing theories, the best predictors of behavior are the attitudes and intentions towards performing it. Therefore, if we assess an organization’s intentions towards a partnership, then it is possible to determine its willingness to collaborate (or engage) in the partnership.	

A theory that seems promising here is the Theory of the Planned Behavior (TPB) proposed by Icek Ajzen (Ajzen, 1991), which aims at predicting the willingness of people's engaging in a behavior. Before proceeding to the modeling aspects, this section starts by first introducing this theory, its application in predicting people's behavior, and its suitability for organizations.

The theory of the planned Behavior

According to this theory, intentions are considered the best predictor of people's behavior. Due to the fact that we might be trying to assess the intention of a single partner, in which its specific interests, expectations, goals and the context of the situation as it is seen, a modification to TPB is proposed. Under this theory, the supported idea is that the main predictor of behavior is people's intentions. The basis for this assumption is that human behavior is goal-oriented and develops according to people's intentions, which can be more or less portrayed as moving along paths of more or less well formulated plans. To a certain extent, people are expected to behave as rational agents that make use of the available information to establish their intentions. Whenever situations appear, people will behave according to their intentions, executing the plans towards the achievement of their goals.

Therefore, the Theory of Planned behavior is a theory that establishes a link between attitudes and behavior. According to the TPB, human action is guided by three kinds of considerations:

- Behavioral beliefs, which correspond to beliefs about the likelihood of outcomes of behaviors and the evaluation of these outcomes (behavioral beliefs).
- Normative beliefs, which correspond to beliefs about the normative expectations of the surrounding (e.g. the others, society, the group) and motivation to comply with these expectations (normative beliefs).
- Control beliefs, which correspond to beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs).

The aggregation of the behavioral beliefs produces a favorable or unfavorable attitude towards the behavior; normative beliefs result in perceived social pressure or subjective norm; and control beliefs give rise to perceived behavioral control. In combination,

attitude toward the behavior, subjective norm, and perception of behavioral control lead to the formation of a behavioral intention.

As a general rule, the more favorable these elements are, the stronger should be the intention to perform the behavior in question. Given a sufficient degree of control over the behavior, people are expected to carry out their intentions when the opportunity arises. In this sense, intentions are assumed to be the immediate antecedent of behavior.

Can the theory of planned behavior be used?

The claim that TPB can be used in organizations to predict willingness to collaborate is justified in two ways. Firstly, an analogy between agents and organizations is considered. Then, the suitability of applying TPB is supported by directly addressing the characteristics of the behavior named as “collaborate”.

According to Corral (Corral, 2001), *TPB* can also be considered suitable for predicting the organizations’ behaviors. This suitability lies in the assumption that organizations behave like rational agents, making systematic use of the available information, in order to decide which goals to pursue. These goals are achieved through corresponding business processes, usually established at a strategic level. Assuming that organization’s strategic planning is based on goals to be achieved suggests that these goals can be seen as organizations’ intentions to perform the corresponding behaviors. In other words, they correspond to the organizations’ planned behavior. As a result, if an organization’s intentions are based on goals to be achieved, and if organization’s behaviors are in turn a consequence of these intentions, then the TPB can be applied to organizations in order to predict their behavior. Consequently, TPB can be used to assess organizations’ willingness to collaborate.

The suitability of the TPB for predicting willingness to collaborate can also be justified by addressing the very concept of “collaboration”. For such, a figure from chapter 2 is recalled here as Fig. 3.22, being its characteristics highlighted and explained below.

The concrete connotations between TPB and collaboration are the following:

- Items in area (1) tell us that collaboration is intentional, planned and structured.
 - In TPB, the perceived intentions are considered the immediate predictor of the willingness to perform a behavior
- Items in (2) tell us that collaboration has specific purposes.

- In terms of TPB, these purposes are similar to goal or intentions.
- Items in (1), (3) and (5), considered together, tell us that collaboration is strategic, planned, and structured.
- TPB is based on the notion of planned behavior.
- Items in (4) can be related to how well an organization works in a collaboration context.
- In TPB, the willingness to perform a behavior depends on the perception of factors that may facilitate or impede its performance.

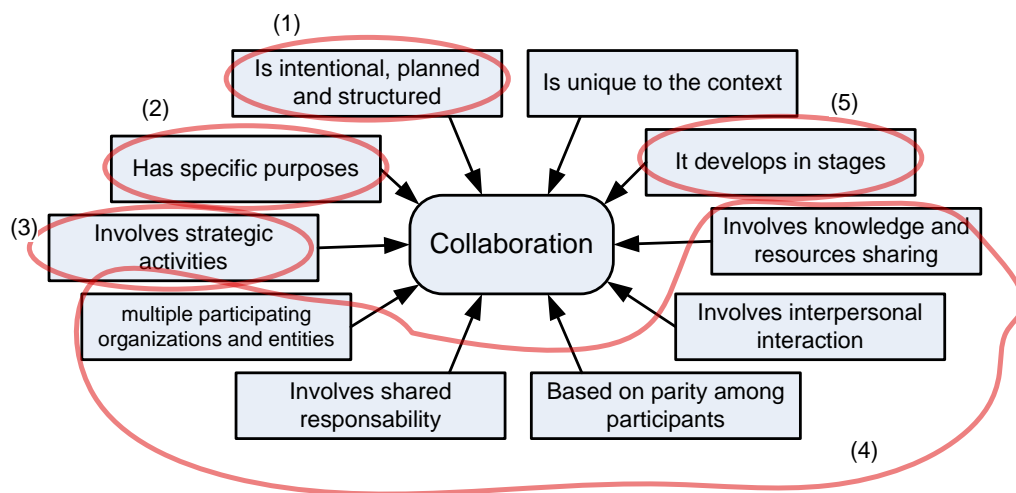


Fig. 3.22 – The characteristics of collaboration (adapted version of Fig. 2.2)

Taking the above arguments as plausible, TPB can be considered a good approach to determine willingness to collaborate.

The willingness to collaborate model

As mentioned before, the willingness to collaborate assessment is a way to evaluate an organizations' interest or desire to participate in a collaboration opportunity. Basically, an organization has an attitude more favorable to collaboration, whenever it perceives that its (strategic) goals are better achieved following a collaborative strategy. Given a collaboration opportunity, an organization's intention to collaborate is greater when the expected outcome of this opportunity fulfills its expectations and goals. If the opportunity is perceived as attractive, the organization will behave according to its intentions and engage in the collaboration opportunity. As such, and according to TPB, an organizations' intention to collaborate corresponds to willingness to collaborate.

The proposed model for willingness to collaborate is illustrated in Fig. 3.23. Each of the constituents of this diagram are further introduced and explained.

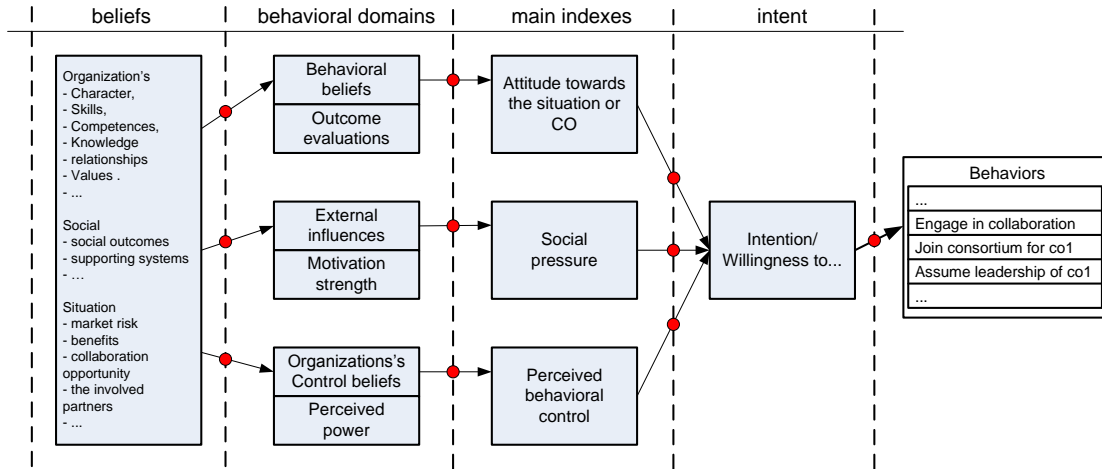


Fig. 3.23 – Willingness to collaborate model. Structure inspired from (Ajzen, 2003) and (Corral, 2001)

In this figure, the arrows represent the flux of values that are fed from one component to the following, as explained below. For a better understanding of the approach, the concepts are accompanied by an illustrative example, which corresponds to the assessment of the willingness to “engage in the partnership”.

Definition 3.4.1 (Background factors) – Are the aspects relevant to the perception of an organization’s intentions to collaborate in a specific collaboration opportunity. Such factors may represent strategic interests, such as to complement skills, share risks, share assets, increase benefits. These factors also encompass behavioral characteristics, situations, contexts, and the relationships with peers. They correspond to the beliefs level that are illustrated in Fig. 3.23.

Definition 3.4.2 (Organization’s Behavioral beliefs) – Correspond to beliefs that a given behavior (e.g. engaging in a partnership) will provides a number of expected outcomes, such as: profit or the access to an extended market. Each behavioral belief is specified by a subjective probability that the corresponding outcome will be achieved. It can be specified as a set $\{(bb_i, v_i) \mid bb_i \in BB, v_i \in [0,1]\}$, in which for each tuple:

- bb_i - identifies a belief about an outcome from the behavior in question.
- v_i – corresponds to a belief strength, or subjective probability (Hájek, 2001), of that corresponding outcome being achieved.

- $BB=\{bb_1, bb_2, \dots\}$ – represents the set of identified behavioral beliefs for the considered behavior.

Examples of organization's behavioral beliefs are whenever an organization believes that engaging in a partnership yields a number of outcomes, e.g. more profit, access to newer markets or product diversification. An example query for a behavioral belief would be:

<i>The organization believes that engaging in the partnership will allow growing abroad.</i>							
Extremely unlikely					X		Extremely likely
	1	2	3	4	5	6	7

During this section, the several questions used to illustrate the concepts are based on a Likert scale, in which questions are in the form of Likert Items. Each item corresponds to a statement accompanied by a visual scale, which a respondent is asked to evaluate according to some objective or subjective criteria. The Likert scale, in turn, corresponds to the sum of responses on the several Likert Items. A discussion of scales for measuring attitudes can be found in (Krosnick and Fabrigar, 1997).

For the expected outcomes stated above, the organization assigns a relative value of their importance, according to its strategic goals and value systems. This is done through the outcome appraisal definition.

Definition 3.4.3 (Outcome appraisal) – It represents how an organization values the outcome associated to each behavioral belief (*Definition 3.4.2*). It can be specified as a set $\{(oa_i, v_i) \mid oa_i \in OA, v_i \in [0,1]\}$, in which for each tuple:

- oa_i - specifies the outcome associated to the behavioral belief bb_i in *Definition 3.4.2*.
- v_i - represents a subjective appraisal of the expected outcome.
- $OE=\{oe_1, oe_2, \dots\}$ – represents the set of outcomes, each related one-by-one to a behavioral belief specified in (*Definition 3.4.2*).

An example query for an outcome evaluation would be:

<i>The organization thinks growing abroad is</i>							
Not important				X			Very important
	1	2	3	4	5	6	7

These two examples are associated to the behavior “engaging in a partnership”. It is important to understand how these two queries are related. Both enquire about growing abroad, but the first query asks for the likelihood of growing abroad if the behavior “engaging in the partnership” is performed, while the second one asks for how the involved organization values “growing abroad”.

In a general sense, an attitude corresponds to a psychological tendency that is expressed by evaluating a particular situation, entity, object or situation with some degree of favor or disfavor (Albarracin, Johnson et al., 2005). For the proposed model, and according to the TPB, the attitude towards the behavior can be obtained by a belief composite, as specified in *Definition 3.4.4*, presented next.

Definition 3.4.4 (Attitude towards the behavior) – It is the degree ‘ A_b ’ to which the performance of a behavior b is positively or negatively valuated by the organization. The value of ‘ A_b ’ is determined as a composite of the beliefs BB (*Definition 3.4.2*) and corresponding evaluations OA (*Definition 3.4.3*). Specifically, the strength of each belief (bb_i) is weighted by the appraisal (oa_i) of the outcome, and the respective products are aggregated, as shown in the following equation:

$$A_b = \frac{1}{n \times (\#scale)^2} \times \sum_{i=1}^n \pi_2[(bb_i, v_i)] \times \pi_2[(oa_i, v_i)]$$

The first part of the above expression, and for the next ones, just transforms the result into a percentage format. The symbol ($\#scale$) stands for the used scale size. For instance, if the scale is defined as $scale=\{1, 2, 3, 4, 5, 6, 7\}$, then $(\#scale)=7$. Additionally, π_2 stands for the project operator, which yields the second element of the corresponding tuple in the argument. For the given example, the value of A_b would be:

$$A_{\text{engaging in the partnership}} = \frac{1}{1 \times 49} \times 4 \times 5 = 0.41$$

The next component of the proposed model, as illustrated in Fig. 3.23, corresponds to the external influences and motivations to comply with these influences. This is specified by the following definitions:

Definition 3.4.5 (External stimulus or influences) – Are used to represent external influences, which favor or disfavor the performance of the behavior in question (e.g. “engage in the partnership”). They can be specified as a set $\{(es_i, v_i) \mid es_i \in ES, v_i \in [0,1]\}$, in which for each tuple:

- es_i – identifies an external stimulus for the behavior in question
- v_i – specifies the degree of belief that the stimulus will occur.
- $ES=\{es_1, es_2, \dots\}$ – represents the set of external stimulus or influences, which potentially influence the organization in the performance of the considered behavior.

Definition 3.4.6 (Motivation to comply) – Establishes the degree or strength of motivation to which an organization complies with the external influences (*Definition 3.4.5*). It can be specified as a set $\{(mc_i, v_i) \mid mc_i \in MC, v_i \in [0,1]\}$, in which for each tuple:

- mc_i – identifies a motivation for complying with the external stimulus es_i specified in (*Definition 3.4.5*).
- v_i – its corresponding motivation strength.
- $MC=\{mc_1, mc_2, \dots\}$ – The motivators associated to the performance of a behavior.

Examples of external stimulus are the European Union’s actions aimed at encouraging SMEs to participate in their framework programmes for Research and Technological Development (European.Commission, 2009). Examples of external influences consist of what organizations are allowed to do in determined environments or situations. For instance, in most countries, agreements established between organizations aimed at setting prices, limiting production or carving up market are forbidden. In certain cases, alliances between competitors are treated more leniently than mergers and acquisitions. In other cases, particularly in the United States, they are treated more harshly (Dussauge and Garrette, 1999). In Italy, there is a strong local government role in regulating and promoting core industries in the nominated Industrial Districts, in which competitors establish a high degree of co-operation to share risks, stabilize the market and share innovation (Alberti, 2007).

For the “engage in the partnership behavior”, the queries about external stimulus and motivation to comply could be:

<i>Will the organization receive support for investing abroad?</i>							
Not likely			X				Quite likely
	1	2	3	4	5	6	7
<i>How important is receiving support to invest abroad for the organization?</i>							
Not important						X	Very important
	1	2	3	4	5	6	7

Definition 3.4.7 (Social influence) – It corresponds to the composite aggregation of each external stimulus with the corresponding motivations to comply. Specifically, the strength of each external stimulus es_i is weighted by motivation to comply mc_i , using the following equation:

$$SI_b = \frac{1}{n \times (\#scale)^2} \times \sum_{i=1}^n \pi_2[(es_i, v_i)] \times \pi_2[(mc_i, v_i)]$$

For the provided example, the value of SI_b would be:

$$SI_{\text{engaging in the partnership}} = \frac{1}{1 \times 49} \times 3 \times 6 = 0.37$$

Organization's control beliefs are related to the presence of factors that may facilitate or impede the performance of a behavior. These control beliefs, in combination with the perceived power of these factors determine the prevailing perceived behavioral control.

In terms an organization in collaboration, a factor that might easy or impede a behavior is the belief about technological issues of a project, being its importance stated as a perceived power value.

Definition 3.4.8 (Organization's control beliefs) – It corresponds to beliefs an organization has got on each factor that may facilitate or impede the performance of the behavior. It can be specified as a set $\{(cb_i, v_i) \mid cb_i \in CB, v_i \in [0,1]\}$, in which for each tuple:

- cb_i – identifies a control factor that may facilitate, or impede, the performance of the considered behavior.
- v_i – the subjective probability that the corresponding factor is present.
- $CB = \{cb_1, cb_2, \dots\}$ – The identified control beliefs associated to the performance of the behavior.

Definition 3.4.9 (Perceived power) – It corresponds to the perceived power of each factor in *Definition 3.4.8*. It can be specified as a set $\{(pp_i, v_i) \mid pp_i \in PP, v_i \in [0,1]\}$, in which for each tuple:

- pp_i – identifies an effect for the corresponding control belief cb_i specified in (*Definition 3.4.8*).
- v_i – the perceived strength of the corresponding effect pp_i .
- $PP = \{pp_1, pp_2, \dots\}$ – The identified perceived power aspects associated to the performance of the behavior.

Definition 3.4.10 (Perceived behavioral control) – It refers to the organization's perceptions on its capability to perform the behavior. This element is determined by the aggregation of the control beliefs with the perceived power of each one. Specifically, the strength of each control belief cb_i is weighted by the perceived power ppi , and the products are aggregated using the following equation:

$$PCB_b = \frac{1}{n \times (\#scale)^2} \times \sum_{i=1}^n \pi_2[(cb_i, v_i)] \times \pi_2[(pp_i, v_i)]$$

For the provided example, the determination of PCB is illustrated by the following queries:

<i>Is the organization prepared to operate abroad?</i>								
Not likely	1	2	3	X 4	5	6	7	Quite likely
<i>Will the lack of preparedness to operate abroad affect organization's performance?</i>								
Very much	1	2	3	4	5	X 6	7	Not much*

$$PBC_{\text{engaging in the partnership}} = \frac{1}{1 \times 49} \times 4 \times 6 = 0.49$$

Definition 3.4.11 (Organization's willingness to collaborate) – According to TPB, the intention to collaborate can be taken as a direct measure of the willingness to collaborate. Intention is based on the attitude toward the behavior (*Definition 3.4.4*), the social influences (*Definition 3.4.7*), and perceived behavioral control (*Definition*

* Remark here the inversion of the scale, so that the right side of the scale always reflects a positive attitude.

3.4.10). Each of these factors is weighted or adjusted taking into consideration the behavior or situations. Its value can be computed by a function

$$I = F(ATB, SI, PBC) = w_1 \times ATB + w_2 \times SI + w_3 \times PBC$$

$$W \sim I$$

The weights w_1 , w_2 and w_3 represent regression coefficients. These coefficients are used to establish the relationships between dependent and independent variables. In this case, they are used establish to which extent the values of ATB , SI and PBC determine the level of the intention or willingness to collaborate. The determination of these coefficients requires a separated research work, in which questionnaires are sent to collaborative networks experts, enquiring about the determinant factors of willingness to collaborate. The provide answers would then be subjected to Regression Analysis for obtaining the mentioned regression coefficients. A useful characteristic of these coefficients lies in their predictive capability (Cai and Hall, 2006).

Assuming the weight values as $w_1=0.33$, $w_2=0.33$ and $w_3=0.33$, the level of the willingness to collaborate is

$$W \sim I_{\text{engaging in the partnership}} = 0.33 \times (0.41 + 0.37 + 0.49) = 42\%$$

The willingness concept just presented, and subjacent definitions are combined in a so called willingness to collaborate assessment schema, presented in the next section.

3.4.4 The willingness to collaborate assessment schema

The willingness to collaborate assessment schema proposed here serves the purpose of illustrating a way of combining the above definitions into an operational schema, ready to be used in the assessment of the willingness to collaborate, as illustrated in Table 3.3. The process of assessing the willingness of a certain partner to collaborate starts by an instantiation of this schema, in which the situation, the organization's characteristics (e.g, character, values, and so on), and a description of a collaboration opportunity are provided. Then, several questions are formulated in order to assess each component of the willingness model, namely the attitudes beliefs (*Definition 3.4.4*), social influences (*Definition 3.4.7*), and perceived control (*Definition 3.4.10*). After these question are answered, these components are evaluated and a measure of intention, and consequently of willingness, to collaborate are provided.

Table 3.3 – The willingness to collaborate schema

(the equations from the above definitions are presented in a simpler form)

Background factors	Willingness to collaborate Assessment				Intention to collaborate	
Character Skills Values	Beliefs	Queries	Aggregation	Weight	$I = w_1 \times A + w_2 \times SI + w_3 \times PBC$	
		Behavioral Beliefs	bb1 - likelihood of outcome 1	Attitudes $A = \sum_{i=1}^n bb_i oa_i$		w_1
		bb2 - likelihood of outcome 2				
...						
outcome evaluation	oe1 – value of expected outcome 1	<i>Definition 3.4.4</i>	w_2			
	oe2 – value of expected outcome 2					
	...					
External stimulus	es1 – belief of external stimulus 1	Social influences $SI = \sum_{i=1}^m es_i mc_i$	w_2			
	es2 – belief of external stimulus 2					
	...					
Motivation to comply	mc1 – motivation to comply 1	<i>Definition 3.4.7</i>	w_3			
	mc2 – motivation to comply 2					
	...					
Control Beliefs	cb1 – control belief factor 1	Perceived control $PBC = \sum_{i=1}^p cb_i pp_i$	w_3			
	cb2 – control belief factor 2					
	...					
Perceived power	pp1 – Perceived power factor 1	<i>Definition 3.4.10</i>	w_3			
	pp2 – Perceived power factor 2					
	...					
behavioral beliefs and outcomes				<i>Definition 3.4.11</i>		

For the behavior considered in previous section “engage in the partnership”, and assuming random values for the remaining questions, the corresponding schema instantiation is shown in Table 3.4. The intentions value corresponds to $I=41\%$, which according to TPB corresponds to 41% of willingness to collaborate. In this example, the weights in column “Weight” have the same value, but different values can be specified according to the type of situations in consideration.

This schema is improved in section 4.8, with a component named as Intention Query Mechanism, which from the description of a collaboration situation selects the adequate questions in order to assess a partner’s willingness to collaborate.

Table 3.4 – Schema instantiation

Background factors	Willingness to “engage in the partnership”				Intention to collaborate
Character Skills Values	Beliefs	Queries	Aggregation	Weight	I = 41%
	Behavioral Beliefs	bb1 – 5	Attitudes 42%	0.33	
		bb2 – 6			
bb3 – 6					
outcome evaluation	oe1 – 4				
	oe2 – 5				
	oe3 – 2				
Past behavior Environment Situation Collaboration opportunity	Normative Beliefs	es1 – 3	Social influences 34%	0.33	
		es2 – 4			
		es3 – 2			
Motivation to comply	mc1 – 6				
	mc2 – 5				
	mc3 – 6				
Peers Affectivity relationships	Control Beliefs	cb1 – 4	Perceived control 47%	0.33	
		cb2 – 4			
		cb3 – 7			
behavioral beliefs and outcomes	Control belief power	pp1 – 6			
		pp2 – 1			
		pp3 – 8			

3.5 Putting all together

It is time now to show some of the parts, described in the previous sections, used to form the collaboration readiness model, as illustrated in Fig. 3.24.

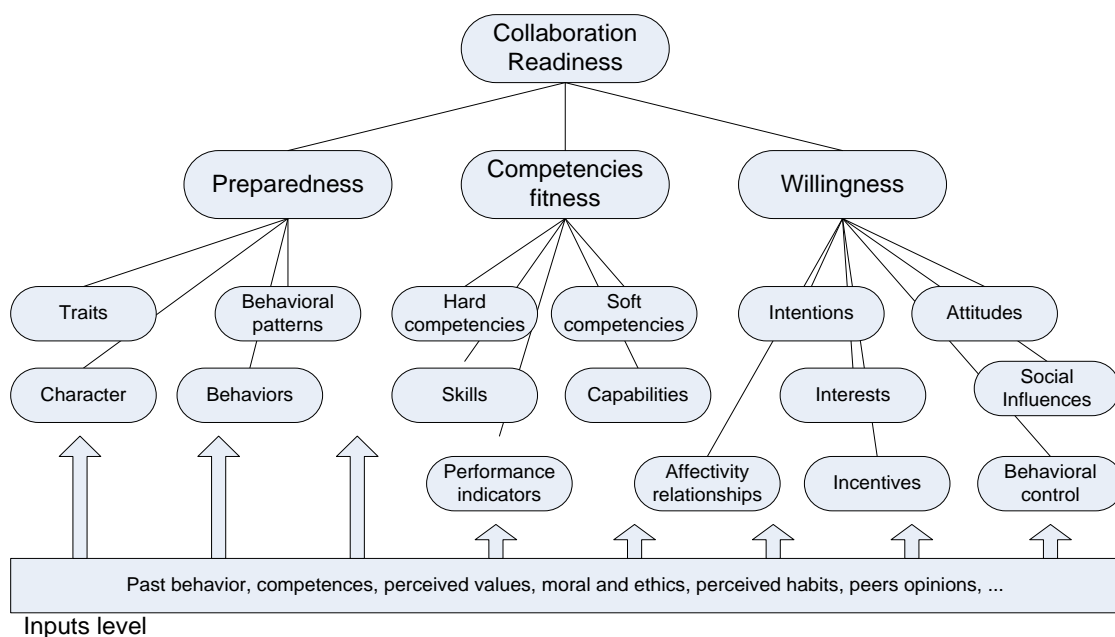


Fig. 3.24 – The “collaboration readiness” model

Each part of the model contributes to an aspect of collaboration readiness. These aspects are summarized as follows:

- *Preparedness* – is concerned with assessing how an organization is likely to behave in partnerships, perceiving whether a partner can develop trustworthy and reliable behavior. Preparedness is based on the concepts of organization's behaviors, behavioral patterns, traits, and organization's character.
- *Competencies fitness* – This concept considers competencies fitness in a dual notion of hard and soft competencies. More than assessing an organization's (hard) competencies, this concept is mainly concerned whether a partner is able to perform well its hard competencies in collaboration contexts, which as mentioned in a previous section, also requires the exercise of soft competencies.
- *Willingness to collaborate* – As described in previous section, this concept is concerned with assessing a partner's intention to collaborate given a concrete collaboration opportunity. It involves assessing a partner's behavioral beliefs about the expected outcomes the collaboration opportunity may provide, the social stimulus to get into collaboration, and the perceived control the partner has got over the respective situation of the CO.

Due to the involved concepts the readiness model is intrinsically behavioral, which to some extent, breaks up with known approaches for collaboration readiness. The model, as expressed in Fig. 3.24, suggests however that it will be difficult to use. This is the subject for the next section.

3.5.1 Issues on using the model

As previously promised, we end this section of conceptual contribution recalling again the issue of obtaining useful models that are straightforward to use. In terms of our readiness model, the reader might already feel, given the theoretical concepts presented before, that this model is indeed so complex that its usability in practice might be considered at least arguable. In order to ease this feeling, it is time to present the collaboration readiness model in its canonical* form. This form of the model is here used as a way to illustrate how the readiness model can be applied in a practical context. This is intentionally presented at the end of the chapter, instead of at the beginning

* A canonical model is one that is reduced to the simplest and most significant form possible, without loss of generality (see <http://wordnetweb.princeton.edu/perl/webwn?s=canonical>).

where it perhaps should be, as a way of helping perceive that all the concepts previously presented are indeed straightforwardly manageable.

3.5.2 The canonical form of the readiness model

Illustrating the use of the canonical model, one might imagine a manager of a VBE organizing a consortium for a new collaboration opportunity. The manager is well aware of each candidate's characteristics, in terms of their competencies, habits and behaviors. So the manager knows well how each partner would behave in the partnership. Assuming there are more candidates than the required number, in order to select which ones should be considered for the consortium, he/she establishes a ranking preference order over these organizations, based on the concept of readiness considered at the most abstract level. The obtained order is exemplified in Table 3.5, dictating each organization and its readiness level. The idea of this assessment is similar to a student being graded at a course. If this student is graded with an "A", his/her teacher is stating that he/her is a very good one. Similarly, when the manager grades an organization with 95% readiness for a given partnership, it is telling other peers that this organization is potentially a very good partner. The reverse effect happens if the manager states a readiness of 5% for a given organization. If the manager is a reputed one, the peers will follow its grading and avoid being involved with these organizations. In this sense, the important aspect of the readiness level is its informative power, and the corresponding peers' interpretations and reactions to these values.

Table 3.5 – Classifying organization by their readiness level.

Organization	Readiness level
o_1	0.70
o_2	0.50
...	
o_n	0.95

Therefore, Table 3.5 corresponds to a canonical form of collaboration readiness assessment: a tuple composed of an organization and its corresponding readiness: (org, readiness). Let's name this canonical form as level 1 (L1).

A L1 assessment would suggest an over-simplistic way to deal with the problem of collaboration readiness. The aim is that a model should be able to be straightforwardly applied both in simple as in complex cases. Let's now imagine that the manager does not know that well the candidates' readiness. Therefore, he/she now needs to assess

their readiness from other elements. Now the manager may consider the candidates' preparedness to collaborate, competencies fitness, and willingness to collaborate. This can be done by adding these elements to the canonical form, as illustrated in Table 3.6. This table shows the readiness involving the three mentioned aspects. By repeating the assessment systematically to the other candidates, a manager can perform a more refined selection of partners that better suit the collaboration opportunity. For instance, in an Extended Enterprise there is a dominant partner which coordinates all the relevant interactions between partners. In this context, this partner is more focused on the hard competencies of its "peers", as there is not much necessity for collaboration-related soft competencies. In a context of a Virtual Organization (VO), which involves more collaborative interactions than in an EE, collaboration preparedness becomes more important. The willingness to collaborate is also more important in VO than EE-like organizations. While in an EE the interactions are more market-based, the partners in a VO must remain interested and feel committed to achieving the joint objectives.

A L2 assessment can be still considered in a canonical form, as it still preserves its basic structure.

Table 3.6 – Example of readiness assessment with the canonical the model for a single organization

L1	L2
Readiness = 0.8	Preparedness = 0.7
	Competencies fitness = 0.6
	Willingness =0.9

A perception from talking with people concerned with the subject, including people from industry, is that the L2-form may not need to be used entirely, but just parts of it, according to what it is necessary to assess in a given situation. In real situations, some information is already known about eventual partners, either by direct or indirect knowledge (e.g. recommendations). This is to say that if a partner needs an assessment involving the three dimensions, namely preparedness, competencies fitness, and willingness, then it is like assessing "Mr. Unknown", increasing the likelihood of engaging with the wrong partner.

3.5.3 Adding more levels of detail

A canonical form is useful for understanding the very nature of a model, and which background it is based on. Unfortunately, reality is not that simple. In most situations, the previous canonical form is not enough, as it is necessary to consider more detailed information regarding a partner's collaboration readiness. For instance, most of the interactions between the members of an EE are coordinated by a dominant partner (Camarinha Matos, 2008), which may give more importance to hard competencies assessment, than the other aspects of collaboration readiness, such as collaboration preparedness. Another situation is when a collaboration opportunity is characterized by its great benefits, but not without high risks, and requiring that eventual partners display a strong sense of innovativeness. Therefore the questions would be whether or not the partners are tolerant to risk, they are innovative and enterprising, and are really interested in the partnership. In such a situation, it is necessary to perceive what the candidates' traits, attitudes and intentions are like.

Considering these situations, it is necessary to consider more levels of granularity for the assessment of collaboration readiness, namely the L3 and L4 levels. As illustrated in Table 3.7, level L3 holds the information about a partner's character, competencies and the aspects related to willingness to collaborate. On level L4 these indications are further decomposed into more detailed data, such as the partner's traits, both soft competencies and hard competencies, and the behavioral beliefs which help perceive willingness to collaborate.

Table 3.7 – Adding more detailed levels the collaboration readiness assessment

L1 (qualification level)	L2 (obtained assessment)	L3 dimensions (aggregated values of)	L4 (Value levels of traits, skills, attitudes...)
Readiness	Preparedness	D1	Trait1, trait2,
		D2	Trait3,
		...	
		Dn	Trait_n
	Competencies fitness	Hard competencies	hc1, hc2, hc3,
		Soft competencies	sc1, sc2, sc3, ...
	Willingness	Attitudes	bb1, bb2, ... oa1, oa2, ...
		Social influences	
		Behavioral control	
Composite level	dimensional	Aggregated level	Operational/inputs level (requires more complex assessment approaches)

By tailoring the collaboration readiness assessment model to adequate levels of granularity, namely between L2, L3 and L4, allows a flexible utilization across the several types of situations. The way the elements of the levels L3 and L4 are assessed is the subject of the next chapter, which is devoted to modeling experiments.

