International Journal of Mechanical And Production Engineering, ISSN(p): 2320-2092, ISSN(e): 2321-2071
Volume- 6, Issue-1, Jan.-2018, http://iraj.in

THEORY OF CONSTRAINTS – STRATEGY FOR CONTINUOUS IMPROVEMENT

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Abstract - Since the evolution of various process improvement methodologies through the domain of industrial engineering in order to make the industries / service sector capable enough to compete with their counterpart in the global market, Continuous Improvement is a word which has been used several times. To improve continuously in order to earn more and more profit is the prime concern of every organization. No organization is capable enough so that it can earn infinite profit. It means that every organization / system has at least one weak link / element which prevents it to make the highest return on investment. This paper describes the use of Theory of Constraints as a strategy for continuous improvement.

Keywords - Process Improvement, Continuous Improvement, Theory of Constraints, Drum-Buffer-Rope

I. INTRODUCTION

The theory of constraints is a continuous improvement strategy for the improvement of an enterprise initially developed by E.M. Goldratt in 1980. This theory is concerned with the approach that any enterprise can be treated as a system having various links / elements. The initial link of this system works as the input while the final link is treated as the output. The primary objective of any system is to earn the highest return on investment. Thus, the primary input can be treated as the investment and the final output can be treated as the return on investment. In between the primary input and final output, there is a series of links / elements which contributes in the conversion of investment in to return on investment. The block diagram for such type of systems is given in Fig. 1.

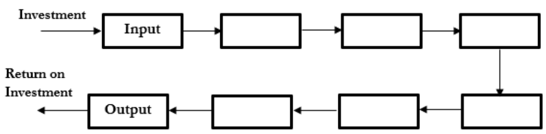

Fig. 1: System of Interconnected links / Elements

Webster defines the system as "a set or arrangement of things so related or connected as to form a unity or organic whole". System can also be said to be the combination of various interconnected rigid bodies primarily focused for the achievement of a common goal. A system may be a profitable enterprise as well as not for profit enterprise.

The productivity of any system depends on the individual performances of each basic link / element as well their performance as the integrated chain. If all the links / elements are performing with their full efficiency, the system is said to have an infinite return on investment. Such systems do not exist in reality. It means that every system has at least one weak link / element which limits its ROI from infinite to finite.

This weak link is defined as the constraint in the Theory of Constraints. This constraint is the important link of any system around which the performance of the whole system depends. If the performance of this constraint is improved, the performance of the system as a whole can be improved.

Theory of Constraints can be applied for the improvement of any system with in any domain such as production, supply chain, project management, operations, logistics etc. by focusing on their respective constraint to make them non-constraint.

II. LITERATURE REVIEW

There is the availability of plenty of literature in the field of Theory of constraints, which deals with the knowledge of the methodology of TOC and its implementation. This literature also deals with the various case studies conducted at different industries in different domains such as Production, Supply Chain Management, Project Management, Logistics etc. with the help of TOC. These case studies are concerned with the various aspects of implementation of TOC as well as its with integration with other process improvement systems.

Blackstone J.H[2]; in his article on "Theory of Constraints – A Status Report" summarizes the implementation of TOC in different domains such as marketing, sales, supply chain, performance measures etc. He explains application of TOC and its outcome on the different domains through various case studies. He defined that any organization must have at least one constraint, without which it may earn the infinite profit.

Nave D.[3]; in his article on "How to Compare Six Sigma, Lean and the Theory of Constraints" emphasize that every process improvement methodology tries to downplay the other process improvement methodologies in one or other way. He compares the three such methodologies (Lean, Six Sigma and TOC) in terms of their approach, steps of implementation and focus area. He explains in his article that How should an organization choose the correct methodology for the process improvements as per their individual requirements.

Ehie I., and Sheu C.[4]; in his article on "Integrating six sigma and theory of constraints for continuous improvement: a case study" explains the integrated methodology for process improvement by combining the features of both six sigma as well as TOC. He explains the implementation of this methodology in a case company which is involved in developing the modular systems technology.

Inman R.A., Sale M.L., and Green Jr K.W.[5]; in his article on "Analysis of the relationships among TOC use, TOC outcomes, and organizational performance" explains the impact of the TOC implementation in industries as well as its outcome. He also defines a customer specification index required to connect the customer satisfaction with production systems.

Ray A., Sarkar B., and Sanyal S.K.[6]; in his article on "An improved theory of constraints" proposes a new implementation model by integrating the Laplace criterion and TOC in a multiproduct constraint resource environment. They also evaluated the effectiveness of this integration model with case studies in different industries. This research was done in an environment without multiple constraints such as production processes.

