Estimation of the importance of trust types and their impacts on information sharing in vertical collaborative networks

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Whereas Small and Medium Enterprises can answer the different business challenges through cooperation within Collaborative Networked Organizations (CNOs), human aspects constitute a fundamental issue in these networks since it is neither organizations nor information systems but people that cooperate. This paper addresses the major human aspect considered in vertical CNOs, namely trust that can significantly impact knowledge and know-how exchange as well as information sharing. A case study on Swiss Microtech, a vertical collaborative network from the industry of machining operations, is presented and discussed with respect to these issues. With the help of an Analytic Hierarchical Process technique designed and developed, different trust types are identified, their corresponding weights are evaluated and their relationships with information sharing and exchange are discussed. The results show that the institutional perceptions of trust and its attributes in the enterprises studied are very close to each others. Furthermore, out of the five identified types, only competence, relational and contractual trust categories have a significant impact on strengthening the relationships between enterprises belonging to a vertical CNO.

Keywords: Collaborative networked organizations, trust, information exchange, knowledge sharing.

1 Introduction

A Collaborative Networked Organisation (CNO) is defined as a variety of autonomous entities (e.g. organizations and people), geographically distributed, and heterogeneous

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in terms of their operating environment, culture, social capital, and business goals (Camarinha-Matos and Afsarmanesh, 2005). Although different objectives can be pursued, most of the companies are interested in cost reduction and market penetration as their main objectives for joining a network (Warner and Witzel, 2004). A CNO evolves in a dynamic manner, depending on the different business opportunities offered by customers. Thus, the selected enterprises (or partners) may differ from one business opportunity to another in order to react correctly and efficiently to the evolution of the exact needs of the customers and the features of partners as well as their relationships. Particularly, two typologies of networks can be identified: horizontal and vertical CNOs. Opposed to vertical CNOs, in which the competences of the enterprises that are needed to achieve a business opportunity are complementary, the companies belonging to horizontal CNOs have close competence fields and are mainly interested in increasing their capacities (inventory, production, human resources, etc.) or their negotiation powers with respect to external parties (suppliers, customers, third party logistics, etc.). Since these kinds of organisation are new, most of the research activities focus either on modelling and formalising business processes for the different organisations related to CNOs, such as virtual organisations or virtual breeding environments (see for example (Romero and Molina, 2010), (Romero and Molina 2009), (Camarinha-Matos et al. 2009), (Afsarmanesh and Camarinha-Matos 2009)) or on IT systems and software for business process deployment at different phases of the lifecycle of a CNO (see for instance (Zirpins and Emmerich 2008), (Kourtesis et al. 2010), (Chituc et al. 2009), (Afsarmanesh and Ermilova 2010)). However, the literature hinders the lack of considering human perspectives as a major element in creating and maintaining relationships and profitable processes between companies within a considered CNO. In our work, we focus on trust as the main representative element of

human factors taking part in the different processes one may identify in running a vertical CNO. Based on a case study, the objective of this paper is to propose a methodology to identify and characterize the different components building trust between partners and to evaluate their corresponding contributions in strengthening the relationships between these companies. With respect to the differences of weights, the main trust types or categories in Swiss Microtech are analysed in detail to identify their contributions to the information management and sharing activities as well as to the different business processes.

The paper is outlined as follows. In section 2, theoretical foundations related to trust and its relationships with information sharing are provided. Section 3 contains a full description of the proposed methodology to evaluate the contribution of trust in strengthening relationships between CNO partners. In section 4, an application of the methodology to the vertical CNO Swiss Microtech to assess the contribution of the different trust types to the information and know-how sharing processes are provided. Finally, a conclusion and future research directions are drawn in section 5.

2   Trust and information exchange issues in collaborative networks

Human aspects are recognized as a fundamental issue to be considered in CNOs as neither organizations nor IT systems, but rather how people cooperate (Pouly et al., 2005). The main human aspects on which this work focuses are trust, its components and its antecedents. Since trust is a complex construct, researchers simplified the way to handle it by dividing it into factors, determinants and attributes (Young 2008). The literature considers the trust concept either from a human perspective, where trust is created or controlled by people and may then influence the institutional trust between companies (Huang et al. 2008, Rus and Iglic 2005) or from an institutional perspective,

where trust is closely linked to information sharing and exchange (Msanjila and Afsarmanesh 2011, Thimm and Rasmussen 2010, Bachmann and Inkpen 2011, Cai, et al. 2010, De Jong and Woolthuis 2008).

According to Kumar et al. (1995), trust encompasses two essential elements: Trust in the partner's honesty, and Trust in the partner's benevolence. In a detailed view of trust and its components, Wong and Cheung (2004, 2005) provide a list of 14 factors in their study, including work competence and effective and sufficient information flows. Tian et al. (2008) incorporate five determinants in the model: Reputation, Information sharing, Relationship length, Satisfaction and Relationship-specific investment. Mun et al. (2009) use two inputs in evaluating the trust value of an enterprise. They are, on the one hand, enterprise information including enterprise capability as well as its collaboration results, and on the other hand, enterprise reputation including peer evaluation and the propagated trust and credibility of an enterprise from the network. Kwon and Suh (2004) address the relationships between various constructs and trust. They identify the negative relationship that may exist between factors like behavioral uncertainty or perceived conflict and trust. Paterson (2006) conducted two case studies with questions related to the 12 factors they identify in the literature as the most important to consider in enterprise networks. On the technical side, Msanjila and Afsarmanesh (2008) propose a trust assessment idea taking into account 3 elements: trust between virtual breeding environment (VBE) with stakeholders, trust between the VBE enterprises and the coach, and trust among partners. However, the formal representation is complex and tested only on simulated examples but has not been confronted to real situations.