4 Modeling experiments

We can't manipulate some stars
while maintaining other stars as controls;
we can't start and stop ice ages,
and we can't experiment
with designing and evolving dinosaurs.
(Jared Diamond, Geography Professor)

This section is devoted to describe a number of experiments, which aim at illustrating additional components for the readiness assessment model, which were not specified in the previous chapter and that are required for applying the model to real situations. In fact, the readiness model is intentionally separated in two parts. For the sake of openness, flexibility and reutilization of concepts, the part introduced in the previous chapter was made as much abstract as possible. The second part, as described in this chapter, is of a more concrete nature, addressing concrete issues of real situations. In this way, any refinement of the readiness model for special types of situations can follow the abstract model presented in previous chapter. Therefore, the development of more concrete parts can then proceed according to the specific requirements of each situation.

The modeling experiments presented here serve two purposes. First, as previously mentioned, for the development of the missing parts, and second for providing guidelines for the improvement of these experiments into components that can be integrated in other Decision Support Systems.

4.1 Aspects still to address

A number of parts, which spread across the preparedness, competencies and willingness components of the model, need to be specified.

Preparedness

It was previously established that the preparedness assessment is based on the observation of a number of traits from the organization's character. However, it is still necessary to determine them. Therefore, the first modeling experiment described in this

chapter is concerned with the identification of the traits that must be observed, in order to assess collaboration preparedness, according to the established collaboration preparedness hypothesis.

Another aspect that remains open is related to the types of assessment that can be performed. This is an issue which depends on the available information concerning an organization's character profile. When there is enough information to construct such profile, the assessment can be based on that profile and given preparedness conditions. However, if that information is not enough, an approach of a more stochastic nature should be used. The followed approach is, in fact, based on Bayesian Belief Networks.

Competencies fitness

In order to perform experiments with the competencies fitness concept, defined in the previous chapter, it is necessary to derive an implementation from the competencies model specification, expressed as a corresponding set of Prolog predicate rules. The resulting component will be used to assess partners' competencies fitness, concerning a concrete situation or collaboration opportunity.

Willingness

The effectiveness and successful use of the willingness to collaborate model, previously defined, depends closely on the formulated questions that are presented to human interlocutors in order to enquire a partner's behavioral beliefs. The part still missing is to define a way to adequately select these questions. A new component, named Intentions Query mechanism, is developed in order to select these questions from a knowledge-base containing a repository of questions aiming at addressing the mentioned behavioral beliefs.

Partners' selection

Thinking about assessing collaboration readiness would not make sense if the purposes for considering it were not addressed. One such purpose corresponds to the partners' selection problem. In fact, the assessment of partners' readiness to collaborate is important for the invitation, or suggestion, of organizations to become partners in collaboration opportunities. As a way to illustrate such purpose, a partner's suggestion

mechanism is presented, which combines preparedness and competencies assessment, together with simulation, in order to obtain suggestions for consortia formation.

4.2 Strategy to follow

In order to illustrate the purposes of experiments, in a clear and intuitively, it was decided to try each part of a readiness separately. This is mainly because some aspects addressed in the modeling experiments require complex modeling approaches, such as text data mining, simulation and decision making under uncertainty. Trying to describe simultaneously a complete readiness assessment approach, in the form of a decision tool, would compromise the illustration of the used methods and the identification of modeling issues. The structure of this chapter is illustrated in Fig. 4.1.

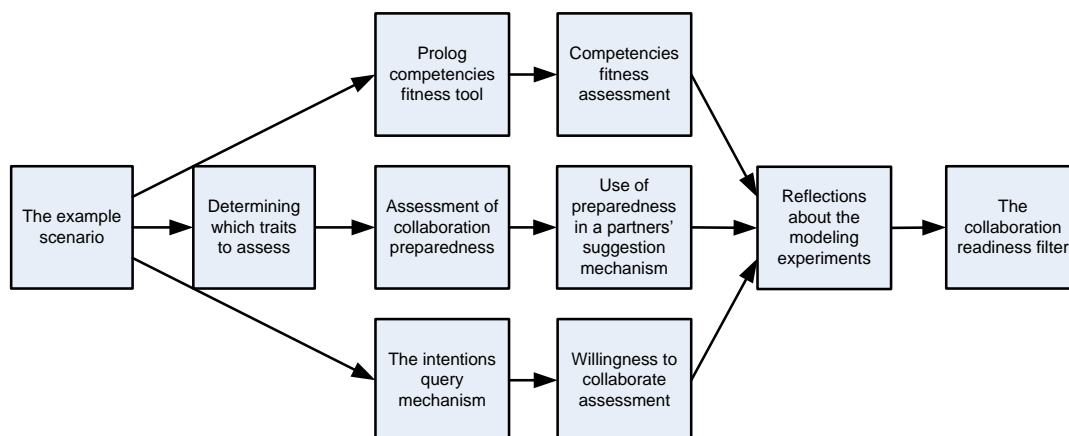


Fig. 4.1 – Structure of this chapter

4.3 The example scenario

The following example is presented in order to illustrate the development of the modeling experiments. It shows a Virtual Organizations Breeding Environment, composed of several organizations, as illustrated in Fig. 4.2. At a given stage some of these organizations can form a consortium, as a reaction to a new collaboration opportunity. As shown in this figure, two situations are in place: the formation of a

Virtual Organization vo_1, in which a VBE member is being invited to the consortium;
and the invitation of a new member (organization o_12) to join the VBE.

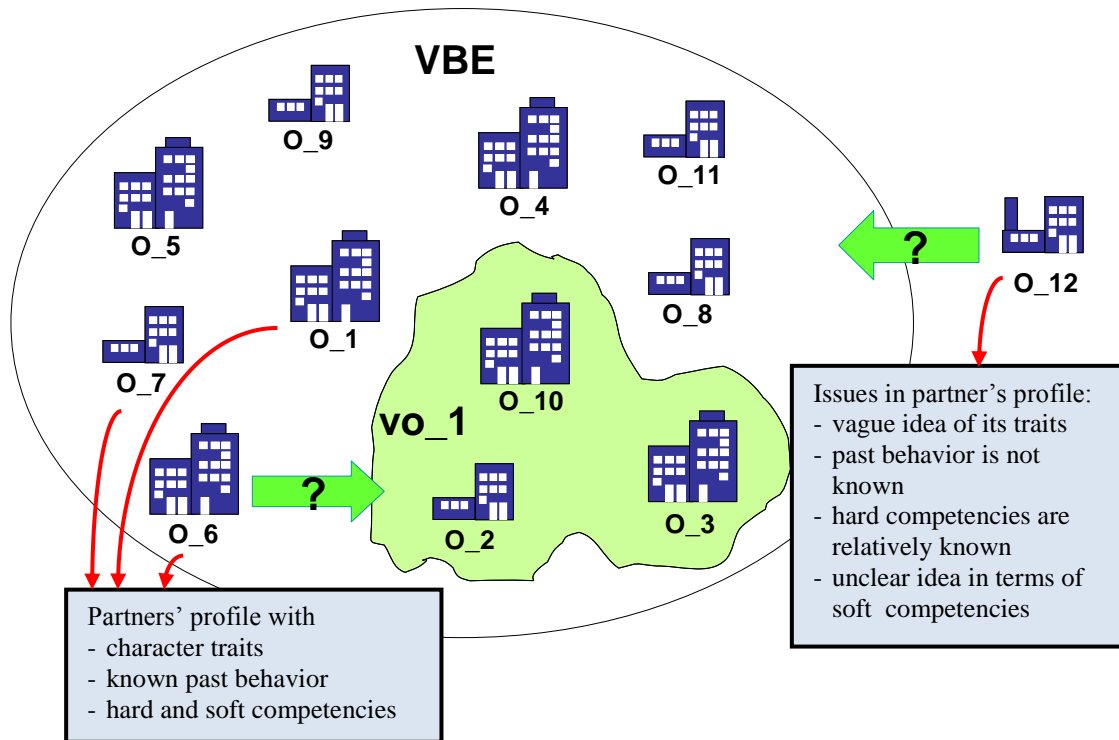


Fig. 4.2 – The example scenario

In the first situation, the partner to be selected for the VO is already a member of the VBE and might have participated in previous collaborations. This means that this partner's characteristics may be known, and that its behavior may to some extent be predictable, as its behavioral patterns were observed before and a corresponding traits characterization was established. For this partner, it is interesting to assess its readiness, encompassing preparedness, competencies and willingness, in the context of the collaboration opportunity.

For the situation involving an invitation to join the VBE, the focus can be just on assessing collaboration preparedness, because the invitation is not based on any collaboration opportunity but rather on the desire to enlarge the pool of VBE members. In this case, both competencies fitness and willingness might not be important at that time. An exception may be the case when an invitation to join the VBE targets members of particular competencies, which are known to be required in a future partnership.

4.4 The organization's character model

4.4.1 Adopting a character model

There are many character models to explain human behavior, but only a few addressing organizations' behavior. However, the development of a character or personality model that can be used to characterize and predict organizations behaviors depends on the utilization of methods and tools, which are specially tailored for use in the Social and Psychology-related areas. Examples of methods are, for instance ANOVA (analysis of variance), (Multi) Regression and Factor analysis (Foster and Meinhard, 2002). Given these considerations, the development of personality/character models are jobs more for the mentioned Sociology and Psychology-related areas. As illustrated in Fig. 4.3, such a job requires intensive social research not only for its development, but also to ensure validity.

Due to the effort and needed skills of social research in the development of a character model, it is not feasible to include the development of such a model as a goal of this work.

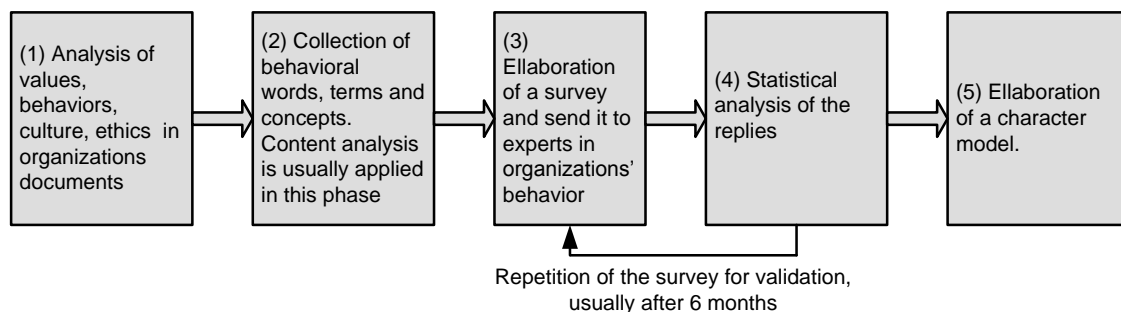


Fig. 4.3 – Phases of a survey for character modeling.

As the aim of this work is not to fully characterize organizations' behavior, but rather to assess collaboration readiness and preparedness, a better strategy is to rely on existing models of organizations' character, one that suits the objectives of this work, namely its use for assessing collaboration preparedness.

For this purpose it was decided to select an existing character model. Among the few available, the one better suited for this research is the model described in (Chun, 2005), which is illustrated in Fig. 4.4. Despite being more focused on an ethical perspective of organizations' behavior, it is also aimed at addressing both the financial and non-

financial success of organizations. Furthermore, this model is the only one found that is tailored for organizations, and that follows a generic structure composed of behavioral dimensions and corresponding traits, which are typical in personality models used in general.

The research in (Chun, 2005) followed the steps described in Fig. 4.3 for obtaining a character model. The work included a survey to the organizations listed in “Fortune 500”. The resulting model, as illustrated in Fig. 4.4, was subsequently obtained through a process of Confirmatory Factor Analysis*. Collaboration preparedness is a great deal related to ethical behavior. Although this model may lack some aspects, the concepts of reliability, trustworthiness, honesty, and responsibility, are traits that this model already considers. Nevertheless, other less behavioral and non ethical issues such as competencies assessment, are considered as a separate part of the readiness model.

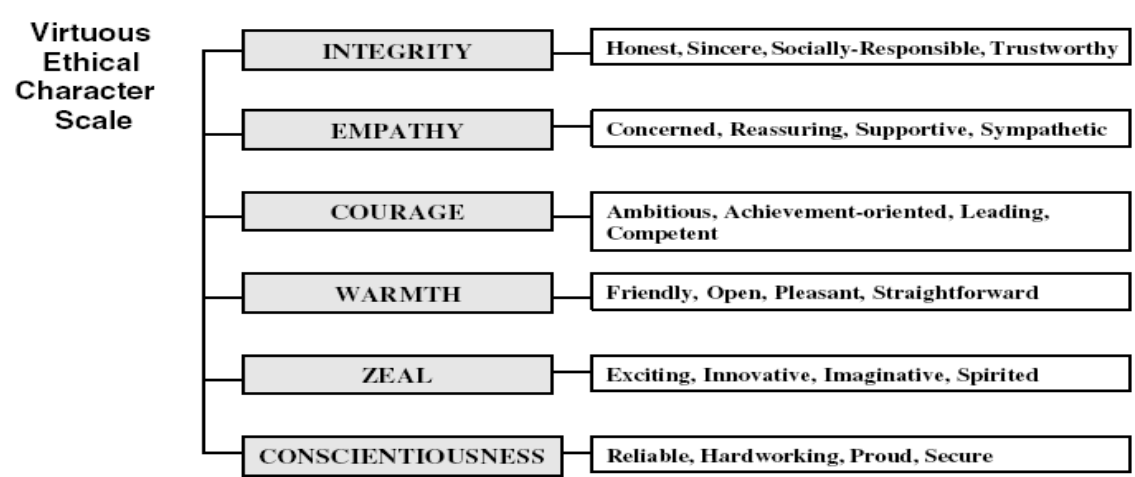


Fig. 4.4 – An organizations’ character model (Chun, 2005).

In this model, each trait allows describing an organization’s predisposition to manifest determined behavioral patterns. It is therefore necessary to determine which traits are related to the manifestation of behavioral patterns that are desirable in collaboration contexts, in order to use them afterwards to assess collaboration preparedness.

* Factor analysis is a common statistical method used to find a small set of unobserved variables (also called latent variables, or factors) which can account for the covariance among a larger set of observed variables (also called manifest variables). Confirmatory factor is a related concept, which allow testing hypothesis about a particular factor structure. <http://www.indiana.edu/~statmath/stat/all/cfa/cfa1.html>, seen at 2009-09-30.

4.4.2 Determining which traits to assess

The number of traits used to assess collaboration preparedness must be necessarily small. This is because the determination of most traits in an organization's profile may be a time consuming task, which at the end yields redundant and unnecessary information. The reason can be understood if an analogy to human behavior is made. For instance, knowing that a person is highly scored in his/her traits of creativity and imagination, which may indicate a predisposition for arts, does not indicate whether this person is an honest and trustworthy one. The other way around, being honest does not indicate any predisposition for arts. This means that some traits embed some information about somebody's behavior, which is not encoded in the other traits. Therefore, if the aim is just to perceive predisposition to arts, then only arts-related traits need to be observed. Similarly to this analogy, organization's traits embed the information about an organization's behavior. Different traits provide distinct behavioral information, and a small number of these traits provide the information about collaboration preparedness. Therefore, the task here is to find that small set of traits, which allow assessing organization's preparedness to collaborate, as illustrated in Fig. 4.5.

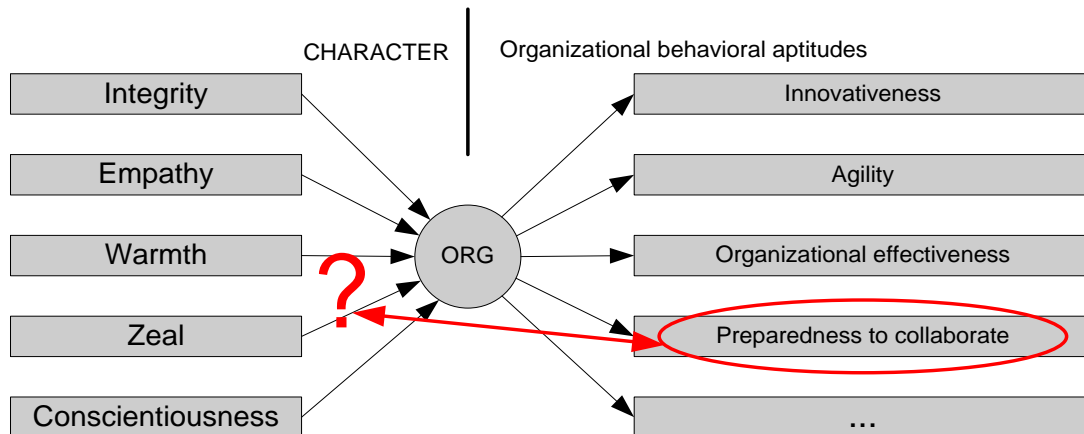


Fig. 4.5 – Character and corresponding organization's aptitudes

There are several ways to determine these traits. For instance, a repository of previous collaboration cases could be used, in order to search, via some data mining algorithm, for the behavioral factors that determined the partnerships' success or failure. However, such a repository of the referred cases is currently rather difficult to obtain, so this approach was not chosen.

A controlled experiment could be performed on existing partnerships, in which success and failure factors associated to the partnerships could be positively or

negatively modified, and observe the corresponding effects on the partnership. However, such an experiment is not realistic to perform, because no organization would allow being influenced or manipulated to failing at achieving their goals.

An alternative approach consists of relying on the experts' knowledge. This can be done by querying these experts and then using a variety of approaches (e.g. machine learning, clustering) in order to formalize their knowledge and integrate in decision-making tools. However, this approach was not adopted due to the difficulty of interacting with these experts with systematic means of knowledge acquisition.

The adopted approach

The approach taken is, to some extent, similar to the one described in the previous paragraph. The approach also involves collecting experts' knowledge, but instead of querying them directly, it is based on the use of Text Data Mining on the documents produced by these experts. That information can be found in the documents published in websites, as illustrated in Fig. 4.6. An issue here is whether the experts, and their corresponding documents, are reliable sources. Provided that most of the sources are reliable, the impact of a small set of unreliable ones is minimized by the filtering capabilities of the statistical techniques used during the text mining process.

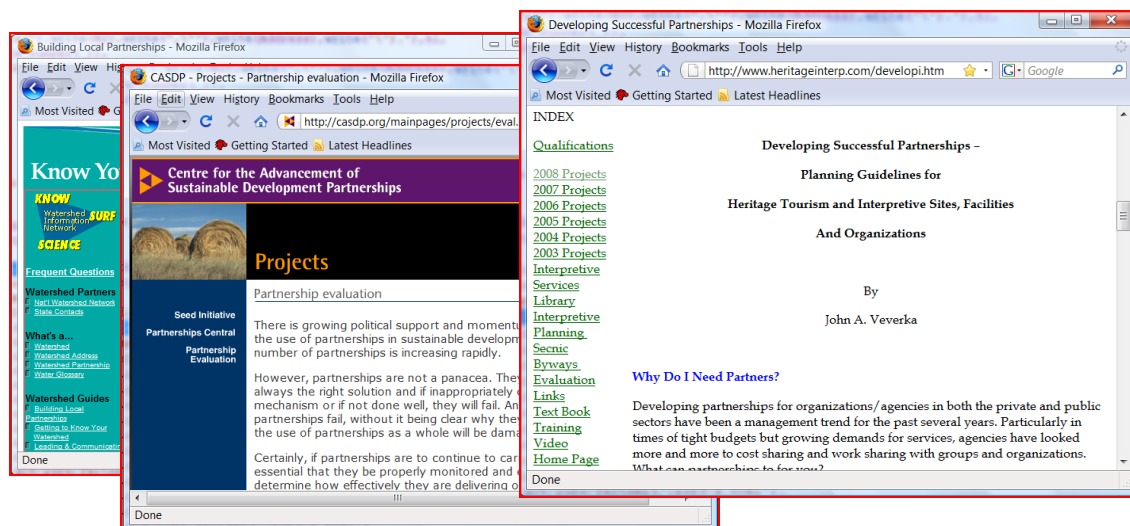


Fig. 4.6 – Illustrating the experts' documents concerning partnership success/failure factors

The expected result of the data mining process consists of establishing an association between the partnerships' success/failure factors and the traits of the chosen organizations' character model, as illustrated in Fig. 4.7. The basic principle is based on

the identification of semantic relationships between these factors and the character traits.

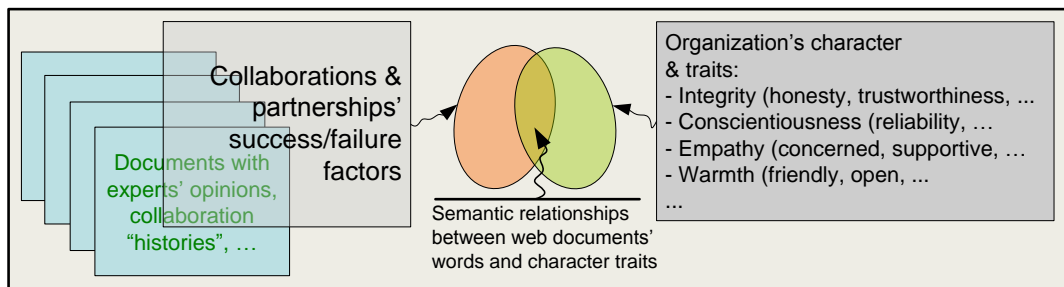


Fig. 4.7 – Identification of semantic relationships between success/failure factors and character traits

An example of a semantic relation is illustrated in Fig. 4.8, in this case hyponym relationships. A hyponym is a word whose meaning contains the entire meaning of another word, known as the superordinate (Pallotta, 2001).

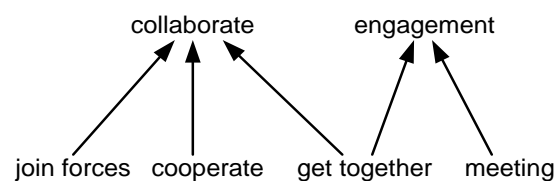


Fig. 4.8 – Example of hyponym relationships

The WordNet semantic network

In order to obtain these relations from the experts' documents the *WordNet* tool (George, 1995) was used. This tool consists of a large lexical database of English, in which nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept. Synsets are interlinked by means of conceptual-semantic and lexical relations. The several types of relations contained in Wordnet are summarized in Fig. 4.9.

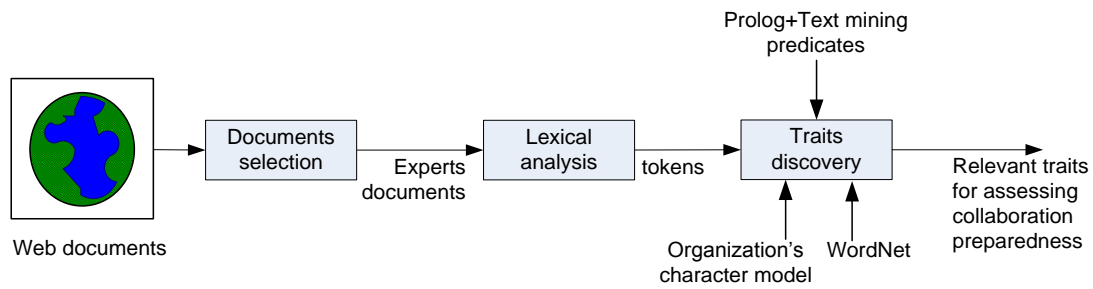


Fig. 4.11 – Approach to determine the relevant traits for assessing collaboration preparedness

The input documents were found using search engines. The sites were chosen also taking in to account the trustworthiness of their contents, which can only be made by personal evaluation of the documents. A list of sites was created as illustrated by the sample in Fig. 4.12. Each document received as input is subjected to a process of lexical analysis, which consists of separating the text into elementary words or terms, for which a corresponding meaning can be found in *Wordnet*.

```

site(1,'http://www.ctic.purdue.edu/kyw/brochures/BuildingLocal.html').
site(2,'http://casdp.org/mainpages/projects/eval.php').
site(3,'http://www.communityfutures.com/cms/Partnerships.165.0.html').
site(4,'http://www.heritageinterp.com/developi.htm').
site(5,'http://www.ed.gov/pubs/Partners/case2.html').
...
  
```

Fig. 4.12 – Sample list of used web documentation (as Prolog facts). The complete list is in annex 3

These words are subsequently provided to a predicate, named as “*find_the_traits_wordnet*”, shown in Fig. 4.13, which discovers the relations between each word and a trait of the character model. Basically, this predicate receives each word supplied by the lexical analyzer and tries to discover whether it is related to any trait or not. If a relation is found, an association is created and recorded in the knowledge base.

The identification of the most important traits is based on the number of semantic relations between the traits and the words contained in the document. Traits with more correspondences are considered as more important, being this importance based on the statistical frequencies of these correspondences.

```

find_the_traits_wordnet(Word,Site_number):-
  findall( hits_word(Word,Dimension,Trait,Word_ref),
    (
      find_dimension(Word,Dimension,Trait),
      max_reference(Ref),
      Word_ref is Ref+1,
      write(a),
      update_reference(Word_ref),
      write(b)
    ), LLL),
  LLL=[],
  forall(member(Hits,LLL),
    (
      hits_word(W,D,T,Ref) = Hits,
      assert(association(Site_number,Ref)),
      assert(Hits)
    )
  ).

```

Fig. 4.13 – Predicate that searches for relations between traits and the words in experts’ documents

In Fig. 4.14 some results from the data mining process are illustrated. For instance, the number of times the trait “honesty” was found in the analyzed experts’ documents was 14075, and for “trustworthiness” it was 16020.

```

?- absolute_frequence_trait(Trait,Hits).
Trait = honesty,
Hits = 14075 ;
Trait = sincerity,
Hits = 702 ;
Trait = responsibility,
Hits = 15616 ;
Trait = trustworthiness,
Hits = 16020 ;
...

```

Fig. 4.14 – Some outputs of the Prolog program

The results of this process for each trait, and corresponding dimensions according to the chosen character model introduced in previous section, are shown in Table 4.1. This table shows the absolute and relative frequencies of the number of times each trait corresponded to a word found in the experts’ documents. As such, the column “word_hits” represents the number of times words related to a trait were found in the experts’ documents. The corresponding relative frequencies are represented by column “Fr_words”. For instance, the value for “honesty” is 14075 or about 10%. On the left side, the fields “absolute” and “relative” stand respectively for the absolute and relative frequencies of the total hits for each character dimension.

Table 4.1 – Results of the text mining process

Dimension	Hits	Trait No	Traits	Word hits	Fr_words
INTEGRITY		1	honesty	14075	9,98%
		2	sincerity	702	0,50%
absolute	46413	3	responsibility	15616	11,07%
relative	32,91%	4	trustworthiness	16020	11,36%
EMPATHY		5	concerned	3870	2,74%
		6	reassuring	94	0,07%
absolute	19233	7	supportive	9779	6,93%
relative	13,64%	8	sympathetic	5490	3,89%
COURAGE		9	ambitious	3135	2,22%
		10	challenging	2998	2,13%
absolute	15690	11	leading	5117	3,63%
relative	11,13%	12	competent	4440	3,15%
WARMTH		13	friendly	3248	2,30%
		14	open	17069	12,10%
absolute	23129	15	pleasant	1684	1,19%
relative	16,40%	16	straightforward	1128	0,80%
ZEAL		17	exciting	32	0,02%
		18	innovative	8782	6,23%
absolute	16645	19	imaginative	6623	4,70%
relative	11,80%	20	spirited	1208	0,86%
CONSCIENCIOUSNESS		21	reliable	15421	10,93%
		22	hardworking	218	0,15%
absolute	19923	23	proud	125	0,09%
relative	14,13%	24	secure	4159	2,95%
Check	100,00%				
Check	141033			141033	100,00%

The results from this table are more clearly illustrated in the chart of Fig. 4.15. They confirm what is intuitively known concerning the idea of a good partner, as one that should have high scores in traits, such as honesty, responsibility, openness, and reliability.

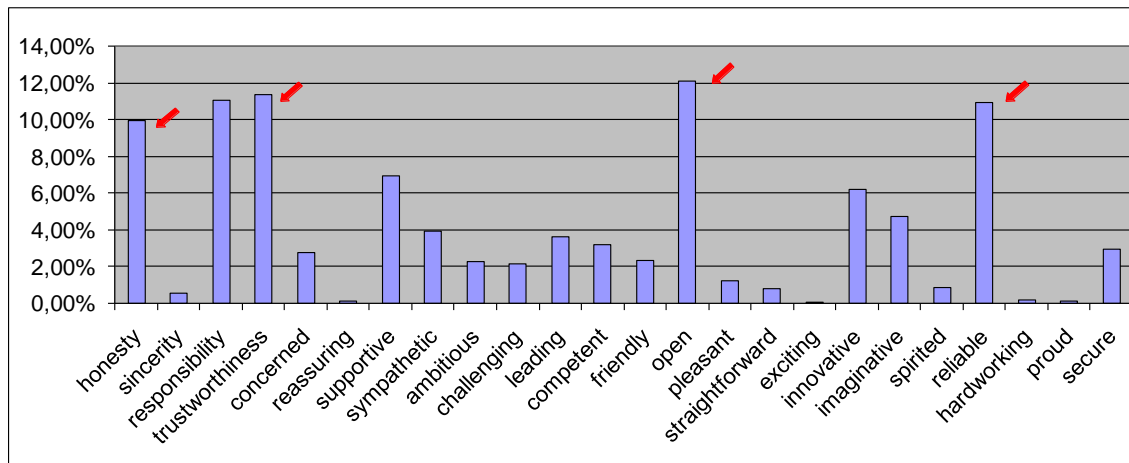


Fig. 4.15 – Highlighting more important traits.

Second round: using clustering

An issue found during the text mining process, was that many words were associated with character traits, but that should have not. For instance, during the process the program created associations between the terms “spacing” and “spatial arrangement” with the trait “openness”, which leads to incorrect results.

In order to overcome this issue, a second round was performed in which every word associated to traits during the first round was organized in clusters of semantically related terms. In this case, all the words of a cluster share a semantic relation. If they are also related to a given trait, then these words express a more accurate relation with the considered trait. As a result, instead of accounting each individual word’s relationship, it is the words inside a cluster which together account for the identification of an important trait. The complete process of text mining, composed of the 1st round and the actual clustering process is illustrated in Fig. 4.16.

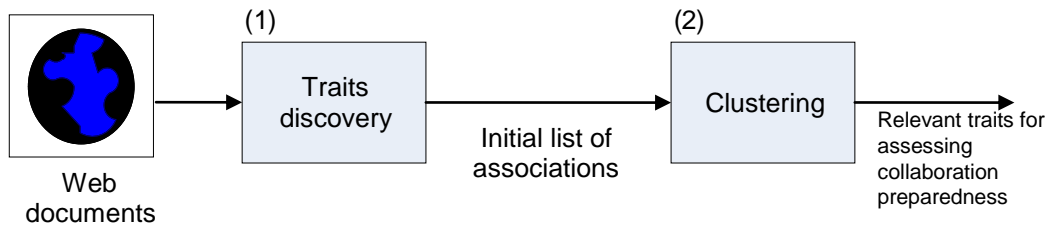


Fig. 4.16 – Two-step text data mining approach to collect experts’ knowledge

The way each cluster is obtained as well as the corresponding absolute frequency is as follows:

- Each cluster is formed by words, which are semantically related to each other.
- A cluster is associated to a given trait if all its words are semantically related to that trait.
- Considering a group of semantically related words and their frequencies $(w_1, f_1), (w_2, f_2), \dots, (w_n, f_n)$, the corresponding cluster is represented by $(ID, [w_1, w_2, \dots, w_n], \sum_{i=1}^n f_i)$, being the ID a number, which uniquely identifies the cluster.

As each word in a given cluster, and therefore the whole cluster, is related to a character trait, the cluster frequency computed in the last final is made on the basis of aggregated frequencies taken from the corresponding words.

Examples of the obtained clusters are illustrated in Fig. 4.17, in which it is possible to observe that each word in the same cluster is semantically related to the others. For instance, in cluster 1 the words *leading*, *guide*, *leadership*, *leaders*, *leader*, and *conduct* are all lexically or semantically related.