Blackstone Jr J.H., Cox III J.F., and Schleier Jr J.G.[7]; in his article on "A tutorial on project management from a theory of constraints perspective" explained the impact of TOC implementation on project management. He also explains that many of the projects fails due to late delivery, without budget management and improper specifications.

Jin K., Razzak H.A. et.al.,[8]; in his article on "Integrating the Theory of Constraints and Six Sigma in Manufacturing Process Improvement" reviews both the methodologies (six sigma and constraint management) with respect to their strengths and drawbacks. They try to eliminate the drawback of one methodology with another and explains the implementation of the integrated approach in a manufacturing case.

III. RESISTANCE TO CONTINUOUS IMPROVEMENT

Continuous improvement of any system is required to make the system alive in this competitive era of globalization. There are various projects in any system or enterprise which do not complete on time. The various reasons behind the non-completion of projects on time can be the uncertainty involved and having the three opposing factors – due date, budget and commitment **(Izmailov A.[11])**. Apart from these factors various organizations tries to manage multiple projects in the same time and resources, this makes the execution of task even more challenging. Due to this many organizations face the various common problems in handling of their projects, despite of the nature of project. These problems could be – too much overtime, rework, more expense than the allocated budget, non-availability of shared resources with all projects at the same time, bad multitasking, student syndrome, Parkinson's law etc. **(Izmailov A. et.al.[13], Blackstone Jr J.H. et.al.[7])**.

Bad multitasking is to stop a project even before its completion to initiate some another project. In such case it is hard to remember the details of previous project in same manner as before in order to restart the project after a certain time. Due to this the projects could not be executed with in the stipulated time frame.

Student's syndrome is a name which suggests the execution of projects in a such a manner that students prepare for their exams. It is widely seen that students always starts studying just before their exams and due to this, they have extra pressure during their exams to perform well, like wise employees involved in the projects starts to execute the project just before the deadline and thus having extra pressure to complete it with the desired results.

Parkinson's law states that if safe time is added to any project for its completion because of various obstacles and during the execution there is no obstacle, then the project would not get completed before the scheduled time. There is a tendency that if the project gets completed before the stipulated time due to no obstacle, next time the scheduled time will be shorten by the management. Therefore, employees would consume all the safe time of the project by showing that they are very busy in the work.

IV. CONTINUOUS IMPROVEMENT WITH TOC

Continuous improvement in any system requires the change in the system. Any change in the system is not necessarily the improvement but every improvement is definitely a change. While making change to any system – either due to technological advancement or to increase the return on investment, there are few who considers these changes as threat to their security. They think that because of these changes they are also required to change otherwise someone would replace them for the benefit of the system. This creates a lot of emotional resistance and can be overcome by another strong desire to change for making system and you as well compatible with the need of market **(Goldratt E.M.[1])**. If a person who considers the change for improvement as a threat to the individual security, He is creating a chance for the occurrence of long term insecurity by not changing the system for the improvement. If this change in the system is for once, it would again create the constraint in the system. In order to compete with the varying need of market due to globalization, the change for improvement should be continuous.

We are fighting fire with fire. But let's not forget, whenever we use fire to fight fire somebody gets burnt **(Goldratt E.M.[1])**.

The continuous improvement with TOC consists of five-step methodology. The steps are as follows;

- Identify the constraint
- Exploit the constraint
- Subordinate everything else to the constraint
- Elevate the system's constraint
- If a constraint is broken, Repeat the cycle

Identify the Constraint

This step requires the identification of the weakest link / element of the system, which is limiting / downgrading the performance of the system. A system could be physical, capacity, political, logistics, market and managerial as well **(Okutmus E. et.al.[12])**. A physical constraint could be anything such as man, machine, material etc. The market constraint may be the insufficient demand. The capacity constraint may be the insufficient supply. The political and managerial constraint may be due to administrative policies, procedures, rules and regulations. The logistics constraint may be not supplying the available resources. Identification of the constraint should be according to the primary objective of the system as a whole so that the major constraint could be broken first.

Identification of the constraint comes with a question "What to Change". It means the management should be capable enough to pin point the core problems of the system. These problems would have a major impact on the system after improvement rather than switching from one problem to another and making fool that job is being done **(Goldratt E.M.[1])**. Any change for the improvement of the system must define the path of achieving the goal of the system and we should measure the impact of improvement in any link / element on the goal of the system. Therefore, the defined constraint of the system, if going under the change for improvement, must be able to improve the system by making the system one step closer to the achievement of the system's goal.

