3.2 SUPERVISION OF COLLABORATIVE PROCESSES IN VOs

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VO managers need a sound information basis to fulfil their management tasks. Hence, performance measurement is one of the key processes in the management of Virtual Organisations (VOs). In case VOs are complex in terms of dimensions, interactions or the level of heterogeneity, information retrieval and performance measurement becomes a demanding task and causes high efforts. A defined methodology that guides the VO manager through the process and support by means of ICT services can help to obtain the needed information basis in an efficient way.
The constraints and characteristics of the networks imply that the applied methodologies and services must be able to cope with distributed, dynamic, heterogeneous environments. They also require a performance measurement approach that is tuned towards the behaviour of the network as a whole, which might differ from traditional approaches that are used in single organisations or static cooperation such as supply chains.
This chapter is about the need and the challenges of a collaborative performance measurement approach and the requirements of its corresponding tool support, aligned to the specific conditions of VOs and relevant aspects for VO management.

1. INTRODUCTION

One of the key elements of VO management is the supervision of the collaborative processes in the VO. A VO manager determines performance indicators that provide information about the status and operation of the network or its entities and gathers the data that is necessary to measure the value of these indicators. The systematic approach to plan and conduct the collection of data regarding the accomplishment of tasks and the corresponding objectives is called ***Performance Measurement*** (PM). PM is part of ***Performance Management.*** Performance Management comprises planning, measurement, monitoring and assessment, improvement and rewarding of performance. The ***supervision*** of collaborative processes comprises the planning of performance, the performance measurement and the monitoring and assessment of the obtained performance data. The supervision provides input for improvement measures and rewarding, which are also VO management tasks. Figure 1 shows this schematically.

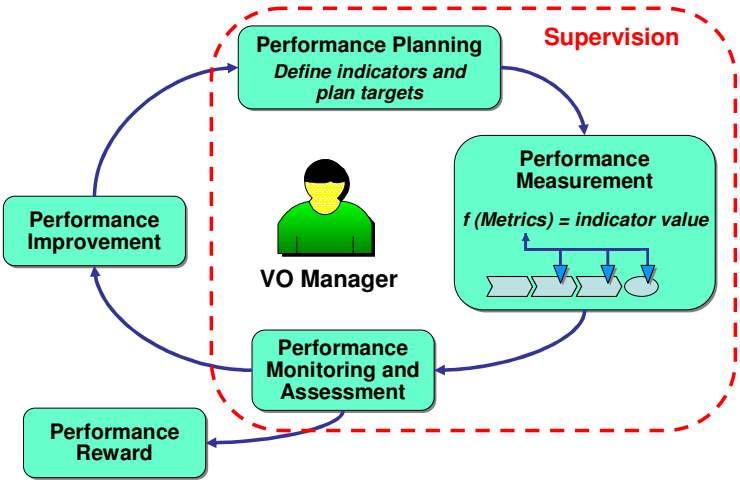

Figure 1: Supervision processes

In short-term VOs with a small number of partners the PM is often done "manually" or in an ad-hoc way; the VO manager uses telephone, fax or e-mail to get the needed data from VO members. According to practical experiences of collaborative networks this causes in many cases significant effort. VO managers describe this as an "annoying" procedure for both the VO manager and the VO members, in particular when the data has to be updated frequently. As a consequence there is a tendency to concentrate the PM in VOs on a limited set of indicators. To limit the effort, these indicators are often the same as in regular business when the companies work on their own. Typical examples are cost deviation from plan, work progress and quality issues. Experiences in these areas show that performance measurement and the considered indicators are not aligned appropriately to the specifics of collaboration in VOs.

As long as the VO Manager and most of the VO members have a sufficient informal overview over the activities and the relations, this ad-hoc PM will fulfil.

However, VOs can be complex with tasks that require a broader variety of competences and more resources. Correspondingly a bigger number of more diverse partners are involved. In addition, complex VOs can cover a longer time-span, be more dynamic, and may have to deal with a higher degree of uncertainty. In these cases ad-hoc, "manual" performance measurement comes to the bounds of feasibility and do not provide the VO management with the needed information in an adequate way. In these cases the VO manager needs a structured approach for PM in VOs and supporting services. For example, a system that supports the selection and retrieval of information might relieve a VO-manager from the unnecessary complexity of specifying, searching and obtaining the information that is relevant for getting overviews and taking decisions.

Research has provided several approaches for PM and some are well established in practice. However, this work was traditionally focused on intra-organisational PM or on inter-organisational PM in static cooperation like supply chains. There are no approaches and tools that were specifically developed for PM in dynamic VOs with

its distributed, independent, and heterogeneous VO members. Therefore it has to be analysed what the particular requirements upon PM in VOs are, how existing PM approaches meet these requirements and how they have to be adapted or completed to meet the requirements.

2. CHALLENGES FOR PERFORMANCE MEASUREMENT IN VIRTUAL ORGANISATIONS

VOs have certain characteristics that differentiate them from traditional, single organisations and static cooperation like supply chains. These differences could also influence the structure and processes of PM. Therefore it should be analysed in this section what the main challenges for PM in VOs are and how existing PM approach and tools can deal with these challenges.

As there no universal understanding and unvarying use of the term "Performance Measurement" it is necessary to describe the basic understanding of PM that forms the underlying concept for the considerations. This provides a basis to identify the challenges for PM in VOs that are caused by the characteristics of VOs.

