

# Managing collaboration performance to govern virtual organizations

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**Abstract** The ability to collaborate with partners will become an essential core competence that is required from companies when they are going to take up future challenges. Growing complexity of products and services, increasing global competition and accelerated business processes will exceed in many cases the capabilities and capacities of single companies. The involvement of other companies can help to overcome these limitations. However, only what is measured can be managed. Consequently it is necessary to assess the effectiveness and efficiency of how partners work together in joint processes for a common goal. In other word: the collaboration performance has to be measured. But traditional Performance Measurement (PM) methodologies and indicators are designed to assess the performance of single companies or static cooperation like in supply chains. Evaluation and management of collaboration performance as a particular performance perspective in cooperation is not covered by existing approaches so far. Therefore there is still a need for an approach that provides an information basis for the management of collaboration when companies work together in in cooperation. In this paper, which is initially based on a paper presented on the ProVE conference in 2007, different perspectives of collaboration performance are identified and structured. The considerations are based on Virtual Organisations VOs, a particular type of cooperation that requires usually intensive collaborative interactions between the partners.

**Keywords** Collaboration performance · Virtual organization · Commitment

## Introduction

Cooperation is today an established option to deal with increase in product and service complexity, dynamic of changes, requirements upon responsiveness, high quality demands, and fierce competition regarding cost. It helps to overcome the limitations of a single enterprise regarding competences, capacities and financial resources. In particular small and medium sized enterprises have to deal with these limitations. A very simple definition of cooperation is to work together for common purposes. This involves information exchange, adjustment of activities and exchange/sharing of resources (Camarinha-Matos and Afsarmanesh 2008, p. 53), (Thoben and Jagdev 2001, p. 422). So, cooperation is more than a number of companies that are connected over market transactions as depicted in Fig. 1 (derived from illustration of market transactions in Thoben and Jagdev 2001, p. 423).

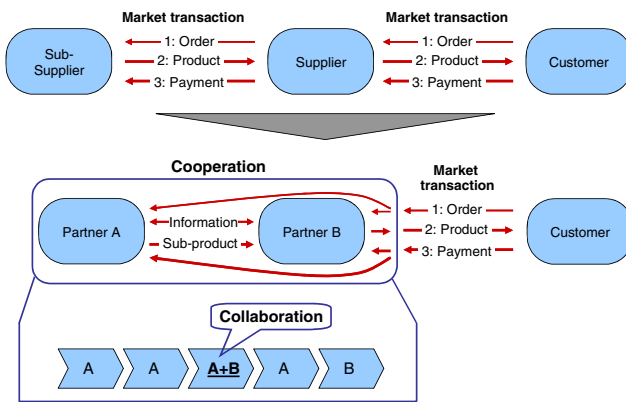
The “working together” can take place in two ways. One is to split the common work into defined single tasks that are assigned to single cooperation partners. The partners work more or less independently on their tasks and deliver a result to the cooperation partners or the common customer. The second way is to perform the work jointly, which means that different partners are involved without an exact definition of their single contributions. Therefore the partners’ contributions can not be assessed separately. Rather the contributions are interrelated and are influencing each other. The results are produced in a “process of shared creation” (Camarinha-Matos and Afsarmanesh 2008, p. 53). The second way is considered as collaboration. In this paper following working definition is used:

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**Fig. 1** Cooperation versus mere market transactions

Collaboration is acting in an incompletely determined and non-hierarchical way to enable joint processes with other independent organisations and human actors that are performed to reach common goals.

However, cooperation is no general guarantee for success. Research has shown that many cooperative organisations were not able to accomplish the set goals (Bamford et al. 2004; Bullinger et al. 2003; Dürmüller 2002). Deficits in the management of the cooperation constitute one category of the identified reasons for failure.

Reichwald et al. interviewed 46 top-managers from automotive industries regarding the management of enterprise networks. According to the interview results the management of network organisations requires different qualifications than management in hierarchic structures. This is caused in particular by higher complexity of structures, processes and tasks. For example the involved entities and persons have usually more leeway that has to be filled. Therefore, it is not sufficient just to transfer the way of management as it is proven in single organisations to network organisations. The main challenge is the management of the relationships in the network (Reichwald et al. 2005, pp. 4, 27–29).

An essential prerequisite for an effective management is a sound information basis. Performance Measurement (PM) is an appropriate method to provide such information. PM can be defined as the systematic approach to plan and conduct the collection of data regarding the accomplishment of defined tasks and corresponding objectives (ECOLEAD 2005). Several research activities dealt with Performance Measurement and various approaches like EFQM, Balanced Scorecard, Six Sigma or the Performance Prism have been developed. Overviews about PM research are given e.g. by Sandt and Joachim (2005) or by Graser et al. (2005). However, most of these approaches were initially designed for intra-organisational PM in single companies. Inter-organisational processes were not in the focus of these approaches.

