ANALYSIS OF THE SELECTED FUNCTIONS OF PRODUCTION MANAGEMENT

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Abstract

The study presents the problems connected with the production function in enterprises. The particular focus of the study was on such production functions as Cobb-Douglas, CES and transcendental logarithmic function. The study also contains the analysis of the production function in terms of industrial production with the standpoint of benchmarking, improved production capabilities, prototype and laboratory production. Furthermore, the author emphasized the organizational determinants of the production function in the enterprise in the operational domain. The properly performed production function in the enterprise is controlled at all stages.

Keywords: production function, enterprise management, disturbances and limitations in production

INTRODUCTION

Due to the intensifying processes of globalization and competitiveness, production activities in enterprises necessitate structured analyses and improvement in the efficiency of management. Decision-making in enterprises is becoming a more and more complex problem. Therefore, different methods and algorithms are being developed to allow making rational decisions that result in improvement in enterprise's performance. An important area of management is production. With system approach, production is considered as a system that includes inputs, outputs and transformation components.

An in-depth analysis of production in system approach is ensured by the production function, which allows for definition of a combination of input factors with consideration of technological solutions. Therefore, the production function exhibits high utility in management of manufacturing process in enterprises. In order to determine the opportunities of using the production function, one can identify this function and define its role in different types of production.

Based on the above relationships it is possible to set the objectives, competencies and resources and to evaluate their effect on competitiveness of the environment. The other areas which are important for the objectives of production enterprises are also the aspects of contacts and integration.

APPLICATION OF PRODUCTION FUNCTION IN ENTERPRISE MANAGEMENT

The production function represents an essential component of enterprise management. Making the decisions in the processes of production necessitates adaptation of a variety of methods which determine measurable planes for evaluation of the relations in the qualitative and quantitative area of manufacturing. These problems also exist if the decision base is provided by the production function. This function determines the final product in the enterprise, depending on all the combinations of the input factors. The production function means a relation based on present status of the technological knowledge and necessitates decision-making in the process of management. Considering the system approach, it is legitimate to emphasize the input and output mechanism with respect to the flow of tangible goods and information (Figure 1).

Fig. 1. The enterprise as an open system

As an open system, the enterprise is comprised of a variety of subsystems. There are a variety of interrelationships, dependencies and interactions that occur between the environment and individual subsystems in the enterprise. At the input, the enterprise receives particular resources, such as information and capital. As a result of production processes, these resources are used for their optimization. During production, the resources are transformed and, at the output, they reach the external environment in the form of goods or services. A precondition for enterprise's functioning as an open system is following the principle which says that the value of the resources at the output (effects of the enterprise's activities) should be higher than the value of the expenditures at the input [1].

The production and its role as a knowledge base allows for determination of the scope of production capabilities in the enterprise, its development and actual potential for changes. Therefore, it can be assumed that the production function can be used in different ways as a knowledge bank in the enterprise e.g. through promotion of such activities as[2]:

- designing products with consideration of the process of production,
• adjustment to customer requirements,
• introduction of innovations that result in development of both products and the whole enterprise.

Implementation of the above objectives through production function is possible due to the existence of the technological relationships, where the volume of products changes with respect to the volume and proportions of the input. There are several forms where the production function can be defined. The examples include Cobb-Douglas function, constant elasticity of substitution or transcendental logarithmic function [3]. Cobb-Douglas production function

$$\theta_i = a_0 K^{a_1} L^{a_2} u_i$$

where: $u_i$ means the vector of normal distribution of breakdown functions, $a_1$ is the elasticity of the output $\theta$ with respect to the capital at the input, $a_2$ is the elasticity of the output with respect to the costs of labour at the output, parameter $a_0$ is the technological parameter.

Constant elasticity of substitution (CES production function)

$$Y = A[\theta (a_K K)^\gamma + (1 - \theta) L]^\frac{1}{\gamma}$$

where: $0<\theta<1$ is shared parameter, $\gamma$ denotes the degree of inputs substitutions, $A$, $a_K$, and $a_L$ are parameters which depend on the units used to express the inputs and outputs.