The purpose of PM is to evaluate the business performance with different perspectives and a variety of uses. Bititci, Carrie and Turner summarise the following reasons why companies measure their business performance [Kellen 2003, p. 4]:

- To monitor and control.
- To drive improvement.
- To maximise the effectiveness of the improvement effort.
- To achieve alignment with organisational goals and objectives.
- To reward and to discipline.

To achieve this, PM has to provide values for ***Performance Indicators (PI)***, which are defined variables that assess the state of an object in scope, e.g. cost figures, the output of a production process or the responsiveness of a partner. PI could be as well quantitative as qualitative measures. ***Key Performance Indicators (KPI)*** represent essential or critical components that have highest impact on the organisation's overall success.

To obtain values for PI corresponding data has to be measured. ***Measurement*** should be understood in a broad sense as general collection of data. This could be done by asking responsible persons (in some cases even for estimations), obtaining data from a gauge like a counter, or by accessing electronic databases. The variables that are measured are called ***Metrics***. Some PI values are calculated from several metrics, e.g. an indicator "lead-time" can be calculated from the date values for the metrics "start-date" and "end-date".

The PI values are provided to the ***Customers of PM***. Main customer is usually the management of the concerned organisational unit. But there can also be additional customers like the employees of the organisational unit, customers of the unit, investors or other stakeholders. They can use the indicator values for further processing and analysis, e.g. time-series, control charts, tend-analysis etc.

In this chapter the term Performance Measurement is used in a broader sense. It should not only cover the gathering of data but also the identification of suitable indicators and the provision of data for further use. This leads to a partial

overlapping with performance planning and performance monitoring/assessment but provides a more complete picture of PM challenges in VOs.

Based on the concept of PM as it was described above it has to be analysed how PM in VOs is affected by the specific characteristics of VOs and what are the resulting differences in comparison to intra-organisational PM respectively PM for static cooperation. The main characteristics of VOs were described in the previous chapters of this book. This leads to the main challenges for PM in VOs.

Independency of VO members: VO members are generally independent from each other. This has two main consequences for the VO. First the companies have their own business outside the VO and their own objectives, planning, structures and processes for this business. On the one hand this means that there could be a kind of competition between activities in the VO and other activities that are not related to the VO. On the other hand there is in many cases the possibility that the VO Members become competitors for other business opportunities. The second consequence is that the common VO has limited opportunities to control partners beyond their contractual obligations.

This has following implications for the PM:

- The PM on VO level has to be connected to the internal processes of the different VO members. There is a chance to make use of existing values for PIs or Metrics from the organisations' internal PM. However, there could also be a need for addition measurement. This produces additional effort to the already existing PM activities, which could cause problems regarding acceptance.
- The provision of needed data for PM depends on the trust level between the VO members and their commitment for collaboration in the VO.
- Usually, the VO members can not be forced to make their data sources accessible or to provide certain data if this is not defined in the contract. In particular when a need for additional PI occurs during the operation phase of the VO the "good will" of the VO members is needed. Therefore PM has to be done collaboratively.
- For many organisations it is important to keep local control of the measurement and the provision of data.
- The PM has to cover the aspect of collaboration, which means contributions and commitment beyond the contractual obligations. This is not only important for the value creation processes but also for supporting functions like the PM itself.

Heterogeneity of structures, processes and cultures: VO members are usually not only independent organisations but are 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 they have different organisational and ICT structures, processes, internal cultures, national laws and legislations and regional cultures.

This has following implications for the PM:

- A very clear definition of the indicators, the corresponding measurement and responsibilities is required to avoid misunderstanding and misinterpretation. While in a single company there are often standards and knowledge about the general structures of internal processes different VO members could have, for example, different understandings about start and

the end of processes or about quality issues and on-time-delivery.
- The PM has to be flexible to regard the specific conditions of the different VO members.
- It is likely that there are heterogeneous data sources. There could be different ICT systems and standards. Some VO members, in particular the small ones, may even have no ICT tools besides standard office application and internet access. This requires various different interfaces to make the data available for PM in the VO.

Distribution of partners: The VO members can be located in a distributed way, even in different countries and on different continents. This means that "face-to-face" coordination on the spot and transfer of physical documents causes higher effort than in a single company.

This has following implications for the PM:
- Again clear definitions are needed to avoid the necessity of on the spot coordination.
- The PM has to be based on ICT, which enables electronic data transfer and distributed access for the different VO members.

Impermanence and uniqueness: VOs are temporary limited. They are created for a certain collaboration opportunity and dissolute when their task is fulfilled. The life-time of VO can be from a few weeks to several years. As a consequence of this temporary limitation each VO is unique, when it is dissolved it will not be created in exactly the same way again.

This has following implications for the PM:
- The PM hast to be set-up new for each VO. This causes new effort for each new VO.
- As the PM is set up new for each VO there is no historic database that can be continued, like in established single companies and static networks.
- The set-up has to be adapted to the lifetime of the VO. When the life span of a VO is very short this set up has to be done very fast to make results available before the task is finished.
- As the PM vanishes with the dissolution of the VO the effort for the set-up and operation of the PM has to be limited to ensure a positive "return rfon investment". In other organisations the PM or parts of it can usually be re-used or further developed for other tasks.
- Generally it has to be ensured that provision of indicator values is synchronised with the lifespan of the VO. Short-term VOs with critical process, for example, may need almost real-time provision of data.