Exploit the Constraint

This step requires the identification of the different ways for exploring the possibility for the improvement of the constraint. A physical constraint should be used effectively for making it non-constraint. A managerial / administrative constraint is not required to exploit. The only way is to replace such policies (managerial / administrative constraints) with new policies, which defines the system's goal and objectives in accordance with the varying need of the market **(Gupta A.[9])**. Many a times after improving one constraint (since it is required to improve for the benefit of the system as a whole), we don't bother to regularly monitor the impact of the improved constraint on the improvement of the system. In such cases, if the constraint is in terms of policies (managerial / administrative constraint), after certain time the reason behind the establishment of these policies will change. Therefore, these policies are required to be redefined / change according to the need of the market.

Subordinate everything else to the constraint

After exploiting the constraint effectively, it is required to set the pace of every non-constraint in accordance with the pace of the constraint in order to efficient utilization of the constraint. Since the constraint is responsible for the generation of throughput of the system, every resource (other than constraint) must be synchronized with the constraint for providing the way for maximum utilization of the constraint. If we utilize the non-constraint beyond their productivity, it would add nothing to the system's performance. It would only create more and more inventory, which does add any value to the system's performance. A concept in theory of constraint is treated as Drum-Buffer-Rope. In this concept, the constraint is treated as the drum, which beats out the pace for the system to follow. The drum decides the output rate of the system. The buffer is treated as a stock mechanism, which is used at a point of time, when the constraint has become sideline from the pace of the system. It fulfills the requirement of the system, due to lack of constraint, in order to maintain the decided output rate of the system. When the constraint comes back on the track, it starts again with beating out the pace for the system to follow. Buffer is always created in a system for maintaining the pace of the system for the maximum effective output. Buffer could be of any type such as constraint buffer, assembly buffer, shipping buffer, and capacity buffer. The constraint buffer is provided as a safety against the disturbances in the flow of operations due to the constraint. The shipping buffer is provided to ensure the delivery of the product to the customer in the decided time frame. The assembly buffer is provided to manage the components required for the assembly with the components being processed at the constraint. The capacity buffer is provided with the non-constraint resource as the extra capacity in order the manage the disturbances at the constraint. The rope acts as a feedback mechanism in a system. It runs from the constraint to the release of resource material so that the buffer stock can be maintained at a constant level. A system with Drum-Buffer-Rope is given in Fig. 2.

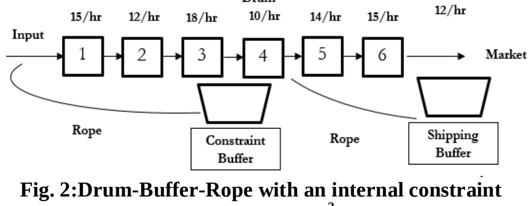

Fig. 2:Drum-Buffer-Rope with an internal constraint (Blackstone J.H.[2])

Elevate the system's constraint

This step requires to increase the capacity of the constraint in order to make it non-constraint. There would be the requirement of additional resources in order to increase the capacity of the constraint **(Chou Y-C.[10])**. The primary purpose of this step is to check that after completing the initial three steps, if the constraint is still the most critical element in the system, it needs to be rectified with the help of additional resources.

If a constraint is broken, Repeat the cycle

This step is the most important step of any continuous process improvement methodology. If the constraint chosen for the improvement of the system has been broken with the help of initial four steps, the system is required to monitor again for identifying another constraint of the system. Now the process is repeated again for this new constraint to make it a non-constraint. After that another new constraint is again identified and thus the process continues in a cyclic manner. This cycle continues up to elimination of all the constraint. Practically there is no system possible without any constraint, therefore the process of continuous improvement through TOC will be repeated again and again.

CONCLUSION

Competition is forcing the industries or service providers to create products or provide services with more and more accuracy and satisfaction. The industries are being forced to deliver their products in the short span of time with better quality than their competitor due to cut throat competition. Competition is more fierce than ever **(Goldratt E.M.[1])**.

Theory of Constraints treat every process / project as a system of interconnected links or elements. It believes that the performance of the overall system depends on the individual performances of its different sub elements and the performance of any link or element in the system depends on the performance of its previous link or element.

Any improvement activity in such systems can take place by identifying the weakest link of the system. After identifying the weakest part, the task is now to improve the performance of this weakest link without affecting the performances of the non-weak links. This weakest link is known as the constraint in the improvement of any system. If this constraint has been made as a non-constraint for the system after improvement, the task is now to find the new constraint for the system and improve it. The improvement process of any system using the constraints of the system can be understood as a cyclic process of continuous improvement.

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