On the other side, information sharing is cited as being the most important antecedent element taking part in building or maintaining trust between enterprises

(Kwon and Suh 2005, Prax 2003, Kumar et al. 1995, Leverick and Cooper 1998). However, when it comes to collaborative networks, the relationship between trust and information sharing is not a well addressed topic. Forzi and Peters (2005) developed a global methodology integrating technical, organisational and human factors to design a knowledge management system for CNOs. However, the human factor has been limited to the know-how frame of knowledge management software. In addition, Lugger and Kraus (2001) argue that knowledge management does not seem to attach enough importance to the issue of communication, in particular, to internal communication and information exchange. In addition to human and organisational transfer barriers identified, they find that communication media can also contribute to create problems and barriers for knowledge transfer. Volpentesta and Ammirato (2007) focus on knowledge sharing and transfer within a specific type of CNOs in a limited geographical area, called technological districts, where a variety of economic entities (enterprises, research centres, public administrations) are involved in high-intensive research activities and distributed scientific-technological processes. They introduce a breeding environment framework for technological districts that aim to achieve innovation projects. However, they lack addressing trust matters in their study.

As a conclusion, the literature related with CNOs partially addresses the relationship between trust and business processes. Furthermore, the relationships are mainly represented from an Information Technology standpoint to support the creation or running of CNOs. Moreover, the few works addressing trust factors in CNOs consider them from the theoretical point of view, without sharing real case studies.

Since the business processes taking place in a CNO do not only include enterprises but human actors as well, interactions on the human level may influence the interactions between enterprises (Rus and Iglic 2005). As a consequence, trust between

institutional partners may partly be enabled or built through trustful relationships between the CNO actors at the individual level. Since the roles and the processes in which people are involved change from a horizontal to a vertical CNO, and since the empirical field considered in this work is the vertical industrial network Swiss Microtech, we only focus on findings regarding vertical CNOs. Aiming at strengthening the relationships between partners, the objective of this work is to identify the different trust types with respect to the different attributes and estimate their relative impacts on information exchange and know-how sharing processes as measures of the relationship strength.

3   Research methodology

The general methodology developed consists of identifying the main trust factors or attributes according to their contribution to create and maintain trust between partners. In a second phase, a categorization process is conducted to identify clusters of relevant items and to assess their importance with respect to their contribution in strengthening the relationships in a CNO. Finally, the impact of the different relevant categories on processes related to information sharing and know-how exchange is analysed from a qualitative point of view. An application of the methodology to the vertical CNO Swiss Microtech provides evidence of our findings from an empirical perspective.

3.1   *Identification of the relevant trust factors*

The literature constitutes a rich field for determining the attributes/factors that directly impact trust between enterprises in dyadic as well as in network configurations such as CNOs (Cheikhrouhou et al. 2011). In order to determine an exhaustive list of attributes influencing trust, a complete literature review is conducted. The selection criteria used

for this phase are the direct antecedence of the attribute with respect to either interpersonal or institutional trust. A cause-effect analysis then permits to identify whether the attribute has to be considered as a factor impacting trust. Furthermore, care is taken in listing the factors in order to avoid considering concepts as being different while they are actually identical from their semantics. This list is then presented to the coach as well as the decision makers of the CNO (the CEOs of the industrial cluster) for comments, modification and validation. In case a factor is deleted or added by one of the respondents, an unstructured interview takes then place with the respondent in order to identify the reasons leading to such a modification. In the case where the modification is well argued and justified, it is then taken into consideration in the new version of the factors list.

3.2 Categorization of trust

For a comparison and an evaluation purpose, a classification of the factors into clusters representing the different trust categories is achieved. The classification scheme is based on the following criteria:

- The factors belonging to a same category should be of the same nature

- The coherence between factors belonging to the same category has to be ensured

- The categories or clusters have to be independent from each others

    The trust attributes are then grouped into five categories. As shown in Figure 1, the trust clusters are:

- Competence trust (T_{Cp})

- Contractual trust (T_{Ct})

- Relational trust (T_R)

- Indirect trust (TI)

- Negative trust   (T$_N$)

Figure 2 represents the distribution of the different attributes, identified in the earlier step, over the five trust clusters.

[Insert figure 1 here]

[Insert figure 2 here]

3.2.1   Competence trust:

This type of trust represents the belief in the competence of the partner to achieve the tasks asked for a considered business opportunity. Since the competence concept is noted to be an important determinant of the customer's perceived trust in the salesperson (Crosby et al. 1990), competence trust expresses the trust of a partner in another one in executing the operations allocated within an acceptable delay if some tasks are shared between partners of the network, or in delivering specific parts with the required quality if a unique purchaser is set up and associated to these partners. The related attributes are as follows:

- Quality: It is the product and service quality levels that need to be fulfilled with respect to the expectation of a considered partner.

- Timelines / Punctuality: Punctuality is the characteristic of being able to complete a required task or fulfill an obligation before or at a previously-designated time. Besides the economical sanctions that are entailed by non-delivering on time, it can be considered disrespectful and would lead to mistrust.

- Reliability: The ability of a system or a component to perform its required functions under stated conditions for a specified period of time helps the other part of the agreement to be confident and trustworthy about the subscribed treaty. Mutual trust between partners is built on the trust in, and

acknowledgement of, the competence of the other partner to provide goods or services customized to their requirements.

3.2.2 Contractual trust

The contractual trust is the economical or "formal" aspects of trust in a relationship. It takes into account the expected manner to work and to bring to fruition an agreement between the partners. These aspects can be written in a contract but not necessarily. The related attributes are as follows:

- Spirit of cooperation/ Problem solving/ Responsiveness (in unexpected situations): Cooperation is seen as a spirit of mutual willingness and coordination as explicit joint activities between partners, such as those associated with logistics, information systems, and promotions, since that a spirit of cooperation should result in congruent coordinative behaviors.

- Customization/Adaptation: A customized product/service can be seen as a generic product/service which is modified by particular customer needs. Customization can offer a competitive advantage with increased customer value and better service, increased sales volume and customer intimacy. Trust between partners can be created in adapting and customizing business operations and providing alternatives to meet the specific needs of the other partner. In addition, collaboration between partners can enable the network members to adapt and customize their practices, goods and services to fit their partner's business and improved performances.

