Adaption of TRIZ Method for Problem Solving: A Review

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Abstract:-Due to the current global market place the tough competition exists between the organizations to survive. So it has been needed to develop new productivity techniques throughout the industries. TRIZ can be used to solve any difficult problems not only in industry but also other scientific area.

This research paper explains the concept of ideality and literature review of TRIZ aiming to benefits the manufacturing industries.

Keywords*: TRIZ, Productivity, Innovation, inventive*

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1. Introduction:

TRIZ is a problem solving technique based on data and logic which help the project team to solve the problems. Due to its structure and algorithmic approach it provides repeatability, predictability and reliability. TRIZ is a creativity science that studies the patterns of problems and solutions.

TRIZ provides the systematic approach for analysing the difficult problems where inventiveness and range of strategies are required to find out the solutions. The main purpose of TRIZ is to apply the strategies and tools to find out the best solutions that overcome the need for a compromise between the two elements.

Following this approach the "Typical solution" shown in the figure 1. can be found by defining the contradiction which needs to be resolved and systematically considering which of the 40 principles may be applied to provide a specific solution which will overcome the "contradiction" in the problem, enabling a solution that is closer to the "ultimate ideal result".

The combination of all of these concepts together the analysis of the contradiction, the pursuit of an ideal solution and the search for one or more of the principles which will overcome the contradiction, are the key elements in a process which is designed to help the inventor to engage in the process with purposefulness and focus.

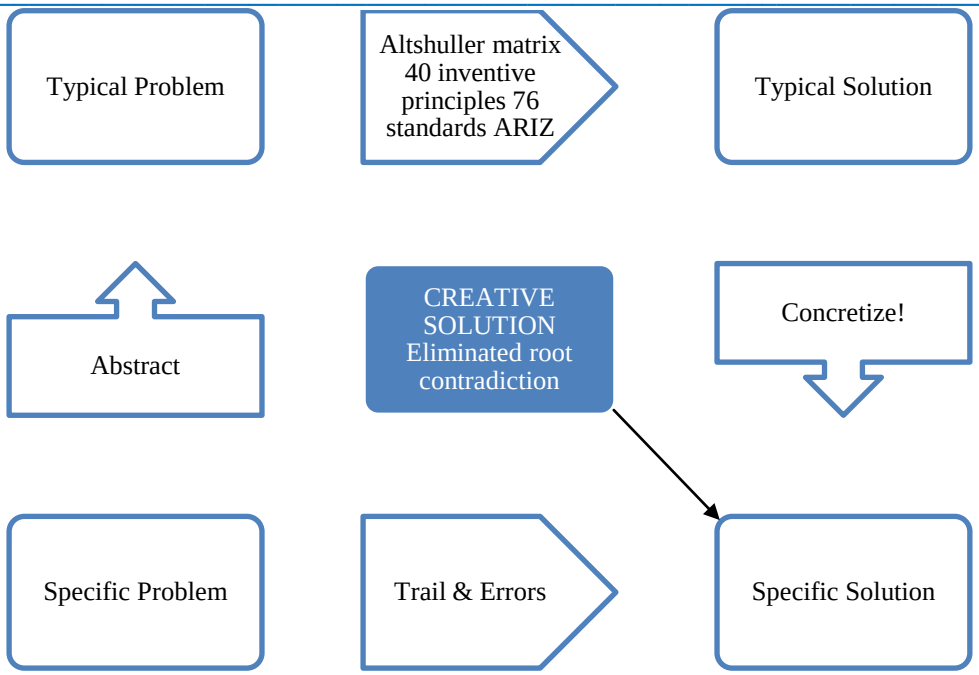

Figure 1. TRIZ process for creative problem solving

By considering above mentioned problems, traditional method of problem solving do not seem to provide help to the industries so to survive in global competitive market, creative and innovative is the only best way for these industries to keep up with shifting benchmark.

2. Literature Review:

Proctor, T. (2009) demonstrated that Creativity involves an ability to come up with new and different viewpoints on a subject by breaking down and restructuring problem solvers knowledge about the subject in order to gain new insights into its nature.

De Bono, E. (1995) stated that though exact definition of creativity is difficult, as concept has many dimensions, basically creativity could be thought as 'the production of novel and useful ideas in any domain.

VanGundy, A. B. (1987) Claims and cited evidence to support the view that divergent thinking processes, as opposed to convergent thinking processes, are related to creativity could be found.

