

TOWARDS PERFORMANCE MEASUREMENT IN VIRTUAL ORGANIZATIONS

Potentials, Needs, and Research Challenges

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Traditional Performance Measurement methodologies are designed to assess efficiency of intra-organizational processes. Those models are applicable for single companies or static networks running a streamlined set of performance indicators. Under the given changes in production paradigms, single enterprises and more static, long-lasting networks, e.g. Supply-Chains in the automotive industry, lose significance to dynamic, order-specifically configured Virtual Organizations that highly depend upon the efficiency of their collaborative processes. Measuring the performance of those processes is not feasible with traditional PM methodologies or at least an extension of those. Ongoing efforts in creating a PM framework for Virtual Organizations are facing several research challenges. This paper describes and analyzes challenges towards a Performance Measurement methodology for Virtual Organizations.

1. INTRODUCTION

Throughout the recent years, the degree of standardization in manufacturing is decreasing continuously, making the way for customized production of product-service conglomerates, so-called Extended Products [Thoben und Eschenbaecher. 2003]. The process of creating these Extended Products and bringing them to the market is too complex to be done by one single enterprise. Instead, this requires networks of companies temporarily joining their core-competencies for collaborative

value-creation. These networks, so-called Virtual Organizations (VO), are dynamic (i.e. re-configurable within one order), order specifically configured, existing for the duration of one order only, and adherent to a specific life-cycle [Camarinha-Matos and Afsamarnesh 1999]. VO Management is strictly compelled by these characteristics: Due to their strict focus on one single business opportunity, time for corrective measures is limited – there is neither time to test and optimize collaboration of partners, nor to improve processes by trial-and-error procedures. This has significant implications on measuring and analyzing the VO performance.

2. PERFORMANCE MEASUREMENT

2.1 General Principles and Mechanisms

Performance Measurement is a toolkit providing methodologies, directives and indicators for measuring and evaluating the performance of business processes. This is done by indicators that are derived from an underlying process model. Applying a detailed set of indicators allows quick identification and assessment of weak-points within the value-chain and, by that, provides a basis for leveraging processes efficiency. With that, performance indicators prove to have traffic-light properties allowing conclusions on “go-” or “no-go”-items in value creation with the objective of being able to anticipate potential “no-go”-items as early as possible.

Generally, the challenge in Performance Measurement is the necessity to transfer highly complex real-world processes to a simplifying processes model, to derive performance information from the model, and to transfer these results back to the real world [Eschenbaecher and Seifert 2004]. Figure 1 highlights this loop of transfers.

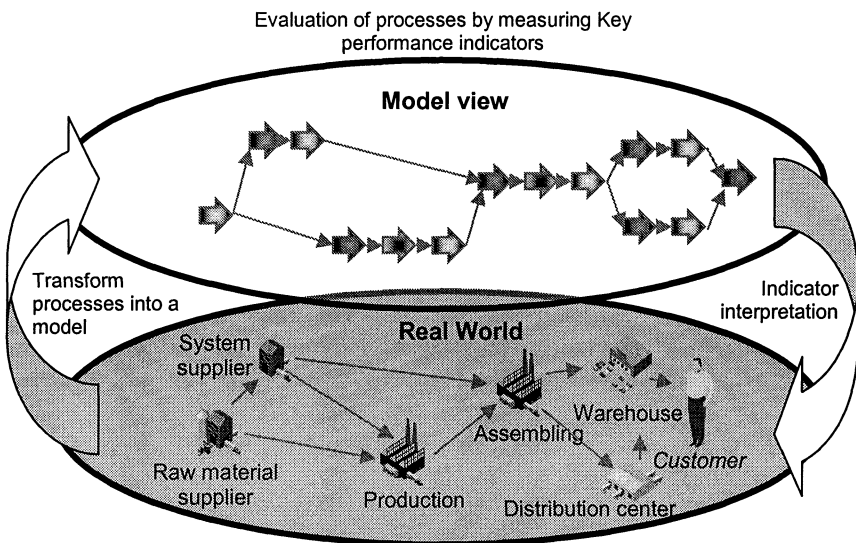


Figure 1 – Transfers between Real-World and Models in Performance Measurement

Theoretically, difficulties in Performance Measurement increase with the complexity of processes to be assessed. This implies that Performance Measurement

within single enterprises in principle is easier as it is within a network of enterprises. On practical grounds, Performance Measurement is often tied-up by lacks of transparency in processes, misty process instructions, and inefficient communication between different business units even within one and the same enterprise. Between enterprises things are more complicated: Different cultural convictions, different standards, process models, performance indicators, gaps in technologies and incompatibilities in information systems create a clearly heterogeneous landscape among the partners that need to be harmonized to draw a transparent picture uniform to all partners of the entire distributed processes chain.