- Transparency: Transparent attitudes like giving evidence of ethical conduct and providing enough information about different aspects of the company helps

being trusted. Informing the partner, proposing different solutions and choosing the best one help build or increase the trust.

- Permeability / Confidentiality: Confidentiality can be defined as ensuring that information is accessible only to those authorized to have access. For Swiss Microtech, and generally in the Swiss culture, confidentiality is of a high importance since information received for agreed purposes and avoiding undesired filtrations give insurance to the information provider.

- Honesty: Honesty is delivering the correct information, including various types of communication, both verbal and non-verbal. Honesty implies a lack of deceit. A statement can be strictly true and still be dishonest if the intention of the statement is to deceive its audience. Similarly, a falsehood can be spoken honestly if the speaker actually believes it to be true. While there are a great many moral systems, generally speaking, honesty is considered moral and dishonesty is considered immoral.

3.2.3 Relational trust

This particular type of trust includes human aspects of the economic relations that could allow developing or improving relations. The related attributes are the following:

- Information sharing: Sharing information may be interpreted as a gesture of "good-faith", a sign of trust within a relationship. Sharing sensitive information, while necessary for strategic coordination among logistics partners, clearly puts a company in a vulnerable position. The willingness to share information for the benefit of the partners speaks well for the long-term intentions and benevolence of the sharing partners (Tian et al. 2008). The exchanged information is from

different types, depending on the objectives of the relationship (Ayadi et al. 2010).

- Shared value: In Collaborative Networks, shared value refers to the idea that corporate success and welfare of the other elements that take part in the economical relation are interdependent to the extent to which partners have common beliefs about what behaviors, goals, and policies are important or unimportant, appropriate or inappropriate, and right or wrong. Shared value is a direct precursor of trust (Morgan and Hunt 1994).

- Commitment to the relationship/ Relational investment: Increased trust can be achieved by demonstrating practitioner commitment (Tian et al. 2008). Commitment is very important because it encourages people to:

  (1) work at preserving relationship investments by cooperating with existing partners,

  (2) resist to attractive short-term alternatives in favor of the expected long-term benefits of cooperating with existing partners,

  (3) view potentially high-risk actions as being prudent because of the belief that their partners will not act opportunistically.

- Benevolent / Supportive / Relational flexibility: Suppleness and comprehension in a relation from an organizational point of view can take pressure off and give fluency to the relationship, thus improving it.

- Predictable behavior: Studies have shown that the lower the behavioral uncertainty is, the higher the level of trust among supply chain partners will be (Ayadi et al. 2010).

- Friendliness / politeness: These factors can maintain and build trust when partners are involved in regular interaction. The human contact can be an important issue even when the main kernel of the relationship is economical.

3.2.4 Indirect trust

The indirect trust focuses on the external factors and components that can indirectly influence trust between partners in a CNO. The related attributes are the following:

- Reputation: Reputation is the set of impressions held by a company. Companies with higher reputation are trust worthier and could then increase the number of business opportunities they are requested to participate in.

- Work standards: They are defined as the most efficient methods to provide a product/service using available equipment, people, and material. The Work standards depict the key process points, operator procedures, production sequences, safety issues, and quality checks. Standards are an essential requirement for any company seeking continuous improvement. All continuous improvement methods influence learning to get better results from their business efforts.

- Financial stability: The financial status of the company affects the decision to trust a company in a CNO. Contractors who have a healthy financial status are trustworthy in views of the clients as their risks to make profits by finding loopholes in contract or applying unreasonable claims are lowered (Wong and Cheung 2004).

- Qualification of employees: Employees are responsible for the process and they should assure a high process capability. Hence, cross training and deployment of workers are important implementation aspects. Furthermore, they can give valuable hints for process improvement because they deal with the process in a

daily manner. Accordingly, training is necessary to guarantee a sufficient qualification level. Although employees have a high potential for improvements, they must still be considered as the source of potential failures.

- Duration of partnership: the duration of the partnership will affect the level of trust in it (Dyer and Chu 2000). Stable relationships help decrease transactional costs, induce desirable behavior, reduce the extent of formal contracts and facilitate resolution of disputes (Sahay 2003).

3.2.5 Negative trust

Negative trust is defined as the difference of power between two partners in a considered relation. If the relation is not on the same level from the point of view of both companies, this can lead to a source of conflicts between the partners. As a consequence, the more the relation is unbalanced, the higher the negative trust will be. The related attributes are the following:

- Dependence / Asymmetric relation: Even if dependence and asymmetry do not irrevocably condemn the partners to ruinous conflicts, they may disturb the harmony and decrease the trust level of their relationship.

- Opportunistic behavior: Opportunistic behavior has more chances to appear if the power in the relation is not symmetric. We observe that when a party believes that a partner develops opportunistic behavior, such perceptions will lead to a decrease in trust. It is also observed that such behavior results in a decrease in relationship.

- Own specific asset: Asset specificity refers to investments in physical or human assets that are dedicated to a particular business partner and whose redeployment entails considerable switching costs (Kwon and Suh 2004). The fact that

transaction-specific investments cannot be easily redeployed gives rise to a safeguarding problem, which implies potential costs. Thus, if a firm always tries to minimize transaction costs, the firm's investments in specific assets provide a rationale for distrusting partners in the relationship. In other words, non-redeployable specific asset investments make the firm behave in a skeptical manner toward the partner, due to the perceived need to safeguard information. This state (the firm's aroused distrust or skepticism) may logically lower the level of trust.

