An Approach for Value Adding Process-Related Performance Analysis of Enterprises within Networked Production Structures

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Abstract

This conceptual paper focuses a methodology for the analysis of performances of enterprises operating in production networks. In order to derive adequate results exclusively the operative perspective of performance analysis is investigated. Operative performance analysis implies the analysis of performances of network members considering a special value-adding-process. The introduced approach is divided into two segments: the value adding process-neutral phases and the value adding process-specific phases. In that context special methodologies for the determination of performance indicators, corresponding parameters, evaluation functions and weightings are focussed. Additionally possible consequences are discussed.

Keywords

Performance Analysis, Network Controlling, Production Network

1 Introduction

In order to successfully stand the competition pressure caused by the large-scale companies as well as the effects of globalisation, especially small and medium-sized enterprises (SME) increasingly form production networks. Thereby, products can be manufactured by several enterprises which remain legally independent and provide their specific core competences. The purpose of the research work predominantly consists in developing an approach for the performance analysis under consideration

of a high degree of automation. Thereby, the performance analysis does not only comprise processes of performance measurement and evaluation but also the consequences which should be derived from the analysis, for example as sanctions or incentives. For the design and structuring the approach, the individual process phases of the performance analysis were classified as value adding process-neutral and value adding process-related. The first mentioned type particularly includes the processes of determining the performance indicators, corresponding parameters, the evaluation functions as well as the weightings. Those processes just need to be carried out by suitable instances from time to time but not before every analysis process. The value adding process-specific approaches include the processes of measuring and evaluating the performance, weighing the indicators as well as calculating an aggregated performance parameter and finally deriving suitable consequences for the single enterprises. These are processes which need to be carried out for every single value adding process based on pre-defined algorithms.

The introduced approach was realised using an adapted cost benefit analysis under consideration of the claim for a high level of automation of the analysis processes.

2 Value adding process – neutral phases

2.1 Determination of Performance Indicators

The most important task of performance analysis is the determination of the relevant performance indicators which are derived based on an adapted Balanced Scorecard (BSC) [1]. Although in literature network-specific Balanced Scorecards [2, 3] can be found, consecutively it is only applied to identify relevant performance indicators.

At first, it must be clarified which perspectives need to be taken into consideration for the derivation of the performance indicators from the strategy of a production network. The classic BSC disposes of four perspectives. The financial perspective, the customer perspective and the perspective of the internal business processes can be taken over to a large degree. However, due to the dynamic orientation of the network, the learning and development perspective can be neglected in this context and a cooperation perspective can be included instead. All the targets of an enterprise are considered whose achievements contribute to the success of the complete network. The BSC applied in this way thus integrates the enterprises as single organisation units as well as the dynamic production network. This generalisation is efficient because finally only those performance parameters shall be derived which are relevant for the performance analysis. Those performance parameters make possible the analysis of the performance of enterprises but they also take into consideration the network

The different perspectives considered in the BSC including specific targets can be allocated to each other with regard to a hierarchy. Starting from the financial perspective which has the target to achieve profits, connections can be made between

the targets for the several perspectives. Finally, basic targets can be identified in the enterprise perspective. Fig. 1 illustrates the described connections graphically.

After determining the performance indicators that need to be considered as well as determining the variables which represent the performance indicators, it is necessary to transform the values of the single performance parameters into an equal metrics in order to allow an aggregation of the results subsequently. This is achieved by determining a value benefit function for every performance parameter.

