

PRODUCTIVITY IMPROVEMENT IN A MANUFACTURING COMPANY – CONCEPTS, METHODS AND TECHNIQUES

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ABSTRACT

The article presents a new approach to productivity improvement in a manufacturing company, based on a rich collection of concepts, methods and techniques in the scope of production management. Productivity improvement is a complex technical-organizational-social undertaking, implemented in order to improve the performance of the entire enterprise. This approach assumes continuous productivity improvement in all phases of the design and operation of the production system. The strategic, comprehensive approach towards productivity improvement is currently becoming more and more important; it is expressed in striving for the implementation of contemporary, complex management concepts. The result of the analysis is a prepared productivity improvement methodology taking account of new production paradigms, among others: Lean Manufacturing, Lean Logistics, Agile Manufacturing, Total Productivity Maintenance, Theory of Constraints as well as Dynamic Process Management. The summary emphasizes the importance of preparing a new productivity improvement methodology for improving production management practices focused on productivity growth.

Keywords: productivity, productivity improvement, manufacturing company

INTRODUCTION

Productivity is an extremely complex and interdisciplinary problem. It refers to macroeconomic systems, such as the world economy and economies of particular countries and to microeconomic systems, especially production systems, which, depending on the degree of aggregation, can be the entire enterprises, divisions, branches, work cells, as well as individual work posts. Productivity is one of the performance measures, which characterizes well the company's operations; especially the degree of using all the resources being at its disposal.

With regard to manufacturing companies, productivity is understood in the economic-social (qualitative) and technical (quantitative) perspectives. In the qualitative perspective, the productivity concept is presented as progress mentality expressed in the organization and support for different types of projects that are intended to continuously raise the effectiveness of business operations, improve the company's market position as well as increase employee satisfaction

from work conditions and the quality of life. In this perspective such matters are stressed as [1]:

1. state of awareness, way of thinking focused on progress, continuous improvement of what already exists (faith in the progress of mankind),
2. the will to improve the condition of the present, regardless of how good impression it makes or how good it really is,
3. continuous adjustment to changing conditions in the economic and social sphere,
4. organization and support for all types of projects, designed to continuously raise the effectiveness of the operation of the organization, improve its market position and increase employee satisfaction from work conditions and the quality of life,
5. pursuit of using new techniques and new methods.

On the other hand, the quantitative productivity concept is the ratio of the amount of output manufactured and sold over the given period to the amount of input resources used or wasted. Productivity is therefore interpreted as the effective use of the system's input resources – human work, capital, materials, energy – in the production of goods and services, being the company's output.