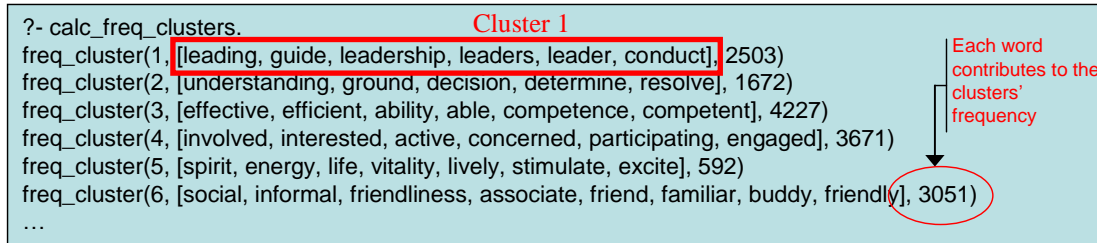


Fig. 4.17 – The obtained clusters.

Fig. 4.18 shows concrete associations between the formed clusters and the character traits. For instance, cluster 1 contains words that are associated to the trait “leadership”, cluster 2 to “decisiveness”, and cluster 3 to “competency. As mentioned before, the character traits used in this process are from the character model described in (Chun, 2005), which is illustrated in Fig. 4.4.

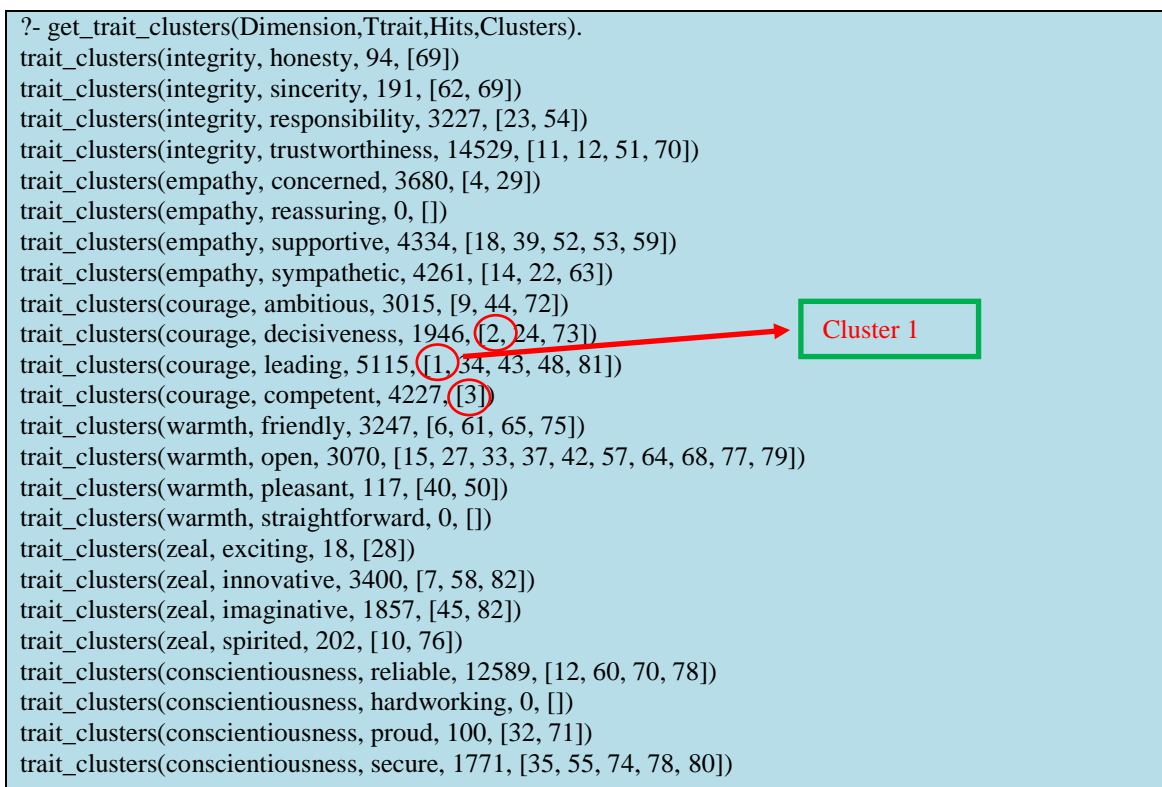


Fig. 4.18 – Found associations between clusters and traits using a `trait_clusters` predicate. Each trait holds a dimension name, a trait name, the absolute frequency, and the corresponding clusters

The results from the clustering approach are presented in Table 4.2. At the left side of the table the fields “total_cluster_hits” and “relative” shown how many relations between the words in the documents and the character dimensions were identified. The meaning of the values “word_hits” and “Fr_words” is as described for Table 4.1. To the right side, there is the “cluster_hits” column, which represents the number of times each cluster was found to be related to a trait. The column “Fr_cluster” corresponds to the relative frequency, from which the importance of the trait can be inferred, as highlighted in the referred table. Another interesting aspect is that, after the clustering process, “trustworthiness” grows in importance in relation to “honesty”. This suggests that in spite of being related terms, this difference may depict the fact that “trustworthiness” is more connoted to partnerships than the term “honesty”.

Table 4.2 – Results from clustering the words/traits associations

(The second column holds the results for dimensions; the remaining columns correspond to the results for traits)

Dimension	Hits	Trait No	Traits	Word hits	Clusters	clusters Hits	Fr. words	Fr. clusters
INTEGRITY		1	honesty	14075 [69]		94	9,98%	0,13%
relative:	25,52%	2	sincerity	702 [62, 69]		191	0,50%	0,27%
total word hits:	46413	3	responsibility	15616 [23, 54]		3227	11,07%	4,56%
total cluster hits:	18041	4	trustworthiness	16020 [11, 12, 51, 70]		14529	11,36%	20,55%
EMPATHY		5	concerned	3870 [4, 29]		3680	2,74%	5,20%
relative:	17,36%	6	reassuring	94 []		0	0,07%	0,00%
total word hits:	19233	7	supportive	9779 [18, 39, 52, 53, 59]		4334	6,93%	6,13%
total cluster hits:	12275	8	sympathetic	5490 [14, 22, 63]		4261	3,89%	6,03%
COURAGE		9	ambitious	3135 [9, 44, 72]		3015	2,22%	4,26%
relative:	19,83%	10	challenging	2998 [9]		1663	2,13%	2,35%
total word hits:	15690	11	leading	5117 [1, 34, 43, 48, 81]		5115	3,63%	7,23%
total cluster hits:	14020	12	competent	4440 [3]		4227	3,15%	5,98%
WARMTH		13	friendly	3248 [6, 61, 65, 75]		3247	2,30%	4,59%
relative:	9,10%	14	open	17069 [15, 27, 33, 37, 42, 57, 64, 68, 77, 79]		3070	12,10%	4,34%
total word hits:	23129	15	pleasant	1684 [40, 50]		117	1,19%	0,17%
total cluster hits:	6434	16	straightforward	1128 []		0	0,80%	0,00%
ZEAL		17	exciting	32 [28]		18	0,02%	0,03%
relative:	7,75%	18	innovative	8782 [7, 58, 82]		3400	6,23%	4,81%
total word hits:	16645	19	imaginative	6623 [45, 82]		1857	4,70%	2,63%
total cluster hits:	5477	20	spirited	1208 [10, 76]		202	0,86%	0,29%
CONSCIOUSNESS		21	reliable	15421 [12, 60, 70, 78]		12589	10,93%	17,80%
relative:	20,45%	22	hardworking	218 []		0	0,15%	0,00%
Word hits:	19923	23	proud	125 [32, 71]		100	0,09%	0,14%
total cluster hits:	14460	24	secure	4159 [35, 55, 74, 78, 80]		1771	2,95%	2,50%
Check	141033			141033		70707		100,00%

These results can be organized as a chart, as shown in Fig. 4.19, for a clearer visualization of the more important traits. As it can be seen these traits correspond to “trustworthiness” and “reliability”.

This would mean that for assessing preparedness to collaborate, the very first traits that should be perceived are reliability and trustworthiness, being the question whether these results were really unexpected. Everybody who enters a partnership wants to get on with a partner who one can trust and rely on. Nevertheless, additional traits, which can be better depicted in Fig. 4.15, such as those corresponding to “supportive” and

“innovation”, should also be considered important for assessing collaboration preparedness.

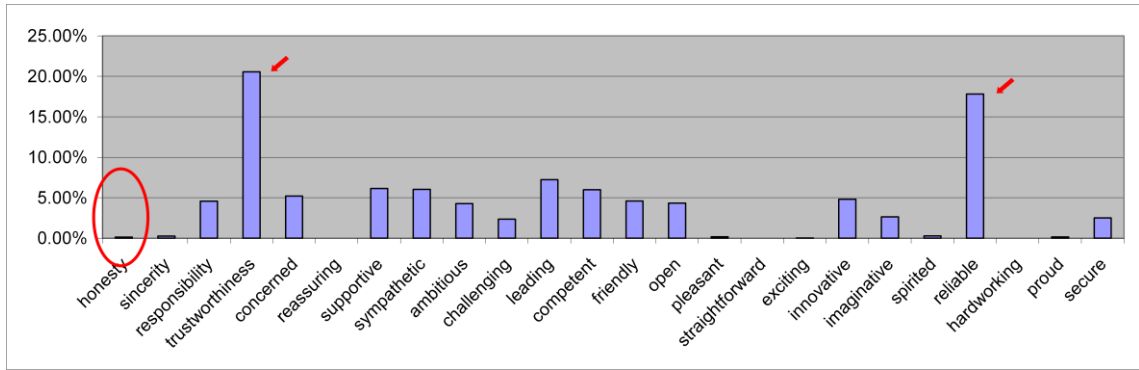


Fig. 4.19 – Trait importance levels, obtained from clusters/traits association

The effect of clustering can be observed by comparing the value of the trait “responsibility” between Fig. 4.15 and Fig. 4.19. The total number of correspondences between the words in the documents and character traits are shown at the bottom of Table 4.2, in which nearly half of the correspondences (about 70,000) were discarded by the clustering process.

The clustering process may have caused loss of information, by not taking into account some words that should have been considered. A third round, which is left for future work, would consist of obtaining the list of the words which were discarded by the clustering process and which would then be subjected to a Pareto classification in terms of their absolute frequency in the documents. According to the Pareto’s rule, nearly 20% of the words accounts for 80% of occurrences in the documents. Afterwards, each word in the list corresponding to the words of the mentioned 20% would be reanalyzed whether they are in fact semantically related to collaboration’s success/failure factors. Although they don’t form clusters, the words in the short list of words that are related to the mentioned factors would be allowed for consideration during the second round.

4.5 Assessment of collaboration preparedness

Previous section described the approach used to identify the traits that are considered more important to observe in collaboration preparedness. In this section, this knowledge is used to infer collaboration preparedness. Two approaches are proposed according to

the amount of information that is known about the organization in consideration. If that information is sufficient for a character profile, then an assessment can be performed using the concept of required collaboration preparedness pattern over the character profile of an organization, as described in chapter 3. But if this information is not enough, then it is necessary to use an approach that can deal with the consequent uncertainty. The adopted approach is based on belief networks.

4.5.1 Assessment based on organization's character profile

The assessment of an organization's character can be seen as a measure of the behavioral characteristics of the organization. As mentioned before, the character model from (Chun, 2005) is used in this research to assess organizations' preparedness to collaborate. According to Bridges (Bridges, 2000), a good way to find clues on how to assess organizations' character is to get inspiration from existing models for human personality. Therefore, the approach to determine an organization's traits can be similar to the practice in human personality assessment. In human behavior, these traits are usually obtained from an adequately formulated questionnaire, in which a number of questions ask for behavioral clues. The range of possible answers is limited and controlled by an assessor, e.g. the manager of a VBE. Typical ranges can be true/false or a Likert scale rating (Krosnick and Fabrigar, 1997). For instance, in this scale a possible answer ranges in a 1-5 scale, in which each value is respectively associated to never, rarely, sometimes, often and always, in order to assess the frequency of a certain happening or action.

Concerning organizations, however, a questionnaire does not seem to be adequate. Sending a questionnaire to the counterparty organization to assess its character might be seen as an impolite gesture, which may undermine confidence from the start. Another approach to collect behavioral clues for an organization's profile is to rely on varied ways to find and confirm the required information. For instance, the organization's web documentation, its level of ICT utilization, its products, whether it has research labs and publishes scientific publications, as illustrated in Fig. 4.20, are useful ways to obtain information for constructing an organization's character profile. The assessor can even inquire entities related to that organization, such as its customers, competitors, suppliers, and even banks for debt/credit notation (Asquith, Mikhail et al., 2005). The assessor tries to categorize that information, relating it to the concrete traits and dimensions, in order to construct the profile.

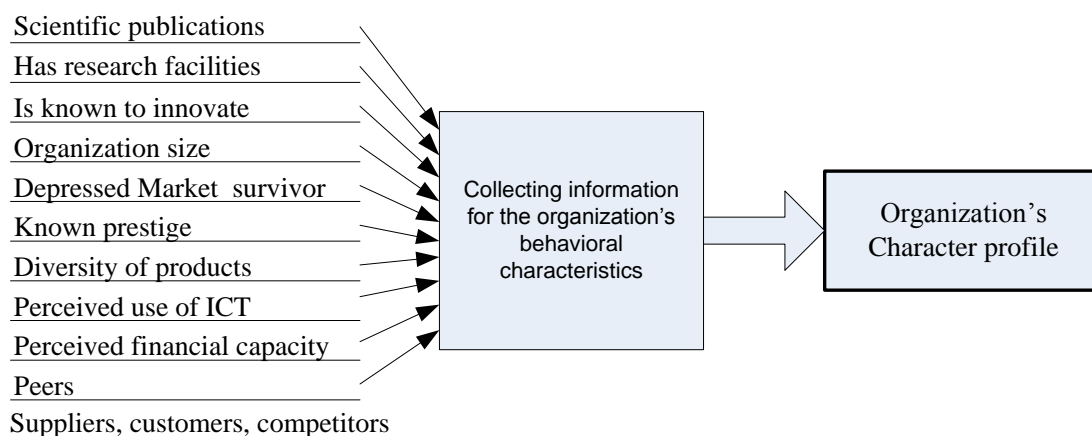


Fig. 4.20 – Ways to assess a partners’ information concerning character profile

The way to determine the dimensions from the character traits is shown in Fig. 4.21. An overview of how to compute values for dimensions and traits is in (Goldberg, 1999).

Integrity	= v(Honest)+v(Sincere)+v(Socially-responsible)+v(Trustworthy)
Empathy	= v(Concerned)+v(Reassuring)+v(Supportive)+v(Sympathetic)
Courage	= v(Ambitious)+v(Achievement-oriented)+v(Leading)+v(Competent)
Warmth	= v(friendliness)+v(pleasant)+v(open)+v(straightforward)
Zeal	= v(Exciting)+v(Innovative)+v(Imaginative)+v(Spirited)
Conscientiousness	= v(Reliable)+v(Hardworking)+v(Proud)+v(Secure)

Fig. 4.21 – Calculation of the dimensions from character traits; function ‘v’ yields each trait value

In Fig. 4.22, an example of a profile chart is presented, based on the model described in (Chun, 2005). As mentioned in chapter 3, it is recommended to first attend to the broad dimensions on the left side, then to the details within each dimension on the right side, in order to facilitate rapid understanding.

As to illustrate how to interpret the profile for a given organization, starting from the left side, the chart in Fig. 4.22 tells us that this organization has a high score in the values of “integrity” and “conscientiousness”, and that it is low in the “zeal” dimension. On the right side, the corresponding traits inform that it is a “hardworking” organization and highly scored on “trustworthiness” and “reliability”. However, it is low scored on innovation related traits, information also provided by the low score in the “zeal” dimension, because as shown in Fig. 4.4, this dimension includes the trait “innovative”, as one of its components.

According to the collaboration preparedness hypothesis, embedded in these traits is the information which tells about an organization’s preparedness to collaborate. An assessor in a given context, e.g. the manager of a VBE who is looking for partners,

starts by determining which traits he/she wants to see in the behavioral profile of organizations, by specifying a corresponding collaboration preparedness pattern (*Definition 3.2.7*). As mentioned before, this concept is used to specify which behavioral patterns are *desired** in partners for a given collaboration situation.

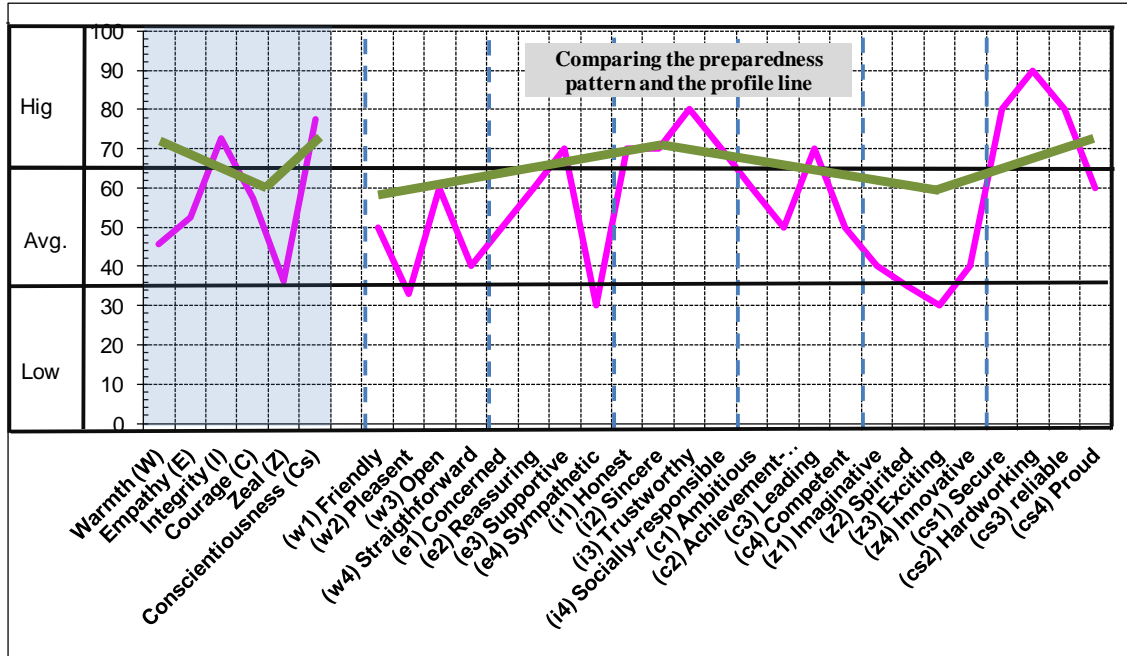


Fig. 4.22 – Profile for a given organization.

If each organization's character is represented together with that preparedness pattern, as illustrated in Fig. 4.22, then it is easy to perceive which profiles resemble the desired pattern. A way to systematically spot the organizations well prepared to collaborate, according to the given collaboration preparedness pattern, can be based on the *Axiom 3.2.1*. This axiom was kept abstract in section 3.2.4. A revised version of it corresponds to:

Axiom 3.2.1 (organization's collaboration preparedness) – The collaboration preparedness of an organization *org* in relation to a required preparedness pattern *pp* can be established by the following sentence:

$$\begin{aligned} \forall_{org} \forall_{pp} (&prepared(org, pp) \\ &\leftarrow \forall_{pc} \exists_{trait} (belongs(pc, pp) \wedge abs(value(pc.trait) - value(org, trait)) \\ &< threshold)) \end{aligned}$$

* By “desired” we mean adequate or required. It can also mean the behavioral patterns a VBE broker wishes in partners. In this case, it might not even be near the best fit, but according to the broker's subjective judgment or personal feelings.

In this axiom, the term *pc* stands for preparedness condition, as according to *Definition 3.2.7*, a required preparedness pattern *pp* is composed by a number of preparedness conditions. A corresponding visual application of this axiom is by comparing the profile line of each organization's character with the one of the preparedness pattern (Fig. 4.22). Provided that the difference in the trait values, between each preparedness condition *pc* and the corresponding organization's profile line, is less than the specified threshold, the organization is considered prepared to collaborate.

Finally, one can imagine a way to operationalize a preparedness filter in a software tool. In that tool a manager draws, using a pen or the mouse, a required preparedness pattern line (the thicker line shown in Fig. 4.22), and the tool automatically retrieves from the Information System the organizations having characters which better match the specified (or drawn) collaboration preparedness pattern.

4.5.2 The impact of imperfect information in preparedness assessment

Recalling the scenario presented in the beginning of this chapter (in Fig. 4.2), the assessment for organization *o_12* is more problematic. As it is a newcomer, there is not enough information concerning its behavioral profile. This contrasts with organization *o_6*, which is already a VBE member, as previously mentioned, and may have already participated in previous consortia. Its behavior was observed before, so it is possible to characterize its profile, and eventually predict how likely it will behave in the future.

Organization *o_12*, on the other hand, is not a VBE member nor is much known by the VBE manager until that moment. Therefore, it is difficult to collect information to assess its preparedness to collaborate. The decision to invite *o_12* will be a more risky one, being that risk associated to the uncertainty about how it is likely to behave in future partnerships. The behavioral profile exemplified in Fig. 4.22 is not useful here, as there will be many unknown traits, leaving the profile chart almost empty. In order to handle these cases, another approach, based on Bayesian belief networks, is used as described in the next sections. Before proceeding some base notions on these belief networks are presented.

4.5.3 Belief networks basics

A Bayesian belief network is a kind of probabilistic model that represents causal relationships on a set of variables (Fig. 4.23). It is composed of two parts: the structural

part, which consists of a direct acyclic graph, in which nodes stand for random variables and edges for direct conditional dependence between them; and the probabilistic part that quantifies the conditional dependences between these variables. Each variable can have state values (such as, 'no', 'yes' or 'low', 'high'). If the value of a variable in a node is known, then that node is said to be an evidence node. More on belief networks can be found in (Jensen, 1996). In Fig. 4.23, the arc pointing from node C to node E, for instance, can be interpreted as C causing or influencing E. Each of the child nodes has an associated conditional probability table that quantifies the effects that the parents have on them. For the nodes without parents, the corresponding tables only contain prior probabilities. Due to these conditional dependences, if a node becomes an evidence node, then the probabilities (or likelihood) of the other nodes change.

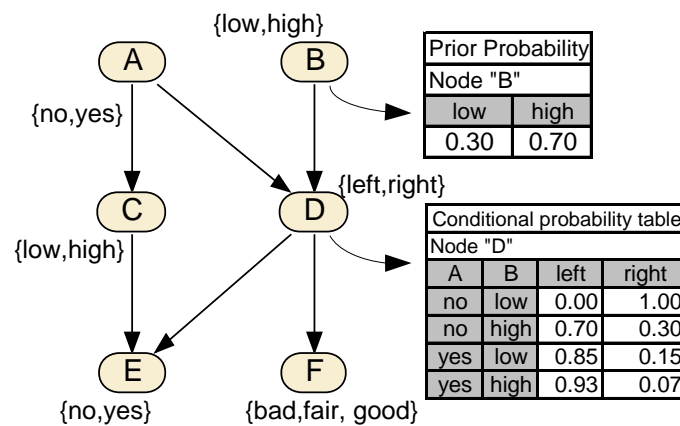


Fig. 4.23 – An example of a Bayesian belief network

For any node of the network, the computation of conditional probabilities is done using Bayes' rule, which can be stated as:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

This rule expresses the idea that it is common to think in terms of updating a belief about a hypothesis A, in the light of new evidence B. Specifically, the posterior belief $P(A|B)$ is calculated by multiplying the prior belief $P(A)$ by the likelihood $P(B|A)$ that B will occur if A is true. The power of Bayes' rule lies in the fact that in many situations, computing $P(A|B)$ is difficult to perform directly. Yet, if direct information about $P(B|A)$ is available, then Bayes' rule can be used to compute $P(A|B)$ in terms of $P(B|A)$.

The denominator $P(B)$ in the equation is a normalizing constant, which can be computed, for example, by marginalization (Fenton, 2009), whereby

$$P(B) = \sum_i P(B, A_i) = \sum_i P(B|A_i) \times P(A_i)^*$$

Hence, the Bayes rule can be stated in another way as:

$$P(A|B) = \frac{P(B|A)P(A)}{\sum_i P(B|A_i) \times P(A_i)}$$

For the above example, the probability of variable E being in state *yes* or *no* is conditioned by its parent C being in state *low* or *high* and its parent D in state *left* or *right*.

Belief networks can be used to perform queries in distinct ways:

- To perform predictions. This is useful whenever some causes are known and it is necessary to determine the probability of possible effects/consequences. For instance, when $B=\text{low}$ and $C=\text{high}$, the probability of $E=\text{yes}$ is given by the query $P(E=\text{yes} \mid B=\text{low}, C=\text{high})$.
- To perform diagnostics. For instance, when the fact $F=\text{bad}$ is known, it is necessary to determine the likelihood of possible causes: $P(A=\text{yes} \mid F=\text{bad})$.
- It is also possible to make queries on the joint distributions, without providing evidences. For instance, the probability of $F=\text{fair}$, without further evidence, is given by $P(F=\text{fair})$.

Belief networks can be extended into decision networks, which correspond to a way of using them in decision making.

4.5.4 Performing decision making

As just described, a belief network is used to reason under uncertainty. It represents a probability distribution for computing probabilities of interest about the problem in

* Given a joint probability distribution, marginalization consists of the determination of the probability of an outcome of a subset of random variables. It involves taking a weighted sum over the possible outcomes of the random variables that are not of interest (http://idiom.ucsd.edu/~rlevy/lign251/fall2007/lecture_4.pdf, seen in October 1, 2009).

question. It models the behavior of a part of the world worth of interest and can be used to perform behavior prediction. What we do with these predictions, however, is another matter that goes into the realm of Decision Theory (Charniak, 1991).

A belief network does not provide, by itself, a mechanism for decision making. A typical decision making process, characterized by uncertainty, involves considering the alternative decisions at a decisions maker's disposal, the characterization of the situations in which these decisions must be taken (usually characterized as states of the "world"), and the decisions' uncertain consequences or outcomes (e.g. benefits, costs, rewards, penalties, joy, regret, ...). In Table 4.3, each decision d_i provides an utility or outcome $u_{i,j}$ in each situation s_j , being the chosen decision the one which yields the maximum Expected Utility $EU(d_i)$, as illustrated later on.

Table 4.3 – Example of information involved in a decision-making problem

Decisions	States			
	s_1	s_2	...	s_m
d_1	$u_{1,1}$	$u_{1,2}$...	$u_{1,m}$
d_2	$u_{2,1}$	$u_{2,2}$...	$u_{2,m}$
...
d_n	$u_{n,1}$	$u_{n,2}$...	$u_{n,m}$
Probability	$P(s_1)$	$P(s_2)$...	$P(s_m)$

Belief networks can, nevertheless, be extended to handle decision making and, in this case they take the form of Decision Networks or Influence Diagrams. These decision making models provide formalisms for capturing the various types of knowledge involved in a decision problem and provide methods for computing preferred decisions (Renooij and Van Der Gaag, 1998). As though, a decision network allows for encoding not only a probability distribution on a set of variables, as belief networks do, but also the decisions that a decision maker can make and the desirability of their (uncertain) consequences.

As illustrated in Fig. 4.24, a decision network is usually built from a belief network with the addition of two additional types of nodes, the "decision" and the "utility" nodes. The nodes of the decision's belief network side are commonly named as "nature" nodes [(Ma, Arentze et al., 2004) and (Nyberg, Marcot et al., 2006)]. The "nature" nodes are the ones corresponding to random variables which encode the prior or conditional probability tables associated to the behavioral part of a decision problem. A decision node is usually drawn as a rectangle and models a decision variable that represents the various decision alternatives at a decision maker's disposal. A value node is usually drawn as a hexagon and represents the desirability of the consequences that

may arise from the various decisions made under the current situation. Arrows into decision nodes represent the information that is available at the time a decision is made. Arrows into value nodes collectively represent the influence of the parent nodes in the desirability value (Szolovits, 1995).

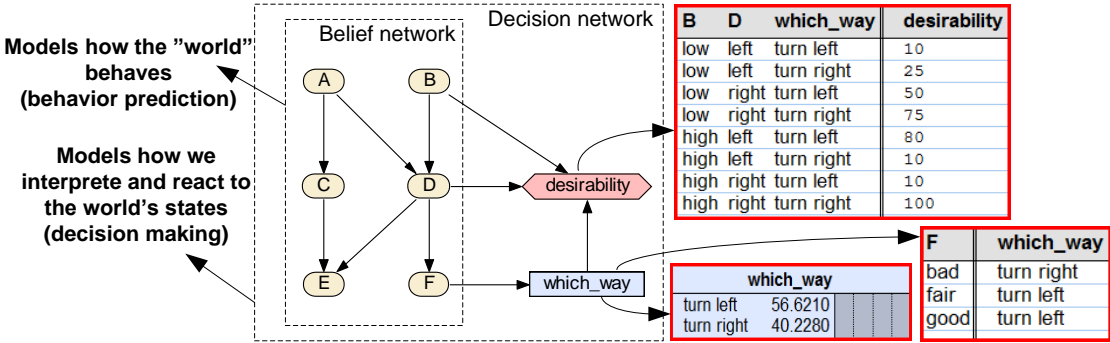


Fig. 4.24 – Example of a decision network

The process of obtaining a decision solution for a decision network corresponds to selecting, for each decision node, the optimal choice given any possible set of informational inputs to the decision node. This is performed with the principle of maximal expected utility, in which a rational choice is made whenever the decision that yields the maximal expected utility is selected (Horvitz, Breese et al., 1988), (Boutilier, 2003). This decision process is illustrated in a later section of this chapter.

4.5.5 Modeling collaboration preparedness predictor

Approaches to model a belief network

The construction of a belief network depends on the existence of an appropriate repository of data to extract conditional probabilities and construct the network structure. The objective is to obtain a belief network which best approximates the joint probabilities and dependencies among the variables characterizing a random problem. In many situations, data is not available because the examined events can be new, rare, complex, or little understood (Bonafede and Giudici, 2007). That is also what happens in terms of collaboration preparedness, it is a subject not yet well understood, and for which there is no data to adequately build a belief network.

In many cases, both the structure (nodes and arcs) and parameters of the local distributions can be learned from historic data, using Machine Learning techniques

(Pearl, 1996), (Cheng, Bell et al., 1997), (Cheng and Greiner, 2001) and (Friedman, 1997). But that largely depends on the availability of the mentioned repository, to which these techniques could be applied. If such repository is not available, no machine learning techniques can be applied. The alternative approach is to rely on the use of expert's information which could be translated into conditional probabilities assumptions for the construction of a belief network.

Constructing the qualitative or structural part of a belief network, although elaborate, is relatively straightforward and experts feel comfortable doing so. This qualitative part represents the “cause-effect” relations which are embedded in experts' thinking (Renooij and Witteman, 1999).

The quantitative part, which consists of the specification of probabilities over the random variables, is more problematic. This part is usually referred as probability elicitation. In this part, experts are required to express these probabilities numerically, which is something they are often reluctant to do. Either they are not familiar enough with the concept of probability, or they find it difficult to attach a number to their beliefs (Henrion, Pradhan et al., 1996). In (Wiegmann, 2005) some approaches for improving probability elicitation are described, namely the Frequency Estimation, Gambling, and Hierarchical methods.

At the output side of a belief network, explanations of the obtained results from belief network queries in terms of variables with numerical probabilities may also be uncomfortable. This process also involves a major psychological component, including the experts' beliefs which might also be subjective (Wiegmann, 2005). People feel more at ease with verbal probability expressions than with numbers, that is, when they communicate probabilities, they frequently do so in words rather than numbers (Renooij and Witteman, 1999). For instance, in a study described in (Renooij and Witteman, 1999), the expressions they found as good for communicating expressions were {possible, probable, improbable, certain, uncertain, expected, impossible}. Furthermore, (Henrion, Pradhan et al., 1996) states that belief networks are insensitive to imprecision in the specification of probabilities, and (Nadkarni and Shenoy, 2004) in turn mention that the inference procedures in a belief network are more sensitive to the qualitative structure than to the quantitative probabilities associated to the structure. These aspects mean that small deviations in the values of the conditional probability tables of a belief network may not affect its performance. However, a mistake in defining the conditional dependencies in its structure poses dramatic changes in its performance. These aspects

are taken in consideration in modeling the belief network used for assessing collaboration preparedness.

The adopted approach for modeling the belief network

The used approach is to illustrate how experts could be used in the construction of the belief network for assessing collaboration preparedness. The approach is illustrated in Fig. 4.25 phase 1, in which the construction of the belief network is performed by an expert.