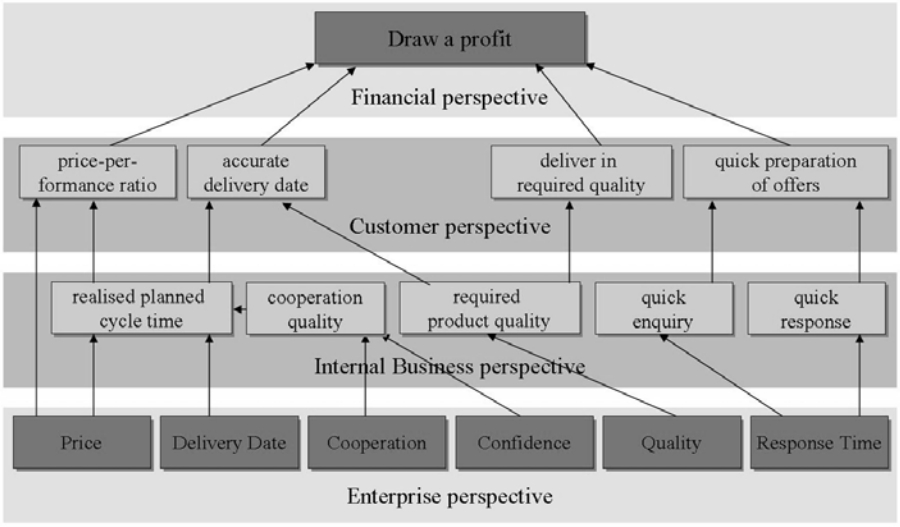

Fig. 1. Methodology for the determination of performance indicators

The value benefit function is of mathematical nature and is used for transforming the results of the measurement process into a credit evaluation. In order to determine such value benefit functions, the preferences of the evaluating person need to be evaluated. Consecutively the preferences of the customers are put on a level with the target value of the corresponding performance parameter, i.e. the target performance.

All criteria have to be illustrated on a 10-credit-scale (10 credits make possible a differentiated evaluation which is easily comprehensible) whereby the value 0 represents the worst and 10 represents the best, the promised, result.

For the six identified performance parameters, in the following chapter a suitable parameter and exemplarily ascertains of the target system and thus of the value benefit function as an evaluation function are introduced. Hereby both hard-facts and social factors (so-called soft-facts [4]) are considered.

2.2 Determination of the Parameters and the Evaluation Function

The performance parameter *price* is represented by the variable price difference. Price difference is defined as the deviation of the realised price from the agreed price in the offer of the enterprise for a value adding process. Thereby, it is important that a possibly cheap price is expected because of the competition in the network in order

to increase the chances of an enterprise to be selected. Because the deviation from the agreed price is a big failure, an evaluation function is suggested as a binary relation. This means that the full number of evaluation credits is granted if the offer price was kept. If this is not the case, no evaluation credits are awarded.

The *date of delivery* also is a significant performance parameter which is represented by the variable keeping the delivery date. This is the possible deviation of the realised date of delivery from the promised one within the scope of a value adding process. Because delays in the dates of delivery could also have already been caused by preceding enterprises, a corresponding clearance needs to be made. This means that only enterprises causing a delay can be considered. For deriving an evaluation function, it is necessary to quantify interdependencies between the character and time of the delay. Thus, the full number of credits can be granted if the date of delivery is kept or the goods are even delivered prior to the agreed date while a devaluation is realised if there is a small delay and the granted number of credits approaches to zero with a longer delay. A corresponding mathematical function can be derived by the means of Lagrange interpolation.

During partner selection enquiries are sent to potential enterprises with regard to their core competences during the offer phase by the network broker instance. Because a quick generation of the response is aimed at based on the high level of automation, the *response time* also represents a relevant performance parameter. The appropriate parameter also is called response time that means the time that passes between the enquiry of the broker to the enterprise and the response of the enterprise to the broker instance. The enquiry time has to be cleared for possible times for sub-enquiries. The derivation of an evaluation function can be analogous to the date of delivery. A target response time is assumed which, if kept, leads to the allocation of the full number of credits. If the actual response time is longer than the target, the number of credits is successively reduced up to a certain marginal value starting from which no more credits are allocated. The ascertainment of a function is carried out by the help of Lagrange-interpolation as well.

Quality refers to the quality of the (partial) product which is represented by the parameter with the same name. In the simplest case, a binary relation is chosen: If the product corresponds to the qualitative requirements, the full number of credits is awarded; if not, the enterprise is given zero credits. If a differentiated consideration is aimed at, single quality features can be evaluated with regard to their level of fulfilment and aggregated to a complete value by the means of weightings. This procedure again makes it possible to derive an evaluation function by the means of Lagrange interpolation.

The performance parameter *cooperation* with the parameter cooperation represents a soft-fact which describes the quality of the cooperation in the network. Because soft-facts are primarily described by linguistic terms such as high, medium or few, a quantitative consideration is very difficult. However, there is the possibility to realise a quantification by the help of the Repertory Grid-methodology [5]. That approach is based on the ideas of the Personal Construct Theory [6]. However, further details will not be given here for lack of space. Information concerning soft-facts can be collected by having a corresponding instance ask structured questions to the enterprises. The appropriate levels of fulfilment of the single partial categories in a weighted version can be aggregated consecutively and thus lead to a complete level

of fulfilment for the performance parameter cooperation. Then, this complete level of fulfilment can be transformed to an evaluation function by standardisation.

Confidence is an important success factor for networked cooperations and also has to be interpreted as a soft-fact. Thus, there is also the problem of quantification. The confidence climate is used as a parameter. Analogous to the performance parameter cooperation, the Repertory Grid-methodology is also applied for quantification for the factor confidence. Furthermore, a corresponding evaluation function is derived.