The challenges concern both the content of PM as well as the methodology. There is only one challenge regarding the content, which is the consideration of collaboration performance. On the other side there are several challenges regarding the methodology for set-up and operation of PM in VOs. They can be summarised as follows:
- PM in VOs has to be done collaboratively by the VO members. This means there should be common objectives and commitment for supporting the PM.
- More distinctive need for clear definitions to reach common understanding between the VO members.
- Need for flexibility to reduce or limit expenditure for setting-up and

operating the PM according to the available time and resources. A rapid set-up must be possible.
- PM must be adaptable to the processes and structures of the VO members and is has to be connected to their internal PM activities.
- Local control has to be enabled to avoid that a lack of trust obstructs the active participation in the PM and prevents the provision of data.
- PM in VOs have to be strongly ICT based to make it efficiently accessible for the distributed VO members.

Existing Approaches in Performance Measurement

Performance measurement approaches consist of mainly two parts: ***Performance perspectives and indicators*** and a ***performance measurement concept***. The suggested performance indicators describe the content to be measured for assessing the performance of a business process. Some approaches suggest performance perspectives that summarise performance indicators that consider the same area of content, e.g. a perspective "finance" can comprise various indicators for costs, revenues or involved capital. The performance measurement concept that describes how to set-up and conduct the PM. The concept may include a process model, rules to execute the measurement or guidelines to identify relevant business challenges. Literature and practice provide several frameworks in the context of business performance measurement. Some are offering pre-defined sets of performance indicators, some provide just the concepts and some are holistic methodologies with integrate a concept with concrete performance indicators. The following graphic gives an overview over this structure and example for existing performance measurement frameworks.

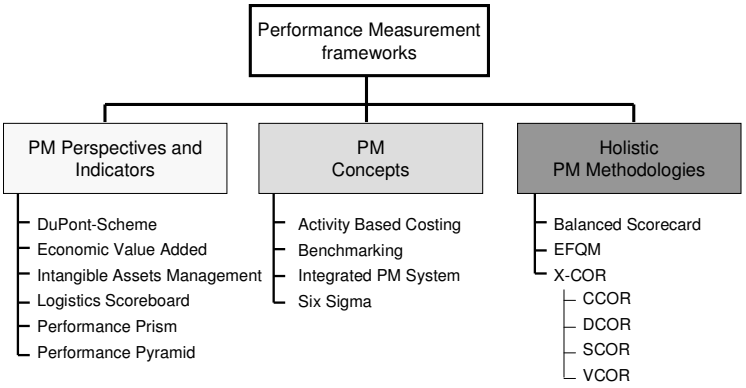

Figure 2: Existing performance measurement frameworks

See for example Kaplan; Norton [1992], Stewart [1999], Klingebiel 2001, Kellen [2003], Jana [2007], or the overviews of Sandt [2005], Graser et al. [2005] and Seifert [2007].

The existing and in some cases well established approaches offer a wide scope of performance perspective and indicators: Financial aspects, process performance, quality, relationship to suppliers and customers as well as value related aspect like intellectual capital and brand value. In addition there are various suggestions for the handling of PM, e.g. comparison with other organisations, reference models,

deriving indicators from strategic objectives or analysing the dependency between PI.

However, none of the existing approaches is aligned explicitly to collaborative business between independent partners. Neither there is a performance perspective the covers collaboration nor a process for collaborative PM. The gap of a missing performance perspective for the interaction between cooperation network partners was already identified and discussed by several research works [e.g. Gunasekaran 2001, Leseure 2001, Hieber 2002, Zhao 2002, Sivadasan et al [2002], Simatupang and Sridharan [2004], Schweier [2004], MacBeth 2005]. Many of these research works considering cooperation in supply chains. They suggest Performance perspectives like 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). Leseure for example developed an approach for meta-performance on network level, which comprises the two dimensions of aggregated performance and equity. Simatupang and Sridharan introduced three dimensions to characterise collaboration: Information sharing, decision synchronisation and incentive alignment. 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.

Nevertheless a consistent PM approach for Virtual Organizations is still missing. Hence, to provide VO manager with guidance and support a framework for VOPM is needed that comprises a concept how to handle PM in VOs as well as a framework of performance perspectives that includes collaboration performance.

3. PERFORMANCE MEASUREMENT IN VIRTUAL ORGANISATIONS

Performance Measurement provides essential input for the management of VOs. To ensure effectiveness PM has to take care of VOs' specific characteristics. Approaches that were developed for single organisations and static cooperation need adaptations and extensions to meet the requirement in VOs. This means tha VO manager can not do PM in VO as in other organisation. A PM framework that is aligned to the requirement of VOs can support the VO Management in its PM tasks. It should offer a basis for common understanding in the VO and guidance in the process of PM. A conceptual framework for Virtual Organisation Performance Measurement (**VOPM**) is developed in this section.

VOPM can be defined as the systematic approach to plan and conduct the collection of quantitative and qualitative data for performance indicators that assess the status of a VO.

VOPM is one of the VO management functions and therefore part of VO Management. The VO managers have to define what PIs should be measured and monitored as well as the target values or permissible corridors.