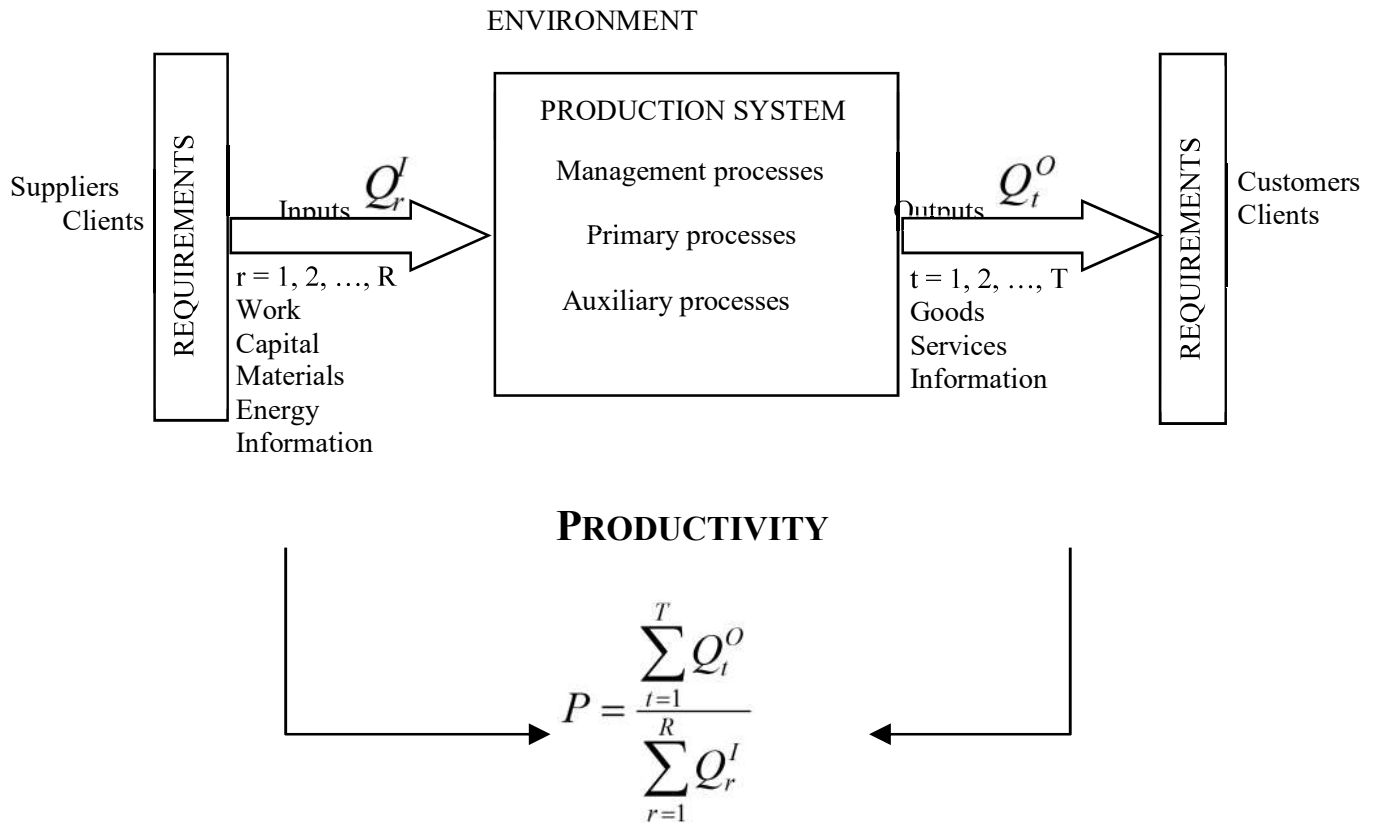
An important problem which a lot of attention has been devoted to are various approaches to productivity improvement. Productivity improvement on the grounds of KAIZEN continuous improvement philosophy is the subject matter of studies by such authors as: M. Imai [2], W. Lareau [3], while the problems of radical productivity improvement on the grounds of process reengineering – of the works by: M. Hammer and J. Champy [4], H.J. Harrington [5], L. Pacholski, W. Cempel and P. Pawlewski [6]. Production process improvement methods and techniques towards productivity improvement are discussed by: R. Harris, Ch. Harris, E. Wilson [7], D. Jones and J. Womack [8]. Productivity improvement by the application of production engineering tools has been examined by H.A. Salaam, S.B. How, M.F. Faisae [9]. Achievement of productivity growth using Lean Manufacturing to reduce cycle time for production processes by Value Stream Mapping (VSM) has been presented by B. Vijaya Ramnath, Vishal Chandrasekhar, C. Elanchezhian, Vinoth Selva Bruce. L, K. Venkataraman [10]. The implementation of lean tools along with the work research methods was the subject of research of P.P. Kulkarni, S.S. Kshire, K.V. Chandratre [11]. On the other hand, I. Dincută-Tănasea, C. Bordea, E. Câmpeana, D. Pop proposed a method to determine the level of productivity for qualitative and quantitative factors [12].

Currently, the most practical approach seems to be an analysis of work processes, namely overview and redesign of activities and the application of modern production management concepts, methods and techniques. At present, only companies using modern productivity improvement programs are successful, as they can rapidly and dynamically adjust to the changing conditions of the

environment. Consequently, productivity assessment is also important in this perspective as vital for both managers and employees. It makes it possible for managers to understand business processes, formulate objectives and strategies, assess the degree of achievement, resource allocation, better plan, control and inspect operations, assess the company's competitive position in the market environment, assess time trends in utilization of the resources, identify problems in the organization, assess any introduced improvements and introduce the so-called management by results, i.e. motivate subordinates subject to tangible results they obtain. For employees important are clearly set goals and scope of responsibility, determined using well-selected productivity indicators as well as objective assessment of their achievements, contributing to higher motivation.

