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An approach for sustainable innovation: TRIZ

Banu Ozkeser*, R & D Center, Koluman Otomotiv Endustri AS, 33000 Mersin, Turkey.

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Abstract

TRIZ, a Russian acronym for the Theory of Inventive Problem Solving, is an approach for systematic innovation planning. In the Theory of Inventive Problem Solving (TRIZ), the overall aim is the development of an enhanced methodology for a smooth innovation mapping. It is also a way of technology management. The base of TRIZ depends on organisational ecology and sustainability concepts. Should a foundation use this scientific method, then, sustainable innovation can easily occur there. In this paper, conceptualised combinations will be further investigated, tested and applied in subsequent phases and results. The organization of this paper has four major phases. The first part is composed of general terminology, benefits of the method and rules. The second part gives information about the definition of the problem and the details of the way which is used. Concept of the third phase is about the implementation. The results, comments and recommendations form the last phase.

Keywords: TRIZ, sustainability, innovation.

* ADDRESS FOR CORRESPONDENCE: **Banu Ozkeser**, R & D Center, Koluman Otomotiv Endustri AS, 33000 Mersin, Turkey.
E-mail address: banuozkeser@gmail.com / Tel.: +90 324 651 00 20

1. Introduction

Theory of Inventive Problem Solving (TRIZ), a kind of innovation road-map, may be thought as the most well-known scientific methodology for creative thinking. It was originated by the Russian scientist and engineer, Genrich Altshuller. In the early 50s, Mr. Altshuller began a deep study in the world of intellectual properties, especially patents. After searching about nearly 400,000 patent descriptions, he reached his aim which was to find out the certain regularities of creating new inventions. He realised only 2% of all patents were new, which means a newly discovered physical phenomenon, like the first radio receiver or camera. The rest used especially well-known information, however, in a different way of implementation. Hence, in other words, 98% of all new problems can be solved by using previous experience—if such an experience is presented in a certain form (https://triz-journal.com/what-is-triz/, 2018).

In this concept , TRIZ has important advantages than the other methodologies, like the fish-bone diagram, brainstorm etc., in the field of problem-solving, since TRIZ presents a systematic innovation in a creative way. In this methodology, there are main tools and techniques of TRIZ so as to help in solving easily and they are written in main topics and detailed as follows:

The main topics of TRIZ tools are

- Principles (contradictions)
- Effects
- Ideality
- Evolution of the Systems
- Standards (S-fields transformations)
- Algorithm for Inventive Problem Solving (ARIZ)

(Justel, Vidal & Chiner, 2006)

- Principles: They are used to solve the contradictions, i.e., the design trade-offs. (40 inventive principles) Contradictions can be technical or physical:
- Technical contradiction: It occurs when, trying to improve a design aspect (or parameter), another one gets worse. To eliminate the contradiction, the contradiction matrix is used. The input data to enter into the matrix are the contradicting parameters, and the outputs are the inventive principles to eliminate the contradiction (Domb, 1997).
- Physical contradiction: Physical contradictions are those that involve a characteristic that should exist or should be increased because of a reason, and at the same time, should not exist or should be reduced for another reason. In other words, the characteristic is in contradiction with itself. To eliminate the contradiction, the effects and principles are used.
  - Effects: Altshuller (Justel, Vidal & Chiner, 2006) observed that a considerable percentage of solutions apply the advantages of a same known physical effect. These effects can be physical, chemical or geometrical (2,500 effects, which are concepts extracted from the body of engineering and scientific knowledge and used for inventive problem solving)
  - Ideality: From the point of view of ideality, the ideal product can perform its function without existing. No ideal system exists though, and therefore, the objective is to push the system towards an increase in benefits and reduction of cost and other harmful effects of the system (Domb, 1997).
  - Evolution of the Systems: There are a number of generic technology evolution trends that determine the evolution of all technical systems (Eight trends of evolution of technical systems for identifying the directions of technology development) (Mann & Dewulf, 2002).

- Standards (S-fields transformations): Standards are rules for solving commonly occurring inventive problems (76 Standard solutions for solving system problems)
- ARIZ: ARIZ is an acronym for the Russian phrase 'Algorithm for Inventive Problem Solving'; ARIZ is a logical structured process that incrementally evolves a complex problem to a point where it is simple to solve. ARIZ, therefore, is best used for complex problems (Marconi & Works, 1998).