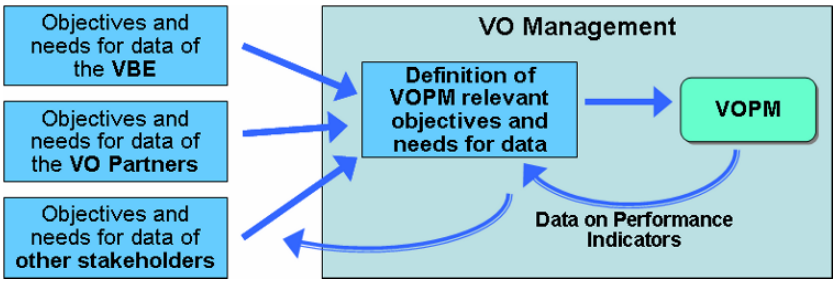

Figure 3: VOPM is part of overall VO Management

PIs and targets can be derived from the VO tasks, contractual obligations and the objectives defined for the VO. The VO management has to define a consistent set of objective that is a synthesis of the different objectives of the VO members, the Virtual Organizations Breeding Environment (VBE, this concept is described in detail in Part 2 of this book) as well as from other stakeholders.

Customers and objectives of VOPM: The objectives can be derived from the requirements of the different customers of VOPM. The customers of the VOPM are the recipients and users of the performance data provided by the VOPM. From this perspective VOPM has to serve different customers.

The following graphic shows how VOPM customers are provided with performance data.

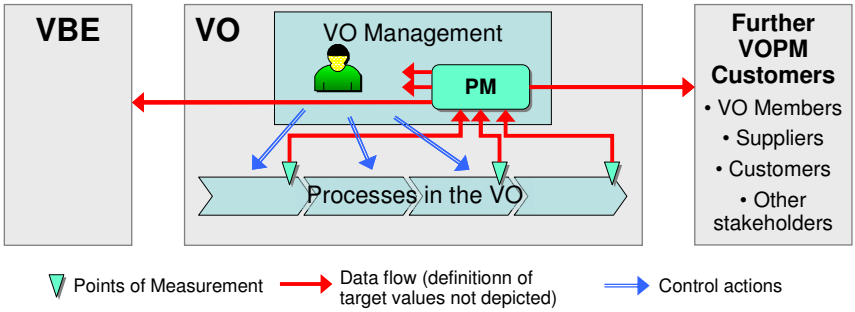

Figure 4: Customers of VOPM

Main customer is the VO Management that uses the data to monitor the accomplishment of the VO's objectives and to control the processes in the VO. In addition the performance indicators constitute a communication tool for the VO Management. In particular in VOs with heterogeneous partners, clearly defined performance indicators, e.g. for on-time-delivery, could help to avoid misunderstanding. Another important aspect for the VO Management is the effect on awareness and motivation caused by the performance indicators, especially in non-hierarchic VOs. Performance data can also support VO Management in trust-building as it creates transparency for the VO members.

The organisational units and employees that are involved in the VO activities can be also customers of the VOPM if they are using the data to monitor and control their work.

Therefore VOPM has to meet following objectives:

- Provide a transparency about the status of the VO and the accomplishment of its tasks as a basis for controlling.
- Provide a basis for communication inside the VO between VO Management and VO members.
- Create awareness and motivation, support trust-building through transparency.

In the ECOLEAD model VOs are created from a VBE. Since the VBE needs a feed-back for its work this organisation is another important customer of the VOPM. The VBE's main objectives regarding VOPM are:

- Provide feed-back regarding the effectiveness of VO creation, e.g. about suitability of initial planning or partner fit.
- Getting input for future VOs, in particular data regarding the performance of VO members for partner selection and data regarding needed resources for planning tasks.

Further customers could be the VO members as independent whole companies, external partners like supplier and customer or public/governmental institutions.

Levels of VOPM: Not every measurement activity of a VO member is automatically part of VOPM. As illustrated in the graphic below VOPM concentrates on the network level. It deals only with PIs that are relevant for the network, which means for more than only one member. On the other side this implicates that VOPM does not replace the members' individual PM. They have to define and measure appropriate PI to control their internal processes themselves.

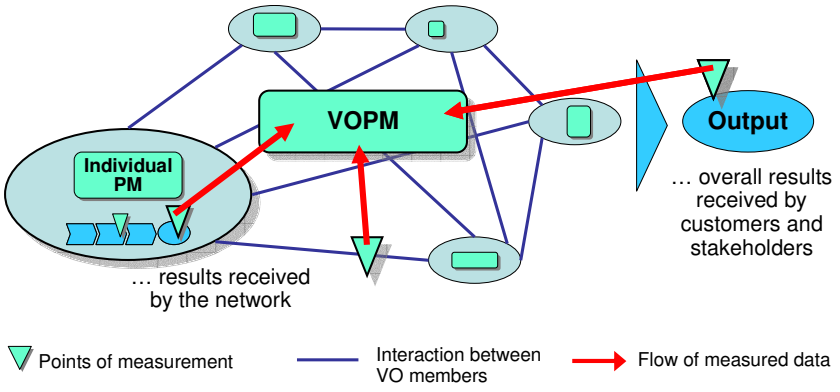

Figure 5: VOPM concentrates on network level

The network level includes a VO level and a VO member level.