2.2 Existing Approaches in Performance Measurement

Performance Measurement can be applied for different purposes. In literature one can find examples for measuring performance for strategies, humans, tools, processes. In this paper the focus is on measuring performance of processes.

The origin of Performance Measurement (PM) could be found in financial accounting that gives information about one of the most essential performance indicators: the profit of an enterprise. The assessment of the financial performance was refined by indicators like Return on Investment (ROI), Economic Value Added (EVA, a trademark of Stern Stewart & Co.).

The major drawback of these approaches focusing only on financial performance is their retrospective character. In addition essential factors for a sustainable success are not covered as they are non-financial aspects.

To fill this gap several approaches are developed in then 1980s and 90s, which include essential PM components or rather build upon PM. The first approaches replenish existing PM with aspects of process performance. Examples are Benchmarking, Six Sigma, EFQM, and SCOR.

Benchmarking got popular in the 1980s. The basic idea is to compare performance indicators between different entities to obtain reference points for the optimization of processes. Typical indicators are for example productivity, efficiency, lead times or quality aspects.

The **Six Sigma** approach measures the process capability and stability by determining the rate of defects per million opportunities (DPMO) which is transferred into a Sigma-value. As a universal indicator the Sigma-value enables the comparison of processes in different functions of enterprises independent from the line of business.

A very comprehensive approach is **EFQM**. The European Foundation for Quality Management (EFQM) developed this reference model for quality excellence as a framework for a quality award. In addition to the process perspective it comprises eight further categories of indicators from leadership and people, to customers and financial results.

The Supply Chain Operations Reference Model (**SCOR Model**) was developed by the Supply Chain Council. This supply chain process model uses hierarchical decomposition into six layers, out of which the first three are generic (or implementation independent). An essential feature of SCOR is the connection of standardized performance indicators to the defined process elements on each level.

Most of these approaches are oriented to single processes or functions, focusing on few certain perspective and are not consequently linked to the enterprise's strategy. Therefore Kaplan and Norton introduced the concept of **Balanced**

Scorecard (BSC) [Kaplan; Norton 1992]. This approach provides a methodology that facilitates translation from strategy into appropriate actions [Kaplan; Norton 1996] by defining performance indicators that represent the fulfillment of objectives derived from the strategy. As BSC covers the perspectives of Financial Results, Customers, Internal Processes and Innovation it is very comprehensive approach that oriented towards the enterprise's long-term success.

The increasing importance of so called intangible assets for companies' values led to specific approaches for Intangible Assets Management. They pay special attention to indicators like know-how of specialists, strong brands or regular customers. Well-known examples are the Skandia Navigator, the Intangible Assets Monitor of Sveiby and the Intellectual Capital Monitor of Stewart [Klingebiel 2001].

The approaches described above are widely used and cover a very wide scope of aspects. However, none of them is aligned explicitly to collaborative business between independent partners. This gap was already identified and discussed by several research works [e.g. Gunasekaran 2001, Leseure 2001, Hieber 2002, Zhao 2002, MacBeth 2005]. Leseure for example developed an approach for meta-performance on network level, which comprises the two dimensions of aggregated performance and equity. Many of these research works considering collaboration in supply chains. Nevertheless a consistent PM approach for Virtual Organizations is still missing.

3. PERFORMANCE MEASUREMENT IN VIRTUAL ORGANIZATIONS

3.1 VO management general aspects

Virtual enterprises are the logical consequence of the shift from standardization to customization in production. In a world of customization characterized by a low vertical range of manufacturing enterprises are forced to collaborate with each other on an order-specific basis: For fulfilling a customer's demand those enterprises engage in a network that are considered to create the highest benefit to the customer [Miles, Snow, and Miles 2000].