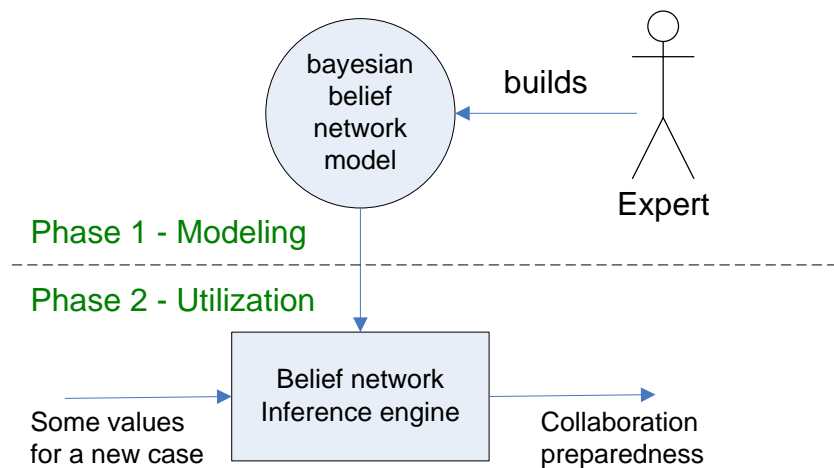


Fig. 4.25 – Belief Network modeling and utilization (Rosas and Camarinha-Matos, 2008)

The expert first models its knowledge concerning collaboration preparedness cause-effect assumptions in structural terms. Then it models the strength of these causal assumptions, namely by elicitation of conditional probabilities, with subjective probabilities. Following the approaches mentioned before, most of the effort must be concentrated in the construction of the structural part of the belief network, because as mentioned before, the probability elicitation can be made with some imprecision.

Therefore, in order to guide the belief network design process for this experiment, a few assumptions regarding collaboration preparedness were considered, which should be taken as merely illustrative. Thus, the following conjectures were considered:

- c1 - An organization of fragile economical condition, in order to benefit from others' competencies (that usually it cannot afford to own), is more willing to accept the risks of collaboration. On the other hand, due to its fragile condition, it tends to be less reliable.
- c2 - An organization in good economical condition might be more reliable, but does not feel the same pressure, as in the previous case, to collaborate and therefore tends to be more risk-conservative regarding collaboration/partnerships.

- c3 - A small size organization (e.g. a SME) might possess fewer competencies and, with the goal of complementing them, accepts to be more exposed to the risks of collaborating with other organizations.
- c4 - The prestige of an organization, which is an attribute that is perceived by its peers, is fundamental in collaboration and adds directly to the preparedness level.
- c5 - An organization characterized by poor reliability has a downgrade of its prestige.
- c6 - The creativity of an organization, which can be roughly estimated by evaluating its rate of generated innovations, might also be important for collaboration, and adds directly to the preparedness level.
- c7 - Higher reliability adds to preparedness; higher tolerance to the risk (of being in collaboration) also adds to preparedness.

Certainly, these conjectures are arguable, but they are considered here only for illustration.

For filling the prior and conditional probability tables, which were previously illustrated in Fig. 4.23, the expert associates a subjective probability value stating its belief strength concerning each conjecture, depending on the values of the involved nodes, as illustrated in Fig. 4.26.

Partner dimension	Economical situation	high	low
high	good	20.000	80.000
high	fair	30.000	70.000
high	bad	50.000	50.000

Fig. 4.26 – Assigning values to conditional probability tables

The obtained model

An example belief network, modeled using the above guidelines, for the inference of the organization's preparedness level is shown in Fig. 4.27, using NeticaTM (Norsis, 1997). The causal links are labeled with the previously specified conjecture(s), justifying the causality between the random variables, which in this case are taken as the organizations' traits. The labels c1, c2..., c7 near the links are placed to indicate which of the previous conjectures originated the corresponding causal link.

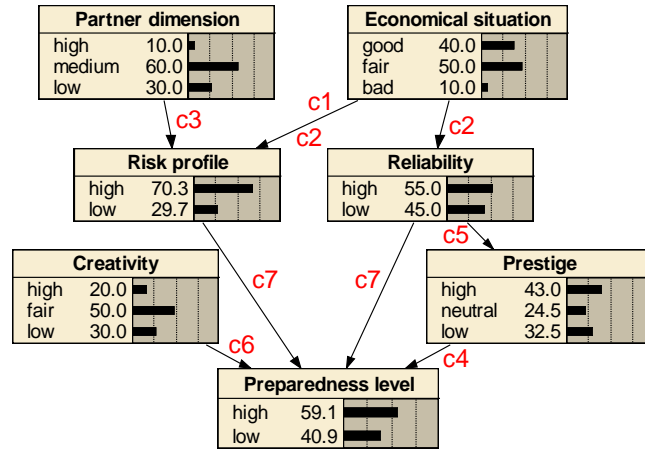


Fig. 4.27 – A Bayesian network example to assess the preparedness level

For this belief network, the joint probability distribution, from which the predictions and diagnostics can be made, is the following (showing only the initials for the nodes names):

$$P(PD, ES, RP, R, C, P, PL) = P(PD) \times P(ES|PD) \times P(RP|PD, ES) \times P(R|PD, ES, RP) \times P(C|PD, ES, RP, R) \times P(P|PD, ES, RP, R, C) \times P(PL|PD, ES, RP, R, C, P)$$

This function can be simplified by considering the conditional independence statements implied in the belief network. For instance, the ‘partner dimension’ variable does not directly influence the ‘preparedness level’, as ‘reliability’ does. This is because $P(PL|PD, R) = P(PL|R)$, so PD can be removed from the above expression. In other words, PL and PD are conditionally independent given R . The same approach can be applied to the other conditional probabilities, which helps removing more variables (the shaded ones) from the above expression. This results in the expression:

$$P(PD, ES, RP, R, C, P, PL) = P(PD) \times P(ES) \times P(RP|PD, ES) \times P(R|ES) \times P(C) \times P(P|R) \times P(PL|RP, R, C, P)$$

As an illustration for the given problem, and assuming most of the nodes as evidences (to reduce calculations), the probability of preparedness level $PL=high$, given that $PD=high$, $ES=fair$, $C=high$, and $P=high$ is given by:

$$P(PL_{high} | PD_{high}, ES_{fair}, C_{high}, P_{high}) = \frac{P(PL_{high}, PD_{high}, ES_{fair}, C_{high}, P_{high})}{P(PD_{high}, ES_{fair}, C_{high}, P_{high})}$$

The value for numerator of this expression is obtained as following:

$$\begin{aligned} & P(PL_{high}, PD_{high}, ES_{fair}, C_{high}, P_{high}) \\ &= \sum_{rp \in \{high, low\}} \sum_{r \in \{high, low\}} P(CL_{high}, PD_{high}, ES_{fair}, RP_{rp}, R_r, C_{high}, P_{high}) \\ &= P(PL_{high}, PD_{high}, ES_{fair}, RP_{high}, R_{high}, C_{high}, P_{high}) \\ &+ P(PL_{high}, PD_{high}, ES_{fair}, RP_{high}, R_{low}, C_{high}, P_{high}) \\ &+ P(PL_{high}, PD_{high}, ES_{fair}, RP_{low}, R_{high}, C_{high}, P_{high}) \\ &+ P(PL_{high}, PD_{high}, ES_{fair}, RP_{low}, R_{low}, C_{high}, P_{high}) \\ &= P(PD_{high}) \times P(ES_{fair}) \times P(RP_{high} | PD_{high}, ES_{fair}) \times P(R_{high} | ES_{fair}) \times P(C_{high}) \times P(P_{high}) \\ &\times P(PL_{high} | RP_{high}, R_{high}, C_{high}, P_{high}) \\ &+ P(PD_{high}) \times P(ES_{fair}) \times P(RP_{high} | PD_{high}, ES_{fair}) \times P(R_{low} | ES_{fair}) \times P(C_{high}) \times P(P_{high}) \\ &\times P(PL_{high} | RP_{high}, R_{low}, C_{high}, P_{high}) \\ &+ P(PD_{high}) \times P(ES_{fair}) \times P(RP_{low} | PD_{high}, ES_{fair}) \times P(R_{high} | ES_{fair}) \times P(C_{high}) \times P(P_{high}) \\ &\times P(PL_{high} | RP_{low}, R_{high}, C_{high}, P_{high}) \\ &+ P(PD_{high}) \times P(ES_{fair}) \times P(RP_{low} | PD_{high}, ES_{fair}) \times P(R_{low} | ES_{fair}) \times P(C_{high}) \times P(P_{high}) \\ &\times P(PL_{high} | RP_{low}, R_{low}, C_{high}, P_{high}) \end{aligned}$$

The final step is to replace every conditional (or prior) probability in the expression by the values taken from the conditional (or prior) probability tables that are in the belief network. This results in:

$$\begin{aligned} & \sum_{rp \in \{high, low\}} \sum_{r \in \{high, low\}} P(CL_{high}, PD_{high}, ES_{fair}, RP_{rp}, R_r, C_{high}, P_{high}) \\ &= 0.1 \times 0.5 \times 0.3 \times 0.5 \times 0.2 \times 0.3 \times 1.0 \\ &+ 0.1 \times 0.5 \times 0.3 \times 0.5 \times 0.2 \times 0.3 \times 0.7 \\ &+ 0.1 \times 0.5 \times 0.7 \times 0.5 \times 0.2 \times 0.3 \times 0.95 \\ &+ 0.1 \times 0.5 \times 0.7 \times 0.5 \times 0.2 \times 0.3 \times 0.65 \\ &= 0.00245 \end{aligned}$$

The calculation of the denominator is similar to the previous steps:

$$\begin{aligned} & P(PD_{high}, ES_{fair}, C_{high}, P_{high}) \\ &= \sum_{rp \in \{high, low\}} \sum_{r \in \{high, low\}} \sum_{cl \in \{high, low\}} P(PL_{cl}, PD_{high}, ES_{fair}, RP_{rp}, R_r, C_{high}, P_{high}) = 0.003 \end{aligned}$$

The corresponding probability is therefore

$$P(PL_{high} | PD_{high}, ES_{fair}, C_{high}, P_{high}) = \frac{0.00245}{0.003} = 0.815$$

Having presented the stochastic model, it is time to use it for assessing the collaboration preparedness of the members of a VBE in a context of uncertainty.

4.5.6 Performing uncertain assessments

The example described below illustrates the estimation of the collaboration preparedness using the belief network specified in the previous section.

Let us recall the VBE example illustrated in Fig. 4.2. The competencies and character traits of that VBE's organizations are shown in Table 4.4. In order to reuse the belief network specified in Fig. 4.27, the traits used in this example are nodes of that network. Beyond the implied imprecision and subjectivity in the traits' values, some of them are even unknown (the ones specified with a question mark), which is an aspect that adds even more uncertainty to the assessment process.

Table 4.4 – Competencies and traits of the VBE's members

Organization	Organization traits ^a					
	PD	ES	RP	R	C	P
o_1	high	good	?	high	high	high
o_2	med	?	high	?	low	high
o_3	med	fair	high	low	high	high
o_4	?	good	high	low	?	?
o_5	high	bad	high	high	high	low
o_6	low	good	high	?	high	high

^a (PD: partners dimension; ES: economical situation; RP: risk profile; R: reliability; C: creativity; P: prestige)

Assessing a single partner

Recalling the mentioned Fig. 4.2, little information that is known about *o_12*'s, as opposite to the other organizations which are already members of the VBE, with the information provided in Table 4.4. Nevertheless, a collaboration preparedness assessment can still be made on that eventual partner, using available information that can be used to feed the belief network. For instance, if it is known that *o_12* is an organization of low dimension in good economical situation, its preparedness can be computed by a conditional probability query made to the belief network about the

probability of that organization having a high collaboration preparedness level, using the mentioned information as evidences. Such a query is of the form:

$$P(\text{"preparedness level"}=\textit{high} \mid \text{"partner dimension"}=\textit{low}, \text{"economical situation"}=\textit{good})=60.1\%.$$

For organization o_1 , which is already a member of the VBE, a similar query using the information of Table 4.4 would be:

$$P(\text{"preparedness level"}=\textit{high} \mid \text{"PD"}=\textit{high}, \text{"ES"}=\textit{good}, \text{"R"}=\textit{high}, \text{"C"}=\textit{high}, \text{"P"}=\textit{high})=96.2\%.$$

The probability value of 96.2% of a high preparedness level for o_3 , as opposite to o_{12} , is related to the fact that its traits are known, and that these traits are positive for collaboration, according to the conjectures used to model the belief network.

Using *Axiom 3.2.2*, it is possible to obtain all the organizations which meet a criteria specified in a collaboration preparedness pattern (shaded area below). This can be done with:

$$?- \text{preparedness}(\text{Orgs}, \{(\text{reliability}, \text{high}, \text{'above'}, 70), (\text{creativity}, \text{fair}, \text{'about'}, 80)\}).$$

Which can be interpreted “as obtain the organizations which are highly reliable, with a belief of above 70%, and fairly creative with belief of about 80%”. Practical results of this axiom are illustrated in the next section.

Assessing a Virtual Organization

An assessment of collaboration preparedness can also be performed on a whole virtual organization. What it is necessary is, basically, to assess the collaboration preparedness of each member. For such, a collaboration preparedness pattern (*Definition 3.2.7*) can be used in order to feed *Axiom 3.2.2*, which yields “true” or “false” whether all the members of the VO are considered prepared to collaborate.

For instance, for the assessment of whether the virtual organization vo_1 is composed of members that are prepared to collaborate, we can define some preparedness conditions, according to *Axiom 3.2.2*, supposedly adequate for a given

situation or context, and run the predicate “preparedness” specified in the *Axiom 3.2.2*. We would invoke the following query:

```
?- preparedness(vo_1, {(reliability, high, '≥', 70), (creativity, fair, 'about', 80)}).
```

In this case *vo_1* is not prepared according to the specified preparedness conditions, because organization *o_2* does not comply with the preparedness conditions. This organization has reliability $P(\text{reliability}=\text{high} \mid \text{known_traits}(o_2))=0.63$, which is less than 0.7, as specified in the conditions. It also fails in terms of creativity, because $P(\text{creativity}=\text{fair}, \text{known_traits}(o_2))=0$. In other words, its creativity level is *low* and the conditions of the query require it to be *fair*. The function *known_traits* collects the traits that are known for a given organization (Table 4.4).

4.5.7 Deciding on who to invite for a partnership

Previous sections showed how a method for collaboration preparedness could be modeled by means of a belief network, for which its predictive capacity could be used to partially validate the preparedness assumptions formulated in section 2. Now it is time to illustrate how this method can be used for decision making in a context of collaborative networks. This is done by formulating a simple decision problem over the belief network.

In a given situation, a broker is responsible to select a set of organizations as candidates for a new collaboration opportunity. Let us assume that these candidates are relatively unknown to the broker, so he has little information characterizing these organizations. Nevertheless, the broker could get an idea of the prestige of each organization after inquiring some partners he already knows. Moreover, he can also characterize each organization in terms of their size. Beyond the prestige, he is also very concerned with the eventual reliability of selected candidates, for which he could not get concrete information. To summarize, this broker has a decision problem with two alternative choices - invite or not invite - and the decision has to be based on two uncertain organizations' characteristics, prestige and reliability.

Due to the fact that we already have a belief network that models the behavior of organizations from their character traits, the approach is now to extend this belief network into a decision network, so that it can also handle decision making, as

described in a previous section. For this decision problem, it is sufficient to have a decision network with one additional *decision* node and a *value* node. In the decision node, the alternative choices of the decision, invite or not invite, are specified. The *value* node specifies which values of prestige and reliability are more desirable for each alternative decision, according to the broker's personal scale of judgment, as illustrated in Table 4.5. The desirability label in this table just informs which combinations of node values are more desirable, according to their meaning in terms of preparedness level. As though, contrarily to the belief network component, this part can be quite subjective, because it depends on the broker's personal preferences. The required decision network for the "invitation" decision problem is presented in Fig. 4.28, separated in behavioral and decision parts.

Table 4.5 – Values of desirability for character traits and decision's choice

Utility Node			
Reliability	Prestige	Invite?	Desirability
High	high	yes	100
High	high	no	0
High	neutral	yes	50
High	neutral	no	10
High	low	yes	10
High	low	no	50
Low	high	yes	10
Low	high	no	50
Low	neutral	yes	5
Low	neutral	no	60
Low	low	yes	0
Low	low	no	100

Observing the decision network, we can see that without any evidence of candidate's character traits, the expected value of inviting a candidate is 45.6 and that for not inviting is 41.2; thus, in this situation, the choice would be to invite. This may seem strange, because without evidences the decision to invite would be negative. However, this decision corresponds to tossing a coin and taking the decision to invite based on the chance head turns up, which provides 50% chance for either sides. Any positive or negative evidences that are provided to the belief network, the utility value of yes/no to invite will change accordingly. A better approach, for future work, may be the consideration of a confidence value, which basically would depend on the amount of evidences provided to the belief network.

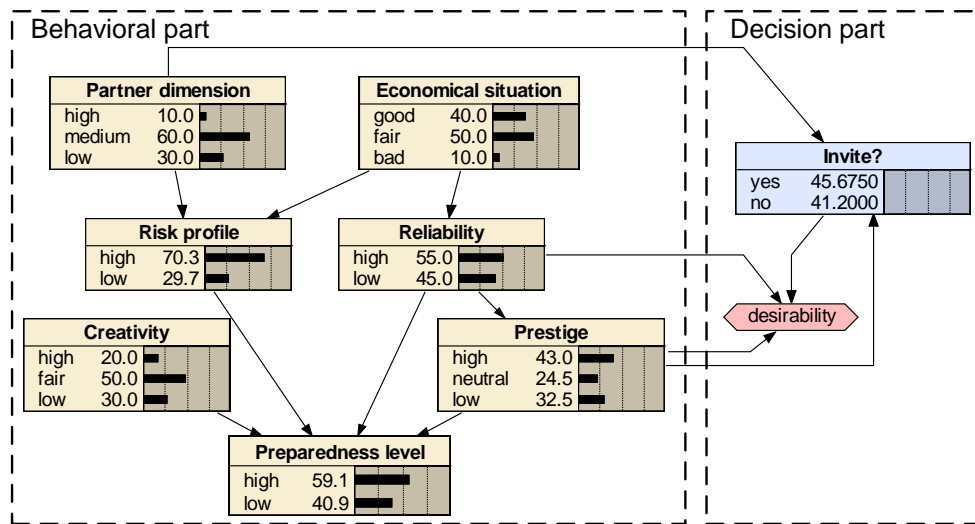


Fig. 4.28 – A decision network for VO partners' suggestion

In order to understand how this desirability value of 45.6 is obtained from the belief network, the inferred value can be equivalently obtained by organizing the information contained in the network as a typical decision table shown in Table 4.6, considering only the “reliability” and “prestige” nodes. Therefore, this table represents a snapshot for the current decision problem presented in Fig. 4.28. The values of desirability, given the traits reliability and prestige, are taken from the value node.

Table 4.6 – A snapshot for the decision instance in Fig. 4.28

	Traits: (reliability, prestige) ^a					
Invitation?	(H,H)	(H,N)	(H,L)	(L,H)	(L,N)	(L,L)
Yes	100	50	10	10	5	0
No	0	10	50	50	60	100
Probability	38.5%	11.0%	5.5%	4.5%	13.5%	27.0%

^a (H: high, N: neutral, L: low)

The values of probability in each column are determined using the concept of joint probability distribution of our belief network, as previously explained, and assigning the values of the traits present in each of these columns. For the column with the state (H, H), that probability is:

$$P(R_{high}, P_{high}) = P(PD, ES, RP, R_{high}, C, P_{high}, PL) = \dots = 0.385$$

The remaining probabilities are obtained in a similar way. In order to proceed, let us consider the sets decision $D = \{\text{yes, no}\}$ and states $S = \{(H,H), (H,N), (H,L), (L,H), (L,N), (L,L)\}$ for the values of the nodes represented by the tuple (reliability, prestige). The determination of the expected utility of each alternative choice, for the specified

decision variable, requires the concept of Expected Utility (EU) function (Renooij and Van Der Gaag, 1998), which is formulated as:

$$EU(d_i) = \sum_{s_j \in S} U(d_i, s_j) \times P(s_j | d_i), \quad d_i \in D, s_j \in S.$$

According to this equation, the expected utility of decision d_i corresponds to the sum of its utility in every state s_j , affected by the probability of s_j being true, given that decision d_i was taken.

In this equation, $U(d, s)$ represents a relation $U: D \times S \rightarrow Desirability$, which for a given state and decision choice, provides a value of desirability (or utility). For our decision problem, these values are specified inside the value node of our decision network in Fig. 4.28, also enumerated in Table 4.6. $P(s_j | d_i)$ yields the same probability as $P(s_j)$, because no arrows go from the decision to the causal side of the decision network. Proceeding in this way, the expected values of utility for our decision choices are:

$$\begin{aligned} EU(yes) &= 100 \times 0.385 + 50 \times 0.110 + 10 \times 0.055 + 10 \times 0.045 + 5 \times 0.135 + 0 \times 0.270 = 45.67 \\ EU(no) &= 0 \times 0.385 + 10 \times 0.110 + 50 \times 0.055 + 50 \times 0.045 + 60 \times 0.135 + 100 \times 0.270 = 41.20 \end{aligned}$$

which are the same as the values of desirability expressed in the decision node of Fig. 4.28*. Under the considered circumstances, the option that is chosen is the one with maximal expected utility.

To illustrate this idea, let us see how our model works when modeling a “gossip”. Let us imagine that a broker’s friend tells him that he is aware that one of the candidates in the shortlist is not in adequate economical situation, which could cause difficulties in its regular “business” activities. The broker, concerned with the impacts that his friend’s tip could have on its decision, adds this new evidence in the corresponding node of the belief network, as illustrated in Fig. 4.29.

Moreover, the broker is aware that now his previous outlook on candidate’s prestige should not weight the same as before, as a result of the new information, so for instance he can stay neutral on prestige. This is because, as established in the causal links of the belief network, a problematic economical situation can prevent an organization from developing a reliable behavior. Less reliability, in turn, is not healthy for organizations’ prestige.

* The equivalence between an influence diagram and a decision table was performed for only one decision node. Additional work is required for more nodes.

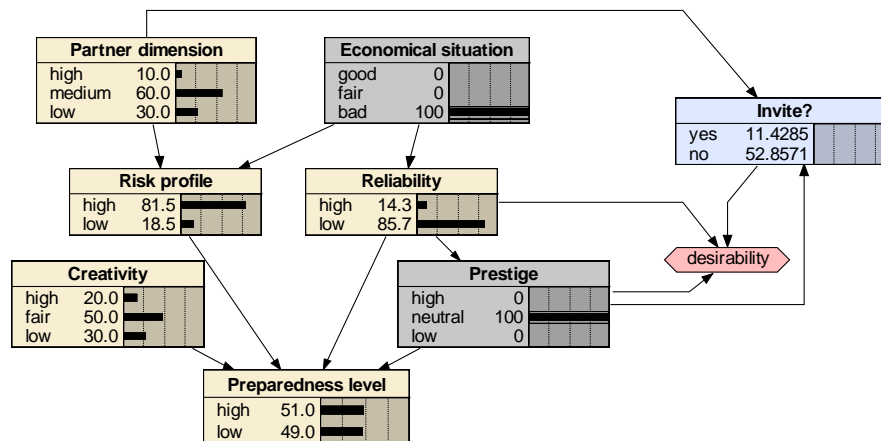


Fig. 4.29 – The decision network with additional evidences

With these new evidences, we have the expected utilities $EU(\text{'yes'}) < EU(\text{'no'})$, as shown in Fig. 4.29, stating that now the rational choice is to take this candidate out of the broker's shortlist.

4.6 Use of preparedness in a partner's suggestion mechanism

This section shows a practical utilization of both collaboration preparedness and parts of the competencies fitness assessment, in a partners' suggestion mechanism. This experiment illustrates how to integrate the readiness concept (or parts of it) into a decision tool. In concrete terms, the mechanism is used in order to select a set of candidates for a given collaboration opportunity. In order to evaluate each suggested consortium, the mechanism also integrates a simulation model and project management concepts. As inputs, the mechanism accepts the description of a collaboration opportunity, and both the traits and hard competencies of a set of members from a given VBE.

As suggested in the beginning of the chapter, the experiments are aimed to be as simple and illustrative as possible. In order not to undermine these aims, the hard versus soft aspects of competencies effects are used in another experiment. For the same reasons, willingness is also addressed in a separate experiment, being readiness addressed at the end of this chapter.

4.6.1 *The partners' suggestion model*

In order to proceed with this part of the modeling experiment, it is necessary to use the following concepts and tools:

- A rule-based knowledge base (inference with crisp data).
- A Bayesian belief network (inference with uncertain, ambiguous and incomplete information).
- Simulation techniques.
- Project management (PERT model).

The description of some of these concepts, namely knowledge bases and simulation techniques, is out of the scope of this work. The knowledge base was implemented in Prolog. For belief networks, adequate references are (Jensen, 1996) and (Norsis, 1997) this last one for the tool used in the belief network modeling.

The model for partners' suggestion mechanism of this experiment requires some definitions, which are presented below. These definitions should be taken as merely illustrative, as many details are out of the scope of this work. Some research works that handle the problematic of partners' suggestion/selection in a VBE context are (Camarinha-Matos, Silveri et al., 2005), (Camarinha-Matos and Afsarmanesh, 2006), (Demšar, Mozeti et al., 2007), (Baldo, Rabelo et al., 2008), and (Crispim and Sousa, 2007).

For the proposes of this experiment, the collaboration opportunity *CO* already appears organized as a business process plan, which is constituted by a set of activities, each one having time and precedence constraints, and requiring specific competencies for their execution.

These activities are specified in a PERT-like approach. The duration of each activity is specified by three estimate values: the most optimistic (*to*), the most likely (*tm*), and the most pessimistic (*tp*). From these values, the duration of an activity is calculated by the formula $Te = (to + 4*tm + tp) / 6$, with standard deviation $s = (tp - to)/6$, which already incorporate the underlying uncertainty for the activity durations (Martinich, 1997).

For the definitions presented below, we abstract from many details that, although important, are irrelevant for the illustrative purposes in this experiment. For instance, our definition of collaborative business process plan is rather simplistic and is better explained in (Camarinha-Matos, Silveri et al., 2005).

Definition 4.6.1 (Activity) - An activity, a component of the collaborative business process plan for the CO, is defined as a tuple $Act=(id, d, C)$ in which:

- id - is the name of the activity.
- $d=(to, tm, tp)$ - is a tuple that specifies the time duration, using a PERT modelling approach. The attributes to , tm and tp stand for the most optimistic, the most likely and the most pessimistic time duration, respectively.
- $C=\{c_1, c_2, \dots\}$ - corresponds to the set of competencies required for the satisfaction of the goals of the activity.

Definition 4.6.2 (Collaborative business process plan) - A collaborative business process plan for a given CO is defined as a project based plan composed of a set of activities and corresponding precedences. This plan is defined as a tuple $Plan=(co, A, Prec)$, in which

- co is the collaboration opportunity.
- $A=\{(act_1, d_1, C_1), (act_2, d_2, C_2), \dots\}$ - is a set of activities as specified in Definition 4.6.1.
- $Prec=\{(a_i, a_k) | a_i, a_k \in A\}$ - is the set that specifies the precedences between the activities of set A .

The following axiom is used to suggest a VO, from the available organizations in the VBE, given the behavioral profile of these organizations, their competencies and the characteristics of the collaboration opportunity.

Axiom 4.6.1 (VO suggestion) – Any VO is an acceptable suggestion for a given CO , if it satisfies the requirements C of the CO and also complies with a specified preparedness pattern pp .

$$\forall_{CO} \forall_{pp} \forall_{VO} (suggest_vo(CO, pp, VO) \leftarrow \exists_C (requirements(CO, C) \wedge satisfy(C, VO) \wedge preparedness(VO, pp)))$$

For this axiom, the predicate “requirements” obtains the set of the necessary competencies from the CO and puts them into the set C . The predicate preparedness is specified by Axiom 3.2.1 described in section 3.2.4.

4.6.2 The simulation component

The simulation component is specified using a similar axiomatic approach as just described for the partners suggestion presented above. Hence, this component is composed of a set of axioms that were also translated into Prolog. During a simulation cycle, the generated events and corresponding states are kept as facts in the knowledge base. The Axiom 4.6.2 specifies a simulation recursively in the following way:

Axiom 4.6.2 (Simulation steps) – At any simulation instant T , if there are pending events, finish the corresponding activities, start new ones and advance simulation to next time step. Otherwise, display the simulation results.

$$\forall_T (run(T) \leftarrow (has_events(T) \rightarrow finish_activities(T) \wedge start_activities(T)) \wedge run(T+1) \vee (\neg has_events(T) \rightarrow write_simulation_state(T)))$$

The simulation can be started at any initial time by invoking this axiom using the term “ $run(initial_time)$ ”, e.g., “ $run(0)$ ”.

In the simulations phase, the character profiles of the involved organizations are also important. For instance, a very reliable member (expectedly) tends to better perform its assigned activities. Consequently, activity durations are influenced according to the entities that perform them (in fact, not just activities’ durations are affected, but here we only consider the durations).

Therefore, the used simulation model computes the activities’ durations that run at each instant, using the following rule of thumb: “If the member that performs an activity has high probability of having high ‘collaboration level’, the duration Te of the assigned activity will slightly decrease, and it will increase otherwise”.

4.6.3 Implementation details

The way the partners’ suggestion mechanism works is illustrated in Fig. 4.30. The business process needed to satisfy the CO and preparedness conditions are provided as inputs. Then the partners’ suggestion functionality selects sets of candidates according to the hard competencies required in the collaboration opportunity. Using only the competencies matching for generating suggestions, this mechanism would yield a large number of solutions. But considering the preparedness concept as part of the suggestion process, the mechanism refines its suggestions to only select candidates that appear to

be more prepared to work in collaboration, according to the specified preparedness conditions. Finally, CO's business process and each VO are given to the simulation model, for performance evaluation.

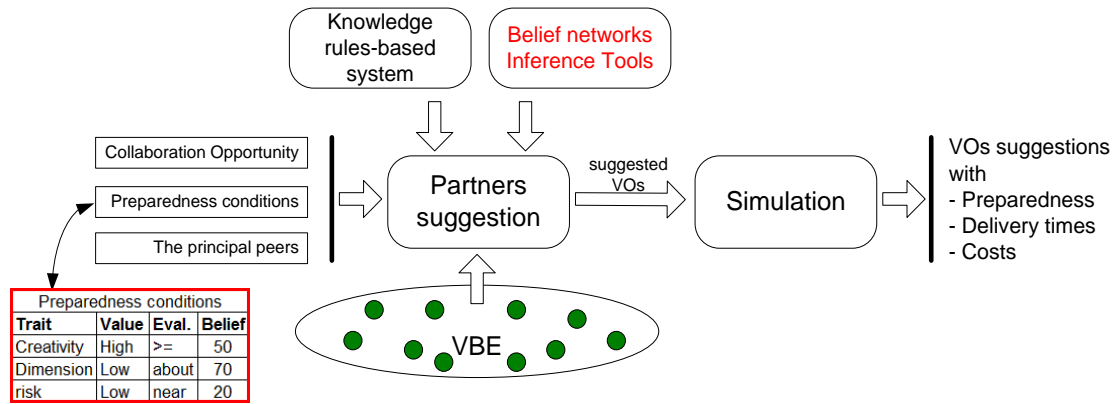


Fig. 4.30 – The partners suggestion mechanism (Rosas and Camarinha-Matos, 2008)

The corresponding axioms for the partners' suggestion mechanism, as specified in previous sections, were translated into Prolog predicates, as illustrated in Fig. 4.31.

```
suggest_vo(CO_id, P, VO):-
  co(CO_id,Act,Links), requirements(co(CO_id,Act,Links),Lcomp),
  satisfy(Lcomp,VoList, preparedness(VoList,P), VO=vo(VoList).

satisfy([],[]).
satisfy ([Comp|Tail],Orgs):-
  satisfy (Tail,Orgs2), competence(Org,Comp), append([(Org,Comp)], Orgs2,Orgs).

preparedness( VO,P):-
  forall( member( (Org,C), VO ), is_prepaired(Org, P)). } Axiom 3.2.1

is_prepaired(Org,PrepList):-
  forall( ( member((Trait,Value,Comparator,Probability), PrepList), } Axiom 3.2.2
    belief(Org,Trait,Value, Probability2)
    ), complies(Comparator,Probability2, Probability)).
```

Fig. 4.31 – Prolog predicates for the partners' suggestion axioms.