In the literature, regarding TRIZ, the terms 'technical contradiction' (TC) and 'The Law of Ideality', the keys to the TRIZ concept, are the terminologies which are used mostly. A TC represents two contradictory properties in the system. While improving one part or property of a machine (e.g. engine power), on the other hand, this improvement effects another part in a worse way (e.g. weight or fuel consumption). According to TRIZ philosophy, the problem can only be solved if the TC is eliminated after recognised. As a second, the law of ideality means that any technical system, throughout its lifetime, tends to become more reliable, simple, effective—more ideal. Ideality always reflects the maximum utilisation of existing resources. In other words, it can be said that TRIZ also opens up completely new ways of thinking. In this way, the level of creativity/difficulty for classified problems carries much more important so as to reach the solution.

These levels are written below:

- Level one: It is about solving a simple problem by using knowledge easily available. It's not a real innovation case.
- Level two: These problems require knowledge and solutions by an outsource organisation but still easily available within the industry.
- Level three: Solutions require a search outside one industry but still within a particular discipline.
- Level four: Here, new technical systems are created by bringing together solutions from wide boundaries of knowledge (e.g. a mechanical engineering problem solved by applying knowledge from chemistry).
- Level five: This level involves discovery—exciting, sometimes unexpected breakthroughs in science to produce new systems which can be used to meet previously unfulfilled needs (Savransky, 2000).

2. Literature review of TRIZ

The TRIZ background started with Mr. Genrich Saulovich Altshuller, the inventor of this approach and he was born on 15th October 1926 in Tashkent, former Soviet Union and died on 24th September 1998 in Petrozavodsk, Russia.

He was only 17 years old when he made his very first patented invention (scuba diving thermo-retaining apparatus). His passion for inventions led him to pursue a career as a mechanical engineer in the 'Inventions Inspection' department of the Caspian Sea flotilla of the Soviet Navy. His primary responsibility was to assist inventors in filing patents but G. Altshuller himself, in 1946, was a successful young, Jewish inventor and a patent officer (Justel et al., 2006).

In the evolution of TRIZ, three stages can be distinguished: (1946–1985)—Classical, (1984–1992)—Kishinev and (1992–today)—Ideation era.

2.1. Classical era (1946–1980's)

During this period, the conceptual foundation of TRIZ was formulated, and many methods and tools were developed, but not integrated. Also, a large body of engineering knowledge was accumulated. However, all results were produced in a descriptive form appropriate only for the manual use of TRIZ. For this reason, as well as the general state of apathy in the former Soviet Union which resulted in a reluctance to change and resistance to innovation, TRIZ had only limited practical application.

2.2. Kishinev era (1982–1992)

The second period often called the Kishinev Era (1982–1992), started when a number of outstanding pupils, headed by one of them Boris Zlotin, an accomplished inventive problem-solving expert, established, along with Alla Zusman, a TRIZ technical school in Kishinev. This school not only provided various forms of training but also continued research on TRIZ. The school's objective was to integrate the individual TRIZ methods, tools and accumulated knowledge, and to present TRIZ in a form acceptable for an international audience and for computerisation.

2.3. 1992 and beyond—the third period, called the ideation era

The rapid deterioration of the economic situation in the former USSR forced many competent TRIZ specialists to immigrate into the U.S., Israel and other countries and start promoting TRIZ individually. Others found international partners and established TRIZ companies, e.g., as mentioned above, Ideation International Inc.—an American company incorporated in 1992.

3. Material and method

3.1. Information about the company

The company, used the TRIZ approach, is a big-scale one in Turkey. This company, called 'A', has both domestic and international markets around the world. It has a major stand in most of the technology fairs every year. Having more than 1,200 employees let this firm invest in human resources, who form the base of organisational ecology. The R&D and continuous improvement are main factors for sustainable innovation in Company A. Thus, the effort of adapting industry 4.0 makes the Company A be more proactive in solving the problems. All of these technological changes lead the company to go in the way of TRIZ. In other words, TRIZ is the pivot point for this company to gain knowledge. In addition to this, it's a well-known fact that TRIZ is a creative key to forming the innovation map of the company's future.

The Company A also has R&D Center, where this approach is implemented. Undoubtedly, R&D Center, where the new products born like a baby of this foundation, needs this TRIZ approach much more than the other departments. Because the effectiveness of R&D Center has more influence than the rest of the departments in the company. Hence, TRIZ is decided to use in the R&D Center of company A.

This R&D Center, has nearly 60 employees, having different qualifications in different R&D product groups. They used TRIZ in a high-utilisation in implementation. Owing to being a technical and approved centre by the government, technical training have more significance than before. Reporting the activities in the R&D Center periodically to the government makes the team be dynamic. One of these activities is TRIZ training before the implementation. All the members of R&D Center in Company A completed this training regarding TRIZ successfully and earned to get the certificate at the end. Hence, it can also be said that Company A got important benefits from this TRIZ training before starting the implementation.

