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ANALYSIS OF BUSINESS PROCESS BY OPPORTUNITY COSTS

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We define opportunity cost as the loss of net income due to a decision to opt for one business programme, leaving out other possibilities of yielding net income. The opportunity cost appears only if some resources are completely exhausted. Otherwise there would be no need to leave out other possibilities of yielding a net income.

If we want to define uniquely the opportunity cost in given conditions and in the accepted way of realizing of the business process, we also have to define uniquely the other possibilities of yielding an income. In a multiphase business process with different production activities, production elements and products, it is possible to determine the opportunity cost only by means of a mathematical model. The opportunity cost related to the accepted realization of the business process can then be defined as the difference in net income between optimal and realized net income.

In the mathematical model it is not necessary to maximize the net income. The opportunity cost can be defined related to the objective function of the mathematical model

$$max\ (\sum_{i \in Y} \sum_{k} s_{ik} y_{ik} - \sum_{i \in Z} \sum_{h} p_{ih} z_{ih} - \sum_{j} m_j x_j) \tag{1}$$

subject to non-negative decision variables y_{ik}, z_{ih} and x_j and

$$\sum_{j \in R_i} r_{ij} x_j + \sum_{h} z_{ih} - \sum_{j \in Q_i} q_{ij} x_j - \sum_{k} y_{ik} \geqq 0, \quad \forall i. \tag{2}$$

For some h and k we can have the constraints

$$d'_{ik} \leqq y_{ik} \leqq d_{ik} \tag{3}$$

$$b'_{ih} \leqq z_{ih} \leqq b_{ih} \tag{4}$$

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The symbols have the following meaning:

s_{ik} — for the marginal sales cost reduced sales price of the i-th element related to the k-th consumer,

y_{ik} — the quantity of the i-th element sold to the k-th consumer,

p_{ih} — for the marginal cost of purchase increased purchase price of the i-th element in the h-th source,

z_{ih} — the quantity of the i-th element bought in the h-th source,

m_j — the marginal cost of the j-th production activity which is not related to the consumption of the elements, for which (2) is considered,

x_j — the quantity of the j-th production activity,

r_{ij} — per unit of the j-th production activity obtained quantity of the i-th element,

q_{ij} — per unit of the j-th production activity consumed quantity of the i-th element,

d'_{ik} — the minimal quantity of the i-th element, which must be sold to the k-th consumer,

d_{ik} — the maximal quantity of the i-th element, which can be sold to the k-th consumer,

b'_{ih} — the minimal quantity of the i-th element, which must be bought in the h-th source,

b_{ih} — the maximal quantity of the i-th element, which can be bought in the h-th source,

Z — the indexset of elements with sources,

Y — the indexset of elements with sinks,

R_i — the indexset of the production activities producing the i-th element and

Q_i — the indexset of the production activities consuming the i-th element.

The first sum in (2) denotes the produced, the second one denotes the purchased, the third denotes the consumed and the fourth denotes the sold quantity of the i-th element. For most elements there appear only two sums. The second and third sum appear at the purchased elements, the first and third at semiproducts, the first and fourth at finished products, the second and third sums at the work equipments. For semiproducts which can be bought the second sum also appears and for semiproducts which can be sold the fourth sum also appears. By inequality (2) we prevent shortage of the i-th element during realization of the business process. Market possibilities and market needs are included by means of inequalities (3) and (4). The objective function is defined as the difference between the revenue and those costs which are proportional to the quantities of activities. The other costs which are mostly fixed have to be covered by the difference. If we want to consider fixed costs then the mixed integer model must be used [2].

A simplified example from the milk industry is given in [3].

In a worker-management system, in the objective function we do not usually subtract costs related to engagement of the workpower. The workers are participating in the distribution of income, and we therefore search for a realization of the business process which will provide us with the highest wage fund. If wages are treated in the model in the same way as costs related to the consumption of other production elements, the engagement of workforce in the optimal business programme can be decreased. This means that the accounted wage fund is decreased as well, which is not convenient if the own workforce fund is fixed. As each of the selected types of workforce may not be overburdened, inequalities in the form (2) must be assigned to the critical workpower types. The purchase price of the own workforce can be zero. For the seasonal and other hired workforce, the real market price must be taken. In such a case, the own workforce is taken into account by opportunity costs and wages have to be covered by the difference (1).

An analysis of the business process based on opportunity costs can be made by the use of shadow prices related to the adequate constraints (2). The shadow price in a non-degenerated case shows the absolute decrease of the objective function, if a small enough unit of the adequate element is not allocated there. The shadow price depends on the prices of the elements which are bought and sold, as well as on the bounds for purchase and sale activities. It includes opportunity cost caused by the shortage of the considered element. The shadow price for the considered element is a discontinuous piecewise constant function of the bounds [4]. It is discontinuous if the bounds cause degeneration. This means that in degenerated cases we have two different shadow prices. With the result we obtain one from both. Although the degeneration in practical cases appears normally [1], the analysis is not seriously disturbed. Our task is to compare the obtained shadow price with the estimated unit utility value of the adequate element. If important difference appears this results from unsuitable definitions of the parameters of the business process or from the false estimation of the usefulness of the element. Because of the deficiency of the technology for processing the adequate element the shadow price can be too low. This often appears at the stage of mixing problems. The most frequent cause for the excessively high shadow price is a too low determination of upper bounds for purchase activities of the considered element or elements which are consumed if the considered element is produced. A further cause can be a too high determination of lower bounds for sale activities of the considered element or elements which are produced by means of this element.

We frequently make estimation mistakes about the usefulness of the element due to taking into account only the purchase price or estimated production cost of this element. The shadow price excludes the fixed cost and includes the opportunity cost which is determined also by the considered bounds. If the parameters of the model are determined in such a way that the feasible solution does not exist, the opportunity costs per unit of the elements which are in deficit are unlimited. If one of the elements has a very high opportunity cost, that means that we are near conditions at which a feasible solution does not exist. Therefore high shadow prices determined by high opportunity costs show the disadvantages of the business process. Small changes in technological or market conditions would make it possible to increase the objective function considerably.

All practical cases cannot be described. The analysis can be made by computer. The computer program LOMP which is used in our enterprises for each production activity can make the calculation using the shadow prices. In this way opportunity costs are included.

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