These axioms can be invoked using the query below. The shaded argument represents the preparedness conditions required for the suggested organizations. The characters and competencies of organizations, represented in Table 4.4 and below in Table 4.7, are modeled as facts in the memory of Prolog's inference engine.

```
suggest_vo(co_1, {(creativity,high,'>',60), (preparedness_level,high,'>',70)},VO).
```

4.6.4 Running an example

The profiles of the organizations in the VBE

The example presented at the beginning of this chapter is now applied here to test this mechanism. The characteristics of the organizations composing the VBE in Fig. 4.2 are presented in Table 4.7, which displays the competencies and character traits of each organization. One important aspect to emphasize here is that some traits are undetermined, which causes uncertainty, and consequently requires a more stochastic assessment.

Table 4.7 – Competencies and traits of the VBE’s members

<i>VBE_1 composition</i>							
<i>Organizations</i>	<i>Competencies</i>	<i>Organization traits</i>					
		<i>P D</i>	<i>E S</i>	<i>R P</i>	<i>R</i>	<i>C</i>	<i>P</i>
<i>o_1</i>	<i>hc1, hc2</i>	high	high	?	high	high	high
<i>o_2</i>	<i>hc4, hc6</i>	med	?	high	?	low	high
<i>o_3</i>	<i>hc2, hc5</i>	med	fair	high	low	high	high
<i>o_4</i>	<i>hc1, hc2</i>	?	high	high	low	?	?
<i>o_5</i>	<i>hc1, hc3, hc4</i>	high	bad	high	high	high	low
<i>o_6</i>	<i>hc2, hc3</i>	high	fair	high	?	?	?
...	...						

(PD: partners dimension; ES: economical situation; RP: risk profile; R: reliability; C: creativity; P: prestige).

The collaboration opportunity

Let us assume that at a given instant, a collaboration opportunity (CO) was identified, for which the corresponding business process plan is shown in the next figure. It can be assumed as being prepared in the so called “preparatory planning” of the “VO creation process” illustrated in Fig. 2.7 (in section 2.2.3).

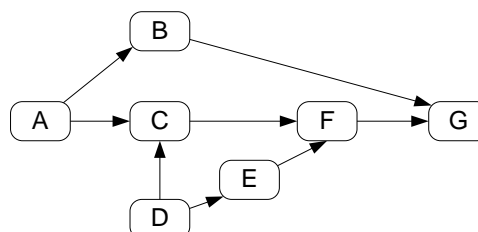


Fig. 4.32 – Business process plan for the given collaboration opportunity.

The details of this plan, as specified by Definition 4.6.1Definition 4.6.2, are shown in Table 4.8. This plan is specified in a PERT-like approach (Martinich, 1997).

Table 4.8 – Detailed plan for the given collaboration opportunity stated in terms of durations and precedences

Time and precedences for project “co_1”					
Activity	Necessary Competencies	Durations			Precedences
		Most Optimistic	Most Likely	Most Pessimistic	
A	hc3	8	16	20	-
B	hc2	10	20	30	A
C	hc1	12	18	24	A,D
D	hc2	12	16	18	
E	hc4	6	9	12	D
F	hc1	10	15	20	C, E
G	hc3	5	7	9	B, F

During the suggestions phase, the mechanism for partners’ suggestion is based on the traditional matching of competencies, as mentioned before. These suggestions are then enhanced by providing preparedness patterns to the mechanism, as the example for the presented CO illustrates.

First iteration: no specified preparedness conditions

Now using the partners’ suggestion model for the given CO, only the collaboration opportunity is provided, at the first try, without specifying any preferences for the candidate members.

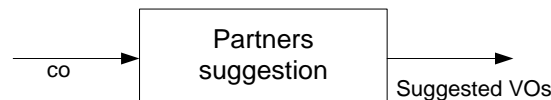


Fig. 4.33 – The Partners’ suggestion process without preparedness conditions

The initial VO suggestions, as shown in Table 4.9, are based on a simple competencies’ matching approach, according to Axiom 3.3.1. Each line in this table represents a VO suggestion. For instance, solution 1 represents a VO composed of the members in the set {o1, o2, o3, o5}. For each suggestion, the simulation module provides the duration of the simulated business process plan, helping spot the best suggestions. In order to restrict the number of provided suggestions, it is imposed that each member can be assigned to only a single competency otherwise the number of suggestions would be unnecessarily big for our illustration purposes.

In this solution, no preparedness conditions were considered. Therefore, some suggestions may in fact be composed of members with low reliability and the VO might fail in achieving its goals.

Table 4.9 – Example of VO suggestions

Solution	o1	o2	o3	o4	o5	o6	o7	Duration
1	hc1	hc4	hc2		hc3			38
2	hc1	hc4		hc2	hc3			39
3	hc1	hc4			hc3	hc2		39
4	hc2	hc4		hc1	hc3			40
5		hc4	hc2	hc1	hc3			40
6		hc4		hc1	hc3	hc2		41
7	hc1	hc4	hc2			hc3		38
8	hc1	hc4		hc2		hc3		39
9	hc1			hc2	hc4	hc3		38
10	hc1			hc2	hc4	hc3		39
11	hc2	hc4		hc1		hc3		40
12		hc4	hc2	hc1		hc3		40
13	hc2			hc1	hc4	hc3		40
14			hc2	hc1	hc4	hc3		40
15	hc2	hc4			hc1	hc3		40
16		hc4	hc2		hc1	hc3		40
17		hc4		hc2	hc1	hc3		41

Second iteration: stating preference for reliable and prestigious organizations

As shown in Fig. 4.34, if we now provide desirable preparedness conditions to the suggestion mechanism, the suggestions would be those in Table 4.10. As the preparedness conditions causes a reduced the number of suggestions (therefore, smaller tables), the imposition of one partner one competency is disabled.

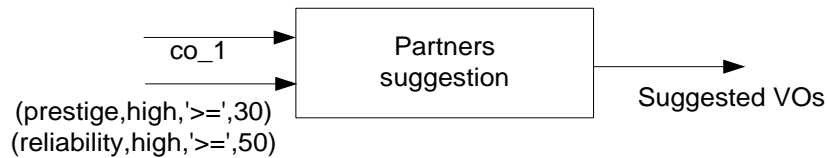


Fig. 4.34 – Applying preparedness conditions

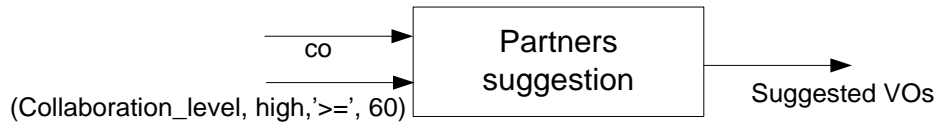
For this case, the mechanism selected only organizations with both high reliability and prestige. Organizations with these traits undefined are also selected, provided that the likelihood of having a high value is at least 30% and 50% respectively. As mentioned in a previous section, this likelihood is determined using the belief network of Fig. 4.28.

Table 4.10 – Another example of VO suggestions

Solution	o1	o2	o3	o4	o5	o6	o7	Duration
1	hc1 hc2	hc4				hc3		38
2	hc1	hc4				hc3 hc2		39

Third iteration: addressing collaboration preparedness level

Finally, if a collaboration level “high” is specified for each candidate, with a probability of at least 60%, just one suggestion shows up.



With the corresponding solution:

Table 4.11 – Another example of VO suggestions

Solution	o1	o2	o3	o4	o5	o6	o7	Duration
1	hc1	hc4	hc2		hc3			39

Simulation results

After performing the simulation for this suggestion, the Gantt diagram appears as it is shown in the next figure. This diagram illustrates how the business process plan’s activities are executed and how they were assigned to the VO members. For instance, activities ‘b’ and ‘d’ were assigned to organization ‘o_3’.

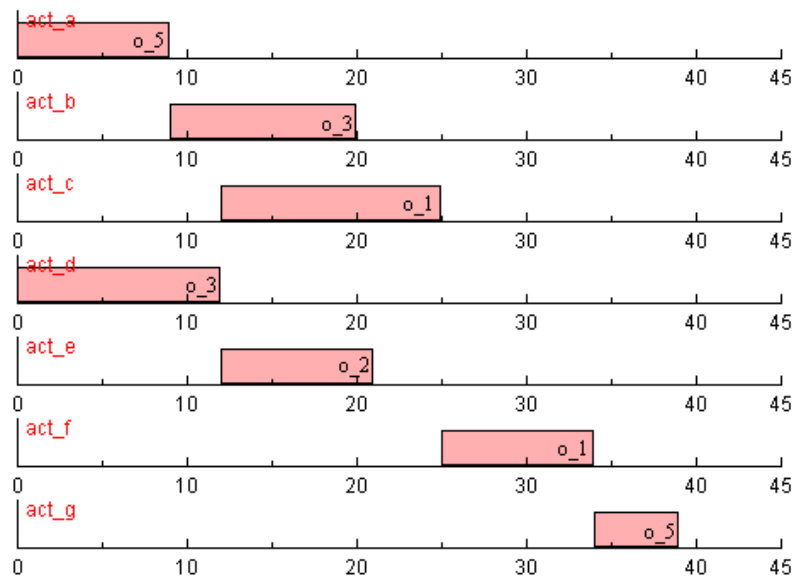


Fig. 4.35 – Gantt chart with the suggested VO (Source-code for the Gantt chart provided by Chris Beck, University of Toronto, 1995)

For the offered suggestion, the project duration is 39, which is the minimum possible duration, if considering only suggestions in which each member provides one

competency. However, durations do not make the whole story, as they could be longer and still having a good network. The point is that the suggested VO is composed of partners with higher probability of a “high” collaboration level, which accounts for a lower risk of working together.

As mentioned before, this example illustrates how to model a collaboration assessment approach and integrate it into a Decision Support System. In this case, the concept of preparedness was used to select partners for a given collaboration opportunity.

4.7 Using the competencies fitness concept

4.7.1 A Prolog-like competencies fitness assessment mechanism

The abstract model for this mechanism is represented in Fig. 4.36, showing the signature of the methods involved in competencies assessment. A signature corresponds to an abstract way of specifying the functionality of a system, without having to refer to their implementation details.

S={observed_behavior, hardCompLevel, softCompLevel, v1, v2, adjLevel}	
$\Omega \rightarrow \times = \{\text{Level}^*, \text{LingValue}^\dagger, \text{Org}, \text{SC}, \text{HC}\}$	
Observed_behavior :	Org \times SC \rightarrow Level
hardCompLevel:	ORG \times HC \rightarrow Level
softCompLevel:	ORG \times SC \rightarrow Level
adjFactor:	CO \times HC \times SC \rightarrow FLOAT
adjLevel:	CO \times Org \times HC \rightarrow Level
v1:	Level \rightarrow LingValue
v2:	LingValue \rightarrow Level

Fig. 4.36 – Signature for the competencies fitness model

The corresponding implementation is done in Prolog, through translating the model into corresponding predicates, as illustrated in Fig. 4.37.

* Level corresponds to a percentage value.

[†] LingValue={‘very low’, ‘low’, ‘average’, ‘high’, ‘very high’}. The functions v1 and v2 make the conversion between Level and LingValue.

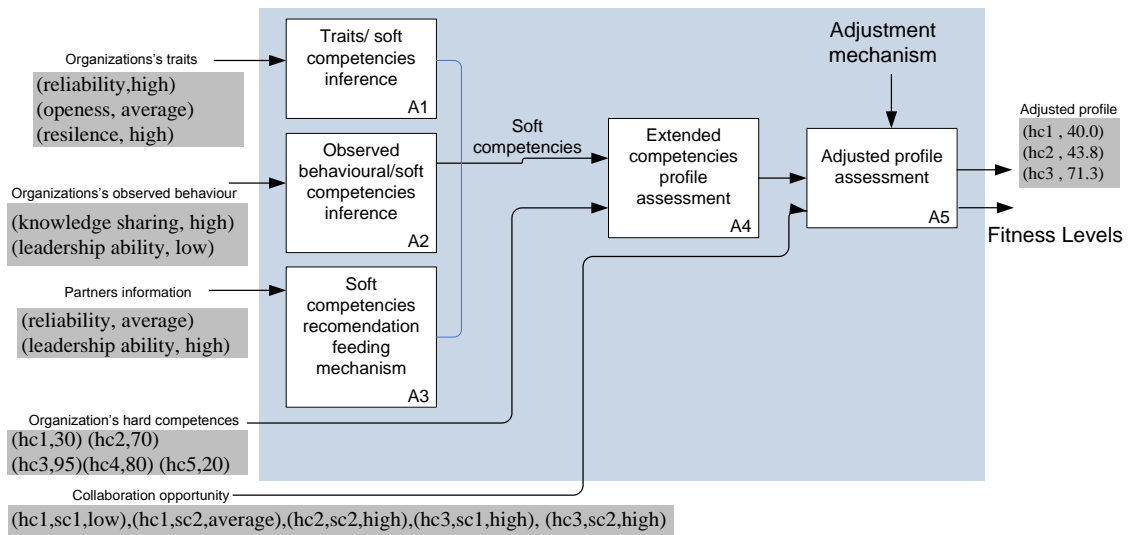


Fig. 4.37 – Diagram for the Prolog version of the competencies model

Each block in this diagram represents the assessment steps previously described. Typical inputs and outputs, instantiated from the above definitions are also illustrated. This program is used in order to obtain the inferred values of competencies fitness in the next section.

4.7.2 Performing assessment of competencies

Let us consider a situation in which there is a possibility to engage in a collaboration opportunity. For this opportunity, a set of candidates are considered for the formation of a consortium. This CO is described in terms of required soft and hard competencies, as illustrated in Table 4.12. The values in this table are assumed to be obtained from the identification and characterization of the CO and its context. By context, we mean the exogenous factors that also imply soft requirements. For instance, this table states that performing hc_1 is not very demanding on knowledge or resources sharing (sc_1 , sc_2), that hc_2 requires a partner with strong leadership quality (sc_3), and that hc_3 is a competency that requires both intensive knowledge and resources sharing.

Table 4.12 – Requirements for the context of the given collaboration opportunity (L:low, A:average, H:high)

Required hard competencies	Collaboration opportunity context		
	Associated (and required)soft competencies		
	sc_1	sc_2	sc_3
hc_1	L	A	-
hc_2	-	H	H
hc_3	H	H	-

The hard/soft competencies organization's profiles

A number of organizations have applied to participate in the given CO. Each organization is characterized by its soft and hard competencies, its traits, and its past behaviors, as illustrated in Table 4.13. In this example, it is established that when we say that a partner assumes a hard competency, it means that it assumes the responsibility to undertake the activities associated to this competency. The soft competencies considered in this example are in the set $SC=\{\text{'ability to share its resources'}, \text{'capacity to exchange knowledge'}, \text{'ability to lead a consortium'}\}$. The set considered for traits is $T=\{\text{'reliability'}, \text{'adaptability'}, \text{'resilience'}\}$. The soft competency levels are assumed to be obtained as specified in Axiom 3.3.2, more specifically from the organizations' traits and observed behavior.

The values for the hard competencies levels were obtained taking in consideration the organizations' competency statements showing the 4C information (*Definition 3.3.3* and *Definition 3.3.4*), in relation to the critical competencies and resources that are necessary in the collaboration opportunity. The candidates provide that information when they apply for the collaboration opportunity, both to convince that they are qualified, and to be subsequently used in the process planning. The VO planner digests this information and translates it to the aggregated competency levels, illustrated in Table 4.13, allowing a straightforward comparison between the candidates.

Table 4.13 – Extended Competency Profile for a set of organizations (*Definition 3.3.4*)

Org.	Observed Behavior	Org. traits			Soft competencies levels			Hard competencies levels				
		t_1	t_2	t_3	sc_1	sc_2	sc_3	hc_1	hc_2	hc_3	hc_4	hc_5
O1	(sc_1, out)	H	A	L	H	L	A	30	70	95	80	20
O2	(sc_2, H)	H	-	A	H	-	L	70	80	50	50	90
O3	(sc_1, H), (sc_2, L)	L	A	H	L	L	A	100	50	30	70	70
O4	(sc_2, H), (sc_3, L)	H	-	H	-	-	H	80	70	60	30	40
O5	(sc_3, H)	H	L	L	H	L	-	50	80	30	70	50

(H: high, A:average, L:low)

The adjusted competencies profiles

Given the inputs provided in Table 4.12 and Table 4.13, let us apply the equation specified in *Definition 3.3.7*, in order to determine the adjusted profile of candidate o_1 . Using the referred inputs, the corresponding adjusted levels are:

$$adjLevel(o_1, hc_1) = 30\% \times 1/2 \times (80/40 + 40/60) = 40\%$$

$$adjLevel(o_1, hc_2) = 70\% \times 1/2 \times (40/80 + 60/80) = 44\%$$

$$adjLevel(o_1, hc_3) = 95\% \times 1/2 \times (80/80 + 40/80) = 71\%$$

Performing similarly for the remaining partners, we get the adjusted competency profiles illustrated in Fig. 4.38, which are next to the initial profiles taken from Table 4.13. In order to evaluate partners, it is better to present this information as profile charts, as shown for partner o_1 in the mentioned figure.

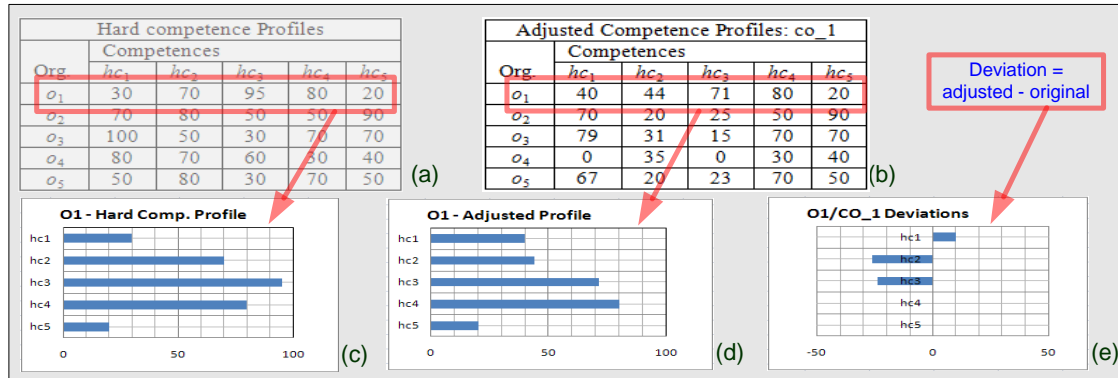


Fig. 4.38 – (a) Original competency levels, and (b) the adjusted values c) o_1 's initial profile, (d) the adjusted profile, and (e) the deviations

The initial hard competencies profile shows that partner o_1 would be very competent at performing hc_3 . However, the information in Table 4.13 states that this partner is low scored at sharing knowledge. But the CO establishes that hc_3 requires intensive knowledge sharing (Table 4.12). This means that, although being initially considered highly qualified in hc_3 , this partner might in fact display poorer performance in the actual CO, due to its knowledge protection concerns. This fact is illustrated in Fig. 4.38d, which shows its adjusted profile stating a lower adjusted level for hc_3 , incorporating the knowledge sharing concern. The values that are shown in Fig. 4.38e correspond to the difference between the adjusted and the original competency levels. Taking into consideration these deviations, this chart shows precisely that there is an inadequate (or negative) adjustment of this partner to the actual CO in terms of hc_3 , caused by its concern to protect its knowledge. It also suggests that this partner should instead assume the competency hc_1 , which might contradict the initial assumption that this partner was very good on hc_3 , probably the very reason it was initially considered for the consortium. If nevertheless it is decided that partner o_1 will assume this competency, the remaining partners involved in the consortium should expect problematic interactions with this partner.

4.8 Assessment of the willingness to collaborate

This section describes a modeling experiment to illustrate the application of the willingness to collaborate assessment. As mentioned before, this model is based on TPB and extended with a component named Intentions Query Mechanism (IQM) as a way to systematize the assessment process.

4.8.1 The intentions query mechanism specification

In order to provide a systematic way of assessing willingness to collaborate, a tool named Intentions Query Mechanism (*IQM*) was developed. From the description of a collaboration opportunity, this tool selects a set of possible questions to be asked, in order to assess willingness to collaborate. The approach used to develop the *IQM* is based on a Prolog knowledge-base, which manages an experts' repository of questions. These questions are used to enquire partners' attitudes towards collaboration-related behaviors and expected outcomes. From the text description of a given collaboration opportunity, the tool detects the semantic relationships between the terms used in the CO description and the questions stored in the repository.

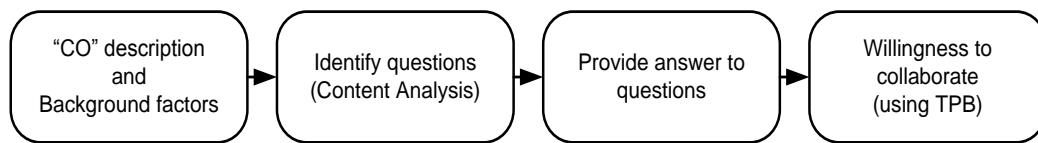


Fig. 4.39 – Extension of TPB with an intentions query mechanism

The way this mechanism works is the following: a text description of a collaboration opportunity and its more important aspects is provided. Then, a text data mining process tries to identify from that description, which concepts, terms, or keywords are being focused. This identification is made from a previously established set of keywords (Definition 4.8.1 below), which are stored in the knowledge-base.

Definition 4.8.1 (Intention's keyword set) – It corresponds to a set of keywords, which are semantically related to willingness to collaborate. It basically corresponds to a set $Keywords = \{k_1, k_2, \dots, k_n\}$.

Examples of keywords can be $Keywords = \{\text{risk, profit, control, knowledge, benefits, law, reputation, incentive,}\}$. The next step corresponds to the identification of

semantic relationships between these keywords, and the questions in the knowledge-base. These questions are modeled using *Definition 4.8.2*.

Definition 4.8.2 (Intention's question) – Is a question that must be answered in order to perceive a partner's belief about the likelihood of an outcome, and its importance, in relation to a collaboration opportunity. It can be specified as a tuple $Q=(id, type, question, outcome, MinLabel, MaxLabel)$, in which

- *id* – is a query identifier, usually a natural number.
- $Type \in \{bb, oa, mc, cb, \dots\}$ – is a label which specifies whether the question represents an attitude, a social influence, or a control belief, according to the definitions established in section 3.4.3.
- *question* – is literally a sentence addressing some aspect of the collaboration opportunity.
- *outcome* – is a value, such that $outcome \in \{\text{negative}, \text{positive}\}$, informing whether the query's answer contributes positive, or negatively, to the intention to perform the behavior in question.
- *MinLabel* – corresponds to the minimum value label of the scale used to answer the question.
- *MaxLabel* – corresponds to the maximum value label of the scale used to answer the question.

Examples of questions for this definition are illustrated in *section 3.4.3*. The axioms below are used to find the adequate questions from the repository of the Intentions Query Mechanism. The following axioms are used to select an appropriate number of questions from the knowledge-base, taking into consideration the keywords found in the text description of the *CO*.

Axiom 4.8.1 (Highlighted words) – It corresponds to the words w_1, w_2, \dots in the text description of the collaboration opportunity, which are semantically related to the keyword set defined in Definition 4.8.1. These words are obtained using the following sentence:

$$\forall_{co} \forall_w \exists_k (highlighted(co, w) \leftarrow description(co, w) \wedge keyword(k) \wedge is_related(w, k))$$

Axiom 4.8.2 (**Suggested question**) – It corresponds to a question q , which is identified as relevant for a given collaboration opportunity description, for which an answer must be provided in order to assess willingness to collaborate. It can be stated by the sentence:

$$\forall_{co} \forall_q \forall_w (suggested_question(co, q) \leftarrow highlighted(co, w) \wedge is_related(w, q))$$

In the above axioms, the predicate $description(co, w)$ provides a word from the text description characterizing the collaboration opportunity. The predicate $is_related(w_1, w_2)$ or $is_related(w, sentence)$ checks whether two terms are semantically related. The discovery of the semantic relationships is performed with using WordNet, a large network of semantic relations between English words (George, 1995).

These questions appear afterwards in a questionnaire that is generated by the intentions query mechanism. The corresponding answers to the questionnaire can be asked to the partner being assessed. They can also be provided by a third entity, which is aware of the partner's attitudes. Finally, the answers provided by the assessor are evaluated using the TPB model. The assessment corresponds to an aggregated value that represents an organization's intentions to collaborate, which according to TPB, corresponds to a direct measure of willingness to collaborate.

4.8.2 Testing with an example

Describing the collaboration opportunity

The description of the collaboration opportunity is made through a text description, made using a text editor as illustrated in Fig. 4.40. During this description, the edited text is continuously scanned by a content analysis module of the IQM, search for important aspects related to the collaboration opportunity. Every time, an important factor is discovered, using Axiom 4.8.1, the corresponding word in the text is highlighted, as illustrated in Fig. 4.40.

The highlighted terms are subsequently used to discover the specific questions from the knowledge-base.

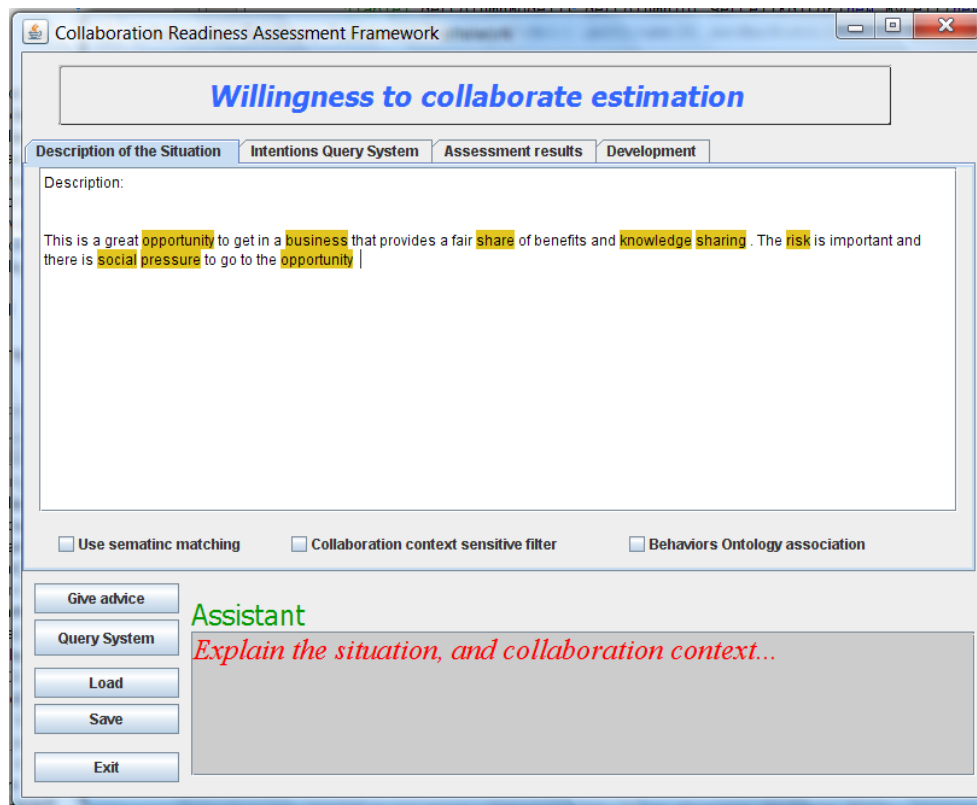


Fig. 4.40 – Describing the collaboration opportunity

The selected questions

From the highlighted terms, a search in the repository of the knowledge-base is performed, using the Axiom 4.8.2. If no description is made, this interface shows no questions, and if some of the questions are not considered relevant, they can be unchecked (Fig. 4.41). The answers should ideally be provided by the organization being assessed, because the aim is to assess its willingness to collaborate and, in this aspect, that organization is the agent more concerned with the aspects addressed in these questions. Nevertheless, a VO broker can also provide such answers, from its perception about the organization being assessed. As the aim of these questions is to obtain subjective behavioral beliefs, the corresponding answers do not require strict crisp values, as suggested by the position of the graphic cursors in Fig. 4.41.

En	Query	Min	Value	Max
<input checked="" type="checkbox"/>	you expect to give and receive knowledge	not likely		quite likely
<input checked="" type="checkbox"/>	importance of knowledge sharing	not important		very important
<input checked="" type="checkbox"/>	commit ows and use others resources	not likely		quite likely
<input checked="" type="checkbox"/>	importance of resources sharing	not important		very important
<input checked="" type="checkbox"/>	fair share the benefits	not likely		quite likely
<input checked="" type="checkbox"/>	profit is the most aspect in this situation	totally disagree		totally agree
<input checked="" type="checkbox"/>	situation is in accordance with regulation laws	totally disagree		totally agree
<input checked="" type="checkbox"/>	concerns due to regulation	not important		very important
<input checked="" type="checkbox"/>	there is social incentive to collaborate	totally disagree		totally agree
<input checked="" type="checkbox"/>	sensitive to social pressure	not important		very important
<input type="checkbox"/>	perceived risk is acceptable	not likely		quite likely
<input type="checkbox"/>	importance of the risk	not important		very important
<input checked="" type="checkbox"/>	partners are of good reputation	not likely		quite likely
<input checked="" type="checkbox"/>	trust is a very sensitive aspect	not much		very much

Assistant
*Evaluate the above queries...
and then go to the assessment TAB.*

Buttons: Give advice, Query System, Load, Save, Exit

Fig. 4.41 – Selected questions for the willingness assessment

Computing intentions to collaborate

Finally, these values are provided as input to the TPB part and the result is a number, which represents the organization's willingness level to collaborate. For the organization in the example this level is 50.96%, as shown in Fig. 4.42, or in a more qualitative way, is at an average level, or not very exciting. If the assessor wanted a partner who expressed a firm commitment, this value would not be enough for an invitation to a partnership, due to the people's preference for one hundred percent committed partners.

In the next chapter, the IQM is used again to perform the assessment of willingness to collaborate in a real situation.

Fig. 4.42 – Estimation of willingness to collaborate.

4.9 Reflections about the experiments

4.9.1 The work done

During this chapter, the descriptions of the modeling experiments were made. A complete application of the readiness concept was not performed. But as mentioned in the beginning of the chapter, the utilization, alone or together, of either collaboration preparedness, competencies fitness, and willingness to collaborate means that readiness is implicitly being also used. The readiness's components modeled and tried during this chapter are contained in Table 4.14, which as illustrated were more focused in the third and fourth level of the readiness concept.

For the reasons explained later, the assessment based on the first and second levels is made in chapter 5, which is devoted to the validation of the collaboration readiness model.

Table 4.14 – Components from the readiness concept addressed during the experiments

L1 (composite level)	L2 (aggregated)	L3 dimensions level	L4 Traits, competencies, behavioral beliefs level
Readiness	Preparedness	character	✓
	Competencies fitness	Hard competencies: ✓	✓
		Soft competencies: ✓	✓
	Willingness	Attitudes: ✓	✓
		Social influences: ✓	✓
		Behavioral control ✓	✓

4.9.2 A collaboration readiness filter

As mentioned before, the utilization of the readiness concept could not be directly applied during the experiments, for the reason that it is a composite indicator, unless it is only used to provide a collaboration readiness classification, as illustrated at the end of the third chapter. By stating it is a composite indicator means that collaboration readiness is based on the other three concepts which were tried during the experiments.

In order to perceive how readiness is affected from this issue is well illustrated if it is projected in the three-dimension Euclidian space. For such, let's temporarily suppose that collaboration preparedness (P), competencies fitness (C) and willingness to collaborate (W) of the readiness concept are orthogonal dimensions, as illustrated in Fig. 4.43.

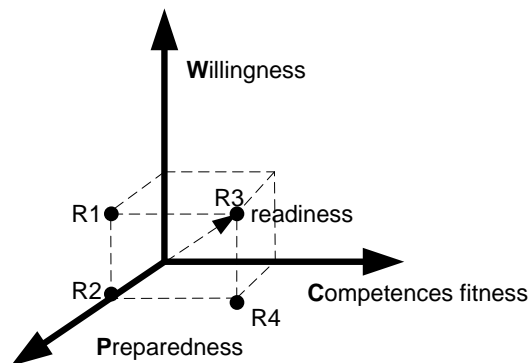


Fig. 4.43 – Projecting readiness in a Euclidian-space

In such case, the readiness value can be obtained by the distance concept to the origin, usually as follows:

$$R = \sqrt{P^2 + C^2 + W^2}$$

Let's consider that a given organization o1 has a readiness value of R1 in a given situation, and that o2, o3... also have readiness values of R2, R3... Therefore the collaboration readiness of each organization can be represented by a point in the mentioned space. Each of these point states a certain degree of C, P, and W for each organization. However, it is easy to perceive that if R1, R2, ... have the same value in Fig. 4.43, they however represent very different situations in terms of collaboration readiness. For instance, although R2 and R3 are equal, the fact is that o2 has got a zero level in terms of C and W. As just R alone cannot depict these facts, it follows that readiness cannot be used alone, or without considering its components.