Osborn, A. F. (1953) stated that the diverging-converging might feel quite impractical and difficult at beginning but experience gradually makes solver proficient with the model. Even though not all six stages would be required to solve each and every problem, it is important to understand that all these six stages always begins with a divergent phase and ends with a convergent phase.

Proctor, T. (2009) stated that creative Problem Solving model could prove effective in order to design and improve process or to troubleshoot problems in process, as currently process industry mainly uses experience-based techniques

(techniques that had worked in past) from designing to problem solving which does not guarantee any solution.

According to **Luchins, A. S. (1942**) Creative problem solving is required to make up for the limitations in basic education where there has been an emphasis on the use of mind for storing information instead of developing its power for fabricating new concepts and turning these into reality.

VanGundy, A. B. (1987) stated that existing processes or products could be improved with minimal production cost by exploring opportunity more efficiently and effectively using CPS techniques. Not only will a systematic approach to problem solving makes problem solver more efficient, but also could result in higher-quality solutions.

Blosiu, J.O. (1999) stated that CPS technique, designed especially for use in groups, encourages participants to express ideas, no matter how strange they may seem and forbids criticism during brainstorming session.

According to **Osborn (1950**), brainstorming was only one of a variety of tools for generating ideas, and idea generation was outlined as only one aspect of the entire creative problem solving process.

Proctor, T. (2009) stated that synectics aims to open up a problem to new insights. It is the process of combining unrelated factors to allow problem solvers to view a problem from a different perspective.

De Bono (1990) stated normal or vertical thinking as to dig the same hole deeper, whereas lateral thinking is concerned with digging a hole in another place. Seemingly, if that hole is in the wrong place, no extent of logic is going to put it in the right place.

VanGundy, A. B. (1987) demonstrated that analogies technique is one of the most powerful idea generation methods.

3. Motivation:

Initially TRIZ developed from the study of patterns of changes in technology, not to business models. After that it found that TRIZ is an excellent problem solving methodology for non-technical problems. It also helpful in other areas of the business to solve the any type of problem.

The main goal of this research paper is to perform a study on TRIZ problem-solving methodology by reviewing its fundamental concepts and the various TRIZ applications in solving engineering-related, technology-related or scientific-related, and also non-technology-related problems.

4. Objectives and Scope:

TRIZ is one of the useful tools, based on analytical methods for creative problem solving. In addition, this research paper would help fresh process engineers to recognize importance of various available methods for creative problem solving and learn TRIZ method of creative problem solving. This research work mainly provides idea on how to modify TRIZ based method according to ones requirements to fit in

particular area and solve problems efficiently in creative way.

The main aims and objectives of this study are listed as follows:

- To introduce present TRIZ approach
- To review applications in the manufacturing industries
- To review past research and works on TRIZ problem-solving methodology.
- To highlight in detail several engineering applications and non-engineering or non-technical applications that have used TRIZ.
- To propose several suggestions that can help improve TRIZ problem-solving effectiveness.

Scope:

Indian industries have been primarily borrowing technologies from West and Japan. However, there are three main difficulties, TRIZ can help, in all the three cases, with quick results using fewer resources, to maintain a competitive edge and hold the good market share.

5. Methodology:

First and foremost, operations that were commonly used in automobile industries were chosen. List of possible problems and solution applied to resolve those problems were created and later used to suggest characteristics that were in contradiction. After review, new characteristics for contradiction matrix that could be used in CPI were suggested.

5.1. Structured and TRIZ Problem-Solving Methodologies:

There are various techniques and approaches in solving critical problems but most common approach used in solving engineering problem is the structured methodology. It consists of several steps to solve the problems systematically. Fig. 2 illustrates the various steps within the conventional structured problem solving methodology [6].

A variation of the structured methodology to problem solving is presented in Fig. 3 where iteration is added to check the effectiveness of the solution. If the implemented solution does not solve the problem, then a new solution is generated. This repetitive step in carried out until a satisfactory solution that solves the problem is generated.

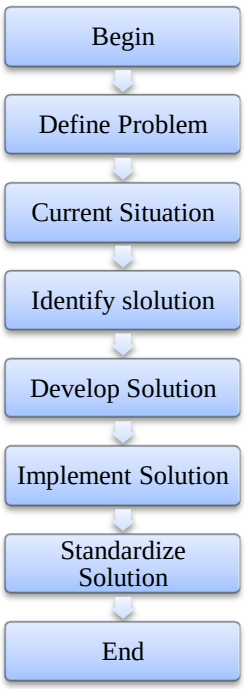

Figure 2. Conventional structured problem-solving methodology's phases [8]

TRIZ and structured methodologies for problem solving have lot in common so it has been proven that using both the methodologies in finding solutions to problems has resulted in better innovative solutions to the problem.