A transcendental logarithm for a single input and two outputs is given by

$$\ln y_1 = a_1 \ln y_2 + (1 - a_1) \ln y_3$$

where: $y_1$ is the input level and $|y_2|, |y_3|$ are output levels.

The production function can be also used for measurement of [4]:

1. productivity of the factors of production

   $$f_K = \frac{\alpha Y}{K} \text{ and } f_L = \frac{\beta Y}{L}$$

2. Elasticity

   $$E_Y = \frac{\alpha Y}{K} \text{ and } f_L = \frac{\beta Y}{L}$$

3. Level of elasticity

   $$r = \alpha + \beta$$

4. Final substitution rate

   $$KSS = \frac{\beta K}{aL}$$

Variety of application of the production function points to its importance in enterprise management. This function determines in particular decision-making attitudes in the enterprise. At present, there are no prerequisites that would suggest that the role of the production function as the base of knowledge about the enterprise would weaken in the future. Conversely, it is likely to be increasing with intensifying pressure on limitation of the costs of production.

**ROLE OF PRODUCTION FUNCTION IN THE PROCESS OF MANUFACTURING GOODS**

The production function performs an important role in enterprise management. This role is on the one hand used for a specific demonstration of the strategic importance of production and, on the other hand, for helping find a variety of goals, objects of interest and resources that might be conveyed by this function. The production function can be analysed from the standpoint of such problems as [5]:

**Industrial production** The enterprise focuses on possible configurations of production on an industrial scale which would represent the competition with world leaders in a particular domain. Production ability is increased in order to adapt to growing demand on the products in a particular enterprise. The production function allows for determination of the relationships that stimulate continuous development and achievement of the profits while meeting market expectations concerning quality, price and timely deliveries.

**Production in the aspect of benchmarking** When choosing this type, the enterprise decides to create the production function with smaller scale, but the competitiveness is regarded to be necessary. Therefore, the main objective is to maintain the relationships of means and new technologies with respect to the quality, opportunities of improving production and the structure of costs of manufacturing. These relationships can be then used by the suppliers.

**Increased production capability** Opportunity of fast creation of the system of production is the main objective. It encompasses e.g. temporary organization of the enterprise and adjustment of the assembly system based on new technologies, which is then subjected to export, e.g. to a daughter company. Combination of the category of efficiency with speed represents another combination of production function.

**Prototype production.** In this role, the production function is the source of development and creation of new products and equipment. Prototype production allows for development of new technological and administrative systems.
Laboratory production. With this type of production, much importance is attached to development and testing of new processes since it concerns experimenting with new materials, processes and technologies. It is also possible to create the basis for development and testing of new types of skills, e.g. configuration of new systems of control.

The five roles of the production function are presented in Table 1.

Table 1 Characteristics of the roles of the production function [2]

<table>
<thead>
<tr>
<th>Strategic role</th>
<th>Participation in creation of enterprise's competitiveness</th>
<th>Goals</th>
<th>Competencies/Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial-scale production</td>
<td>Fast and reliable deliveries to customers, competitive prices</td>
<td>Adaptation to demands in the market while ensuring the quality, price and profit</td>
<td>Top reliability and productivity. Ability to adapt to variable conditions. Continuous progress and learning</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>Knowledge of production capabilities and costs</td>
<td>Reducing the dependence of the enterprise on the knowledge of subcontractors and comparison with best production solutions</td>
<td>Effective production on a small scale. Alternative opportunities of production configuration</td>
</tr>
<tr>
<td>Increased production</td>
<td>Opportunities for preparation of the delivery of a new product or the existing products adjusted to customers' demands</td>
<td>Having abilities of executing express orders with special requirements</td>
<td>Using the scope of the available resources/competencies in order to create a complex system of production</td>
</tr>
<tr>
<td>Prototype production</td>
<td>The enterprise becomes a market leader, defines and presents new opportunities of the production function</td>
<td>Product development, improvement of production, product testing</td>
<td>Maintaining the highest possible readiness concerning the choice of the processes and having opportunities of comparing them with the already used processes.</td>
</tr>
<tr>
<td>Laboratory production</td>
<td>It contributes to utilization of the new markets and/or the potential connected with the product</td>
<td>Development of new production processes and new production configurations</td>
<td>Improving the processes so that they are functional, which should be based on the most modern knowledge and skills in terms of choosing the processes and production lines</td>
</tr>
</tbody>
</table>