3.2. Definition of problem

Before getting the TRIZ training, each team member of R&D Center used different approaches based on their experience and qualifications so as to solve problems in an innovative way. Therefore, it's most probably to miss important issues because of not using a scientific approach. For instance; depending on knowledge may be a solution, but not a permanent one.

On the other hand, it's a well-known fact that innovation states meanings as long as it's sustainable. If the innovation projects are separated from each other and it's impossible to make them get together, the projects may have a risk of repeating each other. Hence, a smart history may not be created. After these facts, the sustainability of innovation can be considered in the base of human resources' qualifications.

In R&D Center of Company A, the innovation projects began with the awareness of a problem and following technological developments. However, it's most probably to be unaware of the advantage of starting a sub-project, in the meanwhile, because a scientific method was not used. Especially in big-scale companies, employees start to think that everything is going on the way, no problem occurs and the minor mistakes are in the nature of daily life. As time passes, this perspective is believed by most of the team. At this point, a strategic tool is needed for creativity. In other words, it's time to be aware of the difference between looking and watching.

Consequently, the problem was lying under accepting all the daily activities as if they were perfect. Every time, every point in business life needs to be improved because of dynamism. In the implementation phase, it's explained how TRIZ approach was used. At the end, the results were compared before and after TRIZ.

4. Implementation

The implementation began with TRIZ training. As it's well-known that organisational ecology is the first step in the creativity. The request form was filled with the expectations from the TRIZ and the daily problems by the R&D team. After that, the long-term training was organised, completed successfully and members were certified. Thus, organisational climate got ready for the next step, which is about sustainability. In this implementation, each one of TRIZ 40 principles was used one by one.

Before beginning, each daily problem was listed and the R&D Center members made the list be in the order of priority. The most major one, HVAC especially about ventilation, causing more problems was taken into account as an example of this implementation and TRIZ started to use its 40 principles by solving this ventilation problem.

Principle 1: Segmentation

Principle 2: Taking out

Principle 3: Local quality

Principle 4: Asymmetry

Principle 5: Merging

Principle 6: Universality

Principle 7: Russian dolls

Principle 8: Anti-weight

Principle 9: Preliminary Anti-action

Principle 10: Preliminary action

Principle 11: Beforehand cushioning

Principle 12: Equipotentiality

Principle 13: 'The other way round'

Principle 14: Spheroidality—Curvature

Principle 15: Dynamics

Principle 16: Partial or excessive actions

Principle 17: Another dimension

Principle 18: Mechanical vibration

Principle 19: Periodic action

Principle 20: Continuity of useful action

Principle 21: Skipping

Principle 22: ‘Blessing in disguise’ or ‘Turn lemons into lemonade’

Principle 23: Feedback

Principle 24: 'Intermediary'

Principle 25: Self-service

Principle 26: Copying

Principle 27: Cheap short-living objects

Principle 28: Mechanics substitution

Principle 29: Pneumatics and hydraulics

Principle 30: Flexible shells and thin films

Principle 31: Porous materials

Principle 32: Colour changes

Principle 33: Homogeneity

Principle 34: Discarding and recovering

Principle 35: Parameter changes

Principle 36: Phase transitions

Principle 37: Thermal expansion

Principle 38: Strong oxidants

Principle 39: Inert atmosphere

Principle 40: Composite materials

After the implementation of 40 principles in the R&D Center for an innovative project in ventilation, the results, as follows, are more efficient than the existing situation.

- The ventilation capacity is optimised and sensors are placed for the reducement of CO2 percentage.
- A new industrial design, having no gaps, was studied so as to block the heat loss.
- A new material was used in the base of the ventilation area for keeping the temperature high.
- The capacity of air was optimised after the simulation programme was used in computer-aided design.

Consequently, this study was completed as if the first sample in R&D Center. It formed the background of innovation mapping. In other words, it can be said that a sustainable innovation ecology was founded by means of TRIZ and its 40 principles in the implementation phase.

5. Conclusion and recommendations

TRIZ not only means creative solutions for problem-solving but also let the company, where implementation has been done, guess the future changes which can be made on the product or the features a new product needs to have. The purpose of TRIZ is to enable the team to access important information quickly by organising creative thinking process.

As a team of R&D Center of Company A, research and development activities should widen the idea of sustainability not only into their prototyping processes but also their design process. The idea of increasing the effect of TRIZ by improving useful tools is an excellent idea that corresponds to the Law of Ideality. Researching technology that has become a subject in the implementation of TRIZ principles was used to overcome the design contradictions.

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