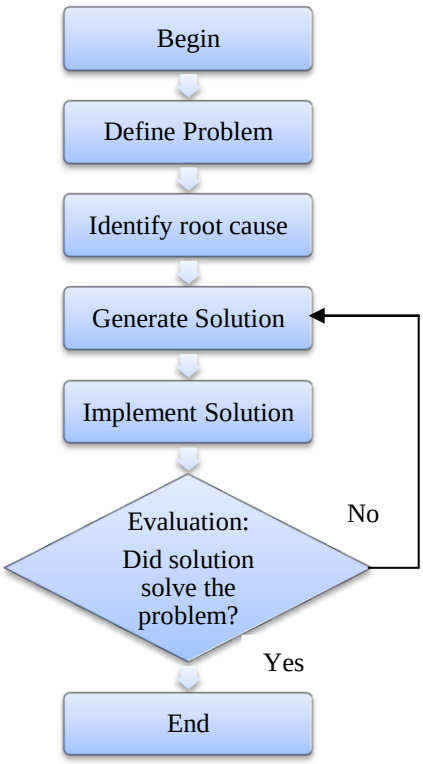

Figure 3. Structured problem-solving methodology's phases with an iteration [12]

5.2. Tools of TRIZ:

I. Contradiction Matrix:

This matrix of 39 improving and 39 worsening parameters with each cell entry gives the most inventive principles. This contradiction matrix is simple and the straightest forward of TRIZ tools.

II. Technical Systems:

Anything that executes a task is a technical system. Any technical system can consist of one or more subsystems. A car is self-possessed of the subsystems engine, steering mechanism, brakes and so on. Each of these is also a technical system unto itself (with its own series of subsystems) and each performs its own function. The grading of technical systems spans from the least intricate, with only two elements, to the most intricate with many interrelating elements [4].

III. Levels of Innovation

Exploration of a large number of patents discloses that not every invention is equivalent in its inventive assessment. Altshuller projected five levels of innovation:

Level #1: is simple enhancement of a technical system. They entail knowledge obtainable inside an industry pertinent to that system.

Level #2: inventions consist of the tenacity of a technical inconsistency. They need knowledge from diverse zones within an industry applicable to the system.

Level #3 is an invention covering a purpose of a physical flaw. It necessitates knowledge from additional industries.

Levels #2 & #3 resolve paradoxes, and consequently are pioneering by definition.

Level #4 is development of a new technology. It is industrialized by consuming breakthrough solutions that involves knowledge from altered turfs of science. This fourth level also rallies upon a technical system, but deprived of solving a prevailing technical problem. As an alternative, it mends the function by swapping the original technology with a new technology. For instance a mechanical system is swapped with a chemical system to accomplish the task.

Level #5 involves the unearthing of new phenomena that permits pushing the standing technology to an advanced level.

IV. Ideality:

The objective of any technical system is to deliver some function that helpful to the human being. Therefore, we must build a mechanism or device to deliver this function. TRIZ philosophy states that it is required to deliver such and such a function without introducing a new mechanism or device into the system. The Law of Ideality states that any technical system, throughout its lifetime, tends to become more reliable, simple, effective more ideal. Every time we improve a technical system, we nudge that system closer to Ideality. It costs less, requires less space, wastes less energy, etc. Ideality always reflects the maximum utilization of existing resources, both internal and external to the system.

V. Problem Solving Method:

This four-step problem solving method as shown in figure 4 provide the basis of psychological ideation techniques.

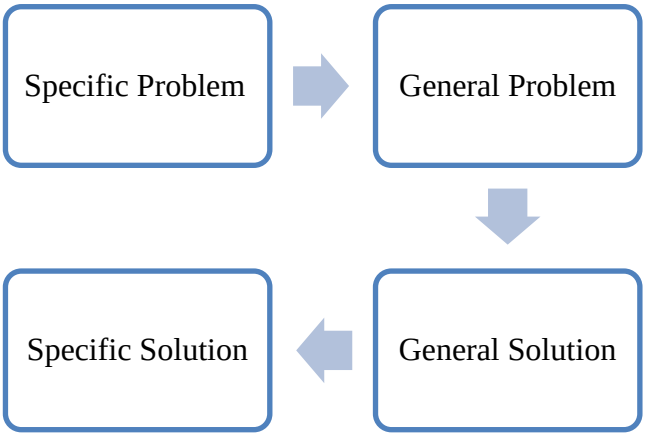

Figure 4. The TRIZ problem solving method

The "General TRIZ Solutions" have been established over the progression of the 60 years of TRIZ study. Some of these are logical methods such as:

- The Ideal Final Result and Ideality,
- Functional Modeling, Analysis and Trimming
- Locating the Zones of Conflict. (This is more familiar to Six Sigma problem solvers as "Root Cause Analysis.")