In order to avoid ambiguous situations, the approach for using readiness is to state it as a filter both in its absolute value and in its components. It can be done, by stating required values of readiness, but also for its components, as illustrated in Fig. 4.44. The role of the readiness filter is therefore to select the points in the readiness space of Fig. 4.43, or in other words the corresponding organizations, which meet the conditions specified in the filter. Using this approach, a broker of a VBE can select organizations for a given collaboration opportunity, by establishing a filter which selects organizations from a certain region of the collaboration readiness space.

Component	Comparator	Threshold
R	">="	70%
P	"above"	50%
C	"<="	80%
W	"below"	75%

Fig. 4.44 – The readiness filter

A manager of a VBE can use this filter in order to seek the organizations which meet the criteria specified in the filter. The comparators can be of any type, including the "<=", in order to allow the manager to filter out the organizations of low score in P,C, and W.

This idea using a Euclidian-space helps understanding the issue behind the readiness concept, but it may not be quite accurate. As stated in chapter 3, in the section of competencies fitness, it was shown that the so called collaboration-related soft

competencies assume an increased importance whether the situation involves a single enterprise, a *VE/VO* or a *VBE* (Fig. 3.19). Similarly to competencies fitness, this also happens to collaboration preparedness and willingness. Another aspect that should also be considered is that preparedness, competencies fitness and willingness are not completely orthogonal. For instance, competencies fitness is partially based on the traits used in collaboration preparedness.

These aspects imply that different versions of the readiness filter can be modeled according the type of situations they are applied. Each version of the filter would establish the strength of each readiness's component as illustrated in Fig. 4.45, by adequately establishing a value for the regression factors w_1 , w_2 and w_3 . That is why in the filter above, readiness can also be conditioned in the filter, as its value cannot be computed by the typical “distance” equation.

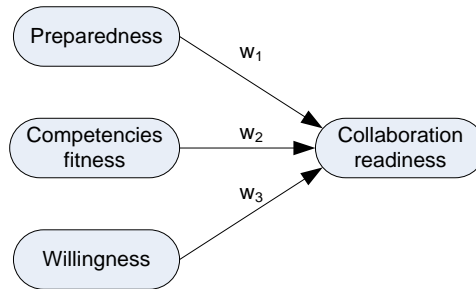


Fig. 4.45 – Assigning correlation weights to the readiness concept

Therefore, the adequate way to compute readiness values can be using an expression similar to the following equation:

$$R = f(P, C, W) = w_1 \times P + w_2 \times C + w_3 \times W$$

As mentioned in chapter 3, the determination of the weights in the above equation can be obtained by statistical methods applied in the collaborations history of a *VBE* or from the opinions provided by experts. This is an aspect, which is postponed for future work.

5 Model validation

“The quest for absolute knowledge is replaced by a conception of defensible knowledge claims”
(Steinar Kvale, 1996)

Here is a part of the research, namely validation, which constitutes one of the most important phases of modeling collaboration readiness. This part is twofold, as it comprises both the validation of the work performed during this research, and the validation of the readiness model. This process starts by addressing some aspects of validation. On one hand, addressing these aspects helps perceive what basically a validation is, as well as its typical phases. On the other hand, it helps decide which way to go in terms of collaboration readiness model validation. The work starts by discussing and validating the research findings. Afterwards, the validation of the readiness model is performed, followed by some reflections about the achieved results. The structure of this chapter is presented Fig. 5.1.

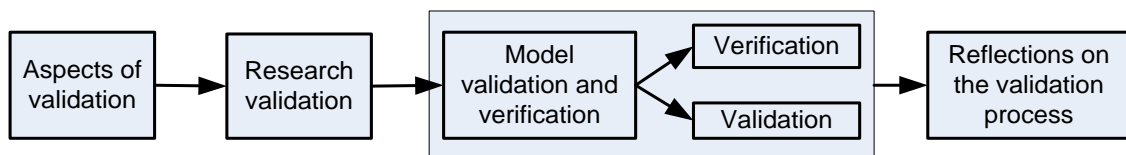


Fig. 5.1 – Structure of this chapter

5.1 Aspects of validation

The validation process of a research work is an aspect that deserves a great deal of attention and constitutes a key step in the scientific method. In fact, model validation and verification must be essential parts of a modeling development process, if models are to be accepted and used to support decision making. One of the very first questions that a person who is promoting a model is likely to encounter is “has the model been validated?” Experience has shown that the model is unlikely to be adopted, or even tried out in a real world-setting, if the answer to this critical question is “no”. Quite often the

model is sent back to the drawing board. Therefore, the challenge becomes one of being able to say “yes” to that very important question (Macal, 2005).

As illustrated by the 3rd block shown in Fig. 5.1 a model assessment process involves assessing the validity of a model and the verification of any of its implementations. Model validation allows to ensure that a conceptual model represents truthfully the real world problem. Model verification allows to ensure that the transformation of the model into a product or service is done correctly (Thacker, Doebling et al., 2004).

Beyond this utilitarian perspective, validation is also important for accepting the results of the research as a valid scientific effort. This is even more important if we are more constrained to perform a validation for the future, i.e., applying the model in real situations and observing the results thereafter. A validation for the future, however, may take years.

Verification

Modeling verification is performed to ensure that an implementation, namely a product or service, accurately represents an underlying conceptual model. Performing verification helps to ensure that the model is implemented correctly, methods or algorithms are properly implemented, and that the model does not contain errors, oversights or bugs. Verification ensures that the specification is complete and that mistakes have not been made during the implementation of the model. This process, however, does not ensure that the model solves an important problem, meets a specified set of model requirements, or correctly reflects the working of a real world process (Thacker, Doebling et al., 2004).

Validation

A model validation is conducted to insure that the creation of a conceptual model has captured all of the important aspects of a real problem. Among the several approaches to performing validation (Fig. 5.2), one can rely on the exploration of critical cases, on one hand, and on the other hand, an exhaustive exploration of cases. We can also rely on experts to perform evaluation, role playing and participatory simulation. Lastly, computational simulations can also be performed (Sargent, 2005).

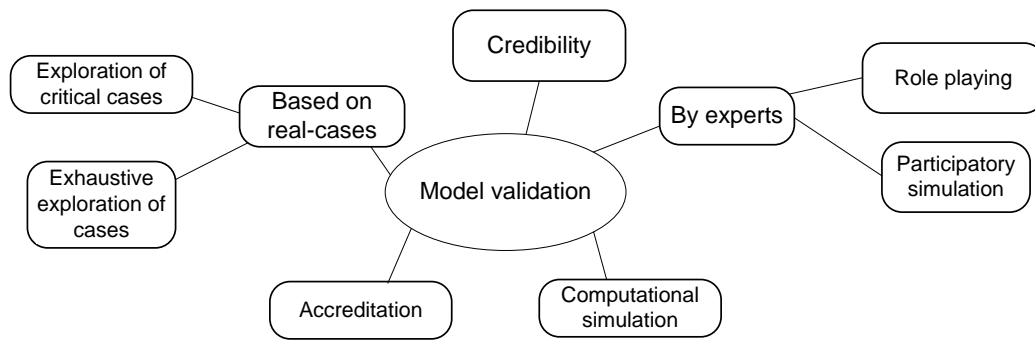


Fig. 5.2 – Approaches for model validation

A related concept of validation is accreditation, which corresponds to the process of determining whether a model is useful for a particular purpose and is applicable in answering a specific set of questions (Sargent, 2005). Another concept, certification, corresponds to the process of ensuring that a model meets some specified standard(s) (Balci, 2003).

Considering human and social aspects

During validation, it may also be necessary to consider additional issues for problems involving human or social aspects. Unlike a physical system, for which there are well established procedures for model validation, no guidelines exist for models containing elements of human decision making. In these cases, validation becomes a matter of establishing credibility in the model. The task is to establish an argument that the model produces sound insights into the wide range of criteria that “stand in” for comparing model results to data from the real system. The process is similar to developing a legal case in which a preponderance of evidence is compiled about why the model is a valid one for its purported use (Macal, 2005). These issues are relevant in the readiness model, as observed below.

It is also worth to mention that the end result of validation does not technically correspond to a validated model, but rather a model that has passed all the envisaged validation tests. Validation also helps obtaining a better understanding of a model’s capabilities, limitations, and the eventual appropriateness for addressing a range of important questions (Macal, 2005).

5.2 Issues on validating the collaboration readiness model

For the adoption of an adequate approach to validate the collaboration readiness model, it is important to consider a number of concrete issues which are addressed below.

5.2.1 Experimentation is not possible

Concerning the validation of the readiness model, there are specific issues, which strongly influence how the corresponding validation can be performed. The first issue is related to the organizations themselves, which are considered social entities. In general, any social system is intrinsically unpredictable, making it very difficult to repeat, or even perform, experiments aimed at validating a model. For instance, no organizations would allow to be turned into a less collaboration readiness state, which for the sake of a model validation would allow obtaining causal assumptions between collaboration readiness and partnerships success. This impossibility lies in the fact that manipulating an organization's structure to a less competitive state would contradict its quest for obtaining profit or other goals.

5.2.2 Considering past partnerships

Another way to validate the readiness model consists of making assessment on past collaboration cases. The difficulty here lies in the fact that it is very difficult to obtain information characterizing cases of past partnerships. For instance, the real cases usually found in media and Internet corresponds to advertisement or information aimed at cheering shareholders, but little information concerning the real concerns of a partnership are provided.

Another aspect, which should be taken into consideration, is that for emergent areas of knowledge, the information must be inherently scarce. If that was not the case, then it would mean that the research topic was already taken many times, and that results would be already there. Therefore, in a case of collaboration readiness model following a behavioral perspective, this lack of information is natural. This also raises the necessity to think of more creative ways to seek and obtain information to feed validation.

5.2.3 Where are partnerships which failed?

In a model validation, more important than testing any partnership examples, is to consider negative ones, or in this case the partnerships which failed. However, the odds to find such cases, compared to positive ones, are even worse. Similarly to what happens in failed research projects, which typically do not publicize the results of experiments, concrete cases of failed partnerships leave practically no traces, nor any information that could be worth to use.

Even considering that information of negative cases indeed exists, the involved organizations are not very keen to give it away, fearing it might provide insights of their strategic thinking to competition.

5.2.4 The “halo effect”

Finally, another aspect concerning validation is that when assessing events from the past, people tend to perform biased assessments, which are known as “halo effects”, which are related to the people’s tendency to evaluate two facts as they were correlated, when in fact they are not (Menzies, 1998). An example of this effect is assuming that a well organized firm is also a reliable one, which might not. As a consequence, these effects may degrade the quality of the validation process.

5.2.5 Using simulation

Another way to perform model validation could be based on simulation. Simulation is useful, but it only allows testing what is already known about the problem in consideration. Beyond its utility to fine-tune a model, or see whether it fits in a concrete situation, it does not actually provide insights whether the model is valid or not. Taking the analogy for the readiness model, simulations would be based on the premises that are known about collaboration and partnership success, but may not be sure whether these premises are true.

A way to overcome this issue consists of comparing simulated cases with real ones. If the behavior and effects in simulated cases resembles the real ones, then odds increase that the model is valid. The difficulty here lies back to the issue mentioned above, which is related to the availability of information of real partnerships to compare with. Furthermore, the time required to apply the model and wait for the results to compare with the simulations would go far beyond the time for this research.

5.2.6 Which way to go?

Considering these issues, and as mentioned before, it is important to envisage a creative approach for model validation. An envisaged solution, which to some extent was found to be fairly adequate is to rely on existing cases of partnerships involving large companies. There is a difference from these cases and the difficulty to access past partnerships' information mentioned before. Such cases involving big companies usually attract the attention of media and are therefore easier to find. Another aspect of this approach is that having the possibility to test the collaboration readiness model with such "hot" cases of the moment, which were not seen, nor even considered during the model development phases, may reinforce the validity of the collaboration readiness model.

5.3 Validation of the research work

The issues mentioned in the previous section, have also some effects in the way the research work can be validated. The fact is that this work was not done without taking some risks, being one of such, the risk of failing the research (Camarinha-Matos, Afsarmanesh et al., 2009). However, being risk-adverse when the aim is to explore creative ideas and obtain innovative results is considered unwise (Denker, 2003). As mentioned before, when a research work deals with many aspects of social nature, it is not possible to perform research validation like in engineering areas. This is also a consequence of trying to be innovative in the way collaboration readiness was addressed, namely the adoption of a behavioral perspective. This of course leads to a research validation which is inherently argumentative.

As a consequence, this section starts by providing an argumentative discussion of the established hypothesis, followed approaches, findings and results obtained during this research work. This is followed by the validation offered by the peers, which was essentially performed in the context of the ECOLEAD project. The reviews obtained from the published papers were also considered.

5.3.1 Findings on the research question and hypothesis

In order to start the discussion of the findings, it is worth to recall the research question pursued during this research work. The question initially formulated was: “How to effectively model collaboration readiness assessment?”. For pursuing this question, it was necessary to observe an organization from an adequate perspective. As discussed in chapter two, the best way to look at an organization is to look at it as if it was a living entity, in which an organization shares many characteristics of the human beings, specially the behavioral ones.

After establishing that collaboration readiness is a behavioral concept based on three other basic aspects, namely collaboration preparedness, competencies fitness, and collaboration willingness, a number of research hypothesis were formulated. The study of these hypothesis conducted do the findings discussed below.

Discussion of the collaboration preparedness hypothesis

The collaboration preparedness hypothesis followed in this work was stated as:

h1: The behavior of an organization can be predicted to some extent, given the knowledge of some of its character traits. If collaboration preparedness is related to de manifestation of adequate collaboration-related behavioral patterns, then an organization’s preparedness to collaborate can be accessed from its character traits.

In order to verify this hypothesis, the following concepts were considered: organizations’ behavior, behavior patterns, traits, character model, and the concept of collaboration preparedness pattern.

The possibility that organizations’ behavior, in a collaboration context, can be modeled and characterized using the concept of character was tested through the consideration of concrete organizations’ character models. These models were the Organization Character Index (OCI), used in chapter 2, and the Chun’s ethical character scale, used during chapter 3 and 4. These models prove that the character concept can be used to characterize the organizations’ behavior in a general context. There is no obvious argumentation against using a character model, in a strict collaboration context, to model collaboration preparedness.

The intimate relationship between behavioral patterns and traits is an aspect intensively debated and researched in social and psychology-related areas. The very notion of behavioral pattern implies implicitly its occurrence in the future (although the

exact moment is uncertain), or otherwise it cannot be considered a behavioral pattern. Using these ideas, it was shown that conceiving the idea of required collaboration preparedness pattern allows establishing which traits, or in other words which behavioral patterns, are desirable in a collaboration context. As a result, the organizations character model, as an composition of traits, can be used to assess collaboration preparedness.

A text mining process allowed finding out which traits should be observed in order to assess collaboration preparedness. These traits are reliability and trustworthiness. A partners' suggestion mechanism allowed evaluating the collaboration preparedness concept in the selection of partners for a collaboration opportunity.

Discussion of the competencies fitness hypothesis

The competencies fitness hypothesis followed in this work was stated as:

h2: In a collaboration context, the use of hard competencies is affected by a partner's ability to perform soft competencies. If we consider the effects of the soft competencies over the hard ones, then it is possible to perceive how well a partner uses its hard competencies in partnerships.

This hypothesis considers the possibility that the use of the partners' hard competencies in a collaboration context is affected by the partner's ability to perform specific soft competencies. Therefore, rather than strictly assessing which competencies and corresponding levels a partner has got, the effort was concentrated on evaluating these effects. Therefore, in order to model the mentioned effects, a hard versus soft competencies dichotomy was considered. Proving that these effects are relevant can be made by following a "Reductio ad absurdum" approach. This approach is based on the formulation of arguments aimed at refuting a (set of) proposition, by showing that it leads to logically absurd consequences. This process consists usually of a logical rebuttal that takes a proposition to its logical extremes and examines the veracity of the conclusions the proposition implies in those extremes (Rescher, 2005). For instance let us consider the soft competencies requirements in a given situation as illustrated in Table 5.1.

In front of these requirements, let us suppose that a VBE a broker does exactly the opposite, giving way to the following contradictions:

- Assigning activities which require intensive knowledge sharing (r1) to a partner o1 who is definitely known not to share anything (sc1), and expecting a high outcome, which is a contradiction.
- Put an organization lead a research project (r2), but that organization's capability for leadership is weak (sc2).

Put a partner in an activity which requires strong networking activity (r3), when its ability to interact with peers is low (sc3).

Table 5.1 – Soft competencies requirements

Requirements of the situation	Soft competency
R1- required intensive knowledge sharing	sc1- ability to share knowledge
R2- required good leadership capabilities	sc2- ability to lead a consortium
R3- required good networking relationships	sc3 -ability to explore network connections

Given the absurdity of these contradictions, the reverse of the hard versus soft competency dichotomy does not provide valid statements. Therefore, in the light of the "reductio ad absurdum", this dichotomy must be accepted.

Discussion of the willingness to collaborate hypothesis

The hypothesis that was established for willingness to collaborate is the following:

h3: Willingness to collaborate expresses to which extent an organization is interested in a given collaboration opportunity. According to existing theories, the best predictors of a behavior are the attitudes and intentions towards performing it. Therefore, if we assess an organization's intentions towards a partnership, then it is possible to determine its willingness to collaborate (or engage) in that partnership.

This hypothesis was used to test the degree to which the attitudes and intentions towards a collaboration opportunity are a determining factor for predicting willingness to collaborate. As discovered in previous chapters a partner's low willingness to join or remain in a partnership produces negative effects in its performance as a partner.

The theory of the planned behavior (TPB) was used to test this hypothesis. This theory was proved as considerably reliable in predicting behaviors in other human domains. In order to assert the relevancy and validity of the use of this theory to predict organizations' willingness to collaborate, two assumptions were considered. The first one was to address the very nature of an organization, considering that it displays a behavior that is classified as rational. The second assumption was to admit that the very

characteristics of the ‘collaboration act’ correspond to ones of the typical behaviors that are usually predicted using the theory of the planned behavior.

The first assumption is true due to the fact that an organization’s behaviors are generally rational. An organization makes a systematic and rational use of the available information, in order to decide which goals to pursue, which are usually established at a strategic level and achieved by adequate business processes. These goals can be seen as organization’s intentions, or in other words, to the organization’s planned behavior. Therefore, these arguments justify the usefulness of TPB to predict willingness to collaborate.

The second assumption used to justify TPB as a valid approach was by addressing the meaning of collaboration. In this sense, collaboration was seen as being fundamentally planned and intentional, which correspond to the exact characteristics that turn collaboration, as a behavior, predictable using the TPB.

5.3.2 Validation of the research by the peers

The validation of the readiness model requires that the steps followed in its development were good ones. In order to do so, the approach was to rely on peer feedback.

This research received significant inspiration from the findings of the ECOLEAD project, in which it was possible to interact with many researchers concerned with collaborative networks. These interactions took the form of international workshops, to where special invitations were made to researchers in areas of interest to collaborative networks. The interactions took place in the form of brainstorming and roadmaps. These workshops were:

- WP5 meeting in Aveiro/Portugal on 15-16 November 06
 - “Soft-modeling experiments”
- WP5 meeting in Valencia/Spain on 14-15 March 07
 - “Workshop on Reference Models for Collaborative Networked Organizations”
- ECOLEAD general meeting in Brussels/Belgium 09-1 May 07
 - “Workshop on Soft-computing approaches in decision making for future CNOs”

During these workshops, it was possible to interact with experts in collaborative networks, in related areas contributing for CNs theoretical foundation, and in members of existing collaborative networks. For instance, the workshop in Aveiro, Portugal, allowed the presentation and discussing, in front of a panel of experts, of some approaches for modeling collaboration preparedness in scenarios of imprecise or incomplete information. The workshop in Brussels allowed interacting with experts of Soft Computing areas. This helped perceive which modeling approaches would be adequate for use in collaboration readiness.

Being a researcher in the ECOLEAD project, it was possible to contribute to the writing of the following ECOLEAD deliverables:

- D51.1 - Main modeling needs and approaches in CNOs
- D51.2 - Selected modeling and awareness raising cases
- D53.1 - Motivation and approach for soft modeling in CNO
- D53.2 - Experiments on Soft Modeling for CNO
- D54.1 - Basis for interoperability among models
- D54.2 - Experiments on interoperability among models.

The researcher of this work also participated, both as a chapter-contributor and as a referee, in the writing of the following books:

- “Methods and Tools for Collaborative Networked Organizations” (Camarinha-Matos, Afsarmanesh et al., 2008)
- “Collaborative Networks: Reference Modeling” (Camarinha-Matos and Afsarmanesh, 2008).

A number of publications were also made, aiming at disseminating the work and receiving inputs and constructive feedback from the reviewers. As illustrated in Fig. 5.3, all parts of the readiness model deserved corresponding publications, disseminated in varied channels, such as a Journal, conferences, and a book chapter.

It is worth to mention some comments from a referee of the paper submitted to Basys’ 08. According to the referee:

“This is a VERY ambitious agenda. I believe it is important work, and worthy of a very much longer treatment. This is the most advanced topic I have seen under the [...] ECOLEAD umbrella. I would encourage the authors to stick with it through the theoretical difficulties...”

As usually said, words mean what they mean. But undeniably, these words were very encouraging for this research work.

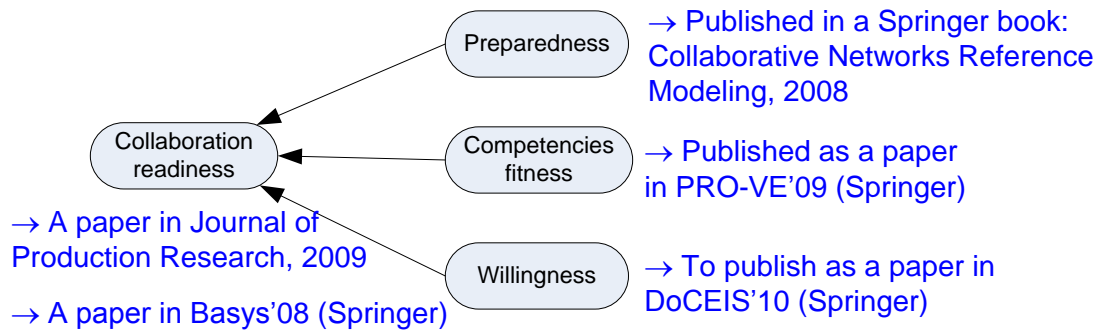


Fig. 5.3 –Work validation and dissemination

The reactions in terms of feedback and suggestions obtained during the ECOLEAD meetings and workshops were useful to consolidate research line followed during this work. During the presentations at the mentioned conferences, some interesting questions and comments were also raised. For instance, in the PRO-VE'09, in which the competencies fitness paper was presented, a question related to whether partners were compelled to share knowledge by contract agreements established between parties was formulated. The answer to that question arose from another comment, stating that organizations sometimes choose not comply with their obligations, preferring to pay eventual penalties and leave consortia. This very question raised the importance for the ability to perform collaboration-related soft competencies, as well as to assess willingness to collaborate.

5.4 Applying the model in illustrative “real” cases

Until now the validation effort was concentrated in validating the research work. It is time now to concentrate on validating the collaboration readiness model.

As mentioned before, the way the readiness model is validated is based on illustrative cases. These cases are related to large companies. These companies are usually more on the spot by media, and consequently, it is easier to find information concerning such cases. Small enterprises are generally hardly cited due to their small impact in the general public.

Nevertheless, an effort was made to select cases with characteristics and challenges which, as much as possible, resemble the aspects and issues in collaborative networks, mainly in terms of collaboration readiness. One such case, which is developing at the time of this writing, corresponds to the collaboration agreement established between Microsoft and Yahoo. This agreement took place after a more conventional approach, namely a takeover, had failed.

During the assessment of these cases, except the last one, it will not be possible to perform collaboration readiness assessments using the mechanisms obtained during the modeling experiments of chapter 4. The very reason lays in the fact that the type and amount of information necessary to feed these mechanisms is only reachable if the assessor is close enough to these cases (which happened in the last example). This limitation also prevents the performance of very exhaustive assessments. Therefore, instead of being that exhaustive, the focus will be put more on the challenging factors that characterize each partnership, for which the collaboration readiness model would contribute with a better perspective of the problems, allowing a prompt reaction to them. In such a way, the recommended approach to assess these cases is based on the utilization of the collaboration readiness canonical form, presented at the end of chapter 3. This canonical form allows considering these cases at the broadest and abstract levels.

The last case took place inside the ECOLEAD project. As such, it was possible to perform a deeper assessment. With this example, it is possible to perceive the gains between using the abstract or the more detailed version of the collaboration readiness model.

5.4.1 Rio Tinto: tackling the cross sector partnership challenge

This case is described in (IBLF, 2009) and shows how Rio Tinto had to move away from a number of ad hoc sponsorship arrangements towards a community engagement program, by establishing strategic partnerships with NGOs and other partners.

The case and context

Until 1995, Rio Tinto's community donations programs, largely consisting of sponsorship of educational and arts activities, had achieved limited levels of long-term relationship building. Rio Tinto's staff realized that the whole program had limited interaction and little rationale to the business. The company suffered from a negative

reputation. It was also clear to them that this community donations approach was doing little to change that reputation, or provide other forms of corporate value.

Therefore, Rio Tinto decided to adopt a new approach, in which they would focus on non-traditional relations, focusing on more strategic, longer-term, and more mutually beneficial collaborations for establishing bio-diversity programs with NGOs and other partners. The mutual benefits of such newer approach are presented in Fig. 5.4.

For Rio Tinto	For Partner Organisations
Enhances the company's reputation	Contributes to the core mission of the organisation in new ways
Access to land and an increased licence to operate	Access to new locations and networks
Helps to mitigate risk	Involvement in a more integrated approach and a far wider range of activities
Access to specialist expertise	Financial support for projects
Greater capacity to work with communities and access local information	Greater capacity for research, training and education
Building corporate values and capacity of staff	Building capacity of individual staff and institutions
Greater credibility with key stakeholders and leverage with other NGOs	Greater credibility and leverage with other corporations
Opportunities to engage with external stakeholders in new ways	Builds more innovative / 'out of the box' approaches to priority issues

Source: Rio Tinto staff and partners

Fig. 5.4 – Benefits achieved by a shift from sponsorship arrangements to more collaborative approaches (IBLF, 2009)

However, this shift did not happen without having to face a number of newer issues. Rio Tinto soon realized that these collaborations required new professional skills and competencies, and that they had to make considerable investment in relationship management aspects. As one of the concerned managers expressed:

*“We did not understand early enough that relationship-building competencies would be at the core of what makes a first class mining company. We know now... that the so-called "soft" skills are, in fact, 'hard' skills: hard to acquire and hard to practice. They are essentially people skills and... they must be integrated into the core competencies of any enterprise that wishes to grow.”**

* 1. Leon Davis, CEO of CRA Ltd. (prior to merger with RTZ Corporation plc) in an address to the Australian Institute of Company Directors, 1995

Rio Tinto realized that early partners, mostly NGOs, were not at easy to establish partnerships for a number of reasons, including:

1. The “partners’ initial preference for a sponsorship.
2. Losing the control of sponsored funds which could be allocated to the other NGOs’ established projects.
3. Unwillingness of some staff from NGOs and other donors to be seen collaborating with a mining company.
4. Lack of experience, skills and confidence for interacting and work directly with the corporate sector.

This information can be considered sufficient for an initial assessment focusing on the principal issues of this partnership. Fig. 5.5 illustrates this case.

Assessment

If the collaboration readiness was applied during the mentioned shift process, the model would prompt “red flags” in terms of soft-competencies and willingness to engage (Fig. 5.5). The soft competencies issues were related to the difficulty of interaction between the NGO and the corporate staff. The low willingness to collaborate was mostly related to the facts that NGOs wanted to keep the control of the sponsored funds, and that they did not want to be seen collaborating with a mining company.

As a way to handle these issues, Rio Tinto had to take several measures. One of such was the creation of the partnership manager role. Partnerships managers were entitled people owning the required soft-competencies and skills for the development and management of the partnerships involving Rio Tinto and its partner NGOs.

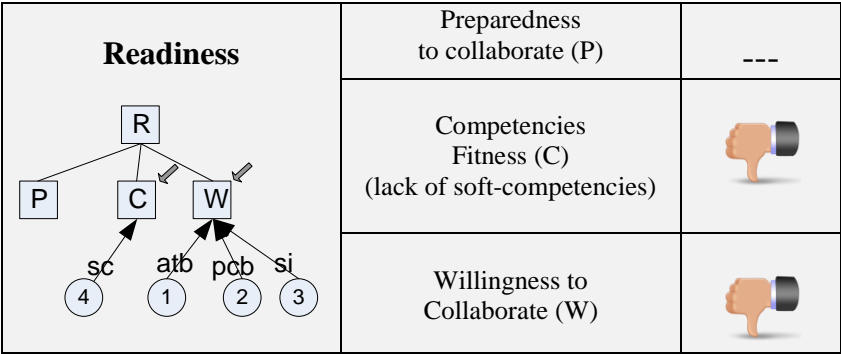


Fig. 5.5 – Focused aspects in the assessment of Rio Tinto’s partnerships (sc: soft competencies, atb: attitude towards the behavior, pcb: perceived behavior control, and si: social influence)

Afterwards, both the staff in Rio Tinto and in the partner organizations expressed they had no doubts that the partnerships arrangements were valuable – perhaps even beyond initial expectations. They also expressed surprise that beyond the impacts at project and program levels, the partnerships had considerable influence on the organizations involved in terms of systems, culture and behavior. In many cases, the staff and other stakeholders within the organizations have moved from positions of skepticism (even hostility) to acceptance (and even engagement).

5.4.2 The UNCPP/MAXLT partnership

This case is described in (IBLF, 2009) and corresponds to a fictional version of a real partnership between a UN* agency and a multi-national corporation. The example shows how the differences in the character profiles of two organizations led to the terminus of a partnership. In this regard, the author of this work said that the ‘raw material’ for reporting this partnership was not easy to obtain. He stated that much of the information, describing cross-sector partnerships, was based only on positive stories and that there were enormous sensitivities about going public and suggesting that such partnerships had ‘failed’. This is an issue previously addressed in this work.

The case and context

This example describes a case of a partnership established between a UN agency, UNCPP, and a multi-national company named as MAXLT. The two organizations involved in a partnership in order to achieve the mutually reinforcing objectives of promoting primary school attendance, gender parity and working against child labor in a developing country in Asia. The incentives for the partnership are illustrated in Fig. 5.6.

In spite of the great optimism at the start of the relationship and the exemplary dedication of a core group of staff from both institutions, the partnership, as originally conceived, was unable to maintain its creative momentum, turning itself into a failure.

* United Nations

MAXLT	UNCPP
Corporate commitment to donating small percentage of pre-tax annual profits to communities around world	Fulfilment of MDGs 2 & 3* - primary education for all and gender equity, especially in areas with competing resource priorities
CSR focus on making strong stand against child labour	Keen to cover education programme infrastructure, training and equipment costs
Community investment programme to support the MDG objective of universal primary education by 2015	Involvement in a more integrated approach and a far wider range of activities
Commitment to developing strategic partnerships internationally	Promotion of gender equity through special interventions encouraging female enrolment in primary education

*MDG 2: Achieving universal primary education - Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.
MDG 3: Promoting gender parity - Eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015.

Fig. 5.6 – Incentives for each partner to work together (IBLF, 2009)

Assessment

The principal reason for the failure of this partnership lies in the fact the both organizations were of distinct types. MAXLT was fast, go-ahead and confident of its brand. It had an unconventional way of working which was reflected in modern office surroundings and flexible hours. Its staff was encouraged to use visioning processes and creative spaces to develop ideas. In addition, streamlined managerial and administrative procedures that avoided too much hierarchical intervention meant that decisions were made rapidly with an expectation that they would be acted upon immediately.

UNCPP, by contrast, worked in a more conventional and bureaucratic manner. Their personnel carried out duties within a carefully monitored system based upon procedural guidelines that had evolved over decades. Work was also undertaken across multiple layers within both headquarters and field operations. As a result, decision-making was slow, and there was hesitancy about making quick choices and assessments without careful consultation and sign-off.