Spoken in terms of process management, a VO is a temporary synchronization of processes and resources between different enterprises to achieve operational or strategic benefit from a specific business opportunity. For entities outside the network, a Virtual Organization appears not to be a network of various organizations, but one single entity.

VOs can be created either from an "open universe" of enterprises, or out of local clusters, so-called Virtual Breeding Environments (VBE). Being a strategic network itself, the VBE is an important concept for shortening lead-times in VO creation and supporting enterprises to quickly build-up infrastructures enabling them to collaborate efficiently [Camarinha-Matos; Afsarmanesh 2003]. Establishing a VO by going the road via a VBE appears advantageous predominantly for the following two reasons:

1. It is a process of down-sizing a completely "open" and almost infinite universe of potential VO candidate enterprises,
2. The VBE is a way of adjusting its enterprises to a common denominator of standards, infrastructures, management methods and tools, cultural

convictions, and mutual trust.

Figure 2 (left part) highlights the possible roads towards a Virtual Organization: either with (1a, 1b) or without (2) a VBE [Camarinha-Matos, Afsarmanesh 2003]. Once the VO is established, it is operated to a standard basic life-cycle. This cycle comprises the stages operation, evolution, and dissolution [Camarinha-Matos, Afsarmanesh 1999]. Eventually, all enterprises end-up where they came from: either in open universe or back in the VBE.

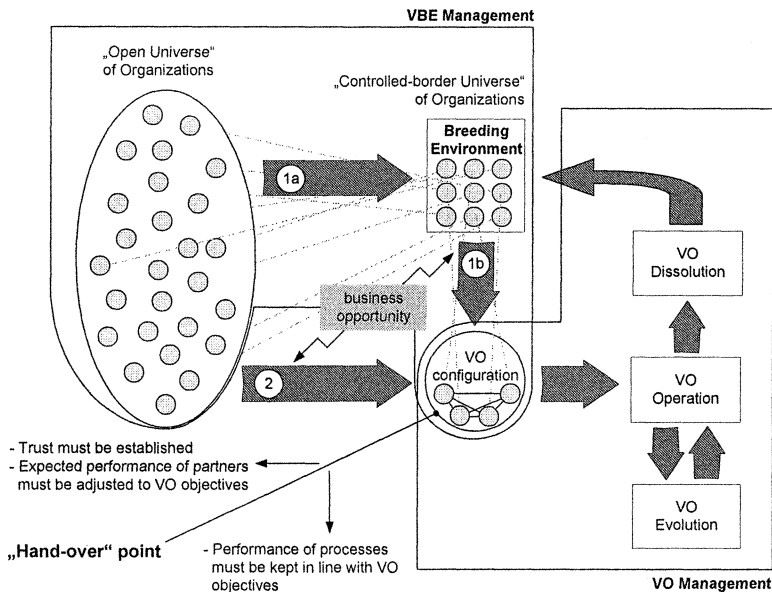


Figure 2: An integrated VBO/ VO lifecycle schema¹

3.2 Needs for Performance Measurement in Virtual Organizations

Assessing Trust in Collaboration

In any kind of business network linking enterprises, individuals, or both, mutual trust is *conditio sine qua non* for fruitful collaboration [Blomqvist, Seppänen, 2003]. Trust is a prerequisite for both engaging in collaboration in general and especially for allowing other entities to view and assess enterprises' performance data. These two stages allow for distinguishing the following kinds of trust:

1. Trust in good behavior in daily business: Comprises for instance trust in timely delivery, responsiveness, reliability in payments
2. Trust in security of essential data/ information/ knowledge shared among the network partners.

¹ This figure is an extended composite of illustrations as stated within [Camarinha-Matos; Afsarmanesh 2003] and [Camarinha-Matos and Afsarmanesh 1999]

While the former is prerequisite for any kind of collaboration, the latter is the key momentum encouraging entities to share their performance data with the network partners: If the entity can trust that none of its partners will turn its information against itself, its propensity to participate in a VOPM increases. Vice versa, mistrust inhibits any kind of VOPM. Thus, efficiency of a VOPM system stands and falls with the trustworthiness of the partners applying it. For establishing VO's it is a critical question on how the entities can estimate their trust in the other partners, and how to enhance trust among them. Although detailed methodologies for trust building are available [Blomqvist; Staehle 2000], models for measuring trust are yet missing.