The need for an extension respectively customisation of traditional PM perspectives to the specific requirements of

cooperation and network organisations was already identified e.g. by Gunasekaran et al. (2001); Leseure et al. (2001) or Hieber (2002). However this research work was focused on cooperation like in supply chains with defined tasks and a more or less hierarchic character. But even for supply chains there are still unsolved challenges regarding PM (Macbeth 2005).

The aspect of collaboration in non-hierarchic cooperation, in which tasks will be performed jointly and the contributions of the partners can not be defined exactly (e.g. in research projects), is not addressed in the exiting approaches so far.

Hence, the objective of this paper is to clarify and structure perspectives of collaboration performance so that they can be regarded in a performance measurement that supports the management of collaboration.

A defined structure of the main aspects of collaboration performance in VOs supports a better understanding of this performance perspective and the related communication. Cooperation management that is actively addressing collaboration performance goes beyond the mere controlling of tasks. The manager reaches a deeper understanding of the activities and the relationships in the cooperation and can trigger processes of self-optimisation. This strengthens the authority of the management and correspondingly the governance of the cooperation. An improved understanding of collaboration performance is not only beneficial for managing the operation phase of cooperation but also for the consortium formation in the creation phase. So the considerations can contribute to current research activities regarding cooperation and in particular collaborative network organisations.

The considerations should be based upon Virtual Organisations (VO). Kürümlüoğlu et al. define a VO as a set of co-operating (legally) independent organizations, which to outside world provide a set of services as if they were one organization, supported by a computer network (Kürümlüoğlu et al. 2005). According to the non-hierarchic and dynamic character of VOs collaboration is an essential element in this special type of cooperation.

Figure 2 gives an overview about how the topic is approached in this paper.

In the first step it is analysed how interactions between companies are assessed in existing PM approaches. This provides a first overview over performance perspectives that are potentially relevant for collaboration. After that the significant characteristics of VOs are considered to derive interactions that are needed to ensure effective and efficient work in such an organisation. It is assumed that collaboration is related to these interactions, so the next step is to identify perspectives of collaboration that enable or support the needed interactions and by this the overall processes in the VO. Finally the identified perspectives are structured to provide a framework for indicators that are used to measure collaboration performance.

Fig. 2 Structure of approach

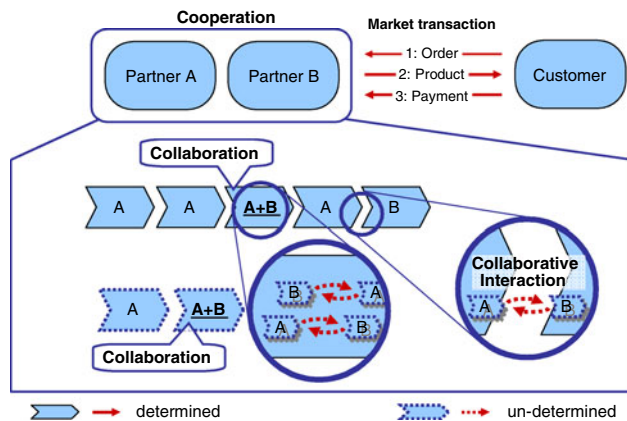
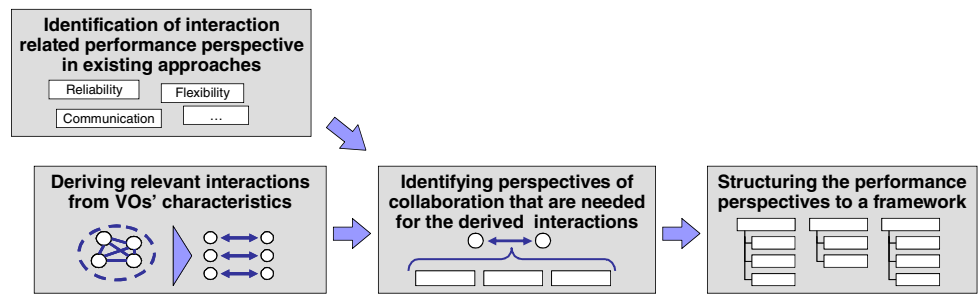


Fig. 3 Interactions in cooperation

**Interactions between companies as basis for collaboration**

Cooperation in the sense of “working together” requires evidently interaction between the partners. The term “interaction” is used in this paper as reciprocal micro-processes between partners that are elementary for the accomplishment of the tasks in the processes. Examples for interactions are information sharing, negotiations or problem solving. Interactions are usually implicit in the value creation processes and therefore often informal (Weber 2007, p. 100). They can be related to (Weber 2005):

- Physical objects.
- Financial resources.
- Information.
- Human resources.
- Legal issues.