On the ***VO level*** two types of indicators are measured:

- Output Indicators. They consider the overall results achieved by the VO. This output is received by the customer, the VO members or stakeholders, e.g. delivered products or revenue for the members. The accomplishment of defined overall objectives is also a kind of output.
- Indicators to assess the interactions between the VO members. Important aspects are effectiveness and efficiency of collaboration. Soft aspects like satisfaction of VO members in the VO can contribute to this assessment.

The second level is the ***VO member level.*** It considers the contributions of a

single VO member to the VO, e.g. the output of a sub-process that is received as input by other VO members or the overall cost produced by the corresponding VO member. Hence, the PM on the VO member level concentrates on the interface between the VO member and the rest of the network. PI for the internal processes of a VO member are generally not regarded if they are not needed as data input for other VO members.

As shown in the graphic above some data can be obtained from the internal PM of the partners. Usually the VO members want to provide only the data that is relevant for the network level. Data concerning VO activities but is not relevant for other VO members and data corners activities outside the VO has to be kept usually inside the company. Therefore the VO member has to extract and process data for the VOPM.

An important aspect is the handling of confidential data that requires a restricted accessibility within the network. This requires an isolated VOPM with different roles and corresponding access rights.

Roles in VOPM: According to Vervest et al. [2005] essential roles for performance measurement are the information creator, the information broker and the information user. The source if information is the information creator that actively measures required data or records data that is produced during the activities in the VO. The creator can process this data and provides it to the user or the broker. The user receives this as input for his decisions and activities. If the information is not exchanged directly between the creator and the user there could be a broker that receives the data, processes it and provides it according to the demand of the user. This generic concept should be related to the main roles in VOs.

The information users were already described above in section "customers and objectives". Following roles in VOs can be identified as creators and brokers:

- The ***VO Management*** (VOM) is not only the main customer (information user) of the VOPM it is also responsible for setting-up and operating the VOPM. This includes the allocation of resources for VOPM, the definition of PI, corresponding data sources and target values. In this way the VOM acts as information broke in the VO. VOM can delegate operation VOPM work to a ***"VOPM officer"***, second broker role. However, also when work is delegated VOM remains responsible for VOPM and the broker function.
- VOPM won't work without PI ***Data Providers*** (information creators). Generally the data has to be provided by the VO members. Responsible are usually the ***process/task owners***. They can act as both information creator and information broker. The management of the involved organisational units has to decide, which data can be provided to the VOPM, which has to be treated confidentially and which is too confidential to make it transparent for other VO members. The practical provision of data is usually done by the employees involved in the tasks and by people from ICT departments.

VOPM process: To obtain results from the VOPM there has to be a process of designing, implementing and operating it. Various research work has been done on processes of performance measurement [e.g. Kaplan et al. 1992, Neely et al. 1996, Bitici et al. 2001, Andersen et al., 2002, Mendibil et al. 2002, Borst et al. 2005]. The processes shown in the graphic below were derived from these considerations, adapted and extended to the specific conditions of VOs. They should provide a

guideline for set-up and operation of VOPM.

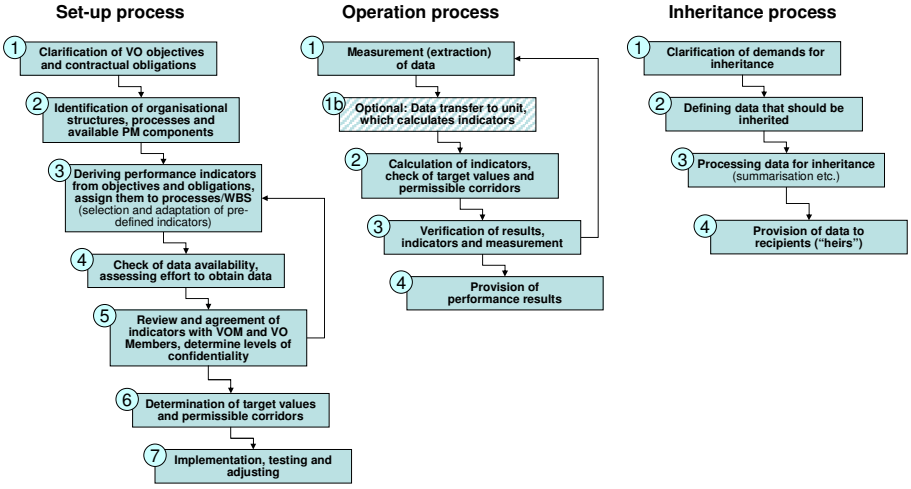

Figure 6: VOPM processes

The collaborative character of VOPM is in particular visible in the set-up process. For the clarification of objectives and conditions as well as for the agreement of indicators to apply all VO members have to be involved. In the operation process the data transfer between the distributed partners with the heterogeneous structures has to be regarded.

A VO-specific process is the inheritance of performance data when the VO dissolves. An important recipient of inherited data is the VBE. In many cases it will be necessary to process data first to obtain an utilizable format instead of transferring all available raw data. Typical processing is the calculation of means, maximum and minimum values as well as standard deviations. The number of measured values and the target values improve the picture.

Performance Indicators: An essential step in the VOPM process is the definition of indicators that should be considered.

