31 PREDICTIVE PERFORMANCE MEASUREMENT IN VIRTUAL ORGANISATIONS

Marcus Seifert, Jens Eschenbaecher
BIBA Bremen, sf@biba.uni-bremen.de
GERMANY

Predictive Performance measaurement is a decisive task for the further evolution of virtual organisations. The methodologies developed so far have a strong focus on either supply chains or extended enterprise orientied structures. Current trends in manufacturing enterprises change from long-term supply chains to dynamic network co-operation where both the structure and the entities of the network are dynamic and created with respect to the actual customers' order. An important management task within this kind of co-operation is to identify the most suitable partners and to build up the best performing virtual team within a short time frame to fulfil the customers' wishes.This paper discusses a predictive performance measurement approach as planning tool for virtual organisations to anticipate the performance of a planned virtual team.

1. OPTIMISATION POTENTIALS WITHIN VIRTUAL TEAMS COMPARED TO TRADITIONAL SUPPLY CHAINS

Long term co-operations between companies and their suppliers as well as the continuous improvement of more or less stable processes have been the main characteristics of the industrial production for a long time. Related concepts such as supply chain management were applicable in those cases where market needs and products are relatively stable and where the competitiveness is mainly based on the continuous optimization of the established process chain. Not the single company competes on the market but the whole supply chain as the provider of a wide variety of processes to offer a complex product faces the competition (Boutellier 1999, S. 66).

Current trends in manufacturing enterprises are changing from long-term co-operations between suppliers to ad-hoc co-operations related to the specific needs of dynamic customers' order (Hieber 2001, p. 2). The structure of these kinds of temporary networks is well known as the concept of virtual organisations (Camarinha-Matos 2004). The duration of collaboration in a virtual organisation consisting of a variety of independent companies is often limited to one certain project and the network has to be re-built for the next project. Virtual teams consisting out of distrib-

uted members collaborating in project teams will become the inevitable path of future (Gassmann and Zedtwitz 2003).

The main characteristic of a network collaboration in virtual teams compared to traditional supply chains is the short operational phase. While supply chains are established to operate over a long time, virtual teams are configured to realize at least one customers' order. Figure 1 shows the life-cycle of a network in virtual organisations (bottom) compared to long-term co-operations in supply chains.

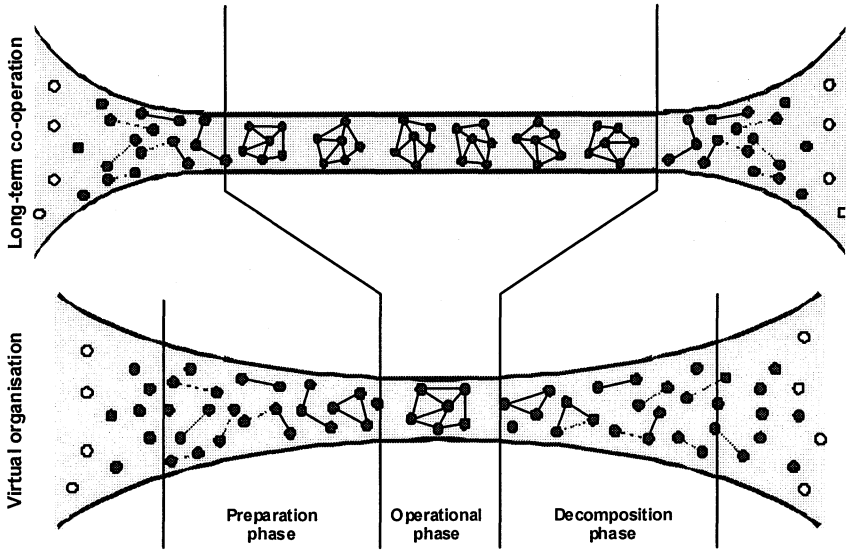

Figure 1 Life cycle of a enterprise network within the virtual organisation compared to long-term co-operations (Thoben/Jagdev 2001)