The functions of interactions in cooperation processes are illustrated in Fig. 3.

A fictive example that should be used to illustrate the issues in this context is the development of a driver assistance system for distance control. To keep the example simple it is assumed that there are only two cooperating partners: the development department of a car producer as partner A and a company that is an expert for radar devices as partner B. The

common objective is to create a new innovative solution that is applied by a new car line, which represents the customer of the development work. Both partners can not develop the solution on their own but depend on the competences of the other partner.

As depicted in Fig. 3 interactions between the partners are necessary for tasks that should be performed in a collaborative way. The partners’ contributions for these tasks are only described generally and not completely determined in detail. In the example there could be a task to develop the general concept for the distance control system in a common brainstorming workshop. Every partner is expected to provide ideas and impulses but it is impossible to specify the contributions in terms of content, quantity or quality. Therefore it is necessary that the partners interact to clarify, trigger and adjust their contributions.

In addition interactions are also important at the interfaces between tasks that are performed by different single partners when those tasks somehow depend on each other. If, for instance, partner B has a clearly defined task to design the hardware component there could be unforeseen questions that arise during the design process and require adjustments with partner A. This could be the case if the required electrical power exceeds the initially estimated values or if the component will become much smaller than planned and can be placed in another area of the car. In addition partner B has to coordinate the hand-over of results with partner A.

Consequently the need for interaction in a cooperation rises with its collaborative character. Effective interaction is a prerequisite for joint processes under incompletely determined and non-hierarchic conditions and thus for collaboration performance.

**Existing approaches to assess interactions between companies**

If interaction is essential for collaboration and by this for reaching the goals of cooperation, in which partners have to act jointly, the collaboration performance is linked to the performance of interactions. So it should be analysed how this perspective of performance is regarded in existing Performance Measurement approaches.

Performance Measurement was subject of various research works, several approaches were developed and some of them are applied broadly in practice. PM approaches can comprise two main components:

- (1) Performance measurement concepts that describe how to set-up and conduct the PM.
- (2) Defined performance perspectives and indicators to assess the performance of business processes.

Since the objective of this paper is to clarify how to assess collaboration performance only the performance perspectives offered by the approaches are considered. The following section gives an overview over performance perspectives that are regarded in PM. Starting point are traditional perspectives that are considered in most PM approaches. Then perspectives that cover interactions between entities are investigated. Finally it is analysed how the described perspectives can be used for the measurement of collaboration performance like it is required in VOs.

In practice many PM activities focussing on perspectives like cost, profitability, quantitative output, productivity, time, and quality (see e.g. [Rolstadas 1998](#), S. 989f.). These perspectives are used to assess the accomplishment of objectives or obligations. Usually there are corresponding target values or corridors as they are defined for example in business plans or for particular customer orders. These performance perspectives are defined for processes that are determined to a large extent.

To obtain information about potential future results and companies' values new perspectives were added by research, e.g. customer perspective, process capabilities, human and intellectual capital, strength of brands or established supplier relationships (see for example [Kaplan et al. 1992](#); [Stewart 1999](#); [Klingebiel 2001](#); [Kellen 2003](#); [Jana et al. 2007](#); [Skandia 2007](#); or the overviews of [Sandt and Joachim 2005](#); [Graser et al. 2005](#); [Seifert 2007](#)). The examples show that also intangible, less determined aspects, so called "soft-facts", can be assessed in a performance measurement.

However there was still a gap regarding the performance of interactions between partners. Approaches that intended to fill this gap are looking at this type of performance mainly from two viewpoints: Either they tend to assess the actual interaction between partners or they consider the general capability of a company, a kind of "maturity", to interact with partners, which is important for self-assessment and partner selection.

Works that are focussed on the assessment and control of interaction are for example [Beamon \(1999\)](#), [Leseure et al. \(2001\)](#), and [Gunasekaran et al. \(2001\)](#), Supply Chain Operations Reference Model (SCOR) [[www.supply-chain.org](http://www.supply-chain.org)], [Hieber \(2002\)](#), [Schweier and Hendrick \(2004\)](#), and [Sivadasan et al. \(2002\)](#), ProdChain project ([Sennheiser and Andreas](#)

[2004](#), p. 18) or [Simatupang and Sridharan \(2004\)](#). Performance perspectives suggested by these approaches are for instance equity, flexibility, reliability, responsiveness, partnership, collaboration efficiency, generic cooperation performance, absorption of complexity in collaboration, information sharing, decision synchronisation or incentive alignment (sharing of risks, costs and benefits). Some approaches, e.g. Leseure and the ProdChain project, introduced a kind of meta-performance on network level.