PRODUCTIVITY MODEL AND ITS ASSESSMENT IN A BUSINESS

For practical effectiveness analysis of a production system, a simplified productivity model can be used, as presented in Fig. 1.



Symbols:

Q_r^I – input resource quantity (I = input) of type r,
 $r = 1, 2, \dots, R$ – number of types of resources used by the production system,
 Q_t^O – quantity of products (O = output) of type t produced and delivered to the buyers,

$t = 1, 2, \dots, T$ – number of types of products manufactured by the production system.

Fig. 1 Productivity model

As presented in Fig. 1, each production system may be characterized by its set of input resources, the processes inside, the set of products (goods and/or services), and its productivity can be determined [13]. At the same time, it should be borne in mind that any product must have its client, as productivity exists only when there is demand for particular goods or services as well as when the manufactured goods are provided to the client.

Currently, most Polish enterprises assess their operations through the prism of indicators of sales profitability and profitability of total capital involved in the operations. This is an insufficient measure sometimes not reflecting the results being actually obtained by the company, because profit can result from the company's non-operational activities, such as, e.g. investment in shares, resale of some assets, etc. A measure that characterizes well the company's operations, especially effective in using all the resources being at its disposal (capital, human or financial) is productivity [14].

The company, in order to be able to control its position on the market and adapt to the changing conditions of the environment by continuously improving the existing condition, should dispose of a productivity measurement system. The indicators selected to be used in the productivity measurement system depend on many factors, comprising the specific nature of the company. It is most important to ensure that the productivity measurement system is coupled with the company's economic and financial system and the production planning and recording system as well as with the production costs registering system.

Productivity is therefore a very "spacious" measure expressing how efficiently and effectively the organization executes its tasks, how efficient and effective it is in pursuing its goals and standing comparison with the competitors.

The observation of productivity indicators makes it possible first of all to:

- assess the results achieved by the company as compared to other businesses, especially in the same industry,
- identify any "weak spots", i.e. areas of operations that are characterized by low productivity and require improvement,
- formulate productivity improvement programs and company's strategic plans,
- observe trends in productivity indicator changes, making it possible to introduce early warning mechanisms about possible threats and opportunities for the company,
- deliver feedback information about the consequences of any earlier introduced productivity improvement programs,

– link the company's remuneration policy with productivity of its organizational units.

In order for the company to effectively control its productivity and consciously stimulate its improvement, it must dispose of an effective and fast tool for its assessment. These requirements are fulfilled by the indicator method, consisting in analysis of a well selected set of productivity indicators. Productivity measures can therefore be classified in terms of:

– productivity definition: 1. direct – indicators expressed by the quotient of the production effects to the outlays incurred (technical perspective of productivity); 2. indirect – exceeding the technical perspective e.g. measures related work quality referring to the level of shortages, costs of shortages as part of production costs, etc.,

– complexity: 1. complex – general for the whole company; 2. partial – productivity indicators of capital, materials, energy and labour,

– method of expressing the parameters: 1. physical – are based on expressing products and resources only in physical units (e.g. pieces, kilograms, minutes, kilowatt hours, etc.); 2. economic – use, apart from the "physical" parameters, also amounts expressed by value (product prices, costs of resources, foreign exchange rates etc.),

– hierarchy: 1. measures for the company – assessment of effectiveness of the organization as a whole; 2. measures for the processes – assessment of the effectiveness of the processes implemented in the organization; 3. measures for posts – assessment of the effectiveness of the work posts.

CONCEPTS, METHODS AND TECHNIQUES USED IN THE COMPLEX PRODUCTIVITY IMPROVEMENT METHODOLOGY

Productivity improvement consists in introducing changes of different nature at all levels in the company in the field of basic, auxiliary production, administrative and management operations.

For this purpose, every company introduces development programs based, above all, on implementing contemporary management concepts, the functioning of which should result in productivity growth (Table 1).