The identification and configuration of the best performing collaborative network to fulfil a specific customers' order during the preparation phase of a virtual organisation is an important management issue. Apart from the intra-company processes, especially the inter-company processes are the main success factors of a high performing co-operation due to competitiveness requires the integrated optimisation of the whole process chain including all resources. In "stable" supply chains with longer-term oriented co-operations, this optimisation can be performed continuously. An appropriate method to support this kind of process improvement is the performance measurement (PM) (Mertins 1995, p. 10). The continuous monitoring and evaluation of the current process performance enables the identification of weaknesses and is the base for the optimisation of the process chain. In this context, the performance measurement can be seen as retrospective method to monitor existing processes which enables the ex-post reaction on measured syptoms.

In virtual organisations, this continuous, long-term process optimisation by applying a "rear-view" evaluation is impossible. The reason is the dynamic character of virtual organisations where the process chain and the collaborating companies are configured specific to the current customers' order. Considering the extreme case,

the best possible performance of a virtual organisation has to be ensured from the first order due to the existence of this specific collaboration is related to only this certain order. In consequence, already the partner selection during the preparation phase of the life-cycle determinates the future performance of the virtual organisation during the operational phase – athough partners can of course be replace if not performing. This means that the prospective performance evaluation of a planned configuration of a virtual organisation during the preparation phase is an important planning task with a high impact on the future performance potential of future inter-organisational team. One criterion during this preparation phase is the qualifying examination of potential partners within the virtual organisation to build a order-specific team to evaluate their capability to contribute to the order specific tasks.

2. PERFORMANCE MEASUREMENT AS METHOD TO QUANTIFY A PROCESS PERFORMANCE

The concept of PM bases on the definition of key performance indicators (KPI's) which represent the performance of the business processes to be measured in a quantitative or qualitative way (Böhnert 1999, p. 92ff.). Using KPIs to support manufacturing operations has its roots back to the late 19th century where Frederick W. Talylor introduced time and motion studies to manage production lines and warehouse operations (Lapide 2001, p. 287). Since value chains are today distributed, companies have spent their efforts to re-engineer and to improve their supply chains. During the last years, a couple of concepts have been developed to measure the performance of stable supply chains (eg. Balanced Scorcard, Logistics Scoreboard, Economic Value-Added EVA). Within this chapter, the SCOR standard to model and to evaluate stable supply chains is introduced which represents currently the most extended approach which is related to Supply Chain Management. It is discussed, which aspects of this approach are also applicable for virtual organisations and which requirements an appropriate performance measurement system for virtual organisations can be derived.

2.1 The SCOR Model as method to evaluate Supply Chains

The SCOR (Supply Chain Opertations Reference) approach developed in the late ninetees by the Supply Chain Council is a methodology to model and to evaluate Supply Chains. The value chain is described as a sequence of standard processes which are namely "make", "source", "deliver", "plan" and "return processes. The contribution of each participant in the value chain can be described as at least one of these processes, which leads on the top level to the general architecture of the supply chain. This top level can be specified on a level of process categories (level 2) and details process elements (level 3). It is obvious that SCOR also focuses on supply chains to describe and to monitor existing value chains with the objective to reach an optimisation.

The benefit of the SCOR model is that it provides standardised processes, which allow to model the whole inter-company value chain with one single method – of course if all network partners agree to this standard. Due to the SCOR approach can be seen as quasi-standard, some of the often-implemented software tools for performance measurement base their models on the SCOR approach. Examples for

these tools are SAP APO, Cognos or SCORwizard. SCOR intends to model the supply chain from the suppliers' supplier to the customers' customer. The performance is described by KPIs belonging to five attributes, which are quality, assets, flexibility, responsiveness and costs.

2.2 Requirements for a performance measurement within virtual organisations

All existing approaches base their method on the belief that processes are relatively stable and most of the approaches focus on the evaluation of intra-company processes. They still rely on the idea to learn from the past to improve the future by measuring the actual performance. But only the continuity of the involved partners on the one hand and the high stability of the installed processes in an ordinary supply chain on the other hand allow an ongoing process improvement on the base of a retrospective performance evaluation.

