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International
Journal
Of Modern Engineering Research (IJMER)

Theory of Constraints – A Review

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ABSTRACT: *Theory of Constraints is a systematic approach which identifies the weakest links in a system and focuses on its improvement there by improving the efficiency of the company overall. The growth of a company, whether service or production depends on a detailed understanding of its structure to survive global competition. Theory of Constraint plays an important role to withstand global competition as it stresses on efficiency at minimal cost. This literature review does an overall study of Theory of constraint and how it can be theoretically be applicable in any scenario be it Manufacturing or Service sectors.*

Keywords: *Theory of constraints, Bottle-neck, Drum-Buffer-Rope.*

I. INTRODUCTION

Theory of Constraints (TOC) is an overall management philosophy introduced by Dr. Eliyahu M. Goldratt in 1984, to help organizations continually achieve their goal. The title comes from the contention that any manageable system is limited in achieving more of its goal by a very small number of constraints, and that there is always at least one constraint. A constraint is anything that prevents the system from achieving more of its goal [1].The vast developments in technology and the change in the accounting and administrative costs that took place in the current era led to the emergence of a range of systems, technologies, and ways that address many of the industrial administrative and cost issues or to provide products. One of the main goals of this group was developing methods that would reduce the cost of products while maintaining the quality and specifications in order to market them in an environment characterized by competition, as well as ensuring that they meet the company's goals related to profitability and maintaining the company's market share. Currently, the need to study modern theories in the field of management, e.g. the Theory of Constraint (TOC), Cost Management Systems and of modern non- traditional management systems, that do not interact with the external environment surrounding companies on various types, due to the increased competition between companies and the desire to design products that achieves the required technology.In order to maintain the market share of companies and satisfy their customers and achieve its competitive advantage and reduce costs, there are many modern administrative and cost management systems that concentrate on enhancing and development the production input operations to secure low cost products that would secure high profitability [2]

Many organizations are facing internal and external challenges that drive them to carry out changes in their various operations and activities that drove the acceleration in finding systems that deal with reducing the time allocated for production and removing activities used in production that do not add value to the product whilst consuming part of the cost of the product, thus determining the cost of the product before taking the decision to start production through researching a plan for the continued development and improvement of several generations of the product, as well as increasing its profitability. Realizing the importance of studying and analyzing the dynamic pricing, complexity of the components of its performance and establishing reciprocal relationships with suppliers characterized by credibility and ability to meet the requirements, management of different companies concentrated on looking for modern cost management systems that would study the organization of the life cycle of products, analyses its cost elements and its impact on each stage of the production cycle as well as the profitability of the product [2].

Theory of Constraints can be defined as a management approach which focuses on improving bottleneck processes to continuously improve the performance of manufacturing operations. Using a number of concepts (e.g. TOC thinking process, TOC five step approach, VAT classification of plants, drum-buffer-rope scheduling), TOC attempts to answer the following three questions relevant to a manufacturing organization: (i) what to change; (ii) to what to change to; and (3) how to cause the change?[3].

TOC looks for answers to the following questions:

i. What to change: every organization in a real environment is overwhelmed with problems and/or opportunities which need the managers' attention and/or corrective actions. However, limited time, effort

and resources make it difficult to act on all such problems or opportunities. Hence, the manager has to find what should be changed, to effectively improve the performance.

ii. To what to change to: once the core problems have been identified, the next step is to find the solutions. If sincere effort is not directed towards finding solutions to the core problems chaos and panic will result.

iii. How to cause the change: perhaps the most difficult of the three questions is to find out how to cause the change in a system. In addition to the time, effort and capital required, managers often face the problem of emotional resistance by people in the organization who perceive change as a threat to their security. If 'to what to change to' is identified, but it is not possible to cause that change, then the solution is not of much use [4].