More recent works like from [Höbig \(2002\)](#) or [Seifert \(2007\)](#) are looking at the performance of interactions between partners from the viewpoint of assessing a company's capability and preparedness for cooperation.

Höbig considered in his work the general cooperation capabilities of production enterprises. The main criteria are: Communication capability, preparedness for future developments, adaptability, stability, reliability, and customer orientation. For each of these criteria generic high-level indicators are defined.

Seifert analyses in his approach different combinations of partners to accomplish a production task. The assessment of the different consortiums is based on the values the potential partners have achieved for defined performance indicators. As the approach is build upon the SCOR model and the corresponding indicators it covers also some aspects of interactions with suppliers and customers.

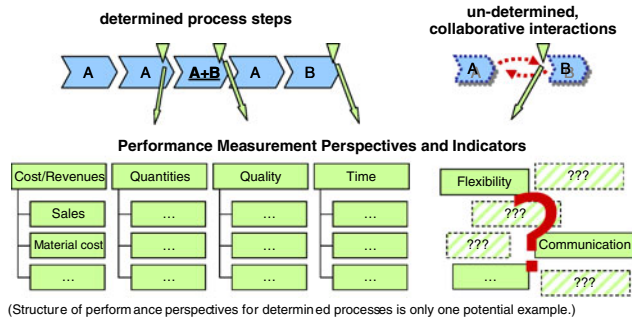
Regarding the practical application of the approaches cited above for a particular VO there are some weaknesses respectively shortcomings. At first, there is a lack of clear descriptions what is included in the performance perspective of collaborative interactions since the approaches address this perspective besides others from a particular point of view and not in a more holistic way. In particular the non-hierarchic and incompletely determined character of collaboration is scarcely regarded. In addition the approaches have some gaps with regard to the completeness of performance perspectives for the interaction of network partners. The perspectives have to go beyond a very generic level and a simple description of interactions. This state of the art is schematically depicted in [Fig. 4](#).

Thus the following section aims at a suitable definition and an overall picture of the performance perspectives that cover the collaborative interactions of partners in VOs.

### Measuring collaboration performance in Vo

As described in the sections above interaction is essential for the success joint of processes in cooperation and therefore has to be regarded in the cooperation's PM. This generic observation should be considered in more detail for cooperation in VOs to obtain corresponding performance perspectives and typical Performance Indicators. Thus collaboration





**Fig. 4** Gap in existing PM approach regarding collaboration performance

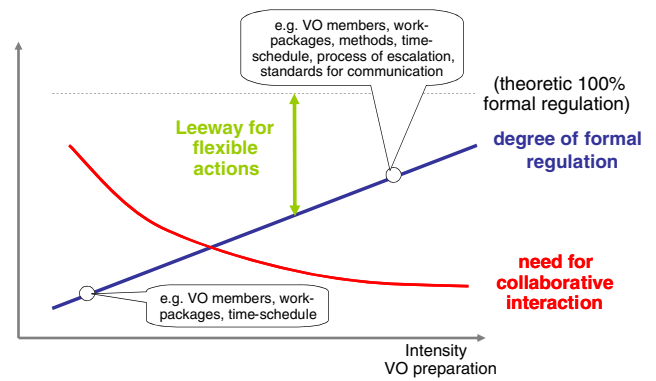
performance becomes more concrete for VO managers and they obtain a clue for actively addressing collaboration between the VO members in their work.

The first step is to characterise the interactions in VOs. This provides a basis to derive and structure perspectives of collaboration performance that are important for the VO Management. The need for interaction and the corresponding requirements upon the VO members are caused by the special way of working in this kind of organisation. Following characteristics differentiate VOs from single companies and more stable and hierarchic networks:

- Independency of VO members.
- Temporary limitation of the organisation and corresponding uniqueness.
- Dynamic.
- Heterogeneity of VO members.
- Local distribution of VO members and corresponding use of ICT (information and communication technology).

According to the *independency of VO members* there is no higher authority that can take the final decision and force VO members into doing something. Only concrete contractual agreements can be demanded from the partners. However, contracts usually cover only elementary issues as they would become very extensive if many details are regulated. In particular for VOs that have to produce creative solutions there are boundaries for contractual regulations since creativity, giving impulses or sharing ideas can hardly be regulated in contracts when the VO is created. Hence, there is a leeway that has to be filled by the partners during the operation of the VO (Reichwald et al. 2005, p. 28). The relationship between regulation, leeway and the need for interaction is illustrated in Fig. 5.

So the independency of partners requires common decisions and agreements as well as initiatives to fill the leeway. The corresponding interactions that are needed for this are exchange of information and impulses, coordination, negotiation, and solving of open issues and problems.