2.3 Determination of the Weightings

In order to allow the consideration of the differing standings the performance indicators can be weighted. As the fist step a check of the independence of the performance parameters has to be arranged. In case these preconditions are fulfilled, the determination of the weightings can be started. Therefore, the trade-off-procedure [7] is applied. The application of weightings allows considering the single performance indicators when carrying out the performance analysis dependent on its meaning. Because the approaches for determining the weightings are all quantitative, an automated procedure usually does not face any problems. Detailed questions, however, need to be answered in the forefront by the decision makers.

The value adding process-neutrally ascertained weightings can be applied for the performance analysis for a long term. However, it is recommended to carry out a check or if necessary a correction of the weightings regularely.

3 Value adding process – specific phases

3.1 Measurement of the Performance

The measurement of the completed performance takes place (at the latest) after a value adding process has been finished. It can be carried out by a specific concept of a workflow management system including a monitoring functionality. The support of the enterprises for the coordination of activities in the network is a central task of a workflow management system. Therefore, a distributed workflow management is proposed which consists of several components. The workflow engine as the central coordination instance is the core of the system. The disturbance management, document management, process definition catalogue as well as the monitoring can serve as supporting modules.

Within the scope of monitoring, data are collected during the value adding process and evaluated to a certain extent. Thereby, the evaluation predominantly refers to the disturbance management where it is necessary to react very quickly to deficient developments. The aspect of performance analysis in this step is not the most important issue. However, the data collecting within the scope of monitoring is indispensable and a basic pre-condition for this aspect.

The actual collection of data, i.e. the measurement of the performance without an evaluating element, takes place based on the specific parameters which were introduced earlier. While in the case of the quantitative performance parameters, a high level of automation in the sense of using the ICT can be realised, (pre-defined) repertory grids need to be filled in by the enterprises for the consideration of soft-facts. This can only be done by correspondingly trained human decision makers who represent the enterprise. In order to protect from manipulation, it is desirable to install control mechanisms such as a plausibility check or further decision makers.

Because not all the data which have been collected in the measurement phase by monitoring within the scope of the workflow management are used for the performance evaluation, it is absolutely necessary to make the relevant data accessible as actual values for the ICT. This means that the corresponding data are stored in a suitable form for the subsequent evaluation phase.

3.2 Evaluation of the Performance

The performance evaluation contributes to the realisation of an evaluation of the completed performance of an enterprise under consideration and in comparison with the pre-determined parameters dependent on all performance indicators or their parameters. Thus, the performance evaluation represents a central component of the operative performance analysis.

The evaluation functions of the single performance parameters, which have been determined in paragraph 2.2 gain special importance during the phase of performance evaluation. Thus, clear evaluation functions should be determined for all performance indicators or their parameters. Within the scope of the value adding process-specific performance evaluation, the demarcations of the parameters need to be determined in the corresponding performance parameter-specific kind and subsequently, they need to be included in the evaluation function. In the following, the parameter-specific value benefits can be determined by considering the related degree of fulfilment.

3.3 Interpretation of the realised performance

As a result of the preceding evaluation process, a vector can be formulated which includes the single target fulfilment levels (value benefits) of the parameters for every enterprise. In order to cope with a possible different significance of the single performance parameters, they can be correspondingly weighted. Thereby, the predetermined weightings are applied. The utility of every criterion results by multiplying the value benefits with corresponding weightings. The value benefits represent a partial utility of the total utility. The total utility has to be ascertained during the subsequent phase of the calculation of the aggregated performance parameter.

The additive model can be applied for aggregating the partial utilities to a complete utility of an enterprise to the successful check of the independence of the single indicators. Thereby, the complete utility represents the aggregated performance variable which can be conferred for the evaluation of the performability

of an enterprise for a value adding process-specifically configured production network. This evaluation of the complete performance by evaluating the value benefits of the single performance indicators serves as a basis for the determination of sanctions or bonuses within the scope of the further performance analysis.

The completed performance of an enterprise is represented by the complete value benefit and forms an enterprise-specific parameter. Thereby, it is assumed that the value benefit function considers possible tolerance values with regard to the performance that needs to be completed, in addition to the single variables for the performance parameters and the full number of credits is awarded in the end despite of acceptable deviations.

4 The Performance Analysis Approach

The comprehensive approach for the value adding process-related performance analysis for enterprises in production networks is illustrated in fig. 2.