Drum-Buffer-Rope Scheduling (DBR): The DBR approach to synchronized manufacturing assures that the inventory buffer in front of a capacity constrained resource remains at adequate levels without being too large [4]. The constrained resource becomes the drum that determines the timing for the system. The buffer is the time related supply of inventory before the constrained resource that assures the constrained resource will not be idled by fluctuations in the system leading up to it. The rope is "tied" between the constrained resource and the lead operation in the system assuring that too much inventory does not develop in front of the constraint. In The Goal, Goldratt has developed an illustration for the idea from a group of scouts. The scouts are marching single-file along a trail and are unable to pass one another. The slowest scout, located somewhere in the middle of the group, represented the drummer determining the pace for the group. The buffer was the natural spacing that spreads between the faster marching scouts in front and the slowest scout. The rope determined the maximum physical distance allowed to develop between the first scout and the slowest scout. The spacing between all scouts following the slowest scout varied somewhat as they change their pace or are detained temporarily, but, being faster, they naturally caught back up to the slowest scout without intervention. In this analogy, the trail traversed represented product moving through the system[5].

II. OBJECTIVES

The objectives of the Theory of Constraint is to overcome the problems arising from the incompatibility of production capacities between machines or stages which requires re-arranging the factory to generate compatibility, through the efficient management of the elements that affect this goal.

These elements include the following:

• Efficient management of records.
• Satisfying workers and enhancing their competence through training and motivation.
• Ensuring customer satisfaction through the control of critical success factors. [2]

III. ASSUMPTIONS

- The underlying assumption of the theory of constraints is that organizations can be measured and controlled by variations on three measures: throughput, operational expense, and inventory. Inventory is all the money that the system has invested in purchasing things which it intends to sell. Operational expense is all the money the system spends in order to turn inventory into throughput. Throughput is the rate at which the system generates money through sales.
- Before the goal, itself can be reached, necessary conditions must first be met. These typically include safety, quality, legal obligations, etc. For most businesses, the goal itself is to make money.
- The Theory of Constraints essential premise is that all firms have at least one critical constraint that limits their production capacity. A constraint is any element whatsoever that occurs in a system and that prevents it from achieving optimal performance.
- TOC claims that a real-world system with more than three constraints is extremely unlikely [6].

IV. PRINCIPLES

The following principles are the basis of solutions developed using Theory of Constraints.

- Systems are analogous to chains. Each system has a 'weakest link'(constraint) that ultimatelylimits the success of the entire system. Strengthening any link in a chain other than the weakest one does nothing to improve the performance of the whole chain.
- Most of the undesirable effects(UDEs) within a system are caused by a few critical root causes.
- Root causes almost always manifest themselves through a number of UDEs linked by a network of cause and effects

- System constraints can either be physical or policy. Physical constraints are relatively easy to identify and simple to eliminate. Policy constraints are usually more difficult to identify and eliminate, but removing the normally results in a larger degree of system improvement than elimination of a physical constraint.
- Inertia is the worst enemy of a process of ongoing improvement. Solutions tend to assume a mass of their own that resists further change[7].

V. FIVE FOCUSING STEPS

The Five-Step Continuous Improvement Process is based on finding the constraints in the system [2]. They are Goldratt emphasizes that the completion of all five steps will lead to continuous process of improvement and, as it does, the nature of the bottlenecks will change. In a manufacturing environment, for instance, the constraint may change from being a physical constraint within the plant to insufficient market demand or a company policy that must be changed [2]

Step 1: Identify the system constraint.

In the first step, an organization identifies what part of the system constitutes the weakest link and determines whether it is a physical constraint or a policy-related issue.

Step 2: Decide how to exploit the constraint.

Organizations "exploit" the constraint by utilizing every bit of the constraining component without committing to potentially expensive changes and/or upgrades.

Step 3: Subordinate everything else.

With a plan in place for exploiting the constraint, organizations adjust the rest of the system to enable the constraint to operate at maximum effectiveness and then evaluate the results to see if the constraint is still holding back system performance. If it is, the organization proceeds to Step 4. It it's not, the constraint has been eliminated and the organization skips ahead to Step 5.

Step 4: Elevate the constraint.

If an organization reaches Step 4, it means that Steps 2 and 3 were not sufficient in eliminating the constraint. At this point, the organization elevates the constraint by taking whatever action is needed to eliminate it. This may involve major changes to the existing system, such as reorganization, divestiture, or capital improvements. Since these typically require a substantial up-front investment, the organization should be certain that the constraint cannot be broken in Steps 1 through 3 before proceeding.