Predicting a VO's performance

Configuring a Virtual Organization and putting it into operations is more or less like playing jeopardy, because up to now it is uncertain how different partners will perform when interacting within a network that, in all of its parameters and environmental circumstances never existed before and will never exist again. This challenge is presently addressed by upcoming approaches of anticipative performance measurement which promises to be a beneficial asset in the process of partner selection: If you can assess how a partner's performance can contribute to the performance of the entire network, this is a crucial criterion for deciding on which candidate partner to involve in the VO. An approach for estimating the performance of a network before it actually exists must be based on experiences and data from the past that are somehow projected into the future. Emerging solutions to that problem are based on the idea of simulating the behavior of a certain VO based on historical data [Seifert and Eschenbaecher 2004]. In that model, trust and the concept of selecting the VO partners out of a VBE are indispensable for ensuring enterprises' willingness to share their performance data with other entities.

Measuring a VO's operational performance

Performance Measurement within a VO's operational phase must deliver information on its actual performance (retrospective to real-time perspective), and to anticipate and inhibit failures before they can occur (prospective perspective). Both aspects are crucial since partners do not have sufficient time to rehearse and improve collaboration in a pre-competitive environment. In fact, VO's are born of competition and must work efficiently from the scratch. The two perspectives in Performance Measurement condense as follows:

1. In the operation phase VO Performance Measurement is needed as a basis for detecting lacks in efficiency and potential threats endangering achievement of the partner's common business objectives. Here the problem is *that optimizing VO processes in operation is a highly time-critical issue due to restraints in time and resources.*
2. Proactive VO Performance Measurement is need for early detention of potential problems in partner's performance. Delays and problems in the performance of a partner my seriously endanger the operation of the whole VO. At this stage the problem is *to define relationships between tasks in work breakdown structure and how to forecast the impact of delays in on task on its subsequent and parallel tasks.*

PM Needs in VO Dissolution

A VO by definition is a temporary construct. After dissolution a VO's partners usually return to their VBE status, keeping ready to join forces with other VBE partners in other VO's. Looking back at the "old" VO it might be good for new VO partners to know the success of the old one and how every partner contributed to the VO's success. Information on that is highly sensitive and it is an open question to which VBE partners they should be made available. to comprises:

1. Retrospective assessment of the individual partner's performance
2. Retrospective assessment of the individual partner's behavior (for instance in terms of integration in the consortium, commitment, active vs. passive role in communication, etc)
3. Re-assessment of the partner's trustworthiness

This information is necessary input to the VBE managers and management systems for selection of partners for new VO's.

Another important topic even after dissolution of the VO is the quality of after-sales-services (for instance maintenance, warranty handling, reverse logistics). Assessing and evaluating the efficiency of after-sales-services is another important element of a Virtual Organizations Performance Measurement system.

4. OPEN RESEARCH CHALLENGES

Performance Measurement in virtual organizations can be considered as completely new research area. MacBeth (2005) discusses that performance measurement in supply chains is a non-solved problem which need to be addressed. Indeed performance measurement on VO is even more dynamic and a much bigger challenge. Consequently the next chapters provide an overview about the main general challenges which have been identified so far.

4.1 Cultural Challenges and Requirements

The following cultural challenges and requirements need to be addressed in developing a Performance Measurement approach for Virtual Organizations:

1. It is not enough to define the ability to co-operate in an isolated environment. The presence of other partners and concurrents other activities needs to be taken into account and reflected in the VOPM approach. *Consequently, a schema for measuring co-operational performance is needed.*
2. Performance Data are sensitive and normally confidential: Unauthorized delivery of performance data to third parties may cause fatal damage to the entire enterprise. Exchange of sensitive performance data is beyond the scope of normal ("operational") trust requiring a deeper confidence in the partners than just believing in his/ hers timeliness. Partners delivering these data must trust in the confidential usage of these data through the receiver/s. *Consequently specific trust-building models must be developed and enriched by organizational models ensuring trustful and secure performance data handling,*

4.2 Technical Challenges and Requirements

In the field of technical challenges towards VOPM, different issues are of

importance. First, VOPM among different partners requires to a certain degree harmonized process models and a uniform set of metrics and indicators applied among the partners. Critical technical challenges towards a VOPM systems are:

1. *Harmonization of Process Models* among the network partners for creating a standardized set of performance metrics uniformly applied among the partners
2. *Real-time requirements* for PM in dynamic environments to allow for quick and reliable response to emerging problems in VO operational processes.
3. Procedures for *Ensuring Data Availability* for securing the process of gathering data from within the enterprise and sharing it with the network partners/ broker for further evaluation/ analysis
4. Data Integration → “Bridging” gaps between intra-enterprise Process Management/ ERP systems

4.3 Organizational Implications

From the organizational point VOPM is a very difficult task due to the distributed nature of the collaborating partners. Considerations and requirements on organizational structures mostly arise from the cultural and organizational challenges to be met for developing and implementing a VOPM methodology.