Table 1 Management concepts/methods used in the complex productivity improvement methodology

| Concepts/ methods | Characteristics of the approach and expected benefits | Technologies/tools | | | |
|----------------------|--|--------------------|-----------------|---------------------|------|
| | | 5S | Process maps | PDCA/SDC A cycle | FMEA |
| Kaizen | Constant process improvement by small improvements, conducted in a continuous manner by all the employees. | ● | ○ | ● | ○ |

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| Concepts/ methods | Characteristics of the approach and expected benefits | Technologies/tools | | | |
|--------------------------------------|---|--------------------|-----------------|---------------------|------|
| | | 5S | Process maps | PDCA/SDC A cycle | FMEA |
| | Benefits: shortened production cycles, assembly time reduction, increased productivity, reduction in waste, capital expenses and complaints, | | | | |
| Total Quality Management (TQM) | Complex business management by quality improvement. Benefits: "no quality" related costs and losses reduced to a minimum, growing customer satisfaction, quick and timely deliveries, higher production efficiency, improved business profitability, | ● | ● | ● | ● |
| Total Productivity Maintenance (TPM) | Quick refitting of technical resources (production line machines). Benefits: labour productivity growth, reduction in breakdowns, reduced quantity of internal waste, reduced number of complaints and production costs, reduced stocks and work-in-progress, | ● | ○ | ◐ | ● |
| Theory of Constraints (TOC) | Improved results by the identification of and focus on "bottlenecks". Benefits: shorter order lead time, improved resource management, shorter material passage time, reduced costs, | ● | ◑ | ○ | ○ |
| Agile Manufacturing (AM) | Fast response to opportunities and threats in the environment, creates and integrates processes, technologies and knowledge-equipped employees, so as to ensure fast response to the client's needs. Benefits: for all participants (manufacturers, suppliers, clients), integration (of resources, methods, technologies, organizational departments), | ● | ○ | ◑ | ◑ |
| Lean Manufacturing (LM) | Reduced costs and maximized profits by eliminating all losses in the manufacturing process. Benefits: reduced shortages, refitting times, stocks and work-in-progress, productivity growth, | ● | ● | ◑ | ● |

| Concepts/ methods | Characteristics of the approach and expected benefits | Technologies/tools | | | |
|---|--|--------------------|-----------------|---------------------|------|
| | | 5S | Process maps | PDCA/SDC A cycle | FMEA |
| Lean Logistics (LL) | Optimization of intra-plant logistics, lean, complex material flow. Benefits: decreased product design costs, stocks and work in progress and personnel costs, shortened production cycle, higher efficiency, improved production quality, | ● | ◐ | ◐ | ◐ |
| Rapid Re TM method | Redesign of the operations process in a short time. Benefits: shortened production cycle and reduced costs, improvement in product quality and customer satisfaction, increased profitability and market share, | ● | ◐ | ● | ○ |
| General Electric method (GE) | Revolutionary introduction of changes to the company in a continuous manner. Benefits: higher revenue and net income, significant productivity growth, | ● | ◐ | ◐ | ◐ |
| Dynamic Process Management (DPM) | Fast response to changing significant conditions of operation. Benefits: focus of the company on customer satisfaction, identification and arrangement of the areas that require improvement. | ● | ● | ● | ● |

Techniques/tools used in the concepts/methods to a degree:

● - comprehensive, ◐ - partial, ○ - not used.

The productivity improvement concept assumes continuous observation, analysis and rationalization of systems. The so adopted course of conduct should be repeated in each of the system's organizational units with regard to every productivity improvement project. Fig. 2. presents a complex productivity improvement methodology.