Step 5: Go back to Step 1

But beware of inertia. After a constraint is broken, the organization repeats the steps all over again, looking for the next thing constraining system performance. At the same time, it monitors how changes related to subsequent constraints may impact the constraints that are already broken, thus preventing solution inertia [7].

VI. ADVANTAGES AND DISADVANTAGES OF THEORY OF CONSTRAINTS

Advantages:

- Potential for tremendous increases in productivity with minimal changes to operations.
- Most powerful and cost effective tool for increasing production capacity
- Very simple to communicate and apply, making it ideal for shop floor teams.
- Great for fostering teamwork as different areas become aware of the constraint and the need to work together to assist the constraint process.
- Great process for kick starting improvement efforts as it provides immediate and very tangible benefits.
- Allows growth of turnover/productivity without the need for additional space or staff.
- Provides a means to evaluate the true value of changes (using T, O, I), and utilize this to select the best options, and drive the right behaviour/decisions.

Disadvantages:

- Can be difficult to apply if the constraint process is constantly moving (for example if the nature of the work sees dramatically different and difficult to predict demands on various production resources).
- Can be difficult to apply in a jobbing environment (howeverit is still very applicable).[7]

VII. APPLICATIONS

Due to its success in managing operations, many are left with the mistaken impression that the Theory ofConstraints is only applicable in Production Management. But over the years, the same TOC Thinking Processes which brought us Drum-Buffer-Rope have analyses other functions, industries andenvironments to create a whole array of TOC applications [8].

- **Production Management: Simplified Drum Buffer Rope(Dbr)**

The classic TOC approach to production management is known as Simplified Drum-Buffer-Rope.Rather than seeking to maximize the output of every resource and operation; S-DBR seeks tomaximize the output of the bottleneck resource(s) only.

- **Project Management: Critical Chain Project Management**

Critical chain project management (CCPM) is a method of planning and managing projects thatemphasizes the resources (people, equipment, physical space) required to execute project tasks. Itimproves the accuracy of project plans by dealing with variation at the project level by using strategically located buffers, or time cushions. These buffers aggregate the safety factor ofindividual tasks and help the project meet its overall commitments.

- **Supply Chain, Retail And Distribution: Replenishment**

The TOC distribution solution moves from a push system to a pull system across the supply chain.Since variation in demand for individual products is far greater at the point of purchase keep onlyenough on-hand to supply our immediate needs, as defined by the replenishment period.Therefore, TOC distribution seeks to hold smaller inventory levels at the point of purchase andlarger ones at the point of production, and then to ensure a rapid replenishment system to serviceregional warehouses and retail outlets, in line with what they actually sell. The total inventory in the supply chain reduces dramatically whileend customer availability rises as well, boosting sales across all links in the supply chain.

- **Finance And Accounting: Throughput Accounting(TA)**

TA is an important development in modern accounting that allows managers to understand thecontribution of constrained resources to overall profitability.TA improves profit performance throughbetter analyticaldecisions based on three critical monetary variables, namely throughput, inventory and operatingexpense:

Throughput (T)—The rate at which money is generated through sales or interest. It is computed asrevenue minus totally variable costs (TVC).

Inventory (I)—All money invested in things intended for sale. It includes totally variable costssuch as material, plus resources used in production such as land, machines, trucks, and computers.The more conventional term, Investment, is sometimes used instead of Inventory.

Operating Expense (OE)—All money spent turning investment into Throughput. It includes directlabour, rent, and labour, plus selling, general, and administrative (SG&A) costs.

VIII. CONCLUSION

Theory of Constraints is a relatively new philosophy in management. In this literature review, principles and a general history of Theory of Constraints were discussed. It was found that TOC principles are proven to be very effective in the recent past and all sectors of industries are adopting it. This paper is a general guide for the application of TOC principles and its basic five steps in any industry. From literatures collected, it is observed that the TOC can be more effective if applied with other management tools such as Lean principles for more efficient application.

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