Regarding the introduction of a performance measurement system in the virtual organisation, there is the lack that there are no approaches available which are able to measure the inter-company processes and which calculate the networks performance (Hieber 2001, p.2). Furthermore, the dynamic character of virtual organisations denies the measurement of past processes to initiate a future improvement due to the missing stability of the network. In a time-restricted co-operation with the objective to fulfil one single order, it is necessary to perform from the very beginning. This means that a performance measurement approach has to be initiated already in the initiation phase of the network to ensure that the operation phase will perform in the best way. This environment where possible partners of the planned network are identified and selected from a pool of potential companies, the so called breeding environment (Camarinha-Matos 2004), has still not been recovered potential and should already been supported by a performance measurement approach. Figure 3 shows the principle, how a virtual organisation can be generated dependent on the available potential partners and the required competencies.

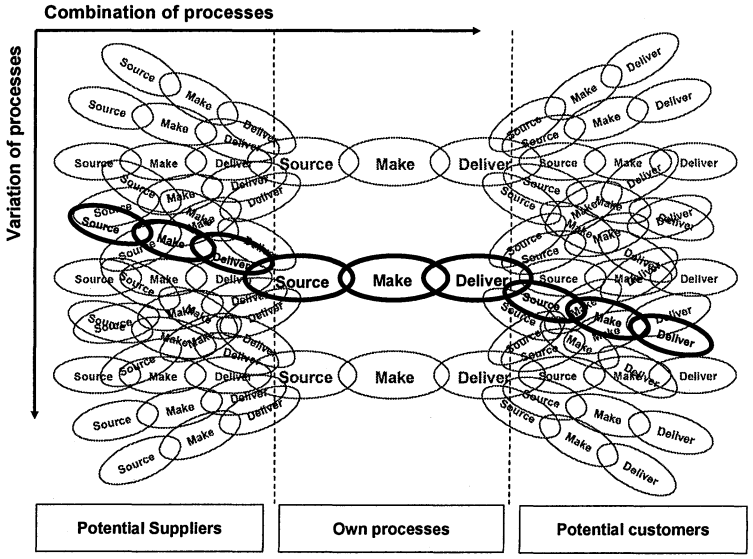

Figure 2: Variation and combination of processes (SCC, 2002)

Each product requires a specific process chain which means a specific combination of processes. Within the virtual organisation, there are multiple providers for each process available which allows to generate different variants of the process chain in terms of the involved partners. The main task within the preparation phase of a collaborative network is to identify that combination and variation of the value process chain which will deliver the best possible performance.

Combination of processes
The breeding environment provides the sum of all available processes from all potential partners for a virtual organisation. According to a specific order, the appropriate selection of processes has to be taken. This selection is in a first step independent from a company and describes the general architecture of the process chain.

Variation of processes
The breeding enivronment usually provides the possibility to select between different process owners which are the potential partners to build up the required process chain. To identify the best performing virtual organisation for a specific order means to be able to anticipate the performance of the temporary process chain.

It is obvious that there is isolated experience regarding the single performance of a potential partner available but not for each possible variation of the process chain with different partners. To ensure the best performing network, it is necessary to anticipate the performance of a planned network. Due to the temporary existence of this network, the traditional approach of continuous process improvement is not applicable. It has to be ensured that the generated virtual organisation represents the best possible selection from the breeding environment. To react flexible and with high quality on customer requests, a decision support within the initiation phase of the virtual team is very important.

Currently, the actual performance measurement approaches do not support this predictive performance measurement. When defining a predictive performance measurement for virtual organisations, a common methodology to measure the performance of all companies within the virtual organisation is required. This covers the following aspects:

Usage of the same process model for all partners within the virtual organisation to enable the modeling of distributed process chains
Up to now, the most completed and detailed model to describe industrial processes is the SCOR model of the Supply Chain Council. Due to its world wide availability and the large community supporting this initiative, it is appropriate to model inter-company process chains. The model itself can also be used to model the processes within in the virtual organisation although some adaptation is necessary. The difference is that the generated "supply chain" within the virtual organisation is dynamic and only temporary existent.