**Fig. 5** Need for collaborative interaction due to missing regulations

In addition the independent partners have usually their own business besides the engagement in the VO. It could even happen that they will compete with some of the VO members for future business opportunities. This influences the interaction of sharing information and in cases where intellectual properties or comparable values are generated the corresponding legal interaction like agreement of contractual regulations. The aspects that influence these interactions are mainly trust towards the partners and willingness respectively motivation to provide information, giving impulses and find solutions.

VOs are created for a particular collaboration opportunity and dissolve after the corresponding tasks are fulfilled. Therefore they have a *temporary limitation* and are *unique* as the partners will not come together in the same constellation after they have split up. Thus VOs can not be built on their own experiences from the past. In addition the effort that is acceptable for preparing the VO during the creation phase is related to the lifetime of the VO. It has to be ensured that there is an amortisation of this effort before the VO dissolves. This leads again to incomplete agreements and regulations. Hence, many things are new and uncertain when the VO is created and regulation gaps have to be filled. The handling of leeway was already described above. To handle uncertainty the VO members have to interact to solve occurring problems and react to changes. The coordination and adaptation of a company's planning according to the conditions and needs of other partners is regarded as type of coordinative interaction. The success of these interactions depends on the flexibility of the partners. In addition the reliability of partners has influence on the degree of uncertainty in the VO and by this on the need for related interactions. Therefore flexibility and reliability are important aspects that influence interaction. Since VOs are created for a particular business opportunity with a limited lifetime there is usually no "second chance". Thus reliability, flexibility and fast reactions are needed to avoid problems and resulting rework.

Another characteristic of VO that occurs in many cases is the *dynamic* in VO creation process and sometimes even

during the operation phase. Since the VO members compose for a particular collaboration opportunity the VO creation has taken place fast enough to be competitive in comparison to other organisations that do not need this creation process, in particular single companies and established supply chains. The short available time leads usually to restrictions regarding detailed formal agreements. Especially if the VO has to fulfil complex tasks there will be many issues that remain un-discussed and un-regulated. Therefore the dynamic amplifies the need for exchange of information and impulses, coordination, negotiation, and problem solving as already described above. In addition the dynamic requires fast interactions, e.g. quick response times.

The *heterogeneity* of VO members cause further challenges for interactions in VOs. As described earlier in this section interactions are a reciprocal process, e.g. request and answer or provision and acceptance. This means that the partners' activities have to fit together at the interfaces. For example if partner A provides information to partner B it has to be ensured that B is able to process the format of this information. A radar device developer, for instance, might not be familiar with the standards in automotive. In VOs the partners usually differ in various ways from each other as they are not only independent organisations but are also covering different complementary areas of competences that are required to fulfil the VO's task. In addition they can be located around the globe. Therefore it is very likely that VO members have different organisational and ICT structures, processes, internal cultures, national laws and legislations and regional cultures. Since the number and variance of all potential interfaces is usually too big to be regulated this increases the risks of misunderstanding and misinterpretation. Consequently interactions will not take place seamlessly but additional coordination, negotiation, agreement and problem solving are needed. In particular the content to be transferred, the transfer process as well as common standards at the interfaces have to be coordinated, negotiated and agreed. In many cases there are tough time constraints for those interactions, which require promptness and fast actions.

The last characteristic of VOs that has significant implications for the interactions between the partners is the *local distribution* of VO members. A significant part of the interactions can not be done "face-to-face" between the VO members but require the use of ICT. To enable this appropriate technical solutions have to be available and the VO members have to be capable to apply them and adapt their interactions to ICT based interfaces.

The main interactions that are related to the specific characteristics of VOs can be summarized as follows:

- Coordination.
- Negotiation.

- Solving of open issues and problems.
- Exchange of information and impulses.

The VO characteristics do not only entail certain types of interactions but cause also requirements upon the VO members in the way they interact:

- Trust towards the other VO members.
- Willingness to provide information and find solutions.
- Flexibility.
- Reliability.
- Promptness/speed.
- Use of ICT.

These requirements can be important for interactions between persons, but they are also relevant on organisational level. For instance a company can have internal standards how to handle documents that restrict the "willingness" to provide information to other VO members. A second example is a company that requires certain security mechanisms in the partner's IT environment before it "trusts" this partner. In this paper only the organisational level is regarded.

The considerations above showed that different types of interactions are needed to enable the common overall value creation process. So collaboration performance represents the ability for effective and efficient interactions between the independent VO members that enable the merging of their processes to accomplish the common task in a non-hierarchical way.

For VO managers it is important to consider this particular performance perspective that has significant impact on the accomplishment of their VO's objectives. To decide about management activities regarding the collaboration between the VO members information about the current status of this collaboration is needed. The challenge is to identify and measure appropriate data that can be used to indicate this status.