These differences were perceived by both parties, as depicted in Table 5.2. The application of the readiness to collaborate model, in this example, would have helped put on the spot the behavioral differences in both organizations, allowing anticipatory measures to prevent the consequent failure of the partnership.

As observed in the above table, the issues raised by both parties were related to preparedness to collaborate. In this case, the application of an adequately specified collaboration preparedness pattern, as defined in chapter 3, would inform which of the organizations involved in this partnership was better prepared to collaborate.

Table 5.2 – Differences recognized by both parties (‘-P’: unpreparedness to collaborate, ‘+P’: preparedness to collaborate)

Item	Quote	UNCPP party	MAXLT Party	Related aspect
1	“We clearly live in different worlds and work in very different ways, but I do not feel that our approaches to the partnership were that different.”	X		-P
2	“We are completely different. We got on well, but ultimately the cultural gaps between our two organizations made the kind of partnership we wanted impossible.”		X	-P
3	“While we had some similarities, our organizations were very different and understanding these differences was vital to ensuring that the project and partnership remained fresh and robust.”		X	-P
4	“I believe that if the partnership failed, it was due to UNCPP’s inability to deliver in the field and also to archaic and bureaucratic procedures i.e. spending authorizations and too much involvement of controlling mechanisms. This is something that we need to address internally.”	X		-P
5	I think that the different ways of working led to frustration and to the slow disintegration of the partnership. Had we delivered exciting results and related back to MAXLT how the lives of children were being impacted, I believe we could have overcome the challenges of different work approaches.	X		-P

The observation of the contrast between the collaboration preparedness pattern and each partner’s character profile, as exemplified in Fig. 4.22, would show which traits of the partners were more problematic. Given these considerations, the issues related to this partnership, which led to its failure, were fundamentally related to preparedness to collaborate (Fig. 5.7).

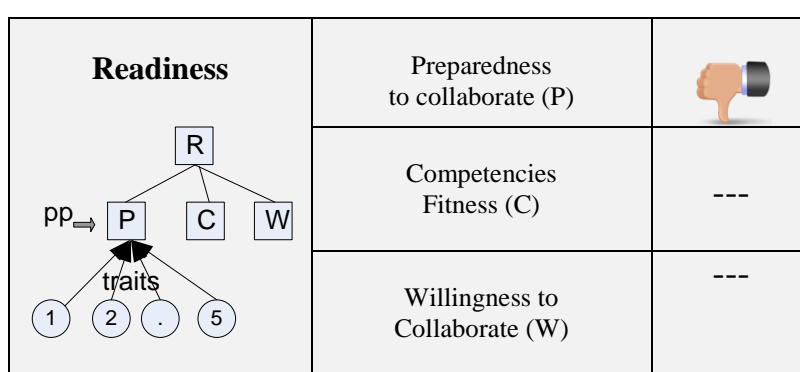


Fig. 5.7 – Collaboration readiness assessment for the UNCPP/MAXLT (pp: collaboration preparedness pattern)

As a final remark, this case helps perceive what key relationship factors impacted the partnership’s development and contributed to its inability to work in the hoped-for

manner. It conveys the frustration experienced on both sides of the partnership in trying to synchronize two radically different types of organizations.

5.4.3 The Microsoft/Yahoo collaboration agreement

The case and context

The case is concerned about two giant companies, namely Microsoft and Yahoo, who established a collaboration agreement. As the case was described in the principal media-channels that publish online in Internet, the information used for its characterization was obtained from Web documents stored in the addresses in Table 5.3.

Table 5.3 – Visited pages for the Microsoft/Yahoo case

Consulted WebPages
<ul style="list-style-type: none">• http://news.cnet.com/Microsoft-bids-44.6-billion-for-Yahoo/2100-1014_3-6228705.html (seen in 2009-10-01)• http://www.computerweekly.com/Articles/2009/07/29/237083/yahoo-microsoft-deal-expected-today.htm (seen in 2009-10-01)• http://news.cnet.com/Microsoft-bids-44.6-billion-for-Yahoo/2100-1014_3-6228705.html (seen in 2009-10-01)

Microsoft is facing increasing competition from Google. The search company is building a portfolio of software through Google Apps, the Chrome browser and the Chrome operating system, which together undermine the Microsoft's strength as a leader in desktop software.

In order to protect its position, Microsoft attempted a takeover of Yahoo. The Microsoft's offer to acquire this search company amounted to \$31 a share and represented a 62 percent premium over Yahoo's closing price on the previous closing date of the stocks market. However, this offer did not succeed, the premium as not enough and as Yahoo wasn't very keen to work with Microsoft as one of its holdings.

Time passed and both parties, eventually, ended up establishing a collaboration agreement. Both Microsoft and Yahoo were trying newer ways and means to dethrone Google from its position of supremacy in the Search Engine market. With this collaboration, Microsoft could achieve its aims, as the agreement constituted an important step for Microsoft shifting its strategy from the traditional business of selling business and consumer software, towards building a viable cloud business, relying on a strategy based on increasing the importance of free software, searching, and online advertising to generate revenue.

Assessment

A first aspect that can be depicted from this case is the Yahoo intention to remain independent. This aim was reinforced by the support provided from the relevant shareholders to the management on not accepting the offer. Even though the 60% premium of the offer considering the market value of shares, Yahoo felt that the perceived benefits from the offer were not very appealing. The collaboration agreement approach was seen with more positive eyes by Yahoo, as it can be seen by the comments organized in Table 5.4.

Table 5.4 – Positions assumed by both parties regarding both the takeover and the collaboration agreement (-WC: negative willingness to collaborate, +WC: positive willingness to collaborate)

Item	Quote	Microsoft party	Yahoo party	Related aspect
1	Related to the takeover: "We have great respect for Yahoo, and together, we can offer an increasingly exciting set of solutions for consumers, publishers, and advertisers while becoming better positioned to compete in the online-services market."	X		-WC (atb)
2	Related to the takeover: "We will evaluate this proposal carefully and promptly, in the context of Yahoo's strategic plans, and pursue the best course of action to maximize long-term value for shareholders."		X	-WC (atb)
3	Reference to Google menace: "Today, the market is increasingly dominated by one player, who is consolidating its dominance through acquisition. Together, Microsoft and Yahoo can offer a credible alternative."	X		-WC (pcb)
4	In a letter from Microsoft to yahoo: "In late 2006 and early 2007, we jointly explored a broad range of ways in which our two companies might work together," Microsoft said. "These discussions were based on a vision that the online businesses of Microsoft and Yahoo should be aligned in some way to create a more effective competitor in the online marketplace. We discussed a number of alternatives ranging from commercial partnerships to a merger proposal, which you rejected."	X		-WC (pcb)
5	The agreement will boost Yahoo's annual operating income by about \$500m and lead to capital expenditure savings of approximately \$200m. It will increase annual operating cash flow by approximately \$275m.		X	+WC (atb)
6	"This agreement has been a long time coming. It is great news for all our customers. It will enable us to innovate in search and provide consumers and advertisers with better transparency and choice."	X		+WC (atb)

Using the collaboration readiness model, it was possible to put on the spot the Yahoo's low willingness to accept the Microsoft's offer, which contrasted afterwards with its positive attitude towards the collaboration agreement approach (Fig. 5.8). The reasons for a low willingness and posterior rejection of the takeover were related to the perceived takeover's benefits, which were considered not enough. The shareholders support/influence over Yahoo's management is also an aspect considered in the willingness to collaborate model as "Social Influence", in supporting the management not to accept the takeover.

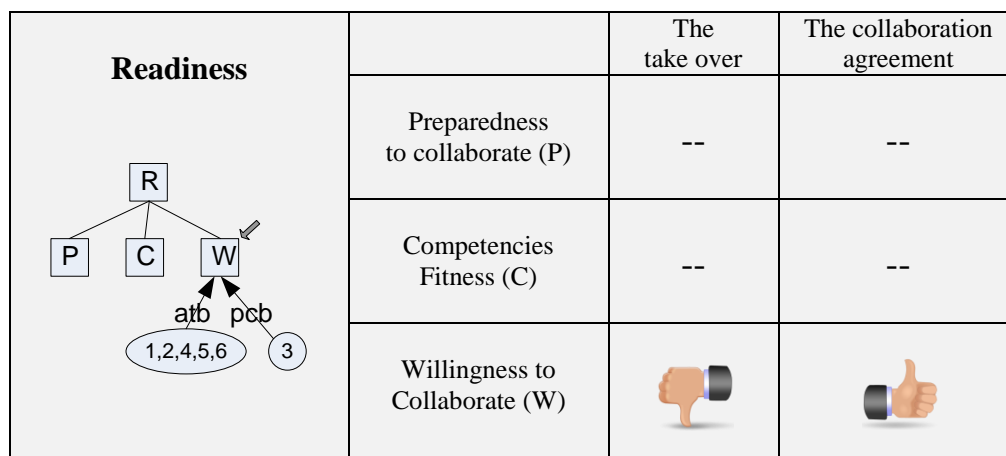


Fig. 5.8 – Collaboration readiness assessment for Microsoft/Yahoo case

On the other hand, Yahoo became more open to a collaboration agreement approach, which was what indeed succeeded. In this approach yahoo could maintain its independence, and at the same time, both companies are now in a better position to deal with their direct competitor, namely Google.

5.4.4 The HP/Canon collaboration agreement

The case and context

This case corresponds to the assessment of a collaboration agreement established between HP and Canon, which was also published in the news. The aim is to illustrate the readiness assessment with a successful case. The information for this case was taken from the news sites referred in Table 5.5.

The collaboration agreement consisted on an expanded alliance to jointly market and distribute a new range of multifunction office systems that united the best of both companies, namely the Canon's leading multifunction devices and HP's enterprise printing and imaging assets. The expectations were to maximize the benefits for both

companies' customers while also paving the way to increase growth for both companies.

The Cannon Company is a partner used to performing partnerships and engaging in joint projects (1)*. Furthermore, the company is known to significantly contribute to society, namely in terms Human aid disaster relief, supporting art, culture and sports; Supporting children in education and science; Valuing interaction local communities; Social welfare (of disabled people) conservation of the environment (2). These actions were embodied as monetary and equipment donations, involvement in campaigns, supporting NGO, partnerships, and joint projects (3).

Table 5.5 – Visited pages for the HP/Cannon agreement

Consulted WebPages
<ul style="list-style-type: none"> • http://www.canon.com/corp/outline/ (seen in 2009-10-06) • http://www.canon.com/scsa/pdf/Canon_SCSA2008_2009_EN.pdf (seen in 2009-10-06) • http://www.hp.com/hpinfo/newsroom/HP_in_brief_010309.pdf (seen in 2009-10-06) • http://www.hp.com/hpinfo/globalcitizenship/ (seen in 2009-10-06)

The HP Company is seen as a trusted global business partner (4), involved in previous successful partnerships (5). It was considered the 15th of the world's most innovative companies ranking by BusinessWeek, with 23 labs across the world (6). The documents (in the Investors relations section) of HP's webpage display good ethical code, valuing higher standards integrity, transparency and accountability (7). HP is also known for its positive contributions to the society (8), such as supporting environment sustainability, human rights, and providing grant to both poverty-fighting and to schools (9).

Assessment

The agreement is an extension of a previous one established between these two companies. This means that they are used to work together and collaborate with each other. Therefore, this adds to a higher preparedness. The characters of both companies are exemplar. There were concrete benefits to achieve from working together, being the risk lowered by a previous trustworthy and fruitful collaboration, which extended over time. All in all, the collaboration readiness assessment for this partnership can be considered positive in all the aspects of collaboration readiness, as illustrated in Fig. 5.9.

The collaboration readiness model aligned adequately with this fairly positive case, in which the evidences showed that both parties were well prepared to collaborate

* Refer to Fig. 5.9 in the assessment part of this case.

(character-related), were used to working together (soft versus hard competencies related (10)), and the shared benefits to achieve were clearly stipulated (willingness related). More on more, it is stated in Canon webpage documents that this company follows the “Kyosei” philosophy, which basically stands for “Living and working together for the common good” (11).

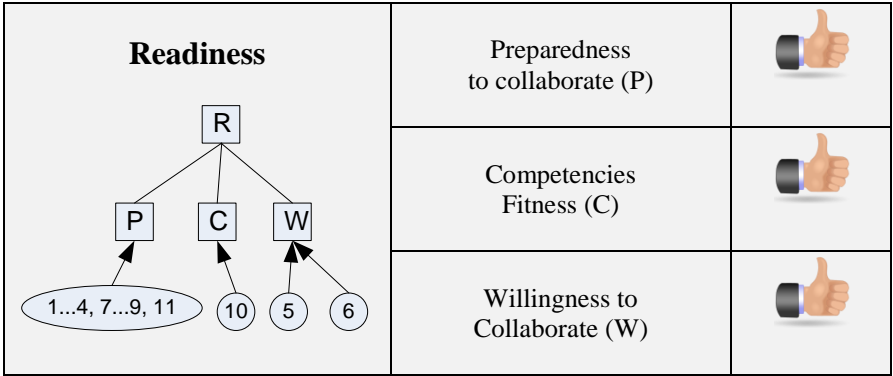


Fig. 5.9 – HP/Canon example: all aspects related to collaboration readiness are positive

5.5 The ECOLEAD/wp5 case

The case analyzed in this section was observed inside the ECOLEAD project, allowing the performance of a deeper assessment. The data used for assessing this case is based on the facts that were kept in the records. Although it could help, no personal information in the partners’ mind was considered. Instead, only observable facts were considered.

5.5.1 The case and context

This case is related to a partnership established in the ECOLEAD project, which was created for achieving the objectives established for the work package 5 (WP5). The objectives of this work package are roughly mentioned in Table 5.6. Of course, these objectives were intended to be achieved through collaborative research work.

The characteristics of the organizations involved in the WP5 are illustrated in Table 5.7. As these partners are either Universities or research institutes, it makes sense to consider both the partners’ competencies (that is, their scientific domains) and the partners’ research interests. Although these two categories may overlap, this distinction

is important for assessing this case. The information in the table corresponds to the limited amount that matters for this assessment.

Table 5.6 – Requirements/objectives in ECOLEAD’s WP5

<p>Formal modeling foundation:</p> <ul style="list-style-type: none"> • Hands-on assessment of promising modeling approaches: formal languages, graph theory, multi-agent models, game theory, modal logics, etc. • Identification and characterization of the necessary modeling purposes. • Establishment of a map between needed modeling purposes and promising modeling tools (“shopping list”). • Formalization of existing empirical knowledge based on selected representative cases. <p>Reference models:</p> <ul style="list-style-type: none"> • Define the terms, scope and guidelines for the reference model. • Define principles for the reference model for CN. • Define a reference model for CN. • - Promotion of education and increasing awareness for the need of a theoretical foundation. <p>Soft engineering models:</p> <ul style="list-style-type: none"> • Combination of soft engineering models and social theories. • Development of soft reasoning models and decision making. • Support Development of graphical visualization and simulation tools . • Understanding of leadership, actors’ roles, and social bodies roles. <p>Models interrelationships and integration:</p> <ul style="list-style-type: none"> • Define a basis for interoperability among models. • Perform experiments on interoperability among models. • Integration of models.

The outcomes from the consortium in this WP were considered very satisfactory. The significant number of publications in journals, the presence in conferences, international workshops, the edition of a book, and even the assessment made by the European Commission reviewers certifies the impact of this project in the community. In terms of the WP5, each partner was also able to provide excellent outcomes, except for partner o4, which displayed unsatisfactory performance. Aiming at discovering which causes led to this poor performance, the collaboration readiness assessment in this case is concentrated on this partner.

Table 5.7 – Partners’ scientific domains and interests

Partner	Scientific domains	Research interests (which matters for ECOLEAD)
o1	Collaborative Networks, “Virtual Enterprises and Electronic Business”, “CIM Information Systems and Systems Integration”, “Interactive planning of CIM systems”, “Machine Learning in Execution Supervision”, “Multi-Agent Systems and Negotiation in Distributed Dynamic Scheduling”, “Mobile Agent Systems”.	Collaborative Networks, Virtual Organizations, Virtual Enterprises, Professional Virtual Communities, Social Networks, VO Breeding Environment, PVC.
o2	Collaborative networks, database Modeling and Management, Conceptual modeling, Federated Information Systems.	Collaborative Networks, Federated Collaborative Databases, Semantic Information Modeling and Ontology Engineering for Interoperability Specialized and Complex Web-based Application Domains: Bio-Informatics, Manufacturing, Bio-Diversity, Distributed Control Engineering.
o3	Industrial systems management, ICT, and business Innovation research, collaborative networks.	Virtual organizations, “Partner/ networking capability analysis” models and tools for managing and developing organizational networks, including virtual organizations, subcontracting networks, supply chains, business logistics and purchasing.
o4	“Data mining, machine learning “, “Text, Web and multimedia mining”, “Semantic Web”, “Knowledge management”, “Language technologies” , “Decision support “ .	“Acquisition, storage, management and discovery of knowledge, especially data mining”, “machine learning”, “decision support and language technologies”.
o5	“Intelligent Production and Logistic Systems”, “Application of Information Communication Technologies in Production”, “Industrial Engineering and Management”, collaborative networks.	“Supply-chains”, “ICT support of Enterprise Networks”, “bid preparation in Enterprise Networks”.
o6	Domains related to the industrial management, collaborative networks, Software engineering and Systems Integration.	Manufacturing intelligent systems, systems control & automation, Software engineering, VO management, enterprise and business processes modeling, VO teaching, VO life-cycle software development, VO supporting platforms.

5.5.2 Information for the assessment

Similarly to any other collaboration opportunity, WP5 can be modeled in terms of activities/phases and competencies necessary to achieve the project goals. Given that WP5 is part of a research project, the necessary hard competencies correspond to each partners’ scientific domains, as expressed in Table 5.7. Considering this table, it is possible to identify the hard competencies the partners are willing to use for achieving the WP5 objectives. A small list of these competencies are expressed in Table 5.8.

As mentioned in previous chapters, the adequate performance of the hard competencies, in a collaboration context, requires the ability to display certain soft competencies.

Table 5.8 – Identification of hard competencies (HC), or scientific domains

H.C.	Description
hc1	Expertise in collaborative networks
hc2	Software engineering
hc3	Database Modeling
hc4	Data mining and knowledge modeling
hc5	Soft modeling/computing
hc6	(Industrial) Management
hc7	Formal (engineering) methods

For instance, joint research work is said to provide leveraged outcomes if partners have the ability to share knowledge (Jones, Herschel et al., 2003). The more important soft competencies in the context of the WP5 are in Table 5.9.

Table 5.9 – Important soft competencies

H.C.	Description
sc1	Ability to create consensus among participants
sc2	Ability to share knowledge
sc3	Ability to continuously contribute to the joint effort

Using the competencies identified above, it is possible to define the necessities of the WP5, for each of its phases, which are discriminated in Table 5.10.

Table 5.10 – The WP5 phases

Phase	Description	hc1	hc2	hc3	hc4	hc5	hc6	hc7
A1	Establishing Formal Modeling foundation	X	X	X	X		X	
A2	Build up of reference models	X	X	X			X	X
A3	Soft engineering models		X			X		
A4	Models interoperability		X	X		X		X
A5	Leadership of the consortium	X	X				X	X

For the achievement of the WP5 objectives, not only the hard competencies are necessary, but also the mentioned soft competencies. This information is displayed in Table 5.11, which takes into account the objectives of the WP and the specific nature of the consortium.

In terms of the specified competency levels, provided that they point to the right direction, the numbers do not need to be very accurate. Rather than crisp indications of each partner's competencies, it matters more a qualitative indication of their fitness, with sufficient accuracy.

Table 5.11 – Necessary soft competencies (high: 80; med: 50; low: 20)

WP5	sc1	sc2	sc3
hc1	H	H	H
hc2	M	M	H
hc3	M	M	H
hc4	M	H	H
hc5	H	H	H
hc6	M	H	H
hc7	M	H	H

Therefore, the competency levels of each partner can be specified as performed in chapter 4, section 4.7.2. These levels can be qualitatively specified as high, medium or low, by comparing each partner's levels to the necessities of the project. These levels can also be established by comparing the relative strength of each partner's competencies*. Considering these aspects, the partners' competencies in terms of both hard and soft are discriminated in Table 5.12.

Table 5.12 – Organizations hard and soft competencies levels

Partner	Partners' hard competencies							Soft competencies		
	hc1	hc2	hc3	hc4	hc5	hc6	hc7	sc1	sc2	sc3
o1	95	90	50	30	70	45	60	H	H	H
o2	90	80	95	30	50	20	20	H	H	H
o3	70	20	50	20	50	70	20	M	L	M
o4	20	50	50	90	50	10	30	M	L	L
o5	80	50	50	10	20	90	20	H	H	M
o6	80	40	20	10	20	80	20	H	H	M

Having defined the WP5 necessities, and the partners' competencies, the assessment of partners' collaboration readiness can be started.

5.5.3 Assessment of collaboration preparedness

A close eye in the previous section shows that the partners' information regarding collaboration preparedness, namely its character traits, was not intentionally specified. Considering the information that can be observed from their respective sites, these partners have a relatively long history of successful collaborations, namely in terms of (international) research projects, collaboration agreements, and the establishment of

* An individual may be classified as thin or fat because we have references to compare with. Similarly, a partner's competency level cannot be considered high or low alone. For such, we need references from the project requirements or comparing with a partner/competitor.

public/private partnerships. Therefore, one can assume that in generic terms these partners are prepared to collaborate. This assumption is supported by the information, provided in Table 5.13, which corresponds to a qualitative measure of their collaboration history.

Table 5.13 – Partners’ previous and current collaborations

Partner	number of collaborations
o1	High
o2	High
o3	Very high
o4	Very high
o5	High
o6	Moderate

In terms of partner o4, the one being subjected to collaboration readiness assessment, its collaboration history is very high. Therefore, it seems not likely that its low performance is related to unpreparedness to collaborate. We should, therefore, find other explanations for its weak outcomes.

5.5.4 Assessing competencies fitness

The assessment of competencies fitness is started by determining each partner’s adjusted competencies profile. All the necessary information is already specified above. Using that information, the adjusted competencies profile can be determined using *Definition 3.3.7*. This process considers together the partners’ hard competencies levels by the degree of soft competency required during the WP5 (Table 5.11). The obtained adjusted profiles are shown in Table 5.14.

Table 5.14 – Adjusted levels of hard competencies

	hc1	hc2	hc3	hc4	hc5	hc6	hc7
o1	95	126	70	36	70	54	72
o2	90	112	133	36	50	24	24
o3	35	14	34	12.5	25	43.8	13
o4	7.5	28	28	45	18.8	5	15
o5	70	64	64	10.8	17.5	96.8	22
o6	70	51	26	10.8	17.5	86	22

Considering both the original and adjusted levels, the corresponding competencies fitness matrix can be determined using *Definition 3.3.12*. This matrix is represented in Table 5.15.

Table 5.15 – Fitness competencies levels

	hc1	hc2	hc3	hc4	hc5	hc6	hc7
o1	0	36	20	6	0	9	12
o2	0	32	38	6	0	4	4
o3	-35	-6.5	-16.3	-7.5	-25	-26.3	-7.5
o4	-13	-22.5	-22.5	-45	-31	-5	-15
o5	-10	13.8	13.75	0.75	-2.5	6.75	1.5
o6	-10	11	5.5	0.75	-2.5	6	1.5

Each line of this table represents a partner's fitness levels for its competencies. According to *Definition 3.3.12*, the nearer the value of a competency fitness is to zero, the better is the fitness*. Observing this matrix, it is easy to see that the biggest deviations are precisely in partner o4. These deviations are better illustrated in the form of profiles chart, as illustrated in Fig. 5.10.

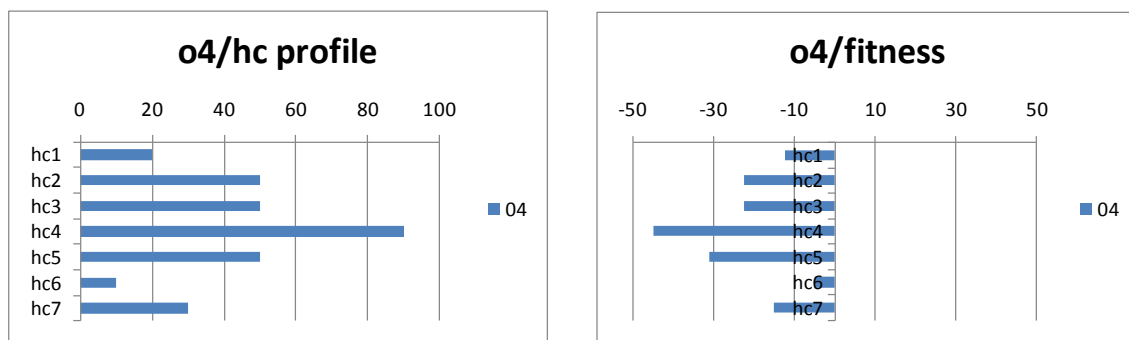


Fig. 5.10 – Partner o4' competencies fitness (on the left the original profile; on the right the fitness levels)

Considering that this is an assessment of a past partnership, these deviations mean that partner o4 delivered poor contributions to the WP5 project. Although it was initially considered a valuable partner, these effects may have taken place due to its incapacity to exercise the mentioned soft competencies during the WP5. In order to establish a contrast, the fitness levels of a partner that did a relatively excellent job are shown in Fig. 5.11.

If the readiness model was initially available in the beginning of the project, and the necessary information was also available, it would trigger an earlier sign that partner o4 could contribute poorly.

* Recalling the example of the fat/thin person, its fitness level is achieved when the person is not too fat, nor too thin. At this level, his/her weight equals a desired reference. In other words, the difference between that reference and the person's weight should be near zero. In fact, in this context, positive differences are not problematic; only negative ones are.

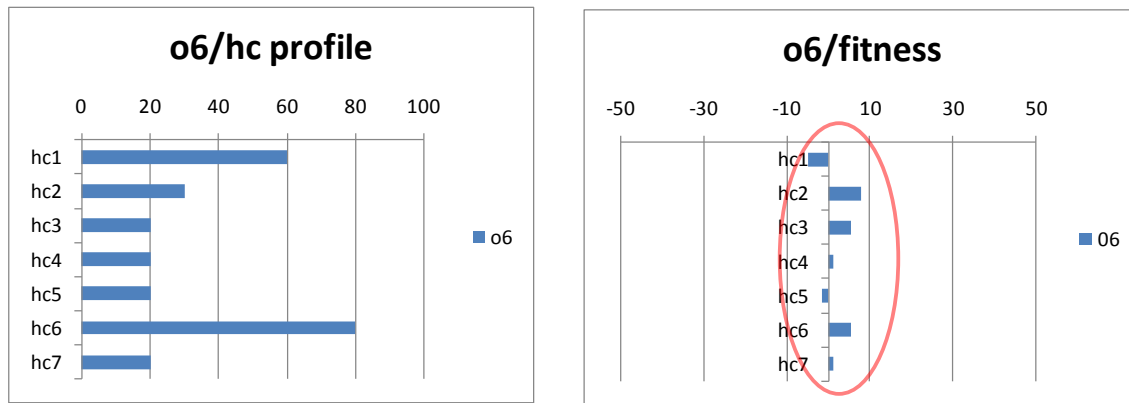


Fig. 5.11 – Partner 06' competencies fit better in WP5

In fact, a closer look at Table 5.7 allows observing that all partners, except o4, share a common subset of competencies, which are more or less related to collaborative networks scientific areas. This aspect may constitute an explanation for the low performance of o4. This partner was excellent at applying data mining and knowledge modeling methods, which was a very important competency for modeling empirical knowledge, which was one of the objectives of WP5. The manifested difficulty in obtaining data from collaborative networks' repositories may have affected this partner's performance.

Nevertheless, not being able to use its best competency during the project may not be a complete explanation for the low performance of partner o4. Confirming this possibility is the fact that other partners, not that good at some phases of WP5, managed to still provide satisfactory contributions. In order to understand why, it is necessary to find other causes for the o4's failure. Let us try willingness to collaborate.

5.5.5 Assessing willingness to collaborate

The assessment of the willingness to collaborate, according to its description in chapter 3, allows evaluating a partner's effective interest in a concrete collaboration opportunity. Basically, if a partner's level of interest in the collaboration opportunity is not high, either before or during the corresponding partnership, then the partner's performance is likely to be low. The willingness to collaborate assessment process tries to evaluate the partner's behavioral beliefs, attitudes and intentions towards a given collaboration opportunity, providing a measure of its willingness to collaborate level as a percentage value.

The intentions query mechanism (IQM), described in chapter 4, is used here to ease the willingness to collaborate assessment process. This process starts by describing the collaboration opportunity, which in this case corresponds to the WP5, as illustrated in the text editor shown in Fig. 5.12. Some words from this description which are semantically related to the questions stored inside the IQM's knowledge-base are automatically highlighted.

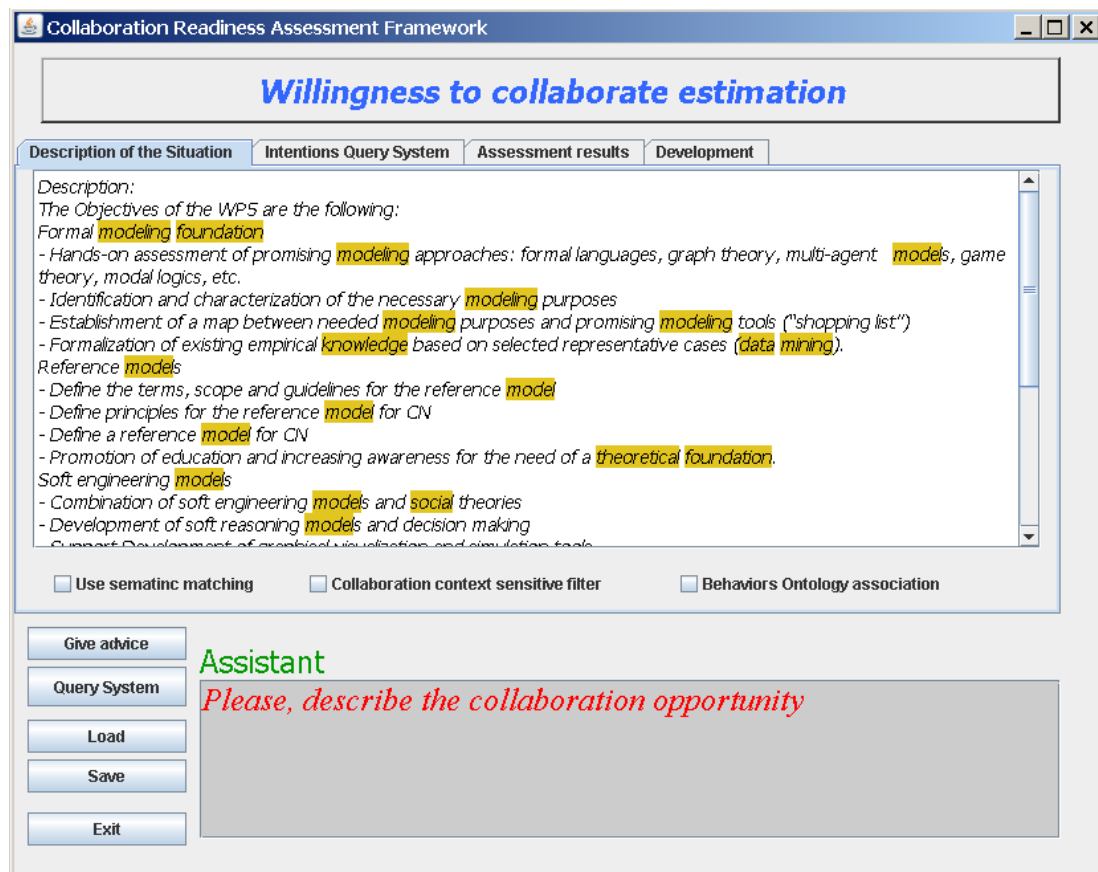


Fig. 5.12 – Text editor of the IQM with the description of the WP5 collaboration opportunity

In a similar way, in the next phase the IQM invokes the necessary rules to search and collect the questions that are semantically related to the highlighted words contained in the description of the collaboration opportunity. The result of the search corresponds to a set of questions that the IQM identified as more relevant to the described situation, as illustrated in the dialog window that is shown Fig. 5.13.

As illustrated in this dialog, it is possible to unselect the questions that are not relevant for the actual situation. The remaining questions are answered using the slider bar of the right side, according to the beliefs perceived during the continuous

interactions with partner o4, direct observation of its behavior and outcomes, and listening to the other partners' impressions. As such, these beliefs may be of subjective nature, but provided that they point to the right directions, no accurate values are required.