3.3 Evaluation of the importance of trust categories

In order to evaluate the importance of each trust category in comparison with the other categories, a Multi Criteria Decision Making method is designed based on Analytic Hierarchy Process (AHP) (Saaty 1980). AHP provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements and for evaluating alternative solutions. With AHP, the different types of trust can be weighted and the major components actually building trust in the CNO are identified. In fact, it is the essence of the AHP to use judgmental information to perform evaluations and convert them into numerical values that can be processed and compared over the entire range of the problem. AHP is first based on the design of a questionnaire that is administrated to the decision maker of each enterprise. The five categories of trust are explained with their respective attributes to avoid giving rise to any kind of confusion or misunderstanding. On these questionnaires, the decision makers are asked to proceed to pairwise comparisons between the categories. The perception of the different categories by each decision makers is then captured, allowing a focus on the most important categories and their corresponding attributes. The result helps strengthen

the relationships between CNO partners. AHP is a well suited approach to solve the considered problem for the following reasons:

- The model contains few inputs. It is advisable that the multi-criteria decision making method has to be able to answer to the question "how much preferred is an input towards another".

- AHP is indicated for models with few criteria since that evaluation provides a relative weight for each category of trust.

- The different identified categories considered as criteria are independent.

Practically, each decision maker taken from the six companies taking part in Swiss Microtech is asked to evaluate the difference in importance between the categories by comparing each one to the other (pairwise comparison). The decision makers can use concrete data about the categories, or they can use their judgments about the categories' relative meaning and importance. A numerical weight or priority is derived for each comparison in a rational and consistent way. This capability distinguishes the AHP from other MCDM techniques. As shown in figure 3, the marks are given with integer numbers on a scale ranging from -9 (for absolutely less important) to 9 (for absolutely more important). The value "0" is not used, so if the importance of two types of trust is equal, -1 or 1 can be used.

[Insert figure 3 here]

3.4 Identification of key categories with respect to information sharing

In addressing the different business processes related to information sharing and know-how transfer, trust could play an important role as an enabler and as regulator. The main goal is to link the key trust categories to information sharing and clarifying on the

practical side the corresponding tools/software that could be the means to strengthen relationships between CNO partners. This permits the identification of the functionalities and tasks that could be directly or indirectly impacted by one or more trust categories. The findings are then discussed and validated with the help of the Swiss Microtech coach in order to avoid generating results in specific situations and to ensure a generalization of our findings. In fact, the latter is responsible for managing the CNO and building the needed business processes and workflows at the network level.

4 Application to the vertical collaborative network Swiss Microtech

4.1 Description of the CNO Swiss Microtech

Originally, a research work on the situation of 10 small and medium manufacturers of high precision parts in 1999 on their strengths, weaknesses, opportunities and threads permitted to identify the needs for synergies between these enterprises (Pouly et al. 2002). With the scientific support of the Swiss Federal Institute of Technology at Lausanne (EPFL), Swiss Microtech was founded in 2001, by four manufacturers. Today, Swiss Microtech is seen as a vertical CNO consisting of 6 SMEs located in close proximity in the Swiss Jurassic arc and active in the production of high precision mechanical parts. The number of employees varies between 12 and 80, depending on the considered enterprise. The network is exporting 90% of the total produced parts and thus is confronted to the global worldwide competition. Its main business objective is to provide a large palette of parts and services that are beyond the individual capability of each member in terms of production and inventory capacities. The network is mainly based on two elements as represented in Figure 4: the industrial cluster and the virtual enterprises.

[Insert figure 4 here]

4.2 Industrial cluster

The industrial cluster is the stable basis of a network consisting of independent enterprises considered as partners when the opportunities come for entering new markets or developing new products or services. Selecting the members of the cluster is a key process during the creation of such a network that gathers companies wishing to remain independent and participate in this project on a purely voluntary basis (cf. (Flores and Molina 2000), (Cheikhrouhou et al. 2010)). According the Swiss Microtech rules, an enterprise is accepted as member on the basis that it:

- brings complementarities at the technical (machinery resources, technological know-how, etc.) as well as the economical (markets, products, etc.) levels; the alliance is then better suited to fulfill the customer needs than any individual partner alone would have been able to,

- has a similar level of quality,

- shares a common approach of doing business with customers, suppliers, partners and competitors (common business ethics),

- is deeply convinced that an alliance is a solution for the future and be ready to invest before collecting gains.

4.3 CNO and virtual enterprises based on the cluster

Virtual enterprises will be set up with cluster members from the CNO to fulfill customer needs or a business opportunity in an optimal way. The best suited enterprises on the technical competences as well as on their availability and response capacities will join the efforts to achieve the business opportunity transformed into orders (Soner et al. 2011). The selection process relies on the following goals:

- To allow its members to reach new markets

- To increase competitiveness by reduction of costs through grouping supply and purchase activities and pooling of several resources (machines, human resource, inventory facilities…)

- To increase the added value of the industrial products by the addition of complementary services

- To reinforce the image of the industry of the Swiss Jurassic arc by an innovative step ready to answer the challenges of modern trade.

4.4   Structure and roles

Even a light framework like a CNO needs a minimum but clear structure to run business. The structure that is used is based on roles. A role is a function which can be fulfilled by one or more persons and takes place in a business or technical process. Four main roles have been identified as represented in Figure 5: In/Out-sourcing managers, coach, order manager and broker.

[Insert figure 5 here]

- **In-/Outsourcing Managers**

    Each enterprise belonging to the cluster must appoint an In-/Outsourcing Manager responsible for the contacts within the network. The I/O manager receives the requests for quotation from the brokers and prepares the bids in case of interest.

Since reaction time is important for a customer, he/she is responsible for a timely answer. He/she is also the contact person for the order manager within a virtual enterprise in which his/her company is participating. Finally, he/she represents his/her company within the cluster and acts as a contact person.

- **Coach**

    The responsibility of the coach is the animation and the management of the network. He/she prospects and evaluates new possible cluster members, organizes the

information and knowledge transfer actions and can also be the arbitration instance in case a problem between the members occurs.

