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INTEGRATING LEAN, THEORY OF CONSTRAINTS AND TRIZ FOR PROCESS INNOVATION

Abstract

A growing challenge for organisations is how to respond effectively to the unpredictable changes that occur today's global economy. These changes often result from increasing competition, falling product life cycles and changes in consumer preferences and expectations. As processes are at the heart of business operations, it has become necessary for organisations to develop competency is articulating and delivering innovative business processes that are adaptable to changes. This chapter proposes the integration of Lean, TOC and TRIZ as a way to bring in creativity and logical thinking within process improvement in order to facilitate innovative and adaptable processes.

Introduction

A growing challenge for organisations is how to respond effectively to the unpredictable changes that occur today's global economy. These changes often result from increasing competition, falling product life cycles and changes in consumer preferences and expectations. As processes are at the heart of business operations, it has become necessary for organisations to develop competency is articulating and delivering innovative business processes that are adaptable to changes. This chapter argues that integrating creativity and logical thinking within existing process improvement techniques would facilitate process innovation. Thus, this chapter explores a number of ways to synergistically integrate three techniques for problem solving and process improvement: Theory of Inventive Problem Solving, which is more commonly known by its Russian acronym, TRIZ; Theory of Constraints (TOC); and Lean Manufacturing.

TRIZ can be seen as a collection of tools that facilitate creativity and innovation in problem solving. The main premise of TRIZ is that creativity can be structured and repeated. The main premise of TOC is that the performance of a system is dictated by the performance of its biggest constraint, and the proposition is that improvement efforts should be focused on the constraint where they would have the biggest impact on the overall goal of the company. The key philosophy of Lean

is that the elimination of non-value adding activities, variability and inflexibility is imperative in order to deliver value to customers at the right time, quantity, quality and at minimum cost.

In the next section, brief background information regarding each of the three techniques is provided. In section 3, a literature review of some of the works that have sought to explore similar synergies is presented. Section 4 explores a number of ways to integrate the three techniques. Section 5 summarises the chapter.

Background

The key philosophy of Lean is that the elimination of non-value adding activities, variability and inflexibility is imperative in order to deliver value to customers at the right time, quantity, quality and at minimum cost (Drew et al., 2004). Lean refers to non-value adding activities as wastes and Womack and Jones (2003) developed a five step process for eliminating wastes: specify value; identify the value stream; flow; pull; seek perfection.

The main premise of TOC is that the performance of a system is dictated by the performance of its biggest constraint, which is usually referred to as a bottleneck. TOC advocates that improvement efforts should be focused on the constraint where they would have the biggest impact on the overall goal of the company, which is to "make more money now as well as in the future" (Goldratt and Cox, 1989).

For physical constraints such as resource constraints, TOC provides 5 focusing steps (Goldratt, 2003): identify the system's constraint; decide how to exploit the system's constraint; subordinate everything else to the above decision; elevate the system's constraint; if in a previous step a constraint has been broken, restart the process.

For policy constraints, TOC provides 3 focusing questions (Avraham, 2009a): what to change?; what to change to? How to cause change?

TRIZ can be seen as a collection of tools that facilitate creativity and innovation in problem solving. The initial TRIZ research was focused on fostering creativity in product development. However, more research has been carried out to apply the original TRIZ tools and thinking to business problems. The main premise of TRIZ is that creativity can be structured and repeated because 'someone, somewhere has already solved a problem like yours' (Mann, 2007). So, why not re-use the strategies that worked for someone else? These strategies are encompassed in the key philosophies of TRIZ: Ideality—the concept that systems evolve in the direction of increasing 'idealness'; Contradiction—the notion that strong solutions to problems are achieved when conflicts and trade-offs are eliminated; Resources—effective and creative use of things within and outside a system even seemingly negative

resources; Functionality—focus on the functions required from a system (solutions change, functions stay the same); Space/Time/Interface—viewing systems from different spatial, temporal and interface contexts.

Literature Review

In this section, other works that have explored similar synergies are presented. The works of Dettmer (2001), and Moore and Scheinkopf (1998) focused on utilising Lean within a TOC framework. The works explored the similarities and differences between Lean and TOC and sought to use the differences to enrich both techniques.

Some other works explored the synergies of TOC and TRIZ such as the works of Stratton and Mann (2003). In this work, the discussions were on the viewpoints of TRIZ and TOC with regards to conflicts and contradictions, and also on the commonalities of the underlying principles. Lebepe and Emwanu (2013) provide a comparison of TRIZ and TOC in relation to the effectiveness of the tools in a production environment.

