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The application of TRIZ to solve the GSC problems in Sobhan oncology pharmaceutical firm

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Abstract

The purpose of this paper is to apply TRIZ for solving the GSC problems in Sobhan oncology pharmaceutical firm. First, a review of the past papers of TRIZ based methods to GSC problem resolution is presented. The TRIZ contradiction matrix tool which was applied to the specific problem brings many benefits e.g.: being rapid acceleration in solving the problem. Moreover provides repeatability, predictability, reliability and also cut costs and times due to its structure. The situation is based on a manufacturing process problem. To recognize, understand, analyze, and solve the problem, the author identifies six steps which are applying Fish bone diagram, illustrating non-existence of optimization, showing the contradiction by classical TRIZ system of contradiction model, Linking the Contradiction, decision and evaluation space, and applying TRIZ contradiction matrix to solve the problem. According to the result of distributive questionnaire the problem is related to ineffective pressing process of one of tablets which is named Flu amid. According to the problem which is technical and has technical contradiction, TRIZ contradiction matrix is chosen. After analyzing the principles, according to comparison of profit and loss, following the principle 35, by changing physical state in process condition could be made to resolve problem. Instead of granule powder, the liquid one can be applied which will be formed in low temperature to solid one. As a result, no wasting time could be happened.

To this end, although TRIZ contradiction matrix provides 39 general parameters to solve technical contradiction (Karimi, 2007), none offers a specific framework which includes details for each parameters.

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Introduction

In the recent years, Chemical Process Industry (CPI), especially the ones related to green issues are experiencing growing pressure to develop new processes or to modify the existing ones .The major challenges are related to the economic, environmental and social sustainability, depletion of resources, increasing demand in terms of quality and quantity of goods and services. There are manifested by the need to limit the emissions, reduce water and energy use, ensure the safe operation of the plants, reduce operation of cost, use low grade raw materials, etc.

Due to the increasing awareness of need for environmental protection among the general public (Ben Moussa et al., 2017), environmental issues have become a challenging topic for organizations involved in supply chain management (SCM).Green Supply Chain Management (GSCM) has emerged as a way to combine environmental management and supply chain management, the additional problem is a need to face these challenges in a much shorter time than previously due to fast changing market conditions. These new circumstance require introduction of new methods and tools for generation of technological and organizational solutions enabling facing of these complex situation ,therefor it is imperative to investigate how problem solving performance can be enhanced through formal structure . The use of methods for systematic enhancement of creativity seems to be an answer to those complex problems.

It has been reported that learning TRIZ increases self-efficacy which is vital for long-term development of problem solving abilities.

TRIZ

The "Theory of Inventive Problem Solving," also known by its Russian acronym TRIZ, was developed by G.Altshuller (Ben Moussa et al., 2017) to propose a framework for the construction of methods to identify and solve problems arising during the evolution of technical systems.

Contemporary descriptions of TRIZ indicate that it extends beyond being merely a theory or a set of principles as its name suggests. TRIZ is a knowledge-based systematic methodology of inventive problem solving (Ilevbare et al., 2013). They described TRIZ as a methodology for the effective development of new [technical] systems, in addition to it being a set of principles that describe how technologies and systems evolve. Also, it has been described by Gadd (2011) as a toolkit consisting of methods which cover all aspects of problem understanding and solving. This toolkit is regarded by some as the most comprehensive, systematically organized for invention and creative thinking methodology known to man (Ilevbare et al., 2013). TRIZ rests on the premise that technology evolution and the way to invention is not a random process, but is predictable and governed by certain laws. It is on analytical logic and a systematic way of thinking. This systematic approach provides an overall structure for the application of the collection of TRIZ tools and techniques.

TRIZ possesses considerable advantage over other methods applied to problem solving and innovation. Methods such as brainstorming, mind mapping, lateral thinking, morphological analysis, etc., have the ability to identify or uncover a problem and its root cause, but lack the capability to actually point out solutions to the problem. On the other hand, TRIZ helps to identify problems and offers direct solutions to them, along with confidence that most (if not all) possible new solutions to the problem have been considered (Ilevbare et al., 2013).

Central to TRIZ is the set of conceptual solutions to technical problems. This set of solutions is a collection of the inventive principles, trends of technical evolution and standard solutions as provided by TRIZ (Ilevbare et al., 2013). To apply any of these

solutions, a specific and factual technical problem is

Reduced to its essentials and stated in a conceptual format. In its conceptual form, the problem can then be matched with one or more of the conceptual solutions. The identified conceptual solution can afterwards be transformed into a specific, factual solution that answers to the original factual problem. This approach is the overview of the TRIZ problems solving process. It is a distinctive feature of TRIZ, distinguishing it from other conventional problem solving methods (e.g. brainstorming) that attempt to find specific factual solutions to factual problems directly.