Definiton of a common set of KPIs to ensure the comparability between the partners
The SCOR methodology provides a wide range of KPIs to quantify the processes defined within the process model. The KPIs have been developed to evaluate the whole supply chain. Most of the indicators are company specific which enables the evaluation of each participating company. But the application of the model to the

whole process chain provides an overview on the performance of the whole value chain. Exact definitions in terms of formulas are not provided by the SCOR model and most of the indicators (especially units) have to be defined by the user.

Access to performance data of all potential partners for the main contractor who composes the virtual team
The isolated evaluation of a companies' performance does not support the evaluation of the whole process chain. To be able to quantify the performance of a virtual organisation, the performance data (KPIs) for all participants in the virtual team has to be accessible for the performance manager. An appropriate way to collect and to share information is a we-based system on the Internet. Due to the confidentiality of performance data, the privacy and security of the data has to be ensured for the industrial application.

Methodology to support the search for the optimal virtual team
Basing on the performance data of each partner in the virtual organisation, a method has to be developed to predict the performance of a virtual team and to compare different variants of a process chain.

3. SCIENTIFIC APPROACH FOR A PREDICTIVE PERFORMANCE MEASUREMENT CONCEPT

The concept bases on the assumption that the isolated processes provided by each single company within the virtual organisation are relatively stable. The process chain within a virtual team is composed by combining and integrating these isolated processes. The stability of the single processes which are the entities of the whole process chain allow to develop a performance measurement approach basing on two main tools and a central database. **A web-based database** collects the performance data calculated by the monitoring tool and provides it to the planning tool for a process chain simulation. The **monitoring tool** supports the measurement of the processes of each company involved in the virtual organisation and delivers the necessary data for the planning tool. The **planning tool** contains the process modeler to model a process chain on the base of the SCOR methodology. Developing and comparing the performance of the possible variants using the database, the tool proposes a virtual team with the probable best performance. Both tools as well as the overall approach are described in detail in the following.

The monitoring tool
The monitoring tool provides a real-time performance measurement for a companies' processes. Each company which is part of the breeding environment gets access to the tool with an own profile where it configures its processes and selects indicators. On the base of the actual processes, each company is able to monitor its own processes while all partners use the same methodology, which is the SCOR model. Basing the whole performance management within the VO on one model ensures the comparability between the partners. The data collection can be done in two different ways:

- The manual collection of each KPI according to the selected acquisition period: The tool identifies continuously the maturity of each indicator and asks for the actual values
- The automated data integration: An XML interface enables the user to link the tool with an ERP database to extract the necessary values automatically according to their maturity. The interface has to be specific to the available ERP source. Prototypes of these interfaces have been developed during the European project APM (Automated performance measurement) IST-1999-10279.

The results of the KPIs are stored in a central web-database which is normally located at the main contractor. This part of the tool covers the traditional process monitoring and enables an ongoing improvement of the own core processes. All KPI's are private and they are only visible for the owner of the data. The main contractor can access the data to calculate and to compare the to-be scenarios. This rule ensures the privacy of the performance data for each participant within the VO. Figure 4 shows the application of the monitoring tool described by the steps a) and b).

