

МИЛИЦА ДЖОРДЖЕВИЧ

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ТЕОРИЈАТА НА ОГРАНИЧЕНИЯТА – НОВА УПРАВЛЕНСКА ФИЛОСОФИЈА

THEORY OF CONSTRAINTS – NEW MANAGEMENT PHILOSOPHY

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Abstract: Achieving high company performance is influenced by numerous limitation factors. Theory of Constraints, as a new management philosophy, recognizes necessity for advancing production process while focusing on those limitation factors.

This paper will introduce basic assumptions of Theory of Constraints followed by quantitative illustration of its implementation in management – more precisely in using and overcoming system limitations, as well as in order to decide on selling price of the product.

Key words: throughput, limitation factors, management.

Introduction:

Adequate management represents a basic assumption for the maintenance functioning of an enterprise. Following that thought, many philosophies of management have been developed. One of the theories among them that certainly attracts significant amount of attention is the Theory of Constraints-TOC. The implementation of this theory represents an enterprise's answer to the changed conditions for managing its affairs-it offers help to the managers in improving total enterprise profitability, giving them clearly defined objective. Many managers comprehend TOC's importance, although it completely changes functioning of an enterprise and can affect all managerial aspects: decision making, planning, every-day operations and evaluation of performances. Namely, every contemporary enterprise, in almost every moment, is exposed to the effect of numerous limiting factors, so the success is strongly affected by manager's abilities to identify and eliminate (or at least decrease) their influence. The TOC itself recognizes great importance of the system's

constraints. More accurately, this theory tends to improve production process, respecting numerous limiting factors, in order to maximize the throughput (a type of the contribution results, calculated as the difference between sales income and direct costs of material). Implementing basic assumptions of this theory, management of an enterprise is enabled to make adequate decisions that will ensure achievement of the most satisfactory results under the influence of limiting factors.

According to all the mentioned, basic premises of TOC will be presented in this paper, followed by an illustration of its implementation in managing limiting factors, more exactly how to overcome them and optimize use limited resources.

1. Basic assumptions of Theory of Constraints

Theory of Constraints was developed by Eliyahu Goldratt i Robert Fox in early 1980s. This theory looks at production process as a system, groups of interrelated and interdependent elements. Thereby, the slowest process influenced by limitation

factors, the bottleneck of the whole system, determines the performances of the whole production process. It can be concluded here that if system wouldn't have any limitation, not physical (capacity of the machine for production of the product parts, capacity of the vehicles, corridor width etc.), nor non-physical (demand on the market, political and managerial limitations, etc.) its performances would be „endless”.

Priory, Theory of Constraints (TOC) is focused on defining system's limitation factors and their impact. By it, Goldratt implies that „a system's constraint is nothing more than what we feel to be expressed by these words: anything that limits a system from achieving higher performance versus its goal...In our reality any system has very few constraints and at the same time any system in reality must have at least one constraint.”(Carbett, 2000.)

In the 1995, Holman has pointed out the most important assumptions of TOC that reflect in following facts (Huang, 1999.):

1. The goal is to make money now and in the future,

2. Throughput is defined as revenue minus the variable cost of materials and energy,

3. There is always at least one constraint on each product that limits the firm's revenue,

4. There are three types of resources: scarce bottleneck resources, non bottleneck resources and capacity constraint resources,

5. Most manufacturing operations have only a few capacity constraint resources, and thus it is easy to control them,

6. Dependent events exist that result in interactions between resources and products. Within every manufacturing environment, statistical fluctuations and random events occur,

7. The optimized production technology system is implicitly stable-at any given time bottlenecks are identified, and the order mix is stable with respect to given resources.

So, in order to increase production performances and earning rate of company,

managers should focus attention to remove limitations (bottle necks). It is also necessary to follow three critical indicators: throughput, inventory and operational costs (Yahya-Zadeh, 1999). Inventory is usually defined as the sum of material and other items purchased but not yet converted into throughput. Operating expenses are defined as overhead plus direct labor expenses.