- **Broker**

The broker promotes the network to the potential customers and manages the requests for quotations. He/she is also responsible for the preparation and follow-up of the quotations until their transformation into real orders. Many people can play the broker role, i.e. salesmen from member companies, independent sales agents, etc.

- **Order Manager**

Once a quotation is validated and transformed into an order, the Order Manager takes over the responsibility up to the delivery point and sometimes even beyond. He/she is the single contact point for the customer and must set up and pilot the virtual enterprise built for this particular job. He/she is accountable for the delays, costs and quality of the order as well as for the commercial part (internal and external invoices). An employee belonging to the company with the biggest share of the order dispatched on the enterprises is normally the one appointed as Order Manager.

- **Working groups**

Working groups can also be created to address particular problems in a smaller circle and propose solutions to the cluster without being a pillar for the setting-up of the CNO. Possible working groups are: common purchase group, IT solutions group, knowledge transfer circle, etc.

4.5   Results of the AHP process

Four enterprises out of the six members participated in the interview process. Helping to achieve pairwise comparisons between trust categories, Table 1 shows the questionnaire administrated to the decision makers of the enterprises. The answers gathered are

depicted in the figures 6 - 9. In each figure, the corresponding weight of every trust type is represented as a percentage over 100%. Within the context of building and maintaining high trust levels, the first surprising result is that the four companies have the same (common) perception about the different trust types and their relative weights. Indeed, all the values obtained are representative and apply for any enterprise in the network since the mean standard deviation of the received responses is 0.013 (see Table 2), calculated with the information received from the four companies as shown in the figures 6 - 9.

[Insert Table 1 here]

[Insert Table 2 here]

[Insert figure 6 here]

[Insert figure 7 here]

[Insert figure 8 here]

[Insert figure 9 here]

As far as the AHP results are concerned, it is clear that the most important trust category considered in the network is competence trust. The second most important type of trust is relational trust (weight between 0.41 and 0.48). Then comes the contractual trust (weight between 0.24 and 0.28) and finally, with very low qualifications indirect and negative trusts (respectively weight between 0.08 and 0.09, and weight between 0.02 and 0.03). Indeed, since the enterprises of Swiss Microtech have been jointly working for a while, they do not expect any of the current partners to behave in an opportunistic way or to create a dependency (creating an unbalanced power situation) that may lead to mistrust. This is due to the fact that, apart from their participation in

business opportunities under the umbrella of Swiss Microtech, the companies also are maintaining their own business activities through their own channels and opportunities, thus reducing the business dependency on the Swiss Microtech offers.

Furthermore, a significant importance of relational trust compared to contractual trust is observed in all the enterprises interviewed. The explanation resides in the Swiss industry culture in which a contract between partners could be just oral and thus commits all the members. Consequently, it is not mandatory in the Swiss industry culture to sign official contracts, thus the relational trust is then more powerful than contractual trust.

4.6   *Information exchange and know-how sharing*

It is well known that information sharing and knowledge transfer between partners is an important criterion to be taken into account in creating and developing trust. In fact, Swiss Microtech uses the Bag of Assets Management System, a web based tool supporting the following functions:

- Information publishing: learned lessons, technical and commercial items, know-how assets and general information of interest can be published using an embedded rich text editor and made available to the other members of the network depending on their access privileges.

- Items evaluation: allowing the network administrator to classify, accept or refuse items and assign a value to them

- Database administration: allowing the network administrator to update and clean the items database.

Information increases the visibility of the CNO from the point of view of the members and can then strengthen the partner trust in the CNO as a whole. This could be achieved thanks to the increase of the contractual trust if transparency is guaranteed and

to the increase of relational trust where the Bag of Assets Management System is used as an information exposure and sharing system.

A simple and quick possibility to publish information contributes to motivate the collaborators of the enterprises to share not only general information but also technical know-how, which is of a high added value for the achievement of a business opportunity. Nevertheless, know-how and knowledge still represent a level of power and reflect the value of a collaborator in his/her organization. It has been noticed that the employees still remain reluctant to share their knowledge if:

- they feel that their value for their company will be reduced and their job jeopardized,

- the goals and the reasons for their company to be member of a collaborative enterprise network have not been clearly explained at all levels of the hierarchy,

- no efforts have been made to present to the other members their products and their collaborators.

4.7   Communication enablers within Swiss Microtech

Webcorp2 is the second generation of an Internet-based collaboration platform developed to support collaborative work and virtual teams. The different functions fulfilled by the platform are:

- MyDesk, personalized view of all relevant information and actions

- community and organization picture

- document management and Web-Content handling

- agenda, tasks, news

- messaging like forums, mail, chat

- project management (planning and controlling)

The functions of the collaborative platform may maintain a high competence

trust. In fact, it is considered as a management system for the business projects and opportunities. The information gathered and the tools offered help fulfil the required technical tasks within the agreed time schedules.

4.8   Competence database

The competence database is used to efficiently find the required competences, technologies and production resources within the network. Since it is public, one of its most important features is its possible use by all interested actors (partners, sales agents, potential customers or even the network members) looking for particular information about the technical competences, either of the network or of the member enterprises. Via the Swiss Microtech homepage, it is actually possible to identify if the network or its members have the required competences to achieve a given project. The database helps in creating transparency within the network and so, in maintaining a high contractual trust level between the partners.

4.9   Internal order management system

The internal order management system is the heart of the collaboration platform used by the members of Swiss Microtech to handle and post inquiries, mainly in the quotation coordination and preparation phase. This module helps the network to create transparency related to the customer's activities, the participation of the partners in the orders and the corresponding turnover. A customer's inquiry goes through a 3-stage process: inquiry, quotation and finally ordering. Inquiries are directly uploaded to the platform by the customers or the network brokers and the different consequent processes are systematically monitored. The target is to improve commercial processes in Swiss Microtech through the following new features:

- easy integration and data exchange between different commercial business software, thus making the cross-company processes efficient and effective,

- real-time functions like audio and video conferences, desktop and file sharing allowing every employee to cooperate online anytime and anywhere with other employees either from the same company or from another one,

- multi-project management and controlling system,

- new process oriented user interface, allowing inexperienced collaborators to use the platform with a minimal training and without the need to go through a knowledge management system.