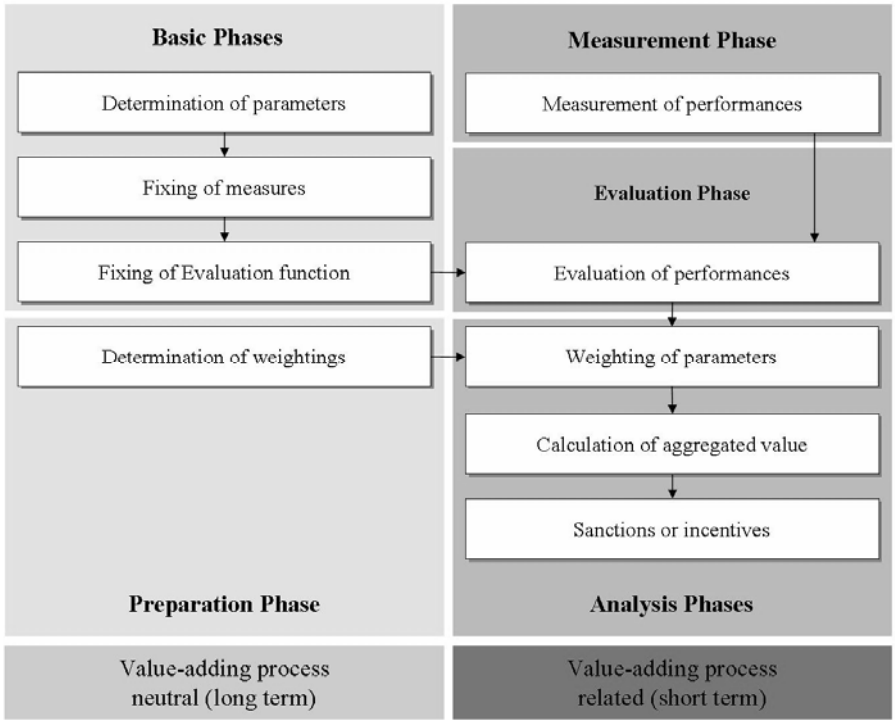

Fig. 2. Approach for value adding process-related performance analysis

From the practical point of view it must be stressed that the application of the introduced approach presupposes a high degree of information which can be guaranteed by the intensive application of the modern ICT. Thereby the analysis data is strictly held confidentially in order to prevent misapplication.

5 Conclusion

The most important finding of the research works is that it could be proved that it is possible to develop an approach for the value adding process-specific performance analysis of single enterprises within networked structures in order to make a largely automated procedure possible. Thereby, the ascertainment of the input information for the soft facts within the scope of the Repertory Grid methodology represents the most challenging task. The approach can be applied generally – however, using an automated network operation and coordination concept is recommended.

The introduced approach focuses on the value adding process-related performance analysis of enterprises within networks and thus closes a gap which established performance measurement systems leave. In most cases approaches for the performance measurement comprise the long term (strategic) view [8, 9]. This means the general economic situation is analysed. Additionally implications of the results are neglected. This approach however analyses the degree of fulfilment of the performance depending on several performance parameters including soft-facts which in order to achieve a comprehensive result, also are considered in addition to hard facts within the scope of the performance analysis. The approach takes into consideration the measurement as well as evaluation and consequences.

By the application of the approach the network controlling will be supported by alterative performance figures and suggestions for consequences in case of a to satisfying performance of single network participants.

6 Literature

1. R.S. Kaplan, D.P.Norton, *The Balanced Scorecard – Measures that drive Performance* (McGraw-Hill, New York, 1992).
2. M. Erdmann, *Supply Chain Performance Measurement* (Eul, Lohmar, 2003).
3. J. Richert, *Performance Measurement in Supply Chains* (Gabler, Wiesbaden, 2006).
4. T. Teich, H. Jähn, M. Zimmermann*, A New Approach for the Analysis of Soft-Facts in Social Networks*, in: Proceeding of the IFIP WG 5.7 Working Conference on Human Aspects in Production Management, edited by G. Zülch (Shaker, Aachen, 2003) pp. 275-281.
5. F. Fransella, D. Bannister, *A Manual for Repertory Grid Technique* (Academic Press, London, 1977).
6. G.A. Kelly, *The Psychology of Personal Constructs* (Routledge, London 1991).
7. F. Eisenführ, M. Weber, *Rationales Entscheiden* (Springer, Berlin, 2004).
8. F. Graser, K. Jansson, J. Eschenbächer, I. Westphal, U. Negretto, *Towards Performance Measurement in Virtual Organizations - Potentials, Needs, and Research Challenges*, in: Collaborative Networks and their breeding Environments, edited by L.M. Camarinha-Matos et al. (Springer, New York, 2005), pp. 301-310.
9. H.I. Kulmala, A. Lonnqvist, Performance measurement of networks: towards a non-financial approach, *International Journal of Networking and Virtual Organisations*, 3, 299-316 (2006).