#### Integration of collaboration performance in VOPM

One approach to obtain data about the collaboration performance is to investigate the interactions between the VO members. There are two ways to do this:

- (1) Assessing if the needed interactions take place and how effective they are.
- (2) Observing the VO members' contributions that enable interactions.

The relevant interactions were identified in the section above. For them it has to be analysed how their realisation and effectiveness can be measured. Input for potential ways of measuring is obtained from literature and practical experiences

from existing networks, in particular from the ECOLEAD project.

The *coordination* activities between the partners can be assessed by the degree of decision synchronisation, as it was suggested by Simatupang and Sridharan (2004). Corresponding indicators are for example: Frequency of adjusting/coordinating the planning with related VO members, degree of participation in meetings or conference calls or relation between adjusted decisions and instructions given by the VO management without VO-internal coordination. The effectiveness of coordination could be measured e.g. by the stability of decisions and planning or by the number of conflicts caused by incompatible planning of different VO members.

*Negotiations* between VO members are necessary to obtain common agreements and decisions when VO members have different interests or opinions, e.g. when it comes to coordination of activities or solving problems. In those situations negotiation is indispensable as the partners are independent and can not be forced into something. Therefore it is not beneficial to measure if negotiation takes places. However, the effectiveness of negotiations is essential to ensure that the VO members evaluate the distribution of cost, risks and benefits as appropriate and fair. The questioning of VO members regarding their degree of satisfaction on these subjects can provide corresponding data. Simatupang and Sridharan (2004) introduced the dimension of “incentive alignment” to evaluate the degree of collaboration between partners. The evaluation is done by using defined checks, e.g. if savings and reduced inventory costs are shared. Another approach that fit into the measurement of negotiation effectiveness was developed by Camarinha-Matos and Abreu (2007) who suggest measuring the relations between provided and received benefits.

*Solving of open issues and problems* is another type of interaction that is relevant for VOs. Since open issues and problems have to be solved to accomplish the VO’s tasks and objectives it is, similar to negotiations, more significant to measure the effectiveness of these interactions than to measure if they happen or not. There are two major questions that enable conclusions regarding the collaboration performance in effective solving of problems. The first one is, if problems and open issues can be solved directly between the partners in a more or less informal way or if they need escalation to a higher decision level and more formal processes of problem solving. Thus, a potential indicator is the number of problems that need escalation to VO management. Another indicator that can be applied in this context is the so called problem compensation rate as it was suggested by Sivadasan et al. (2002). It measures the relation between deviations from planning regarding the input and remaining deviations regarding the output—based on other performance indicators like on-time delivery. The second question to assess the problem solving performance is how fast and

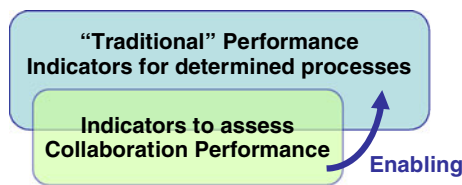
with how much effort the problems are solved when they require formal processes of problem solving. This can be measured for example by the time between the moment the problem is formally reported and the moment when a solution is decided.

The fourth type of considered interactions is the *exchange of information and impulses*. To assess the collaboration performance both the degree of information exchange as well as the effectiveness of this exchange are relevant. The degree of information sharing was suggested by Simatupang and Sridharan (2004) as a collaboration dimension. In their concept they suggested to measure this degree by checking, if particular types of data are exchanged, e.g. forecasts of the partners, point-of-sales data or order status. Additional indicators can consider the quantity of provided information, e.g. how a common document management system is filled, or the frequency of information provision, e.g. the update of project management data. If the number of impulses a VO member gives to the VO and its members is measured it is a challenge to define what is considered as relevant impulses. An example for the measurement of information exchange effectiveness is the number of problems in a defined period that are caused by late or missing information from partners.

The second way to obtain data about the collaboration performance is the observation of VO members’ contributions that enable interactions. As analysed above the contributions depend on trust towards other VO members, willingness to contribute, flexibility, reliability, promptness/speed and on the use of ICT.

*Trust* and *willingness* to provide information and find solutions are difficult to measure directly as they are “soft facts” that can not be evaluated in an objective quantitative way. One option is to ask the VO members directly how far they trust other VO members or how strong their willingness to contribute is. Still, these questions are sometimes difficult to answer for the partners and may produce unreliable values. Another option to approach the assessment of trust is to identify the requirements that are basic conditions for particular VO member to trust others and check if they are met by the other VO members. Alternatively, the degree of trust and willingness can be assessed indirectly by the indicators for coordination, problem solving and information exchange as described above.

