

## COMPARISON OF PERFORMANCE ANALYSIS BY AHP, ANP AND DEA - APPROACHES<sup>1</sup>

**Petr Fiala**

Department of Econometrics, University of Economics,  
W. Churchill Sq. 4, 130 67 Prague 3, The Czech Republic  
pfiala@vse.cz

**Abstract:** The paper presents a comparison of some approaches to study and to measure performance of production systems. The performance pyramid managerial concept is appropriate for applying, comparing and combining AHP, ANP and DEA approaches.

### Introduction

Productions systems are focused on transformation of inputs into outputs and can be shown as interrelated sets of resources, products, processes, tasks, plans and events. Performance is an index that measures output relative to the input used to produce them. Performance models estimate the measures of system performance for a given set of decisions and system parameters. Performance analysis of production systems helps to understand the behaviour of these systems and to provide guidelines to improve their performance.

### Performance Pyramid

The performance pyramid represents a comprehensive, fully integrated performance system that captures multiple perspectives as internal, financial, customer and innovation (Rouse, Puterill and Ryan, 1997). Each side of the pyramid represents a perspective as a hierarchical structure of success factors, managerial measures and process drivers. Not only are measures and process drivers linked to each side of pyramid, but linkages also exist to other sides of the pyramid as impact of process drivers on more than one key perspective.

### Analytic Hierarchy Process

A hierarchy is an efficient way to organise complex systems. It is efficient both structurally, for representing a system, and functionally, for controlling and passing information down the system. The Analytic Hierarchy Process (AHP) is the method for setting priorities (Saaty, 1990). A priority scale based on reference is the AHP way to standardise non-unique scales in order to combine multiple performance measures. The AHP derives ratio scale priorities by making paired comparisons of elements on a common hierarchy level by using a 1 to 9 scale of absolute numbers. The absolute number from the scale is an approximation to the ratio  $w_j / w_k$  and then is possible to derive values of  $w_j$  and  $w_k$ . The AHP method uses the general model for syntetisation of the performance measures in the hierarchical structure.

---

<sup>1</sup> The research project was supported by Grant No. 402/ 99/ 0852 from the Grant Agency of Czech Republic „Modelling and Analysis of Production Systems“ and CEZ: J 18/98: 311401001 from the University of Economics „Models and Methods for Economic Decisions“.

### **Analytic Network Process**

The Analytic Network Process (ANP) is the method (Saaty, 1996) that makes it possible to deal systematically with all kinds of dependence and feedback in the performance system. The well-known AHP theory is a special case of the Analytic Network Process that can be very useful for incorporating linkages in the performance system. The structure of the ANP model is described by clusters of elements connected by their dependence on one another. A cluster groups elements that share a set of attributes. At least one element in each of these clusters is connected to some element in another cluster. These connections indicate the flow of influence between the elements. Paired comparisons are needed for all the connections in the performance model.

### **Data Envelopment Analysis**

The DEA model was first introduced by (Charnes, Cooper and Rhodes, 1977). The essential characteristic of the CCR ratio model is the reduction of the multiple input and multiple output to that of a single „virtual“ input and a single „virtual“ output. For a particular production unit the ratio of the single output to the single input provides a measure of efficiency that is a function of the weight multipliers (u,v). Instead of using an exogenously specified set of weights (u,v), the method searches for the set of weights which maximise the efficiency of the production unit  $P_0$ . The relative efficiency of the production unit  $P_0$  is given as maximisation of the ratio of single output to single input to the condition that the relative efficiency of every production unit is less than or equal to one. The formulation leads to a linear fractional programming problem. If it is possible to find a set of weights for which the efficiency ratio of the production unit  $P_0$  is equal to one, the production unit  $P_0$  will be regarded as efficient, otherwise it will be regarded as inefficient.

### **Conclusion**

The performance pyramid managerial concept is appropriate for applying some quantitative methods for evaluation of production units and consequently to demonstrate usefulness of the methods for managers. The comparison of AHP, ANP and DEA approaches gives some advantages of the methods. Combination of the methods gives a powerful instrument to capture managerial problems.

### **References**

- Charnes, A., Cooper, W.W. and Rhodes, E. (1978), "Measuring Efficiency of Decision Making Units." *European Journal of Operational Research*, 1, 429-444.
- Rouse, P., Puterill, M. and Ryan, D. (1997) "Towards a General Managerial Framework for Performance Measurement: A Comprehensive Highway Maintenance Application," *Journal of Productivity Analysis*, 8, , 127-149.
- Saaty, T.L. (1990) *The Analytic Hierarchy Process*, Pittsburgh, RWS Publications.
- Saaty, T.L. (1996) *Decision making with Dependence and Feedback: The Analytic Network Process*, Pittsburgh, RWS Publications.