2. Constraints management

The aim of constraints management is constant improvement and development of system, and improvement of company performance. TOC implies that this process brings constant improvement, as companies follow next five steps can continuously increase their throughput, and therefore profit (Weil, Maher, 2005).

1. Identify constraints of the system.

Bottle neck emerging as limitation factor of undisturbed processes of production and selling, is easily identified. Namely, accountants, production managers and engineers jointly work on identifying existing constraints, by developing network diagram of production flow and by analyses that describes each process activities in detail.

2. Make use of system constraints.

When demand is bigger than company's capacities, company is not able to answer to the all potential customers' demands, so accountants make effort to use resources in the most efficient way. More precisely, if company produces one type of product, it is necessary to find a way of maximizing production flow through constraints. On the other hand, if it produces more than one type of product, it is necessary to determine the most profitable combination of the products in the product range. In that situation, priority will be given to the production of the product with highest throughput per unit of limited resource.

3. Subordinate everything to the decision to make use of constrained system.

If company wants to strengthen all interlinked production processes, then it must have in mind that there is no point in investing time in strengthening already

strong processes, while weak processes continue to exist. So, attempts for improvement should be focused on strengthening the weakest links.

4. Overcoming system constraints firstly mean increasing capacities of the bottle neck. Management can achieve this goal in various ways: maintaining operations on bottle neck all the time, decreasing the time for preparing the bottle neck, focusing to the possibility of reengineering bottle neck by eliminating unnecessary steps, increasing capacities of bottle neck by adding new machine, employing new workers etc.

5. If the constraint is removed, it is advised to go back to the step 1. While so, there is a possibility that company will discover new constraint that should be made use of, subordinate all other decisions to it and overcome it.

From all the mentioned, it follows that TOC aims at maximizing throughput by removing, or at least decreasing „bottle necks” that slow down production processes, and that are characteristic for

production of complex products. So, existing constraints demand that managers define possible action directions in order to eliminate or at least weaken its negative effects on throughput.

Quantitative illustration of implementing TOC for deciding on ways to make use of system constraints

Implementation of TOC for deciding how to make use of system constraints will be illustrated by an example of an Indonesian factory which, using simple production processes, makes messing gongs and bells. Namely, employees pour melted messing into modules, wait for it to cool down, and then polish it. Melted messing is gotten from arbors that are being melted in special stoves. With capacities of 10kg of melted messing per hour, this stove represents the constraint of production system. Relevant data referring to production and selling of gongs and bells are given in the following table (Weil, Maher, 2005).

Elements	Gongs	Bells
Selling price per product unit	10.000 eur	5.000 eur
Costs of direct material per product unit	6.000 eur	2.000 eur
Throughput (a)	4.000 eur	3.000 eur
Melted messing per product unit (b)	0,50 kg	0,25 kg
Throughput per a kilo of melted messing (a)/(b)	8.000 eur/kg din/kg	10.000 eur /kg

So, if demand overcomes the capacity, a question that can be asked is: which of these two products – gongs or bells – should have bigger priority in production? From the previous table, it can be seen that gongs make bigger throughput per the product unit, than the bells. On the other hand, gongs demand twice as much of melted messing (0.50kg) comparing to the amount of this material needed for bells (0.25kg). Company should make a decision about using limited supplies of melted messing in order to increase throughput.

Important fact is that fixed costs are irrelevant for deciding because company using its capacities will make the same amount of these costs for gongs and for bells.

If we start from assumption that factory has 1kg of melted messing it can be used for production of two gongs or four bells. Throughput made by selling two gongs is 8.000 eur (2gongs x 4.000eur/unit), and by selling four bells 12.000eur (4 bells x 3.000eur/unit). It follows that although bells make lower throughput per unit than gongs,

on the other hand, it makes more efficient spending of limited resources, and by that have priority in production.

So, if a limitation exists, the company will not be able to fully satisfy the demand. In order to decide on which activities should be continued, and which of them should be abandoned, managers must count throughput per unit of limited resources for each product, or activity. In absence of the most important factor (maintaining good relations with key consumers), company should abandon product or activity with the lowest throughput per unit of limited resource.