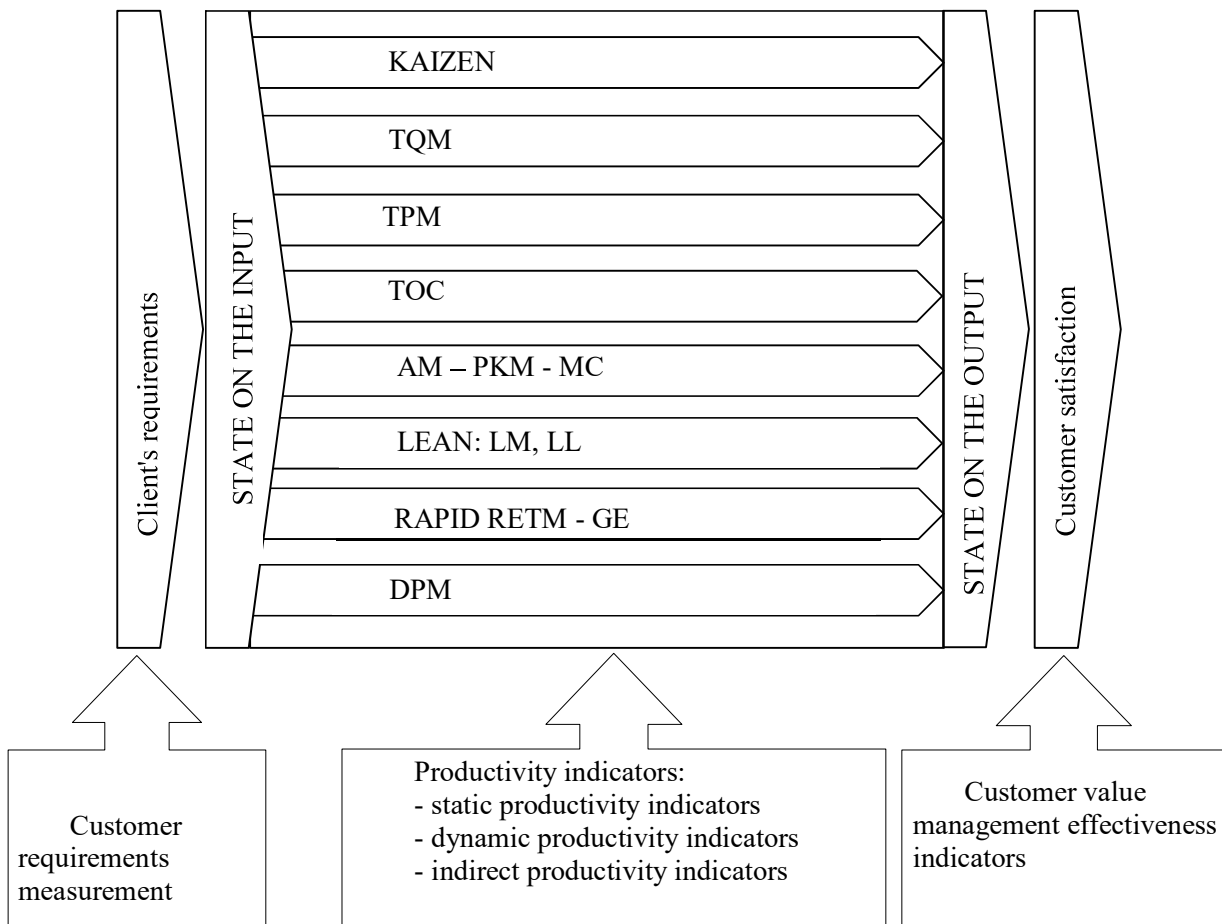


Fig. 2. *Complex productivity improvement methodology*

A significant problem in the functioning of the productivity improvement process is a selection of the management concept (one or several), after the implementation of which the desired changes will occur. The subject literature indicates that the selection of the methods and their effectiveness is largely dependent on the specific nature of the business. Factors such: as business focus and organizational culture, depending on people, their preparation, experience, readiness for change and team problem-solving skills, play a role here.

The productivity improvement process, as the unique type of activities designed to solve problems, should be a sequence of actions with the following course:

1. identification of the goal to be reached in the given organizational unit,
2. existing condition diagnosis using a well-selected system of measures,
3. search for solutions and choosing the solution for implementation,
4. planning and implementing the improvements program,
5. controlling the obtained results.

In order to analyse and design the productivity improvement methodology in a manufacturing company and ensure its proper and effective functioning, stage-

based implementation of a number of tasks of organizational, technical and social nature is necessary (Fig. 3).