As results from the above considerations, the production function plays an important role in managing manufacturing processes. This function also affects the strategy of the enterprise, allows for improvement of the competitive position as a result of maintaining proper relationships between the resources that are available in the enterprise. The key importance for the production function results from the potential of achievement of the enterprise's goals. The variety of these problems necessitates analyses in the context of reaching the enterprise's goals, entering into business relationships and integration. Basic relations in this area are presented in Table 2.

Table 2 Characteristics of the enterprises in the aspect of achievement of the goals, entering into business relationships and integration [2]

<table>
<thead>
<tr>
<th>Enterprise - aspect of achieving the goal</th>
<th>Enterprise - aspect of entering into business relationships</th>
<th>Integrating enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea</td>
<td>Expert, enterprise that necessitates much knowledge, which entered into the relationships with other enterprises.</td>
<td>Its activity consists in integration of other enterprises. It analyses the market in order to find new transactional opportunities.</td>
</tr>
<tr>
<td>Product and services</td>
<td>Specialized components and systems</td>
<td>Combined large-scale systems, products in dynamic markets</td>
</tr>
<tr>
<td>Partners</td>
<td>Few customers, high degree of the interdependence</td>
<td>Production activities are usually performed by the suppliers</td>
</tr>
<tr>
<td>Production</td>
<td>Production and knowledge exhibit high relationships</td>
<td>Acquisition and maintaining competencies by external partners</td>
</tr>
<tr>
<td>Limitations</td>
<td>A complex area of knowledge with high level of risk</td>
<td>Choice of partners represents serious problem</td>
</tr>
<tr>
<td>Skills/competencies/production resources</td>
<td>Cooperation with other enterprises allows for improvement in competencies and acquisition of the financial means</td>
<td>Control over logistics and value chain. Partners within the supply chain share value creation</td>
</tr>
<tr>
<td>Systems of control/management</td>
<td>Statistical control of processes, production planning. Function for customers and knowledge development</td>
<td>Spontaneous activities and fast response. Ability to adapt changes and market trends</td>
</tr>
</tbody>
</table>

Planning of production, scheduling and monitoring of operational activities forces
companies to utilize a variety of technologies and methodologies, including the production function. Application of such systems as MRP, ERP, Kanban or Just in Time allows for precise planning of the production function. On the other hand, the principles of production control can be described by five points [6]:

1. Agreement on the production plan.
2. Fast and effective pathway for change management
3. Control of the system of production scheduling.
4. Production under conditions of limited potential.
5. Availability and accuracy of the data.

The above five principles set the framework for both production function and for total control of the production system (Figure 2).

There are four dimensions of the production function, which include [8]:

1. physical distribution of the means of production,
2. strategy of throughput,
3. organization of the process of production,
4. organization of the system of decision-making.

The dimension of the physical distribution of the means of production describes the way they are arranged with respect to each other. Principally, the three different forms can be emphasized. In the linear system, the physical distribution of the means of production consists in that the operations on certain products are performed in the unchanged, constant order, using different types of means of production. Therefore, means of production are arranged in one line [8].

The problems of management in the context of control of production and production processes can be determined with respect to the client's requirements [9]. He stated that it is necessary for effective and timely performance of the activities which are consistent with the strategy of the enterprise in the process of decision-making to build operational plans. They represent necessary decision-making elements in creation of the relationships in the production function.

We consider the system where the means of production are grouped together, based on particular functions that are supposed to be performed. This might mean the likelihood of the means of production placed together. In other studies, this form is defined as a functional arrangement. If a product remains in one place and the means of production are moved to the product, this is termed the fixed arrangement of positions [8].

A particularly important problem of the unit and serial production is determination of the time of availability of the product for the customer [9]. Therefore, the production function represents an important mechanism that allows for arrangement of the production tasks so that the enterprise maintains the demanded competitive position. In the mass production, the focus should be on costs and the quality of the product.