Indicators to measure *flexibility*, *reliability*, and *promptness/speed* are already discussed in other approaches, e.g. SCOR, Beamon (1999), or Höbig (2002). Typical indicators are on-time-delivery, volume flexibility (how much % deviation from initial planning can be handled in a given period) or time flexibility (manageable deviation from initially planned dates/lead times). Although those approaches had another intention than measuring collaboration performance and their considerations need some extension (e.g. the



**Fig. 6** Collaboration performance and other performance perspectives

aspect of confidentiality in the perspective of reliability) a general notion about these performance perspectives is given.

In the section above it was described that due to the local distribution of VO members usually some interactions require the *use of ICT*. On the one hand it is a requirement upon the VO members that they are capable and used to apply the needed ICT solutions. This is particularly relevant when companies are selected as members for the VO. Corresponding indicators are based on the check to what extend the defined requirements are met. On the other hand it can be measured if ICT is applied as planned, e.g. by measuring the number of processes that are based on ICT. The effectiveness of this application affects the coordination, negotiation, problem solving and information sharing. Therefore it can be measured indirectly by the corresponding indicators.

These considerations show that it is possible to define and measure indicators that are appropriate to assess the collaboration performance of VO members. Therefore this performance perspective can and should be integrated into VOs' performance measurement. Collaboration Performance is not a "stand-alone" perspective. Rather it is related to other performance perspectives that are regarded in VOPM as illustrated in Fig. 6.

On the one hand there is an overlapping with other performance perspectives, e.g. indicators for reliability, flexibility and promptness/speed are also used to assess general process performance like in SCOR. On the other hand, collaboration performance is an enabler that supports the performance regarding other performance perspective. For instance, a good responsiveness (promptness) of VO members could reduce cycle times and improve overall on-time delivery.

#### Structure of collaboration performance perspectives in VOs

In the previous section several aspects of collaboration performance and potential performance indicators for these aspects were identified. To provide an overview and orientation regarding this performance perspective it is necessary to develop a structure that organises the different aspects. This supports also the integration of collaboration performance in existing PM approaches. Figure 7 gives an overview over the potential sub-perspectives of collaboration performance in VOs.

When analysing the set of single sub-perspectives it became clear that there are two main categories that form the first level of structuring. On the one hand there are more traditional performance perspectives that are also used in existing PM approaches for single companies and stable hierarchic networks. One of these perspectives is the ability to communicate, which includes the aspect of using ICT as a significant way of communication in a VO. On the other hand "commitment" was introduced as an essential perspective of collaboration performance that is specific for dynamic VOs with independent members. This perspective summarises the aspects of collaboration performance that are strongly related to the members' attitudes towards the VO. It considers contributions to the VO that are not formally defined but come from the motivation of partners. Although commitment can be regarded as a "soft" aspect of collaboration performance the considerations above have shown that there are measurable indicators that can be used to assess the performance regarding the different sub-perspectives.

On the structuring level below the perspectives were defined mainly based on terms that are already used in research. Only the new sub-perspective of "giving impulses" was not used in the regarded existing approaches so far.

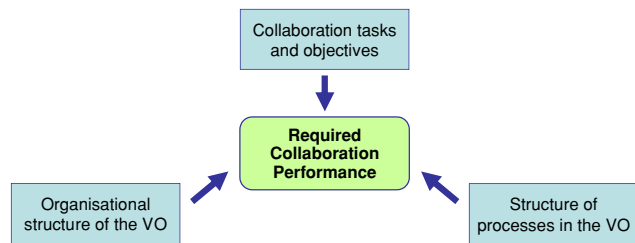
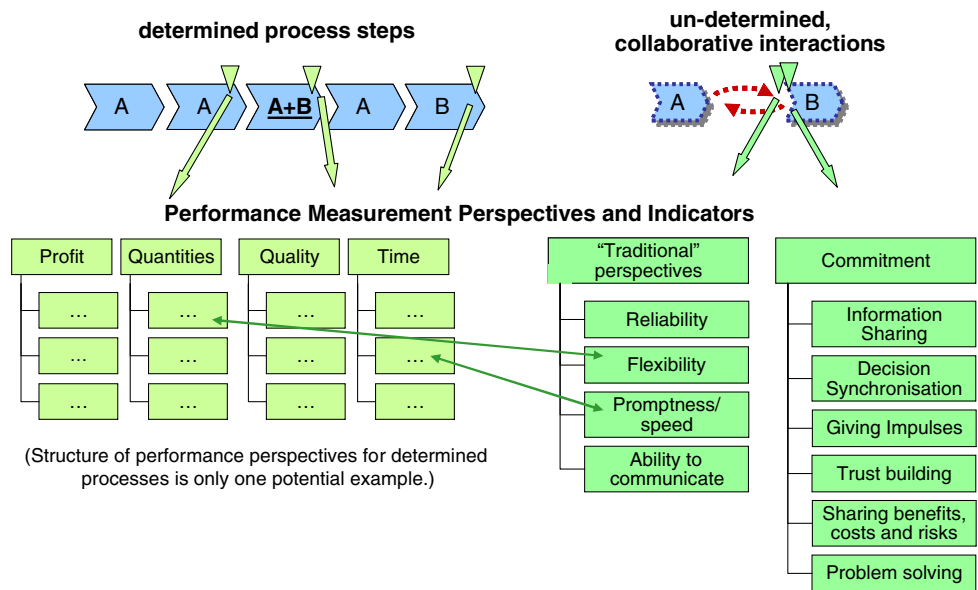
#### Implications for VO management