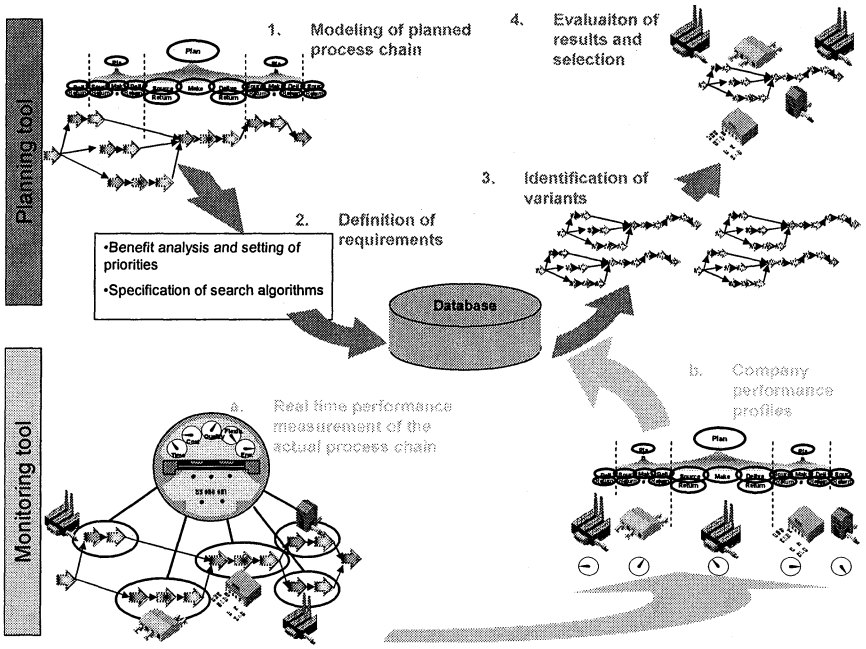

Figure 3: Concept for a predictice performance measurement system

The planning tool

The aim of the planning tool is to support the main contractor to generate different scenarios of a process chain by combining possible partners in the process chain. The comparison is executed by accessing the performance data from the different partners, which allows to estimate the prospective performance of the whole process chain. In a first step, a model of the whole process chain has to be developed by the

main contractor. This company-independent model is the starting point for the simulation part where the database is used to identify possible companies for each process. All possible variants of the process chain gained from the database are compared on the base of the stored actual KPI values. This approach allows to simulate the performance of a virtual organisation which sometimes never co-operated in this certain configuration before by using the actual performance data of each partner. Figure 4 shows the necessary steps for this simulation where the first step is the modelling of the planned, company independent process chain. The second step is to define the priorities in terms of costs, quality, responsiveness, assets and flexibility which determinates the selection of the possible partners. The third step identifies possible variants for a virtual team to run the required processes which are compared and evaluated on the base of their KPIs in the forth step. The tool itself is browser-based and uses the PHP script.

4. CONCLUSIONS

Existing performance measurement approaches still base on traditional supply chains and there is a lack of considering the growing influence of virtual organisations which require a interorganisational focus of the performance measurement. The main constraint for the establishment of an interorganisational performance measurement approach is of course the trust between the partners within the breeding environment. The agreement to share performance related information within the network and the understanding that the common output of the network determinates the customers' satisfaction are the main drivers for the success of an interorganisational performance measurement approach.

6. REFERENCES

1. Boutellier, R.: Konkurrenz der Logistikketten, in Logistik Heute, May 1999
2. Shields, M.-G. (2002) ERP-Systeme und e-business schnell und erfolgreich einführen. Wiley-VCH Verlag GmbH, Weinheim 2002.
3. Hieber, R. (2001) Supply Chain Mangement, A collaborative Performance Measurement Approach, VDF Verlag, Zürich 2002
4. Thoben, K.-D, Jagdey, H., (2001) Typological Issues in Enterprise Networks
5. Böhnert, A. (1999): Benchmarking: Charakteristik eines aktuellen Managementinstruments, Hamburg 1999
6. Lapide, L.: What about Measuring Supply Chain Performance?, AMR Research, http://lapide.ASCET.com, 15.11.2001
7. Camarinha-Matos, Luis M. (2004) New collaborative organiszations and their Research needs, in Processes and Foundations for virtual organizations. Kluwer Academic Publishers, Bosten / Dordrecht/London, S. 3ff.
8. Gassmann, O., von Zedtwitz, M (2003). Organising Virtual R&D teams. In: R&D management, 33, pp. 243-262.
9. Mertins, K: Benchmarking: Praxis in deutschen Unternehmen, Springer , Berlin 1995