VI. Contradictions:

An important notion of TRIZ is that inconsistencies should be removed. TRIZ distinguishes two groups of inconsistencies:

- Technical inconsistencies are the classical engineering "trade-offs." In other words, when something gets improved, something else gets inferior.

  Classical examples include:

  - The product gets stronger (good), but the weight increases (bad).
  - The bandwidth for a communication system increases (good), but requires more power (bad).
- Physical flaws, also called "inherent" contradictions, are situations in which one object or system has contradictory, conflicting chucks. Everyday examples abound:

  - Surveillance aircraft should fly fast (to get to the destination), but should fly slowly to collect data directly over the target for long time periods.

- Software should be complex (to have many features), but should be simple (to be easy to learn).

VII. Standards:

Standards are structured rules for the synthesis and reconstruction of technical systems. Once understood and with some experience in their implementation, Standards can help combat many complex problems that regularly occur throughout industry with some common constraints.

Standards provide two functions:

1. Standards help to improve an existing system or synthesize a new one.
2. Standards are the most effective method for providing a graphical model of a problem.

5.3 Problem Solving Techniques:

Five problem solving techniques are described in this section, when faced with a problem, choose one that you feel comfortable with and that best suits the situation.

The following techniques can be used when problem solving in groups or on your own.

1. The Five Whys Technique
2. The PROACT Technique
3. The Creative Technique
4. The Collaboration Technique
5. The Plan, Do, Check, Act Technique

1. Five Whys Technique:

The Five Whys Technique can be used to identify the root cause(s) of a problem. You can use this technique to help determine the reason the problem exists by asking "why" certain things have occurred.

2. PROACT Technique:

The PROACT Technique encourages a thorough problem solving approach. The problem is examined in detail and potential solutions are carefully reviewed before any decisions are made. Answer the questions in each of the steps to work towards a solution.

3. The Creative Technique:

It can be helpful to include a variety of people and ideas in the problem solving process. The Creative Technique uses group work and brainstorming to develop solutions.

4. The Collaboration Technique:

The Collaboration Technique also involves group work, but is more focused on dealing with sensitive issues that involve a variety of people and perspectives. It encourages respect and understanding for everyone involved in a situation.

5. The Plan, Do, Check, Act Technique:

The PDCA Technique is focused on continuous improvement. Rather than solving a problem after it has happened, this technique anticipates how a situation or process can be improved so that problems can be avoided.

PLAN:

• Identify a process or situation that needs to be improved.

• Develop an action plan (solutions) to address it.

DO:

• Carry out the action plan.

CHECK:

• Study the results of carrying out the action plan. What did you learn? Were improvements made?

ACT:

• Make a decision. If the action plan was successful, use it to plan future improvements.

If it was not successful, repeat the cycle and develop a new approach.

The plan–do–check–act cycle (Figure 1) is a four–step model for carrying out change. Just as a circle has no end, the PDCA cycle should be repeated again and again for continuous improvement.

6. Conclusion:

- TRIZ technique can be used to solve systematically all classes of engineering problems faced by industries
- It could be applied to Value Engineering (VE) as well to reduce cost of quality and improve reliability.
- For successful engineer problem solving skill is an important quality which can ne acquired by TRIZ methodology
- Creative problem solving method had proven to be the most efficient and effective mode to solve ill-structured types of problems, compared to ordinary problem solving process, which solely depends on problems solver ability to deal with problems depending on solver's past experiences.
- TRIZ, one of the analytical methods and being knowledge-based systematic methodology of inventive problem solving potentially used in process industry.
- A systematic approach to problem solving makes more efficient and also could result in higher quality solutions.
- Finally, Step wise method was used in formulation of contradiction and for problem resolution which provides clear idea on how TRIZ could be used to solve problem methodologically. Problem formulation which is often known to be the most challenging task was done easily by following the steps, and solution finding seems much more accurate by use of *principles*.
- It would also provide idea on how to modify TRIZ based methods according to ones requirements to fit in particular area and solve the problems efficiently in creative way.

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