Like single companies VOs have to fulfil the requirements of their customers upon quantities, cost, time and qualities. The base set of indicators can be derived from these contractual obligations. The subsequent step is to identify indicators to control the value creation and supporting processes that produce the overall output for the customers. While the value creation processes contribute directly to the output, e.g. assembly of a product, the supporting processes provide necessary conditions and input to the value creation process, e.g. the ICT environment, the procurement of goods or the management of human resources. Processes, output and the corresponding points of measurement for the different types of indicators are illustrated in the following graphic.

Output, value creation and supporting processes are comparable to single companies. For example the steps of an assembly processes will be more or less the same if a production line is doing that for an internal order or integrated in a VO. Therefore the corresponding indicators in VO are comparable to the indicators in single companies. Hence, the VO manager can use existing frameworks of

indicators (e.g. SCOR or the Performance Prism of Neely). Some frameworks even provide benchmarks for particular standard indicators (e.g. from SCOR or Six Sigma). This can be relevant if one of the VO's objectives is to compare its capabilities to other organisations. In the same way additional indicators has to be derived from the other objectives of the VO and the requirements of its stakeholders.

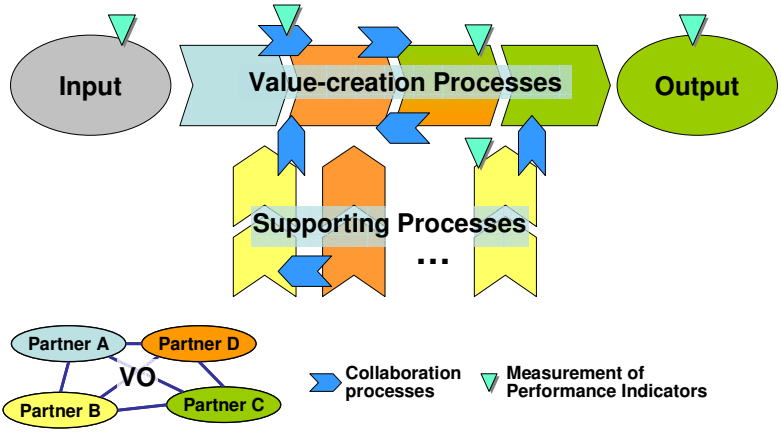

Figure 7: Types of VOPM indicators

Essential differences in comparison to single companies or static, hierarchical networks are the collaborative processes that are also shown in the graphic above. The VO manager has to consider the effectiveness and efficiency of interactions between the independent VO members when they merge their processes to accomplish the common task in non-hierarchic way. This ***collaboration performance*** is described in more detail in the following section.

4. MEASURING COLLABORATION PERFORMANCE

A very specific challenge for VOs is the measurement of collaboration performance. Collaboration is a kind of "lubrication" or "catalyst" for the value creation and supporting processes in the VO. A high collaboration performance ensures that all VO members can contribute to the VO according to their full potential.

The need for collaboration performance is caused be the characteristics of VOs: Independency of partners, heterogeneity of structures, processes and cultures, and the impermanence of the VO.

Generally it is almost impossible to regulate all issues and all potential situations when a project is set-up or cooperation is created. In VOs this is amplified by the temporary character of a VO and the heterogeneity. The effort for such regulations has to be limited to ensure that there is an amortisation within the limited lifetime of the VO. On the other side the heterogeneity increases the number and variance of interfaces and situations that have to be regulated. Consequently, unforeseen and not regulated problems will occur during the operation phase of a VO. This gap in agreed regulation has to be filled by the VO members with new agreements and actions, in many cases under tough time constraints. But there are not only

unforeseen problems that need collaboration performance. In some VOs creative solutions have to be developed to fulfil the contractual obligations and reach the objectives. Creativity, giving impulses, sharing ideas can hardly be regulated in contracts when the VO is created. However the partners are independent and can not be forced to actions that are not regulated in contracts. There is a need for "good will" and motivation so that all VO members can make full use of their general capabilities to accomplish the defined tasks according to the defined objectives. Without effective collaboration the overall success of a VO could be jeopardised.

Collaboration performance focuses on efficiency of interaction and emergent behaviour within the VO.

To obtain corresponding data for the management of the VO the aspect of collaboration performance has to be integrated into the VO Performance Measurement (VOPM). As analysed in the chapters above existing PM approaches do not offer a concept of collaboration performance that fit for VOs. Therefore the provided frameworks for performance indicators have to be extended. It is proposed to regard collaboration performance as an own performance perspective that summarises different indicators that assess the effectiveness and efficiency of interaction between VO members. This is an addition to traditional performance perspectives that are also applicable in VO (e.g. cost, quality and time). The background of this new performance perspective is illustrated in the graphic below.

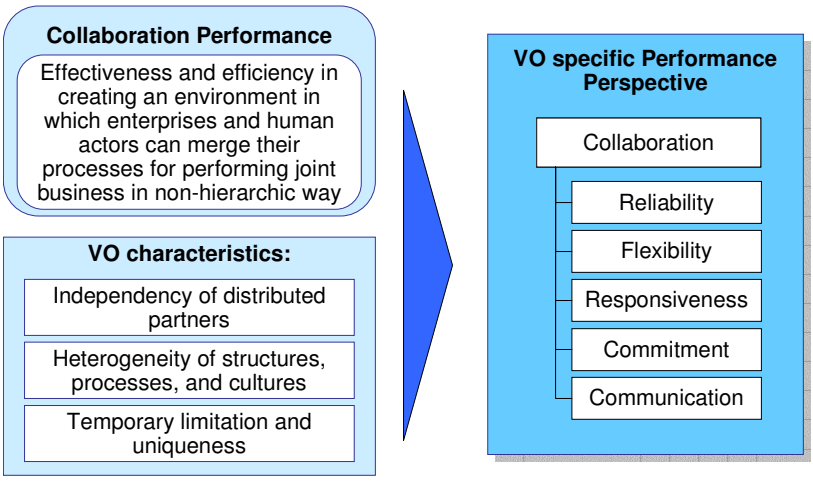

Figure 8: Perspective of Collaboration Performance in VOPM

The sub-perspectives derived from the characteristics and requirements of VOs.