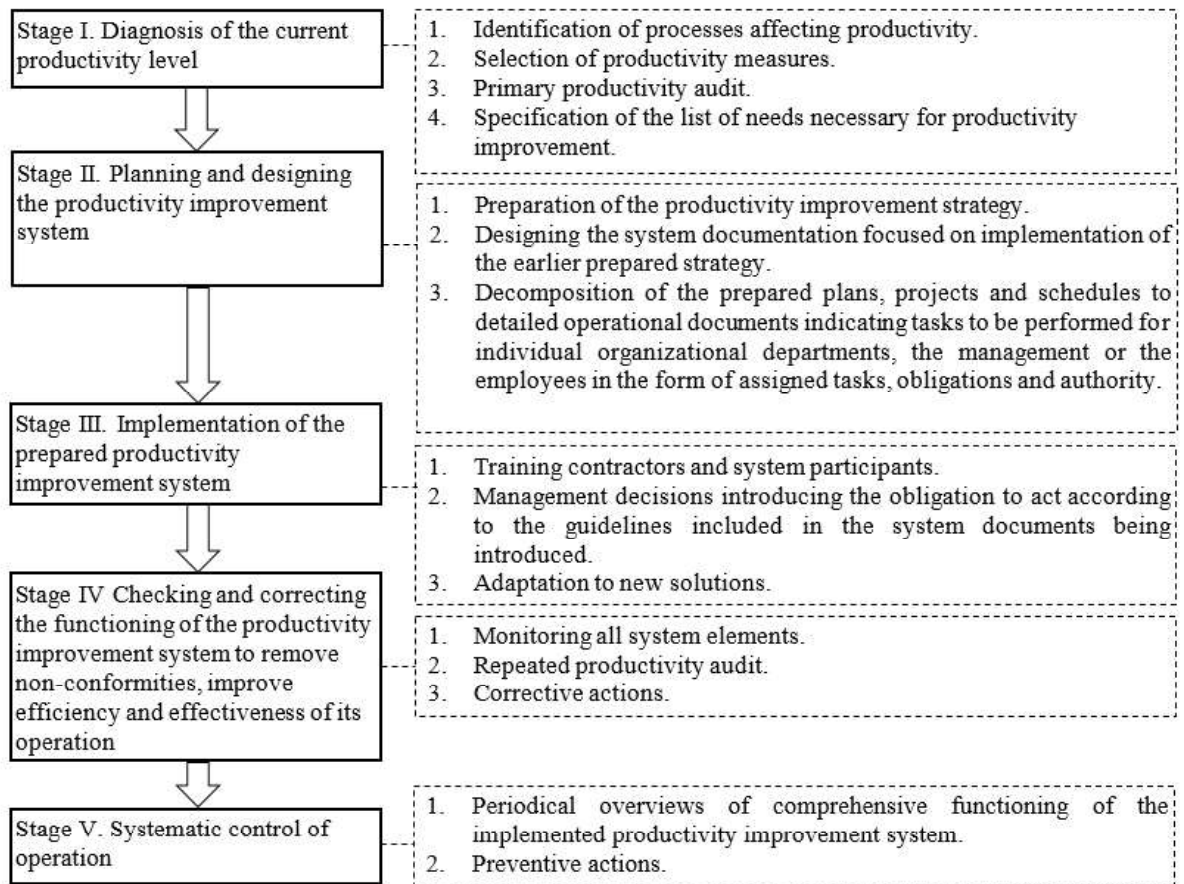


Fig.3. Stages in the implementation of the complex productivity improvement methodology

These stages are binding both in the situation of local changes, coming down to productivity improvement on the level of a manufacturing work cell or a group of positions and those which encompass the entire company. These changes may involve a series of small modifications, but also projects being innovative in nature.

CONCLUSIONS

The prepared complex productivity improvement methodology arranges the implementation process of contemporary concepts, methods and techniques focused on productivity growth, taking advantage of their complementary nature and synergy resulting from using common specific tools. The methodology may be helpful for manufacturing companies in programming productivity improvement in the field of production management. Its advantage is that it puts emphasis on sustainable and harmonious implementation of modern management concepts.

To sum up, it may be said that the effectiveness of implementing particular concepts and the related methods is largely determined by the specific nature of the business. A great effect on the implementation process of contemporary management concepts is exerted by the organizational culture, dependent on people, their experience, preparation, commitment, readiness for changes and team problem-solving skills.

The solutions presented in the study are practical. Their readiness for application consists in: making entrepreneurs aware that the productivity of their organization depends on the degree of implementing the contemporary concepts, methods and techniques used in production management and proposing organizational solutions which will make it easy to implement an employee motivation system based on the Kaizen concept in the company, to ensure active and creative participation in productivity improvement projects. The answers to the following matters should be treated as challenges: considering new management concepts in the proposed methodology, starting research determining the factors that have a particularly strong effect on the degree of its implementation as well as identification and elimination of barriers to introducing new management concepts.

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