Therefore, the dimension of organization of the production process concerns the way in which the operating tasks are grouped together and existence of interactions between the formed groups. The task is defined as a series of activities. With respect to the process of production, one can distinguish between the two different forms. The functional organization of the production process is characterized by the fact that the operational tasks concerning a particular process are divided based on

ORGANIZATIONAL PREREQUISITES FOR THE PRODUCTION FUNCTION

Application of the production function in management of enterprises can be directly translated into process management. In this case, the basic element is determination of the structure of the process using the techniques of mapping. The map of the process flow is used to draw the actions which are necessary for performing the task and the system of relationships for the flow of materials and information between the departments in the enterprise with priority goal of minimization of the time of execution of the customer's order [7]. This allows for determination of the fundamental relationships that are present in production processes. These relationships are described by the production function.

Analysis of the production function can be also carried out in the area of organization and strategy of enterprise's operation. The organizational factor determines the basic relations, whereas the strategy defines the basis for production decisions.
certain similarities e.g. casting, welding or machining.

The product-oriented organization of production processes consists in that the operating activities concerning a particular process are divided according to the criterion of the type of product or a group of products. While the previous dimension defined the operational task grouping, the dimension of organization of the system of decision-making describes the set of tasks of control of the production process.

In the case of the lack or delayed response to the changes in the system of production through changes in the order of giving orders at the input, the disturbances might lead to reduced quality of activities in production area, which results in disturbances at the output. Figure 1 presents the disturbances in production at the input and output [10].

![Disturbances in production](image)

**Fig. 3. Disturbances in production at the input and output [6]**

In the case of changes in the system of production, one can choose two ways: not responding or changing the orders in the schedule. In the case of reacting to changes, the unit costs of manufacturing of the product will change [10]. A precondition for the efficient production processes and thus elimination or limitation of the disturbances is proper organization of the production resources. The theory of constraints represents an important concept in management of production systems. The variety of limitations necessitates their identification. The following types of the production systems in this context are used in the literature [13, 14]:

- **V** - divergent,
- **C** – convergent,
- **T** – mixed.

In the following table is shown comparison of the types of production systems.

<table>
<thead>
<tr>
<th>Parameters by type</th>
<th>V</th>
<th>C</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>System type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of final products</td>
<td>High</td>
<td>Low</td>
<td>Big</td>
</tr>
<tr>
<td>Amount of materials</td>
<td>Low</td>
<td>High</td>
<td>Variables</td>
</tr>
<tr>
<td>Character of manufacturing process</td>
<td>Machining</td>
<td>Assembly</td>
<td>Machining and/or assembly</td>
</tr>
<tr>
<td>Amount of limited resources</td>
<td>One</td>
<td>Several</td>
<td>From 1 to several, depending on the system</td>
</tr>
<tr>
<td>Process of identification</td>
<td>Collecting resources before limitation</td>
<td>Identification of the resources that generate the delay after analysis of the production flow</td>
<td>Performing the production orders determines the resources that affect the delays, with indication of their causes</td>
</tr>
</tbody>
</table>

### CONCLUSIONS

An in-depth analysis of production in system approach is ensured by the production function, which allows for definition of a combination of input factors with consideration of technological solutions. Therefore, the production function exhibits high utility in management of manufacturing process in enterprises. In order to determine the opportunities of using the function of production, one can identify this function and define its role in different types of production.

Based on the above relationships it is possible to set the objectives, competencies and resources and to evaluate their effect on competitiveness of the environment. The other areas which are important for the objectives of production enterprises are also the aspects of contacts and integration. In the activities of this type, the principles of control and performance of the production function in management are essential. The process of management necessitates taking into consideration the prerequisites for the production function, with particular focus on the method of grouping the operational tasks with the relationships between the groups that were created. The relationships generate disturbance which, based on the theory of resource limitations, should be either entirely or partially eliminated. The activities of elimination can be carried out by means of the divergent, convergent or mixed systems. Each of the systems unequivocally suggests certain opportunities of application of the production function in enterprise management.
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