For example, the involvement of distributed independent VO member leads to a dependency between the contributions of the different members. Therefore one essential aspect of collaboration performance is the reliability of the members. In the process perspective the reliability could be evaluated with indicators that measure if materials, information or resources are delivered in the agreed quantity, quality and time. In the financial perspective it is analysed if this also take place for agreed cost.

On the other hand there are additional aspects of reliability, which are related to trust, e.g. information is kept confidential and decisions are stable.

Performance indicators for reliability, flexibility, responsiveness and

communication occur already in other approaches, e.g. SCOR or Höbig [2002]. However, they were used with another intention than measuring collaboration performance, they only cover only a part of the aspects (e.g. the aspect of confidentiality was not regarded in the perspective of reliability) and there was no consistent overall concept for this performance perspective. Nevertheless, these sub-perspectives should not be described in detail in this place.

In contrast the perspective of commitment is a specific core element of collaboration performance in VOs. It summarises the aspects of collaboration performance that are strongly related to the attitude towards the VO and the interaction with other VO members. Commitment considers contributions to the VO that are not formally defined but come from the motivation of partners. At first sight, commitment seems to be a "soft" aspect of collaboration performance that is difficult to measure. However, if commitment is divided into further sub-perspectives its meaning becomes clearer and potential performance indicators become perceptible.

On the one hand there are re-active aspects that describe how the VO members react on critical situations or problems:

- Problem and conflict solving (e.g. number of problems that require escalation to VO management).
- Willingness for compromise (e.g. degree of accepted adaptations in new planning).
- Problem compensation (e.g. difference between delay of input and delay of output).

On the other hand there are also active aspects:

- Giving impulses (e.g. number of realised suggestions for improvement).
- Information sharing (e.g. provided accessibility to documents).
- Decision synchronisation (e.g. degree of participation in meeting).
- Problem avoidance (e.g. provided reaction time when critical status is reported).
- Trust building (e.g. provision of confidential information).
- Motivating (e.g. questioning of other VO members).

This exemplifies that collaboration performance can have significant impact on the results of the VO (output indicators). For instance responsiveness and problem compensation VO members could reduce cycle times and improve on-time delivery to the customer. If the VO manager is monitoring collaboration performance he gets alerted before effects on process and output indicators became visible. In addition an active control of collaboration performance can improve the satisfaction of the VO members. Because even if the VO delivers the results as planned the VO members can be unsatisfied with the cooperation inside the VO and will not participate in comparable VOs again. Therefore the controlling of collaboration is a vital task for VO managers.

5. ICT SUPPORT FOR VOPM

In case a VO becomes more complex in terms of its size, dynamics or level of heterogeneity, PM needs to be supported by ICT tools that relieve a VO-manager from the unnecessary and time consuming tasks. ICT support should also reduce the

complexity of specifying, searching and obtaining the information that is relevant for getting overviews and managing the VO.

There are many products and solutions for management support being developed. Large ICT oriented organisations, such as SAP, IBM, HP, Microsoft, Tibco, Cisco and Oracle provide software and approaches that support management and monitoring processes in organisations. Although their solutions have evolved from monolithic systems towards centralized, homogenous network systems, they are often focused on support within the boundaries of a single organization, and therefore not directly applicable in network organisations.

In line with the mentioned elements of the PM approach described above, examples of ICT support of VOPM are:

- VO Ontology management
  Tools that support common terminology and relationships
- VO Topology, KPI and WBS management
  Tools (databases) containing the information about the members,management indicators and workbreakdown structure
- Distributed information provisioning
  Tools that provide a secure and reliable mechanism for data retrieval
- Monitoring and alerting support
  Tools that help assessing and analysing the performance information
- Planning and decision support
  Tools that support in task planning, and simulation of alternatives

The challenges for VOPM, as mentioned at the beginning of this chapter, have their influence on the design and implementation of the supporting ICT tools. For example, measurement needs to be carried out in the various member environments dealing with diverse communication protocols and changing information streams. Furthermore, to allow proper usage by the VO manager, different kinds of supporting tools must be able to cooperate and integrate their information, while hiding the complexities of the underlying technical environments.

The requirements needed to meet these challenges can be grouped in three categories:

- dealing with heterogeneous ICT environments
- dealing with communication and ways of accessing local information
- dealing with semantics

In the process of data fetching each individual organisation has its own preferences and possibilities to reply to the fetching requests. For some organisations it is possible to use direct links to their local systems, enabling the performance measurement tool to fetch the values automatically. Other organisations prefer to key in the requested values by means of email, excel sheets, or electronic forms. One of the technical challenges is therefore to design and manage a flexible and extensible way of fetching that can perform the data fetching in a local environment and communicate the result to the network.