According to the importance of the internal management system and to the multitude of processes driven, these features clearly can help to strengthen the relational, the contractual as well as the competence trust.

4.10 Discussion and negotiation processes

The Swiss Microtech members use drawings as the main source of technical information and data. The recent versions of commercial CAD/CAM software allow the exchange of 2D or 3D drawings. However, interoperability remains an issue. Indeed, it is still difficult to share information in different formats between enterprises regarding the heterogeneity of the different databases and software used to create the drawings. A powerful and easy to use desktop sharing tool is used for the e-discussions between the members with the following features:

- "Software as a Service" tool,

- no high-speed connection required,

- only the host of the discussion needs a software license,

- very easy and intuitive handling,

- low price for acceptable technical performance.

The software allows people to show attendees the different applications, file-like documents or drawings on their own computer screens through the Internet. In combination with the voice over internet protocol function, discussions can be conducted easily. The control of the keyboard and mouse can be given to any attendee. These functions allow them to draw directly on a document uploaded on the host screens and independently from the software which is running at that time. This feature is used during technical discussions to highlight details directly on drawings or add information. An example is shown in figure 10 on where the pen function is used to change the tolerances on a specific part. The software contributes to share technical knowledge and know-how between partners' teams as well as within enterprise teams and thus to maintain relational and contractual trust.

[Insert figure 10 here]

4.11 Common understanding tool

Technical misunderstandings can appear between the members of a network if they work in different cultural and industrial environments and do not share the same knowledge. Notions, symbols or terms, which are obvious for one side and are normally not explicitly described, could be unclear for the other side and reciprocally. The consequences of these misunderstandings considerably disturb the business processes and add unnecessary delays and costs. This kind of problem can be avoided through the use of Ontology. The Ontology Discovery and Management System tool ODMS developed within the European ECOLEAD project (Ermilova and Afsarmanesh, 2007) supports ontology functions at different levels of abstraction:

- the meta level represents meta-concepts like the abbreviations or acronyms used to define other concepts,

- the core level used to define common concepts, notions and terms related to the CNO,

- the domain level used to define common concepts, notions and terms related to a specific activity like metal working or tourism,

- the application level used to define usual concepts, notions and terms related to a particular network such as Swiss Microtech.

At the application level, terms or notions such as commonly used norms and standards (ISO or DIN), definition of particular machining operations and surface treatment or specifications for raw material can be introduced in the corresponding ontology database and viewed with a web browser. Actually, Swiss Microtech uses the definitions of the so called German "Stahlschlüssel" handbook to specify steel materials used. The advantage of such a system relies in the facts that concepts, symbols and terms introduced in the ODMS do not have to be explicitly re-defined during the clarification phase of the quotation request process. As a consequence, the risk of misunderstanding between people and between partners is considerably reduced and the relational trust mainly increases as well as the contractual trust, but at a minor level.

5   Conclusion

Considering the huge potential for collaborative networked organizations in all sectors of the economy, a majority of newly created networks disappear in the first two years of their life cycle for different reasons:

- Some networks are not market driven and do not bring significant competitive advantages neither for the customers nor for the members of the network,

- The collaboration domain either is not clearly defined or represents partners' competences overlap which could lead to conflict of interest and a situation of mistrust,

- Collaboration, know-how sharing and information exchange are not necessarily the common working way for opportunistic companies; changing the mentalities needs time.

As the main key success factor of CNOs, collaboration among the network members is enabled by high trust levels. The study of the vertical CNO Swiss Microtech shows that five different trust categories encapsulating different attributes can be identified. These categories do not have the same weights in strengthening the relationships and fostering collaboration between the partners. Through the development of an AHP technique, we prove that the main important categories influencing the relationships are competence trust, relational trust and contractual trust. This result is similar for the four network members that answered to the questionnaire. As a consequence, the focus has to be put on these categories and particularly on their corresponding attributes for the establishment of long term profitable and sustainable relationships.

Besides, the presented methodology allows linking the trust categories to the information exchanged, either between the CNO members or between the network and its external environment. The analysis of the different CNO-related processes shows that information sharing and exchange can be boosted by focusing on particular trust types and their corresponding attributes. However, whether these findings from a vertical CNO apply to horizontal CNOs is still an unsolved question. The methodology presented will be extended in the future with an evaluation of the impact of information sharing degree and quality on the trust levels. Moreover, an interesting research

direction is related to partner selection in a CNO for the creation of virtual organisations to answer to specific business opportunities. The challenge is to identify the impact of trust evolution over time on the robustness of the decisions made in selecting the best partners.

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Table 1. Design of the pairwise comparison questionnaire

Competence trust is	☐	important than	Contractual trust
Competence trust is	☐	important than	Relational trust
Competence trust is	☐	important than	Indirect trust
Competence trust is	☐	important than	Negative trust
Contractual trust is	☐	important than	Relational trust
Contractual trust is	☐	important than	Indirect trust
Contractual trust is	☐	important than	Negative trust
Relational trust is	☐	important than	Indirect trust
Relational trust is	☐	important than	Negative trust
Indirect trust is	☐	important than	Negative trust

Table 2. Weights distribution of the five trust categories for the members of Swiss Microtech