The considerations above and the developed structure of collaboration performance perspectives help to fill the gap in existing performance measurement approaches regarding the assessment of collaboration performance in VOs. The collaboration between the VO members can be made conscious and transparent for all VO members. This supports the VO management in governing the VO. A monitoring of corresponding indicators enables VO managers to take actions if collaboration has reached a critical status. In industrial practice this can be utilised to enhance the awareness regarding the needed commitment of each partner and to implement an early warning system that indicates frictions between partners. The developed structure of collaboration performance can also improve the selection of VO members, either by regarding performance indicator values from VOs in the past or by assessing the general capabilities regarding the different collaboration performance perspectives.

Measurement and monitoring of performance indicators generate effort. According to limited resources and time the VO management has to decide which performance perspectives should be considered and which indicators should be applied. The developed structure of collaboration performance perspectives should provide orientation for this decision. The selection of indicators is done according to the specific conditions of a particular VO. If, for instance, the VO members know each other well and have collaborated in



**Fig. 7** Sub-perspectives of collaboration performance in VOs



**Fig. 8** Influence on the required collaboration performance in VOs

previous VOs the need to measure trust building will be low. Figure 8 shows the main conditions that have influence on the required collaboration performance.

Still it has to be taken into consideration that several of the indicators for collaboration performance do not provide absolute values that are objectively comparable. In addition there is a strong dependence between the indicator value and the particular composition of VO members. For instance the information sharing of partner A could be very good if he interacts with partner B but, according to bad experiences in the past, very limited in the interaction with partner D. This has to be taken into account when indicators for collaboration performance are used as criteria for the selection of VO members and also when targets or permissible corridors for indicator values are defined. Since the traditional perspectives reliability, flexibility, promptness and ability to communicate are also used for single companies they are less depended on relationships to other VO members. Furthermore there could be indicator values for these perspectives even if the company has no experience in VO collaboration yet.

If collaboration performance indicators are monitored during the operation phase of a VO it is not obligatory to have

clearly defined target values or corridors. For the VO management it is important to identify “atmospheric disturbances” early enough to enable an active management of collaboration between the VO members. Therefore it can be sufficient to only analyse the development of indicators values without defined target values.

**Conclusions**

Existing approaches for Performance Measurement do not meet all specific requirements of VO management. In particular the aspect of collaboration performance, which is essential for the success of a VO, is not considered in a sufficient way. The analysis of needed interactions that were derived from the specific characteristics of VOs produced perspectives of collaboration performance and examples for corresponding indicators. Input for these considerations was obtained from research work that has already provided some approaches to assess interactions between companies and from practical experience.

Collaboration Performance can be integrated as an additional performance perspective in the performance measurement of VOs. This provides an information basis to the VO management that enables active governance regarding the collaboration between the VO members.

To provide an overview about collaboration performance perspectives that are potentially relevant for VOs an overall structure for the perspectives and sub-perspectives was developed. This supports VO management in deciding which perspectives should be considered in a particular VO. In this structure “Commitment” was introduced as new sub-perspective of collaboration performance that completes the

perspectives that were already discussed in literature. The perspective of commitment summarises aspects of collaboration performance that are mostly informal and strongly related to the attitude towards the VO and the interaction with other VO members.

Besides the application of these results in VOs they could also provide new ideas for other networks of interacting partners, e.g. for supply chains.

Nevertheless, the intention behind the development of the suggested structure was to provide a starting point for the assessment of collaboration performance in VOs. On the one hand, this implies that the perspectives and indicators have to be further improved, e.g. according to new experiences. On the other hand, it means, that even if many indicators for the collaboration perspectives are applied it has to be regarded that they will not be able to draw a complete and objective picture of the collaboration performance.

One of the next challenges is to support VO managers with a method for identifying an appropriate set of indicators that provides the necessary transparency about the collaboration performance in a particular VO without causing inappropriate effort.

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