Other research works explored the synergies between Lean and TRIZ including the works of Bligh (2006), Iyer (2006) and Ikovenko and Bradley (2004). Also, Martin (2010) provides a very brief description of the commonalities between TRIZ and TOC, and between TRIZ and Lean. He also suggests the combination of the three techniques as a way forward. The main drawback of this work is the lack of details. To the best of our knowledge, this unpublished work by Martin (2010), which is under three pages in length, is the only work that has attempted to consider the synergies between TRIZ, TOC and Lean.

Integrating lean, Toc and Triz

This section explores how the three techniques can be integrated. Specifically, it explores how to incorporate: Lean and TRIZ tools within a TOC framework; TOC and TRIZ tools within a Lean framework; and TOC and Lean tools within a TRIZ framework.

Using Lean and TRIZ tools within a TOC Framework

This work presented in this sub-section utilises the 5 focusing steps of TOC and draws from the works of Dettmer (2001), Moore and Scheinkopf (1998) and Vorne (2013).

i. Identify the constraint
Lean

Value stream mapping (VSM)—when used within a TOC framework, VSM can be help to identify resource constraints in a system.

Gemba visits—Lean and TOC advocate visiting the shop floor and having conversations with shop floor workers as one of the conventional ways of identifying wastes and bottlenecks respectively.

TRIZ

Conflicts/Contradictions—in TOC, the identification of conflicts within a system is most often achieved using Current Reality Tree (CRT) and Evaporation Cloud. This can be supplemented using TRIZ which has some tools that are equally effective but less rigorous than CRT such as 'root contradiction analysis' tool (Mann, 2007) and 'why-what's stopping' tool (Basadur, 1995; Mann, 2007).

S-Curve analysis—S-Curve is known in a number of fields of work to represent the way in which a wide range of systems evolve. A very good example is 'product life cycle' which usually goes from conception, birth, growth, maturity to decline. Carrying out an s-curve analysis on the different aspects of a process might help to identify the aspects that have reached their limits on their s-curves or those that are near.

Function/Attribute Analysis (FAA) (Mann, 2007)—FAA is a graphical technique for analysing how a system works by mapping the functional interrelations amongst the components of system. Different types of arrows are used to show different functional relationships such as effective, insufficient, excessive, missing and harmful relationships. This kind of mapping could be very useful in identifying the constraint of a system.

ii. Decide how to exploit the constraint

Lean

A number of Lean tools are applicable in this step of TOC. These tools include: Kaizen, 5S, Standardised Work, Pokayoke, Visual Management, Single Minute Exchange of Die (SMED), Jidoka etc. Any of these could be used to maximise the performance of the constraint.

TRIZ

Ideality—employing the ideality concept in this step would help to envision an ideal situation for the constraint. TRIZ advocates the use of ideality to encourage people to envision an ideal situation first and then work back, if necessary, to the most practical situation. This approach encour-

ages 'out of the box' thinking.

Contradictions—within a system, there may be conflicts and contradictions that prevent the constraint from reaching its maximum performance. This step in TOC is an ideal place to utilise TRIZ contradiction resolution methods.

Trends of evolution—this concept is based on the premise that the stages of evolution of systems and their components are identifiable (Mann, 2002). And once the current stage of evolution of a system is identified along a particular trend, the future stages of evolution of the system can be predicted. There are 35 trends in TRIZ which could be examined to identify the trends that are relevant to the constraint. For each of the relevant trends, the current stage of the constraint along the trend's evolution path could be identified. Together, these trends would provide directions on how to exploit the constraint.

S-Curve—if, for example, the s-curve analysis in step (ii) suggests that the constraint has reached its limit, then there is no point in trying to squeeze out anymore from it. The focus should then be on transitioning to a new S-Curve to enable step change innovation.

iii. Subordinate everything to the constraint

Lean

Kanban for non-bottlenecks—Kanban can be used within this step in the TOC framework to regulate the flow of materials from upstream resources to the constraint.

The other lean tools mentioned in step (ii) can also be applied to non-constraints to ensure that the non-constraints have the capability to appropriately serve the constraint.

TRIZ

Functional/Attribute Analysis—FAA can also be used at this stage to help understand the interrelationships amongst the components of the system and to identify the harmful, insufficient and missing actions that may exist.