Trust category	Mean weight
Competence Trust T_{cp}	*0.44*
Contractual Trust T_{ct}	*0.18*
Relational Trust T_r	*0.26*
Indirect Trust T_i	*0.09*
Negative Trust T_n	*0.03*
Mean Standard Deviation	0.013
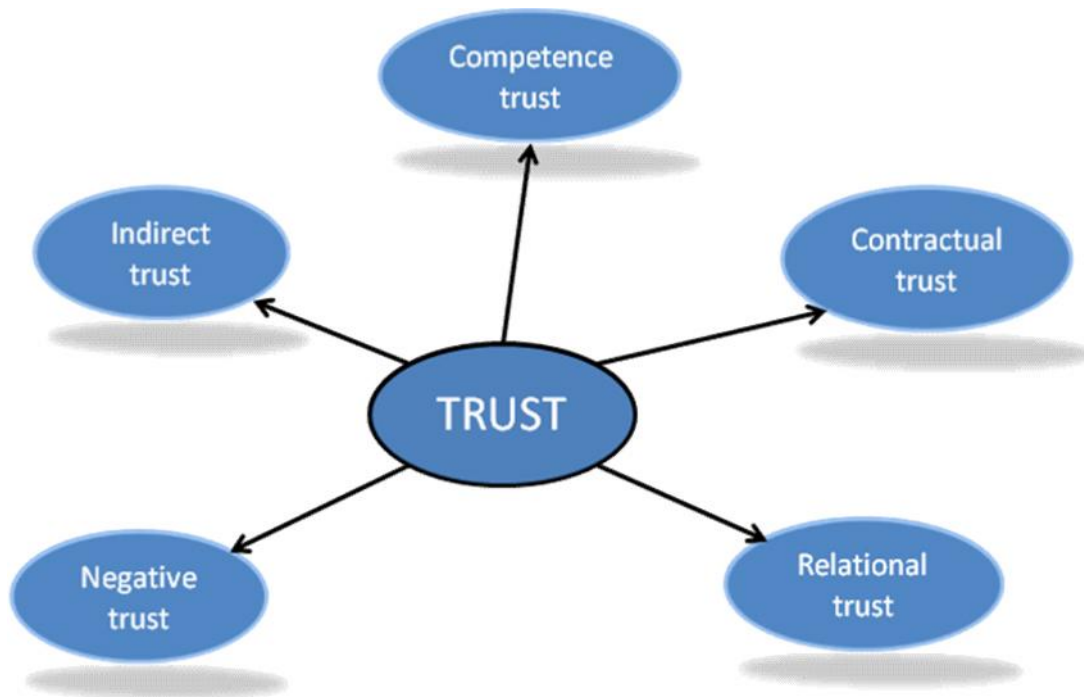
Figure 1. The five trust categories
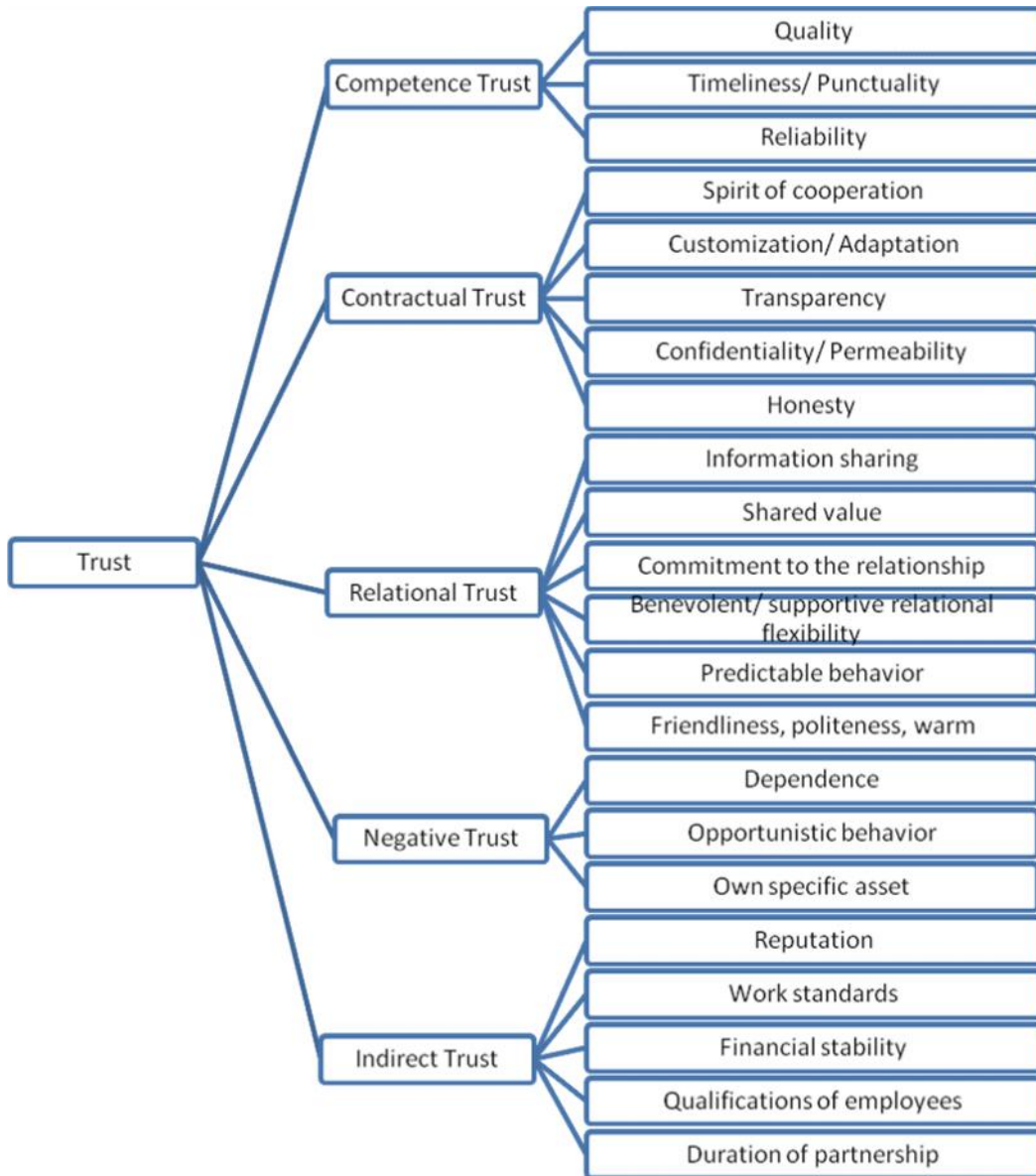
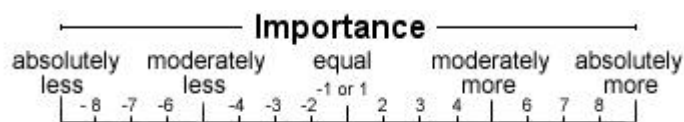Figure 2. Trust categories with their respective attributes