First, clear and uniform collaborative patterns and processes need to be implemented allowing for laying a clear and mutually accepted basis for VOPM. For instance, the business objectives and processes must be stated clearly and in an operable way for deriving suitable indicators for performance measurement.

Second, as seen before, the question of doing collaborative Performance Measurement touches questions of trust between the entities involved in the network. Generally, two ways of handling the problem are considerable:

1. *Centralized Performance Measurement*: Within the VO, one entity takes the part of a VO broker. This broker is responsible for setting-up the network out of the VBE, turning it into an operable network, and to keep this network in operation. Thus, Performance Measurement would be the task of this broker, and it would be the only entity that needs to know all partners’ performance details. In this scenario it is sufficient that all entities trust their confidential data to the broker only.
2. *Decentralized Performance Measurement*: This is the most democratic way of managing the network. No obvious predominant power is visible, and every entity is able to access and to evaluate the network performance and the performance of all of its partners. In terms of trust this scenario is much more difficult to handle for everyone must be able to unconditionally trust everyone else within the network.

4.4 Summary

Authors such as MacBeth (2005) have identified a set of research issues for PM in supply chains which give first ideas about issues to be resolved:

- Who owns / can influence the network?
- Mutuality of consideration but are all partners of a VO equal?
- Dynamics of change in context of preferred solution?
- Can enterprise control in a classic sense ever work?
- Focus measurement of the output or input enablers?
- It is about rule sets agreed by all but who constitutes the all set might

change with time?

- What are the performance indicators and processes to replace a member of a network that are not longer appropriate or performing well enough?

Based on these research issues we have discussed the most prominent challenges. Figure 3 shows a summary of the discussion before. The identified challenges are a result of a common discussion about the most demanding challenges regarding PM in VO. Time restrictions, trust and the availability of data have been judged as most critical for the success of any VO.

The idea of complexity illustrates that uncertainties, dynamics, variation of goals and number of involved participants have a crucial impact of the performance of a VO.

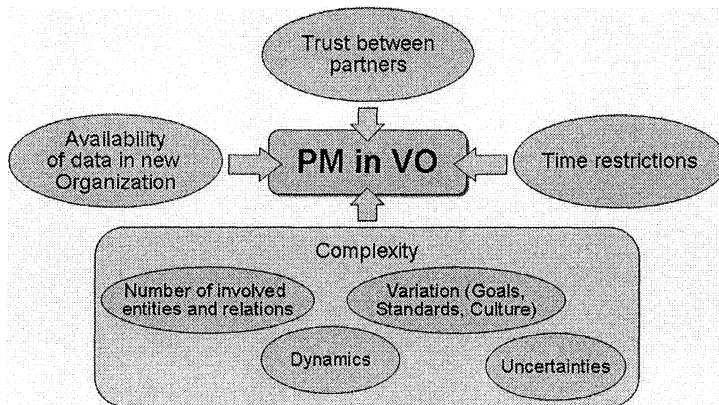


Figure 3 – PM in VO - challenges

PM in VO will be of major importance if a further dissemination of the VO concept should have any possibility to succeed. Only if managers of single organizations have instruments in hand allowing them to simulate and understand the high performance of a VO the further evolution of VO will be highly accelerated.

5. CONCLUSIONS

Performance Measurement in VO is a new scientific issue which needs to be solved. The discussion has shown that not even supply chains can be supported by proper instruments and tools. This is due to the fact that most of the available approaches for Performance measurement do focus on single organizations. Additionally the dynamism of a VO makes it very difficult to develop solid approaches. The challenges show that research is needed to solve organizational, technological and human aspects such as trust before a PM approach can really have a major impact on VO.

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