Collaboration Readiness Assessment Framework

Willingness to collaborate estimation

Description of the Situation	Intentions Query System	Assessment results	Development
<input checked="" type="checkbox"/> you expect to give and receive knowledge		not likely	quite likely
<input checked="" type="checkbox"/> importance of knowledge sharing		not important	very important
<input type="checkbox"/> fair share the benefits		not likely	quite likely
<input type="checkbox"/> profit is the most aspect in this situation		totally disagree	totally agree
<input checked="" type="checkbox"/> A theoretical foundation on is a significant part of the project		not likely	quite likely
<input checked="" type="checkbox"/> Theoretical foundation for the partner is a valuable aspect		not important	very important
<input checked="" type="checkbox"/> Partner feels the pressure for sharing		not likely	quite likely
<input checked="" type="checkbox"/> Partner is willing to share		not much	very much
<input type="checkbox"/> there is social incentive to collaborate		totally disagree	totally agree
<input type="checkbox"/> sensitive to social pressure		not important	very important
<input checked="" type="checkbox"/> Partner has no concerns in applying knowledge modeling approach		not likely	quite likely
<input checked="" type="checkbox"/> Partner sees the application of knowledge modeling as very important		not important	very important
<input type="checkbox"/> partners are of good reputation		not likely	quite likely
<input type="checkbox"/> trust is a very sensitive aspect		not much	very much

Give advice

Query System

Load

Save

Exit

Assistant

Explain the situation, and collaboration context...

Fig. 5.13 – Question for computing willingness to collaborate

The answers to these questions are then used to obtain a value for the o4's willingness to collaborate. As described in chapter 3, this is done through the application of the theory of the planned behavior. The corresponding result of the willingness to collaborate level for o4 is illustrated in Fig. 5.14. According to the provided beliefs, its value is about 21%, which is quite low.

As a result of this assessment, the conclusion that can be taken is that this partner failed to contribute satisfactory to WP5 due to its low willingness to collaborate, participate, or commit to the several phases of WP5.

Looking again at Table 5.7, allows perceiving that all partners, except partner o4, have in their internet sites a statement of their research interests, which includes areas

related to collaborative networks, suggesting an initial low interest of partner o4 to participate in these phases.

Fig. 5.14 – The willingness to collaborate assessment

All in all, this allows concluding that this partner failed the collaboration readiness assessment in terms of competencies fitness and willingness to collaborate. In terms of competencies, the partner could not apply its best competency for modeling empirical knowledge, which undermined its expected outcomes and performance. Furthermore, its scientific domains did not include topics related to collaborative networks, suggesting its low competency for the other phases of WP5. Finally, and as suggested by the Venn diagrams, the principal research interest of this partner was precisely in the modeling empirical knowledge phase, displaying low interest in the other phases of WP5. These aspects apparently led to the poor performance of this partner.

Although these examples apply the method a posteriori, one can also consider that in the context of a VBE we can accumulate historic data that will allow us, in the future, to apply the method before a collaboration is attempted.

5.6 Reflecting on the validation process

The presented argumentation showed the validity of the collaboration readiness assumptions researched during this work, which also led to conclude that the model is a plausible one. This plausibility was confirmed by the positive reactions displayed by the peers who reviewed the model, either inside ECOLEAD or through the published papers.

The application of the model to a number of existing (real) cases helped perceive how this approach can be applied in practice. The results seem promising in the sense that the model underlying this approach may in fact help predict whether partnerships are likely to face problems.

In spite of the difficulty to obtain concrete cases of partnerships, the evidences found are enough to encourage a further improvement of this model. The application in the above cases showed that this readiness model helped observe a partnership in a distinct and brighter perspective. Many times, the power of a model lies not in its prediction capabilities, but in its ability to display a problem in a black-and-white, and clearer, way. The cases tested in this chapter aimed to illustrate this objective.

The last case, involving the ECOLEAD/WP5 project, allowed a deeper assessment of collaboration readiness. Given the richness of available information, it was possible to use the mechanisms described in the previous chapters. The assessment allowed a successfully identification of the causes that led to the low performance of partner o4. Incidentally, the application of the more abstract version of the collaboration readiness model would also lead to the same conclusions. That is, the observation of Table 5.7, both in terms of scientific domains and research interests, with the collaboration readiness premises in mind, would help raise an alert for potential performance issues concerning the mentioned partner.

Considered these examples together, the application of the collaboration readiness assessment model allows concluding that it can be used in a straightforward and intuitive way, that it can be applied either at abstract or more specific/detailed levels, and that its practice brings value to the partners' selection decision-making process.

6 Conclusions and future work

"Would you tell me, please, which way I ought to go from here?"
"That depends a good deal on where you want to get to," said the Cat.
(Alice's Adventures in Wonderland)

This work involved the development of a collaboration readiness assessment approach for evaluating the organizations' ability to work well together inside partnerships. The main findings and obtained results are summarized in this chapter. A synthesis of the performed work is first made, followed by corresponding findings and contributions. Afterwards, a number of open issues are established for future work.

6.1 Synthesis of the work

This research work aimed at modeling an assessment approach for measuring the organizations' readiness to collaborate. Recalling the research question, namely "how to effectively model collaboration readiness", it was found that a suitable answer would be found by considering a behavioral perspective. This contrasts with, and complements, previous works which were more focused on "hard" factors such as competency matching or technological preparedness. The study of that question led to the establishment of the research hypothesis, for which its verification, resulted in the development of the collaboration readiness assessment approach. The underlying model for this approach is based on three fundamental concepts, namely preparedness to collaborate, competencies fitness assessment, and willingness to collaborate. The main aspects of these concepts include:

- Preparedness to collaborate - Aims at assessing a partner's behavioral aptitude to behave as desired in a collaboration situation. The assessment is based on the concept of organization's traits. A trait indicates which behavioral patterns are perceived in an organization.
- Competencies Fitness – The suggested competencies fitness assessment is based on the dichotomy of the soft versus hard competencies, in which we studied the

effects of the soft competencies over the hard ones in order to measure how well a partner can use its competencies in collaboration situations.

- Willingness to collaborate – To evaluate whether a partner is really interested to participate in concrete collaboration situations.
- Readiness to collaborate – It was modeled as an aggregation of the other concepts to represent the organizations' preparedness, competencies fitness and willingness to collaborate in collaboration situations. It is represented as a composition or aggregation of the three previous aspects.

A number of experiments aimed at modeling several parts of the readiness model were performed in order to illustrate the utilization of these concepts in an assessment approach for assessing readiness to collaborate in concrete situations. These experiments were also useful to suggest how to integrate them in decision support systems.

The use of the assessment approach in a number of known cases of collaboration agreements and partnerships helped to perceive how well it could model collaboration readiness and the predictive value of the assessments.

6.2 Contributions from this research

The contributions from this work were twofold, namely in a conceptual and in more modeling and “technological” aspects. The conceptual contributions involved the introduction of new concepts for modeling collaboration readiness, such as the idea of preparedness condition and preparedness pattern (as a set of preparedness conditions) to establish a desired organization's character in a concrete collaboration situation. Other concepts were brought from other scientific areas and adjusted to a CNOs realm, such as willingness to collaborate. Contributions were also made in terms of modeling, through the modeling experiments described in chapter 4, namely for discovering which traits are desired in a organization's character in order to be considered prepared to collaborate. These contributions are detailed for each of the readiness's components during this section.

6.2.1 Collaboration readiness

The main contribution of this work was to recognize that collaboration readiness should be fundamentally viewed from a behavioral perspective. This perspective was applied in the three aspects of collaboration readiness, namely preparedness (P), competencies fitness (C) and willingness to collaborate (W). An interesting feature is that these components can be assessed together or independently. This aspect aids for a greater flexibility in the utilization of the approach. The readiness concept is better used as a filter, namely the collaboration readiness filter in which its P, C, and W constituents can be tuned for the concrete collaboration situations, helping discern which organizations are better suited for each situation. Some of the contributions made to the collaboration readiness concept are illustrated in Fig. 6.1.

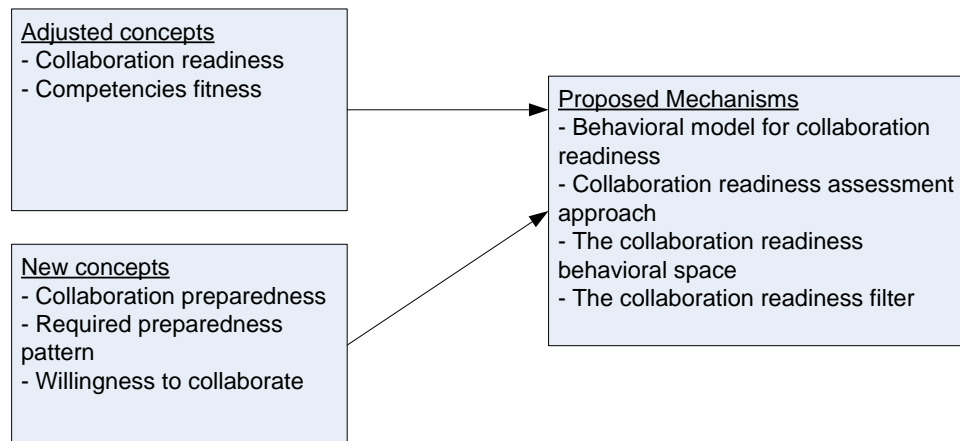


Fig. 6.1 – Illustration of the relevant contributions for the readiness to collaborate concept

6.2.2 Collaboration preparedness

It was proposed that collaboration preparedness should be fundamentally based on the organizations' character. The specification of what is an organization well prepared to collaborate can be made using the preparedness pattern concept, which consists of a set of preparedness conditions. Each of these conditions specifies a trait and corresponding value which must be observed in an organization's character in order to be considered well prepared to collaborate. Therefore, a preparedness pattern specifies the desired behaviors perceived in an organization. An organization is basically identified as having, or not, good preparedness by comparing its character and the specified preparedness pattern.

The idea of using Bayesian Beliefs networks was proposed as a way of dealing with the cases in which a deterministic assessment could not be performed due to uncertainty. These type of situations happen when the essential traits necessary for assessing collaboration preparedness are not known, uncertain or vague.

Some of the contributions made to the collaboration preparedness concept are illustrated in Fig. 6.2. The upper left block shows the concepts which were adjusted from other scientific areas to the CNOs realm, followed by the block showing the new concepts developed during this work. These concepts are either used in a profile-based, or stochastic based, collaboration preparedness assessment mechanism.

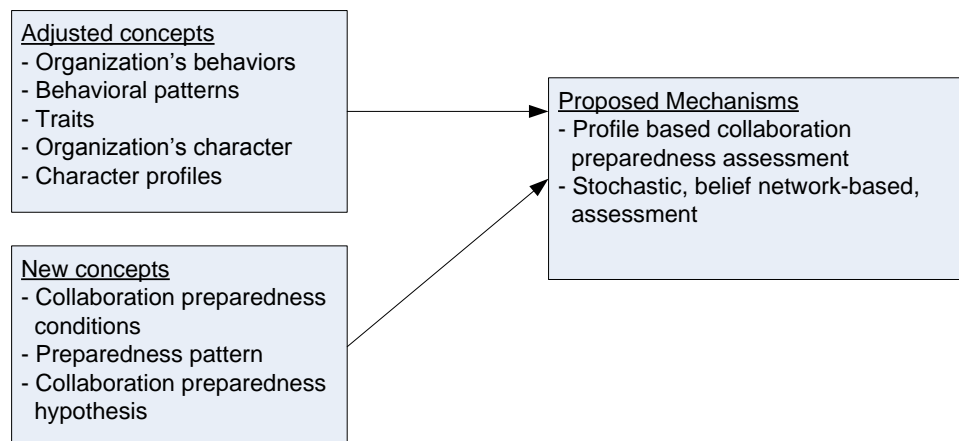


Fig. 6.2 – Illustration of the relevant contributions for the preparedness to collaborate concept

6.2.3 *Competencies fitness*

It was proposed that the concrete competencies an organization brings to a partnership should be considered together with the very requirements subjacent to the act of collaborating. A hard versus soft competencies combination was proposed in order to measure the impacts of the collaboration-related soft competencies in the use of the hard ones, in a collaboration situation. For handling and evaluating these effects, an extended competencies model was proposed, which consider both these hard and soft competencies. The adjusted competencies levels, as an expression of these effects, allow perceiving whether partners are likely to perform above, or below, the expectations initially established in the original hard competency levels. The fitness level concept is used to express how well the competencies of an organization fits in a given collaboration opportunity. Competencies allocation rules were also proposed in order to assign competencies to organizations, or vice-versa, using this concept of fitness.

Some of the contributions made regarding the competencies fitness concept are illustrated in Fig. 6.3.

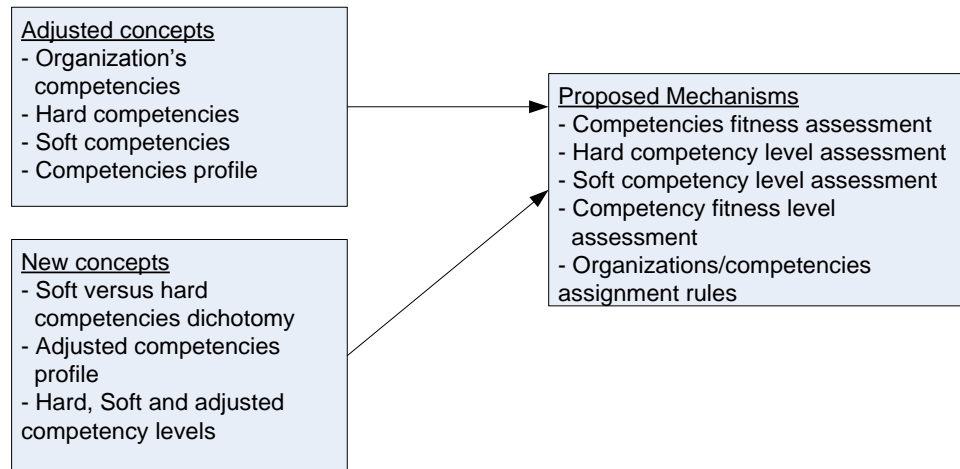


Fig. 6.3 – Illustration of the relevant contributions for the competencies fitness concept

6.2.4 *Willingness to collaborate*

A model based on the Theory of the Planned Behavior was proposed in order to assess the organizations' willingness to collaborate. This theory, usually used in a human context, was adjusted for an adequate utilization in an organization's context. The resulting model was extended with a mechanism, namely the Intentions Query Mechanism which from the descriptions made from a partner in relation to a concrete collaboration opportunity, selects an adequate set of questions in order to assess the willingness of that partner in participating in the mentioned collaboration opportunity. This evaluation of willingness is very important in order to perceive how likely the partner is really interested and committed to a partnership, willing to perform joint work and share its assets. Not performing this assessment can be very risky to the partnership. This risk is not even significantly minimized by the necessary signatures of the bylaw agreements, in order to ensure commitment and assets sharing during the partnership. The fact is that if a partner feels afterwards that it is not worthy to be in the partnership, it may prefer to assume the penalties and go away.

Some of the contributions that were made to the willingness to collaborate concept are illustrated in Fig. 6.4.

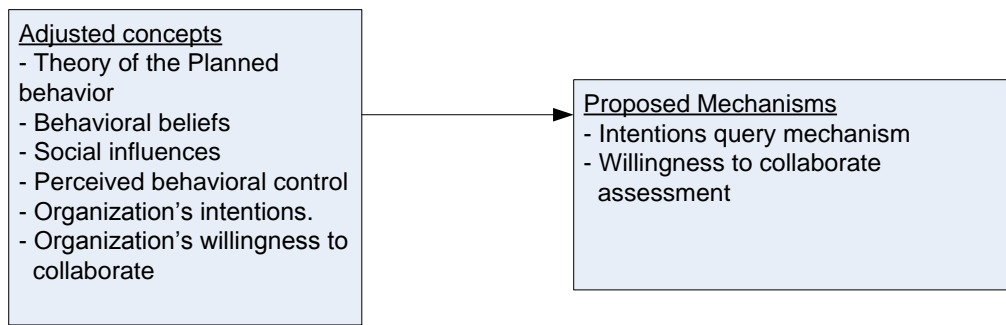


Fig. 6.4 – Illustration of the relevant contributions for the willingness to collaborate concept

6.3 Future work

It may be fair the statement that this work contributed to open more doors, raised even more questions, and may have identified many issues still to address. This should not be seen as a negative aspect, as (in good) research we may open up new paths and cross new boundaries, leading to the formulation of new questions. This is well illustrated by the following quote:

“The scientist, by the very nature of his commitment, creates more and more questions, never fewer. Indeed the measure of our intellectual maturity, one philosopher suggests, is our capacity to feel less and less satisfied with our answers to better problems.”

G.W. Allport, *Becoming*, 1955

This work may not be an exception, as several issues are yet to address and new questions may have arisen. The research questions and corresponding research hypothesis, for the presented collaboration readiness assessment approach, require additional effort to address these issues that need to be handled. They spread across the several aspects of collaboration readiness. The very first impression is that preparedness, competencies fitness and willingness are large and complex subjects, and that each deserves dedicated research in order to reach a full exploitation and understanding of the fundamental concepts and their ingredients. Some of the issues scheduled for subsequent research are summarized below.

During this research, no character model intentionally tailored for organizations in a context of collaboration was found. A model which explicitly integrates collaboration-

related traits, however, is very important for the continuity of this line of research, which specifically assumes a behavioral perspective for collaboration readiness. However, this job requires the intervention of a multidisciplinary team composed of experts from the Organizational, Social, Collaborative Networks and Knowledge Modeling areas. A contribution to this effort from this work can be the inputs provided by the Text Data Mining process described in chapter 4, which was performed in order to find clues about the mentioned collaboration-related traits, which would help establish that job.

The collaboration readiness concept requires more modeling experiments for its subsequent development. The experiments described in chapter 4 were fundamental for the development of the collaboration readiness assessment approach, and they should continue for a full understanding of collaboration readiness and its development to newer and improved levels.

An issue which also deserves additional work is to construct an adequate Bayesian belief network to handle the problem of uncertain assessments. A belief network, during this research, was proposed as an alternative to behavioral profile-based assessment, when there is not enough information to characterize a partner's traits. The development of such belief network also requires the intervention of a team of people from Collaborative Networks, Organizational Behavior, and Knowledge Modeling in order to first establish its structure, to specify causal independencies, and to perform the probability elicitation process, which is necessary to undertake for the filling of the belief network's conditional probability traits.

It is also necessary to research on the determination of the weights between attitudes, social influences and perceived behavior control in relation to the willingness to collaborate.

The collaboration readiness assessment approach requires application in more examples of partnerships or collaborative networks. It is desired that these cases consist of both past and futures ones. This will help perceive whether the model can be applied and explain what happens in these cases in terms of collaboration. If the approach is applied in a significant number of cases, a statistical validation can also be achieved.

As a final remark, considering what has been researched, found and discussed, the best belief of this research work is that this model provides a better perspective - a behavioral one - which in turn allows improved decision making related to collaboration readiness assessment.

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Annex 1- The big five personality scale

Table A1.1 - Description of the big-five personality model (inspired in (Yee, 2009))

Neuroticism (N)	
<u>Facets</u> : anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability	
High Neuroticism	Low Neuroticism
Someone with high neuroticism is easily affected by the surrounding atmosphere. They get worried easily, are quick to anger, and easily discouraged. They often feel uneasy and embarrassed. They have difficulty resisting temptations and coping with stress.	People with low neuroticism have very stable moods. They often appear calm and relaxed. They are able to cope with stress around them and thus it takes more to discourage and embarrass them. They are composed and are able to handle stressful situations without anxiety.

Extraversion (E)	
<u>Facets</u> : warmth , gregariousness, assertiveness, activity, excitement-seeking, and positive emotions	
High Extraversion	Low Extraversion
Individuals who score high on Extraversion are affectionate, friendly and intimate. They are gregarious and prefer company. They tend to be assertive and drift towards leadership positions. Craving excitement and thrills, they work and play at a fast pace. They usually have cheerful, optimistic outlooks on life in general.	Individuals who score low on Extraversion are reserved and formal. They prefer to be alone and seldom seek out company. They tend to stay in the background and perform their activities at a more leisurely pace. They have a low need for thrills and have a less exuberant attitude in general than extraverts do.

Openness (O)	
<u>Facets</u> : fantasy, aesthetics, feelings, actions, ideas, and values	
High Openness	Low Openness
People with high openness are imaginative and daydream a lot. They appreciate art and beauty and place value on emotions. they prefer variety in their lives and enjoy trying new things out. They have a broad intellectual curiosity and seem to be able to talk knowledgeably about many different things. They are liberal and open to re-examining their own values.	People with low openness focus on the here and now. They find speculative talk a waste of time. They are uninterested in artistic endeavors and discount the value of emotions. They prefer familiar, routine tasks and life styles. They have a narrow intellectual focus and are very conservative and dogmatic about their own views and values.

Agreeableness (A)	
Facets: trust, straightforwardness, altruism, compliance, modesty, tender-mindedness	
High Agreeableness	Low Agreeableness
Individuals high in this scale see others as honest and well-intentioned. Thus they are often straight forward and frank with others, and are willing to help and trust in them. If placed in a conflict, they usually defer under a higher authority. They are humble, sometimes self-effacing, and are usually tender-minded and easily moved.	Individuals low on this scale have a cynical and skeptical outlook on life. They find it hard to trust others and often appear guarded and reluctant to get involved. They are aggressive and competitive, especially when placed under conflict. They often feel superior to others, and are hard-headed and rational.

Conscientiousness (C)	
Facets: competency, order, dutifulness, achievement, striving, self-discipline, and deliberation	
High Conscientiousness	Low Conscientiousness
People with high conscientiousness feel capable and effective. They are well-organized, neat and tidy. Governed by conscience and honor, they are driven to achieve success. They focus on completing tasks and think carefully before acting.	Individuals low in this scale often feel unprepared. They are unorganized and unmethodical in performing tasks. They are casual about obligations and have a low need for achievement. They procrastinate frequently and are easily distracted. They are spontaneous and hasty in tasks.

Annex 2- Metaphor which sees an organization as a living entity

Table A2.2 – Characteristics of an organization as a living entity (Barrett, 1998)

<p><u>The physical well-being of an organization:</u></p> <p>It is determined by its financial success. Finance is to companies what water, food and air are to humans. It is the source of energy that keeps companies alive. The indicators that can be used to measure physical-well being are the profit, cash-flows, return on assets and share-holder value, are the indicators usually used to measure an organization's physical-well being. The problem with financial indicators is that they focus on the past and tell nothing about the factors which govern future financial success, namely customer satisfaction, employee morale, internal cohesion, strategic alliances, innovation and productivity. Nevertheless, these indicators are used by most companies to assess corporate health. An organization that sees itself as a living entity understands the long-term financial success is a function of the organizations physical, emotional, mental and spiritual health. It constantly seeks to improve and monitor all these aspects.</p>
<p><u>The emotional well-being of an organization:</u></p> <p>It is determined by how good it feels about itself and the quality of its relationships. Corporate fitness, namely productivity, efficiency, quality, and interpersonal relationships are the types of indicators that are used to measure emotional well-being. Employees at all levels need to feel they have a strong sense of friendliness and connection to their co-workers and their supervisors. Without these relationships, they rarely contribute with more than they are asked. Employees also need to feel a sense of fairness, equality and recognition. They want responsible freedom and to take pride in their work. An organization that sees itself as a living entity strives to treat their employees as it would like to be treated itself. It understands that when you care for others, they care for you in return.</p>
<p><u>The mental-well being of an organization:</u></p> <p>It is directly related to the openness of the company to both internal and external feedback. Learning as a fundamental factor to survive in a competitive world, as without learning employees are unable to progress and companies become quickly extinct. There are two type of learning: Learning contributes to improvements in products and services, by focusing in external market-based achievements, and the second contributes to internal culture-based improvements.</p> <p>External achievement fuels corporate self-esteem and morale, while internal. Participation and innovation are types of indicators that measure mental well-being. The author says that fostering creativity is far more important than fostering knowledge. Knowledge should be regarded as a springboard to creativity, but not as a goal in itself. When knowledge is combined with rigid thinking, it blocks learning. Organizations that see themselves as living entities encourage employees to grow in both their personal and professional lives. Personal growth builds emotional intelligence and professional growth builds skills and intellect.</p>
<p><u>The spiritual well-being of an organization:</u></p> <p>It is determined by its degree of internal and external connectedness. Cohesion, cooperation, partnering, strategic alliances, community involvement and social responsibility are the types of indicators that are used to measure spiritual well-being. Internal connectedness occurs in organizations with strong values-driven cultures. When employees have a common identity, strive to achieve a common vision and share the same values, they work together for the common good. They participate in collective learning and develop a strong sense o loyalty to the company. External connectedness occurs when the organization forms strategic alliances with customers and suppliers, and builds partnerships with the local community. The sense of external and internal connectedness is weighted when the company takes an ethical stance on issues that affect the well-being of society. Companies that see themselves as living entities focus on employee fulfillment. They know that when employees are encouraged by their supervisors to find meaning through their work, to make a difference in their local community, and to serve humanity or the planet, they bring forth the deepest levels of motivation, creativity and loyalty. Spiritual well-being is the cultural glue that makes the difference between a good and a great company.</p>
<p><u>Author's conclusions</u></p> <p>Emotional and spiritual motivation, not physical engineering, provide the ultimate answer to increase productivity and creativity. What has been labeled as "soft stuff" by diehard scientific management theorists is about to become the next arena for corporate change. The soft stuff will join ranks with the hard stuff in management theories. Managers and leaders will have to become comfortable discussing their values and behaviors and learn the difference between change, transformation and evolution.</p>

Annex 3 – List of sites for the Text Mining Process

Below there is a list of sites used, in the text mining process of chapter 4, to determine which traits are more important in order to assess collaboration preparedness. These sites comprise information regarding partnership success/failure factors, as well as the description of some cases. The sites' information are modeled as Prolog facts. The last time they were used was in 2009-09-02.

site(1,'http://www.ctic.purdue.edu/kyw/brochures/BuildingLocal.html').
site(2,'http://casdp.org/mainpages/projects/eval.php').
site(3,'http://www.communityfutures.com/cms/Partnerships.165.0.html').
site(4,'http://www.heritageinterp.com/developi.htm').
site(5,'http://www.ed.gov/pubs/Partners/case2.html').
site(6,'http://www.ed.gov/pubs/Partners/case4.html').
site(7,'http://www.ed.gov/pubs/Partners/case5-a.html').
site(8,'http://www.ed.gov/pubs/Partners/case5-b.html').
site(9,'http://www.ed.gov/pubs/Partners/case6-a.html').
site(10,'http://www.ed.gov/pubs/Partners/case6-b.html').
site(11,'http://www.ed.gov/pubs/Partners/case7-a.html').
site(12,'http://www.ed.gov/pubs/Partners/case7-b.html').
site(13,'http://www.ed.gov/pubs/Partners/case8-a.html').
site(14,'http://www.ed.gov/pubs/Partners/case8-b.html').
site(15,'http://www.ed.gov/pubs/Partners/case9-a.html').
site(16,'http://www.ed.gov/pubs/Partners/case9-b.html').
site(17,'http://www.ed.gov/pubs/Partners/case9-c.html').
site(18,'http://www.powerhomebiz.com/vol145/partnership3.htm').
site(19,'http://www.cdc-crdp.gov.kh/cdc/building_partner/building_partnership.htm').
site(20,'http://www.cdc-crdp.gov.kh/cdc/building_partner/process_since.htm').
site(21,'http://www.cdc-crdp.gov.kh/cdc/building_partner/building_example.htm').
site(22,'http://www.cdc-crdp.gov.kh/cdc/building_partner/theway_forward.htm').
site(23,'http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VB0-3WF819K-1&_user=2975255&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_version=1&_urlVersion=0&_us
erid=2975255&md5=6d505737a1b7f88cbeb3a73d22ad1bd6').
site(24,'http://www.partnerships.org.uk/pguide/fulltext.htm').
site(25,'http://www.partnerships.org.uk/AZP/A-Zp.htm').
site(26,'http://www.partnerships.org.uk/guide/intro.htm').
site(27,'http://www.partnerships.org.uk/guide/tour.htm').
site(28,'http://www.partnerships.org.uk/guide/ideas.htm').
site(29,'http://www.partnerships.org.uk/guide/easy.htm').
site(30,'http://www.partnerships.org.uk/guide/frame.htm').
site(31,'http://www.partnerships.org.uk/guide/stance.htm').
site(32,'http://www.partnerships.org.uk/guide/time.htm').
site(33,'http://www.partnerships.org.uk/guide/theory.htm').
site(34,'http://www.partnerships.org.uk/guide/howto.htm').
site(35,'http://www.partnerships.org.uk/guide/AZpartic.html').
site(36,'http://www.partnerships.org.uk/AZP/sheets.html').
site(37,'http://www.partnerships.org.uk/articles/still.htm').
site(38,'http://www.partnerships.org.uk/pguide/trusts.htm').
site(39,'http://www.partnerships.org.uk/pguide/create.htm').
site(40,'http://www.partnerships.org.uk/pguide/start.htm').
site(41,'http://www.partnerships.org.uk/pguide/stage.htm').
site(42,'http://www.partnerships.org.uk/pguide/az.htm').
site(43,'http://www.partnerships.org.uk/AZP/start.html').
site(44,'http://www.partnerships.org.uk/AZP/agree.html').
site(45,'http://www.partnerships.org.uk/AZP/bid.html').
site(46,'http://www.partnerships.org.uk/AZP/gold.html').
site(47,'http://www.partnerships.org.uk/AZP/gov.html').

site(48,'http://www.partnerships.org.uk/AZP/princ.html').
 site(49,'http://www.partnerships.org.uk/AZP/manage.html').
 site(50,'http://www.partnerships.org.uk/AZP/roles.html').
 site(51,'http://www.partnerships.org.uk/AZP/steer.html').
 site(52,'http://www.partnerships.org.uk/AZP/vision.html').
 site(53,'http://www.partnerships.org.uk/AZP/board.html').
 site(54,'http://www.partnerships.org.uk/AZP/bus.html').
 site(55,'http://www.partnerships.org.uk/AZP/case.html').
 site(56,'http://www.partnerships.org.uk/AZP/comms.html').
 site(57,'http://www.partnerships.org.uk/AZP/comp.html').
 site(58,'http://www.partnerships.org.uk/AZP/constit.html').
 site(59,'http://www.partnerships.org.uk/AZP/core.html').
 site(60,'http://www.partnerships.org.uk/AZP/dev.html').
 site(61,'http://www.partnerships.org.uk/AZP/events.html').
 site(62,'http://www.partnerships.org.uk/AZP/feas.html').
 site(63,'http://www.partnerships.org.uk/AZP/fin.html').
 site(64,'http://www.partnerships.org.uk/AZP/mat.html').
 site(65,'http://www.partnerships.org.uk/AZP/project.html').
 site(66,'http://www.partnerships.org.uk/AZP/stbudg.html').
 site(67,'http://www.partnerships.org.uk/AZP/A-Zp.htm').
 site(68,'http://www.partnerships.org.uk/pguide/ad.htm').
 site(69,'http://www.partnerships.org.uk/pguide/lr.htm').
 site(70,'http://www.partnerships.org.uk/pguide/sz.htm').
 site(71,'http://fivevital.educe.co.uk/fs_5vital_01.htm').
 site(72,'http://fivevital.educe.co.uk/fs_5vital_02.htm').
 site(73,'http://fivevital.educe.co.uk/fs_5vital_03.htm').
 site(74,'http://fivevital.educe.co.uk/fs_5vital_04.htm').
 site(75,'http://fivevital.educe.co.uk/fs_5vital_05.htm').
 site(76,'http://www.wipplaw.com/partnership-failure.html').
 site(77,'http://www.content4reprint.com/business/management/business-coaching-five-key-factors-in-developing-successful-partnerships.htm').
 site(78,'http://www.artipot.com/articles/38441/business-coaching-five-key-factors-in-developing-successful-partnerships.htm').
 site(79,'http://www.government-grants-101.com/partnerships.htm').
 site(80,'http://www.contracosta.edu/documents/Partnerships.htm').
 site(81,'http://www.sandhill.com/opinion/editorial.php?id=150').
 site(82,'http://ezinearticles.com/?Why-Most-Partnerships-Fail&id=886900').
 site(83,'http://www.businessknowhow.com/marketing/marketing-partnership.htm').
 site(84,'http://www.inc.com/articles/1999/10/14563.html').