Figure 3. Importance scale used in Analytical Hierarchic Process
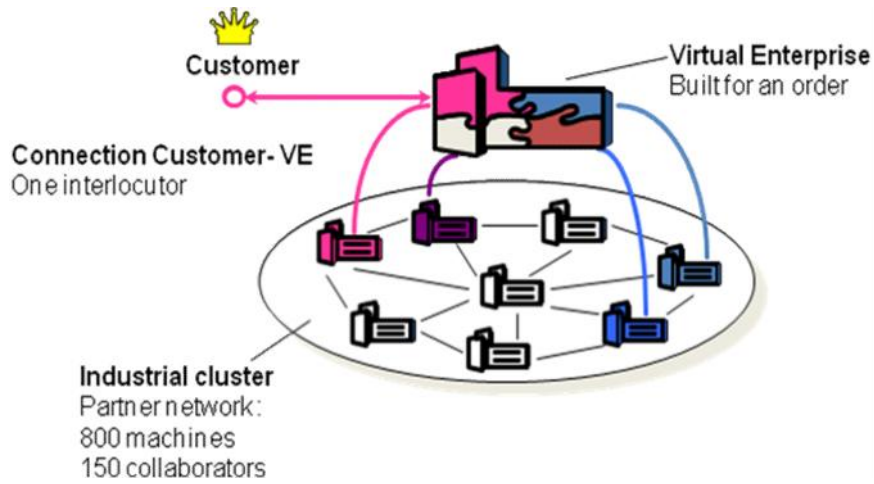
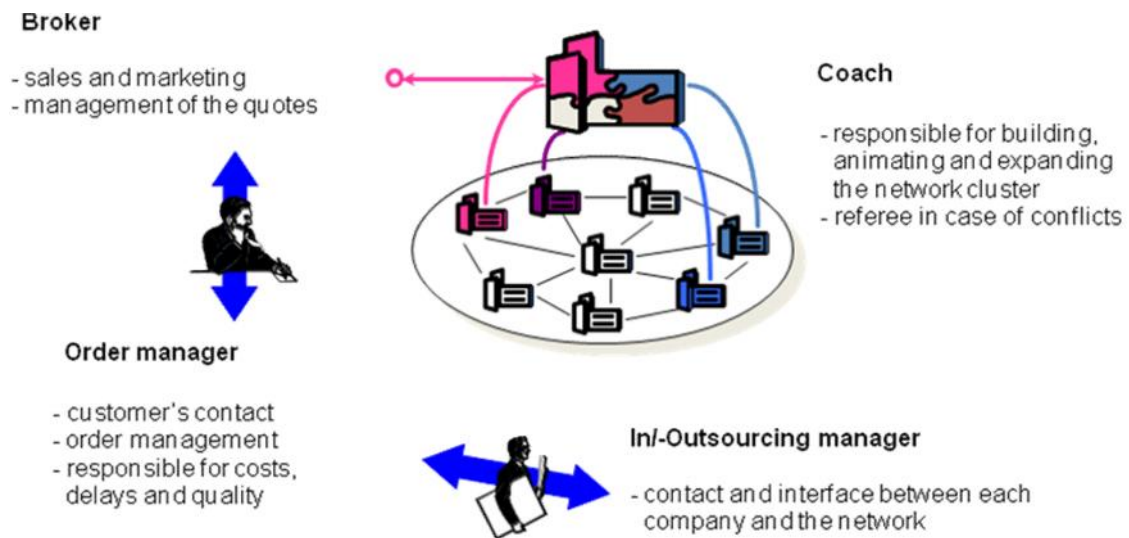Figure 4. Main elements of the vertical CNO Swiss Microtech

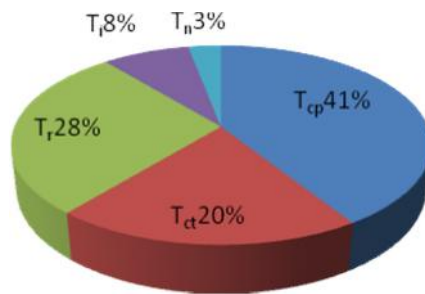Figure 5. Roles and actors in the CNO Swiss Microtech

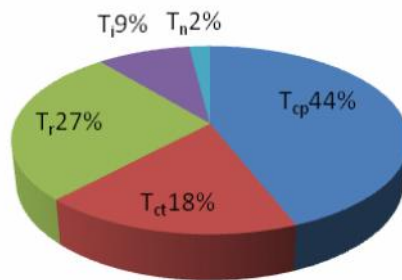Figure 6. Weights of the trust categories for the enterprise 1

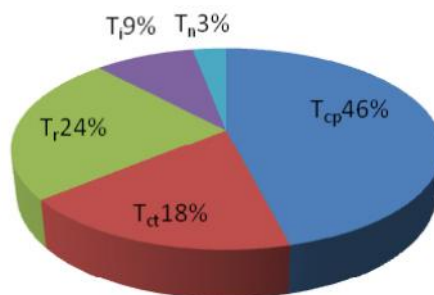Figure 7. Weights of the trust categories for the enterprise 2

Figure 8. Weights of the trust categories for the enterprise 3

Figure 9. Weights of the trust categories for the enterprise 4

Figure 10. Illustration of the "pen function" in a negotiation process