Space-Time-Interface (Mann, 2007)—this is tool is an attention focusing devise that encourages users to examine the system from different spa-

tial, temporal and interfacing perspectives. For instance, one may examine the constraints spatially from the sub-system, system and super-system points of view, or from specific temporal views of past, present and future while at the same time examining any interface issues.

iv. Elevate the system's constraint

Lean

Lean tools such as SMED, TPM and Jidoka can be used to significantly improve the performance of the constraint.

TRIZ

S-Curve—it might be necessary to think about transitioning to a new S-curve whether or not the constraint has reached its limit.

Trends of Evolution—moving onto another step on a trend's path could also help to elevate the constraint.

Space-Time-Interface—examining how the constraint could change over time may suggest ways to elevate the constraint.

Return to step 1

Using TOC and TRIZ tools within Lean framework

i. Identify value

TOC

TOC goal—in addition to identifying value from the perspective of the customer, this step in Lean can be complemented with an important aspect of TOC which is about identifying the goal of the system in order to maximise throughput.

TRIZ

Ideality—ideality in this context is about considering customer value from an ideal perspective. This would enable users to gain broader sense of the concepts of value and help to refine the direction of Lean implementation.

ii. Map the value stream

TOC

This step can be complemented with TOC tools such as CRT and Future Reality Trees (FRT) to identify any policy constraints that affect the

behaviour of the system.

Also, a constraint mind-set may be adopted to help prioritise improvements.

TRIZ

Function/Attribute Analysis—FAA could help to provide deeper insight into the inter-relationships that exist amongst a system's components.

Ideality—it may also be necessary to think about future value streams in terms of ideal value stream.

iii. Create flow

TOC

TOC bottleneck concept is very applicable in this step to help identify resource and policy constraints that are impeding flow. TOC's tools such as CRT, FRT and evaporating cloud can be used to achieve this.

TRIZ

Trends of evolution—can be used to understand where the system/process is at different evolution paths. Some trends that may be applicable include: Space Segmentation, Trimming, Dynamisation and Action Co-ordination (Mann, 2002).

Conflicts/Contradictions—it may be beneficial to seek out the conflicts and contradictions that block flow.

Inventive principles—there are 40 inventive principles in TRIZ that represent problem solving strategies that have resulted in innovative solutions (Terninko, 1998; Mann, 2007). Identifying the applicable inventive principles that would support the work in this stage can be very beneficial.

iv. Establish pull

TOC

In this step of lean, it is possible to use the DBR system (Avraham, 2009b) instead of kanban system or as a complementary set of tools.

TRIZ

Trends of evolution—the following trends could be applicable in this step of Lean: Action Co-ordination, Rhythm co-ordination, Controllability (Mann, 2002).

V. Seek perfection

Using Lean and TOC within a TRIZ framework

In this section, the focus is to explore how TRIZ problem solving routine can support Lean and TOC implementation. In literature, there are different TRIZ problem solving routines but this section will be based on the routine developed by Mann (2007) as presented below.

Define problem

In every problem-solving situation, understanding and defining the problem is a very crucial step and this is the purpose of this step. This chapter argues that combining the problem classes from Lean, TOC and TRIZ could help in providing a range of alternatives in problem definition: *Wastes; Constraints; Conflicts; Contradictions; Inflexibility; Variability; Reliability; Robustness; Cost; Risk; Missing, Insufficient and excessive actions.*

Select tool

The 'select tool' step guides a user through a process of identifying which techniques, strategies or tools that maybe most applicable for a particular problem. For example, if the predominant problem is 'waste', the 'select tool' may point to the direction of utilising Lean as a base framework.

Generate solutions

This step focuses on generating potential solutions using the tool(s) selected in step (ii). In Lean, this could be creating a number of future state VSM options. In TOC, this could be creating a number of FRT options and evaporations clouds.

Evaluate solutions

This step identifies the most suitable solution from the solution set. In Lean, the various future state VSMs can be subjected to analysis to identify the best VSM. In TOC, this would involve the analysis of different FRTs to identify the most appro priate.

Summary

This chapter explored how to integrate Lean, TOC and TRIZ to facilitate process innovation. The idea is to draw on the inherent strengths of each technique: TOC brings focus and logical thinking to process improvement; Lean facilitates waste elimination and process stability; and TRIZ enables lateral thinking, creativity and foresight. TRIZ tools such as ideality and trends of evolution can enable foresight in process improvement in such way that the processes become the vehicle for helping an organisation to adapt to changes in the business environment.

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