In this communication one has to deal with two other challenges; the first one is security. Apart from the encryption of the data that is send and shared by the network, also the content itself and the level of detail is often subject to careful design. Organisations want to be in local control of this information flow and often want to prevent automated fetching mechanisms to access their core information systems. A second challenge at the level of communication is the housekeeping

about the topology. A distributed information retrieving mechanism must be aware about the locations of the individual fetching parts, and vice-versa, these parts, in sharing the results must be able to access each other as well as the address of the original data-requesting parts to which they should send the retrieved results.
The third kind of challenge lies in the area of semantics. The meaning, entity definition and unit-definition of the information that is requested needs to be defined and -if necessary- translated into various forms. On one hand organisation might use different names and descriptions for the same entity, and on the other hand different units might be used. Manual translations, open message formats, and the use of ontology rise up to be of important relevance here.

As VOs are temporary, and usually created in dynamic environments, the supporting tools must be very flexible in order to be able to adapt quickly to specific needs. The technical architecture must therefore be based on a modular, service oriented approach. It is here where technology and trends of service orientation (SOA) and software as a service (SAAS) find their application in the area of VOPM. Further more, in line with the concepts and trends of service orientation, tools that provide this support can be best described in terms of their end-user usage, i.e. in terms of services they offer for the VO manager.

Instead of supporting ICT tools, we then talk about ***supporting ICT services*** or VO Management eServices. While chapter 3.3 contains more details, we provide here a short introduction with respect to the aspects of PM.

The term service has a broad scope in its definition. Business process engineers, information annalists and computer engineers have a different understanding of what a service is. In our context, a ***service is understood as conceptual building block in the provision of value in terms of support or delivery to the VO Manager***.

Services can be seen from both, a business perspective as well as an technical perspective; The ownership of the service may –in line with the VO thoughts- belong to different organisations. In their technical realisation and implementation, they often appear in the form of web services.

With respect to PM we can think of services in terms of ‘monitoring service’, ‘information retrieval service’ or ‘alerting service’. As mentioned before, information and indicator management is one of the important elements of VOPM. Regarding this from a service perspective, allows us to design a systems that meets the requirements in a feasible and natural way.

Distributed information provisioning [Mulder et. all 2006] can be done by means of data fetching and information services in the individual member environments. They combine the individual results in predefined, summarized formats, (based on KPI definitions) and share it with other services or inform the VO Manager directly. The figure below sketches this approach.

The ECOLEAD project has developed a set of services that support in various aspects of VO Performance management. They are part of a so-called VO Management toolkit.

The ECOLEAD-VOM toolkit is a distributed system consisting of several independent services that can be configured to integrate and share information with each other. This means that the components are in principle self-contained, supporting in some particular management aspects, but can work together, forming a set of collaborating services supporting VO management processes. The components form a toolset, and are interconnected by defined functionalities and interfaces.

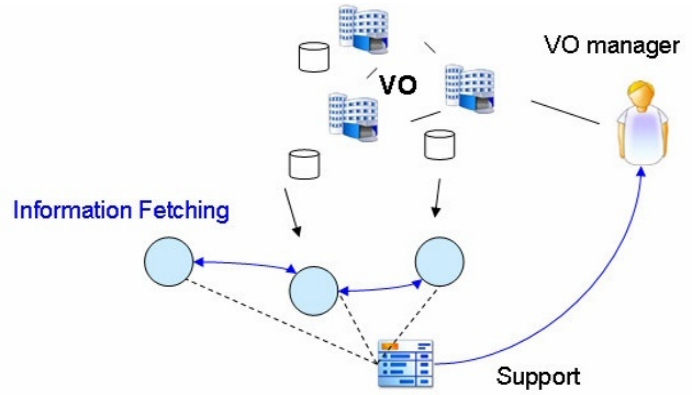

Figure 9: Information services supporting data retrieval in VOPM

6. CONCLUSIONS

This section if focussed on Performance Measurement in Virtual Organisations. VOPM is an essential part of VO Management that provides necessary data input for the supervision of processes in the VO. The challenges for PM in VOs and the differences between VOPM and PM in traditional organisations were identified. Although many PM approaches are provided by research and applied in practice they still leave some challenges when applied to VOs. As the existing approaches are mainly developed for single companies or static hierarchic networks the performance perspective of collaboration is not provided. In addition the suggested concepts for PM are not aligned to a temporary limited network of independent distributed partners. Necessary coordination steps and the inheritance of VOPM data when the VO dissolves can not be found in those approaches.

The proposed approach and framework for VOPM intends to fill these gaps and provide VO Managers with necessary support and guidance. Important elements are collaboration performance indicators and ICT support for VOs that are complex in term of their size or degree of interaction. The framework, developed by the ECOLEAD project, supports the performance measurement process. Amongst others it provides services for indicator management and distributed performance monitoring. The concepts and services do not claim a universal and unrestricted applicability to all kinds of VOs. As well as they do not demand a complete application of all elements. Rather, they are meant as an offer to the VO managers. They can make use of the concepts and service by selecting and applying those elements that facilitate their work in a particular VO best. Even though not all elements will be applied without any adaptation in every VO, the comprehensive consideration of PM in VOs should provide on overall picture of relevant aspects that helps the VO managers to orientate.

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