Quantitative illustration of implementing TOC for deciding on ways to overcome system constraints and increase throughput

It is already mentioned that TOC is based on comprehension of limited resources in order to improve business. Implementation of this management philosophy for deciding on ways to overcome system constraints and increase throughput will be illustrated by the following example.

If we assume that hypothetical company 'X' produces electrical heaters for household appliances. Production of heaters consists of two phases: filling and closing. During that (Antic, 2006):

- Available annual capacity for managing both phases (filling and closing) is 20.000 units,
- Real annual capacity for filling is 20.000 units and for closing 16.000 units,
- Selling price per product unit is 20 eur,

- Costs of direct material are 9 eur (TOC is not taking into consideration variable costs of other functions in value chain)

If we analyze these data, we can conclude that machine for closing heaters with real annual capacity of 16.000 units, represents „bottle neck” or system constraint. It shows, in the filling phase there are accumulated supplies because annual capacity of this phase is 4.000 units bigger than in the next phase. For these reasons, on the filling machine an amount of heaters that should be processed is the same amount that machine for closing can process - 16.000 units of the heaters.

In this situation, management is expected to, knowing basic assumptions of TOC, take appropriate actions in order to overcome problem of constraints. Namely, there are a few alternative ways of acting:

- Eliminate machine's period of inactivity. It is a period in which closing machine is not engaged in processing operations, when the products are not being process on it, nor its preparation for continuing work is being done. This period of inactivity can be eliminated by employing two additional workers who will move finished heaters just after closing a series and prepare machine for closing the next series. We will now start from the assumptions:

- That annual costs of employing additional workers are 16.000 eur, and
- That solving this problem in the described way, output of the closing machine is increased for 2000 units per year.

1. Selling income	2000 units x 20 eur = 40.000 eur
2. Direct material costs	2000 units x 9 eur = 18.000 eur
3. Throughput (1-2)	22.000 eur

By selling additionally 2000 units of product, throughput of 22.000 eur will be achieved. If throughput is compared to

costs for additional employment of 16.000 eur, we can conclude that this alternative of

overcoming system limitations is completely justified.

- There is another alternative for manager to take into consideration: using other company's services. Namely,

company can outsource closing a part of filled heathers. If we assume that company outsources closing of 1.000 filled heathers on the price of 8 eur per heather, achieved throughput would be 11.000 eur:

1. Selling income	1.000 units x 20 eur = 20.000 eur
2. Direct material costs	1.000 units x 9 eur = 9.000 eur
3. Throughput (1-2)	11.000 eur

Amount of throughput of 11.000 eur is bigger than costs of using services of closing heathers by another company in amount of 8.000 eur (1000 units x 8 eur). It follows that decision making about outsourcing is completely justified.

- To decrease preparation period of the machines and period of process for the operation that represents „the bottle neck”. This alternative implies that simplification of design or decreased number of parts of the

product must be done. The assumption now is that decrease of preparation period for the heather closing is:

- enabling closing additional 2.500 heathers, and
- causing additional costs of 16.000 eur for decreasing preparation

By selling additional 2.500 heathers, company will achieve throughput of 27.500 eur:

1. Selling income	2.500 units x 20 eur = 50.000 eur
2. Direct material costs	2.500 units x 9 eur = 22.500 eur
3. Throughput (1-2)	27.500 eur

Throughput achieved this way is bigger than costs caused by decreasing preparation period in amount of 11.500 eur. This fact verifies this alternative and makes it completely justified.

Based on this example, it can be easily concluded that every alternative for overcoming constraints that ensures throughput bigger than realization costs is acceptable.

Quantitative illustration of TOC implementation in order to decide about selling price of the product

Managerial decisions about selling prices of product significantly determine company's position on the market. In that sense, TOC offers appropriate information which, when implemented for deciding about pricing can be analyzed using the following example.

Hypothetical company „M” produces product A which has average selling price is 40 eur per product unit. Company has production capacity for 100.000 units annually. Direct material costs per product unit are 14 eur, and operational costs (all production costs except direct material costs) are defined as an amount 900.000 eur (Kreshaw, 2000).

Because of limited demand on existing market of 75.000 product units, company has unused production capacity of 25.000 units. According to basic assumptions of TOC, company wants to overcome limitation, entrancing new markets, while increasing throughput. With this amount of direct material costs, level of throughput will be influenced only by selling price of the product.

Analyze of demand of new market gives two alternatives to the company's management: by selling product on new

market on average price of 28 eur per unit company can expect the demand of 25.000 product units. If company defines selling price based on the level of existing price of 40 eur, the demand of 8.000 units can expected.

In the table no.1 relevant accounts for both alternatives are given: a) company sells 75.000 product units at existing market for 40 eur and 25.000 units on new market for 28 eur and b) company sells 75.000 product units on existing and 8.000 units on new market for 40 eur per unit.

Table no.1 *Throughput and profit for different alternatives*

Elements	Present state (selling 75.000 units for 40 eur)	Selling additional 25.000 units for 28 eur	Selling additional 8.000 units for 40 eur
1. Sales range	75.000 units	100.000 units	83.000 units
2. Sales income a) on the price of 40 eur b) on the price of 28 eur	3.000.000 eur 75.000 un. x 40 eur	3.700.000eur 75.000 un. x 40eur 25.000 un. x 28eur	3.320.000 eur 75.000 un. x 40 eur 8.000 un. x 40 eur
3. Direct material costs (14 eur per unit)	1.050.000 eur	1.400.000 eur	1.162.000 eur
4. Throughput (2-3)	1.950.000eur	2.300.000 eur	2.158.000 eur
5. Operational costs	900.000 eur	900.000 eur	900.000 eur
6. Profit	1.050.000 eur	1.400.000 eur	1.258.000 eur

Based on the data given in this table, it can be concluded that throughput level for the first alternative is bigger, and the management decision is to engage unused capacity for producing additional 25.000 product units that will be sold for 28 eur/unit.

However, at the same time it can be seen that TOC considers other operational costs as fixed and do not analyze them as relevant – it starts from the statement that

production of additional products will not lead to operational costs increase. But, if we start from assuming that company must increase quality of its products in order to respond to demand of the consumers from the new market it would additional costs for employees training in the amount of 450.000 eur will be necessary. Starting from this assumption, analyses must include additional costs, as illustrated in the table 2.

Table no. 2 *Throughput and profit for different alternatives respecting all other costs*

Elements	Present state (selling 75.000 units for 40 eur)	Selling additional 25.000 units for 28 eur
7. Sales range	75.000 units	100.000 units
8. Sales incomes c) On the price of 40 eur d) On the price of 28 eur	3.000.000 eur 75.000 un. x 40 eur	3.700.000 eur 75.000 un. x 40 eur 25.000 un. x 28 eur
9. Direct material costs (14 eur/unit)	1.050.000 eur	1.400.000 eur
10. Throughput (2-3)	1.950.000 eur	2.300.000 eur
11. Operational costs	900.000 eur	1.350.000 eur
12. Profit	1.050.000 eur	950.000 eur

So, it can be easily concluded that by accepting this alternative, throughput will be increased, but, at the same time, company's profit will be decreased.

As selling price includes only variable costs of material, and neglect all other costs, accounting relying on TOC can lead to choosing alternative which is not in accordance with long term strategy of the company – achieving leading market position.

For these reasons, company has to analyze other factors as well (not only influence on the level of achieved throughput) while decision making process.

Conclusion:

Today, company represents very complex business unit that consists from big number of parts, segments, activities and functions. Its survival and development are strongly influenced by success of managing its business that is under the maximize throughput.

influence of limiting factors in almost every moment. TOC is just one of numerous management philosophies developed for company to successfully respond to these factors. Starting from assuming that production process represents group of interrelated and interdependent elements, TOC consider different alternative ways of acting in order to overcome constantly present constraints or make use of them in order to eliminate or at least weaken its negative affect on throughput.

As costs of direct material are in focus of this theory, while production technology, product range, capacity are fixed elements, it is considered that TOC represents short term approach to profitability analyses. More precisely, this theory can be considered to be short term optimizing procedure for resources management and bottle neck removing in order to

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