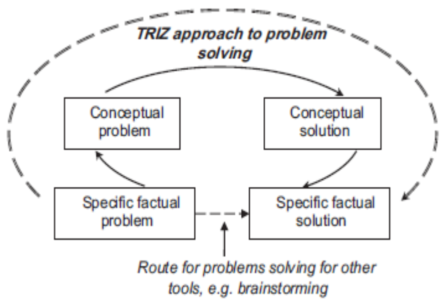

Fig 1. TRIZ systematic approach to problem solving (the TRIZ prism) (Ilevbare et al., 2013).

It has been reported that in order to resolve problems effectively, the problem solver needs to carry out problem finding (Harlim et al., 2015). While TRIZ is well-known for its sound problem solving tools that help to develop creative solutions, Ikovenko suggested that traditional TRIZ tools are not effective in formulating a problem statement and in conducting adequate problem analysis. The on-going evolution of TRIZ tools has catered for this by reshaping TRIZ from being solely focused on solution-generation to a comprehensive set of problem solving tools that also facilitate reliable situation analysis. It is important to explore current tools of TRIZ that can assist in problem finding which can be included as part of the training of engineers.

GSC

Supply chain management is defined by the Council of Supply Chain Management (SCM) Professionals (CSCMP) (2004) as “the planning and management of all activities involved in sourcing and procurement, manufacturing processes, and all logistics management activities, including coordination and collaboration with suppliers, intermediaries, third-party service providers, and customers”.

Due to the intensifying issue of the global environment, the concept of sustainable development is widely accepted, there by contributing to the increasing research on green supply chain management (GSCM) (Zhu and Cote, 2004; Karakayali et al., 2007; El Saadany and Jaber, 2010).

GSCM compels chain members to reconsider many problems, such as inventory decisions, product innovation, returns management, reverse logistics design and coordination between channel players (Bo Li et al., 2016).

GSCM has emerged as an important organizational philosophy in the industrial world that has been recognized and applied by manufacturing companies. It aims to attain corporate profit and market share objectives by reducing environmental risks and impact while improving the ecological efficiency of organizations (Ben Moussa et al., 2017). We adopt Srivastava's definition of GSCM (Ben Moussa et al., 2017) as “integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers and end-of-life management of the product after its useful life".

In fact, the implementation of GSCM requires consideration of many factors, for example, the importance levels of greening activities, financial and non-financial effectiveness, and outcomes/performance (Bo Li et al., 2016).As one of the importance factors of greening activities, green products play an important role in the development of GSCM with regard to decision making processes.

Green supply chain management consists of a wide range of practices classified into three main domains (Srivasta, 2007):

- Green product and packaging design, which aims to improve ecological conditions during the design or product improvement stage

- Green operation (green process design),which explores green procurement, green production/remanufacturing, reverse logistics/waste treatment and green distribution/supply, which is split into green transportation, green storage and distribution network design

- Managerial practices that correspond to a set of strategies and practices aiming to design, coordinate, and manage the operations of the Supply Chain (SC).

The green supply chain concept can aid in evaluating global and systemic environmental footprint reduction (Sarponga et al., 2016). Green supply chain management (GSCM) is a systematic and integrated approach that can help companies to develop 'win-win' strategies resulting in profit and market share objectives achievement and environmental efficiency (Sarponga et al., 2016)

Thus, innovation is the top priority for GSCM, particularly for green products (Lin and Tseng, 2014). Therefore, an increasing number of companies focus on green products and put plans into practice.

GSC innovation and TRIZ

This part aims at exploring the past contributions of TRIZ-based methods to GSC problem resolution. The review is based on crossed research for articles published in the databases « Science Direct » and « Scopus » using following keywords: "green, environmental, supply chain, logistics, TRIZ, innovation". In total, twenty one articles addressed the application of TRIZ methods to GSC problems and were analyzed. According to a first overview of the uses of the TRIZ in GSC problems, the existing attempts primarily focus on green product & packaging design and green production & remanufacturing. The application of the TRIZ in the GSC domains concerns subjects that are similar to the traditional application of TRIZ-based methods, i.e., the design of products and the design of manufacturing processes. Indeed, when considering the design of technical systems, integrating green constraints do not change the fundamental nature of product, packaging, production or remanufacturing design problems. Thus, it is not surprising that a theory and its methods, techniques and tools, which have been largely used for product and process design, can also be used for green design. However, no obvious or straightforward reason that could prevent the TRIZ from being applied to other categories of green operations domains, such as reverse logistics, waste treatment, distribution (i.e., transportation, storage, and distribution network design) or even production flow design, was provided in the literature. This observation leads one to wonder about the possibility or relevancy of using the TRIZ in these categories that are not yet covered by the TRIZ. Nevertheless, when referring to the trials of the TRIZ application in areas other than those for which it was designed, it was often necessary to adjust the tools and methods, even avoid using some of them (Ben Moussa et al., 2017). The author hypothesized that the use of the TRIZ is possible in the areas of GSC mentioned above for which there is not yet feedback; however, they question the degree of change to be made to tools, methods and fundamental concepts of the TRIZ to be applicable to the different inventive problem encountered in GSC.

Research methodology

The situation is based on a manufacturing process problem in a pharmaceutical product manufacturing company. To recognize, understand, analyze, and solve the problem, the author identifies six steps, which are summarized in fig 2:

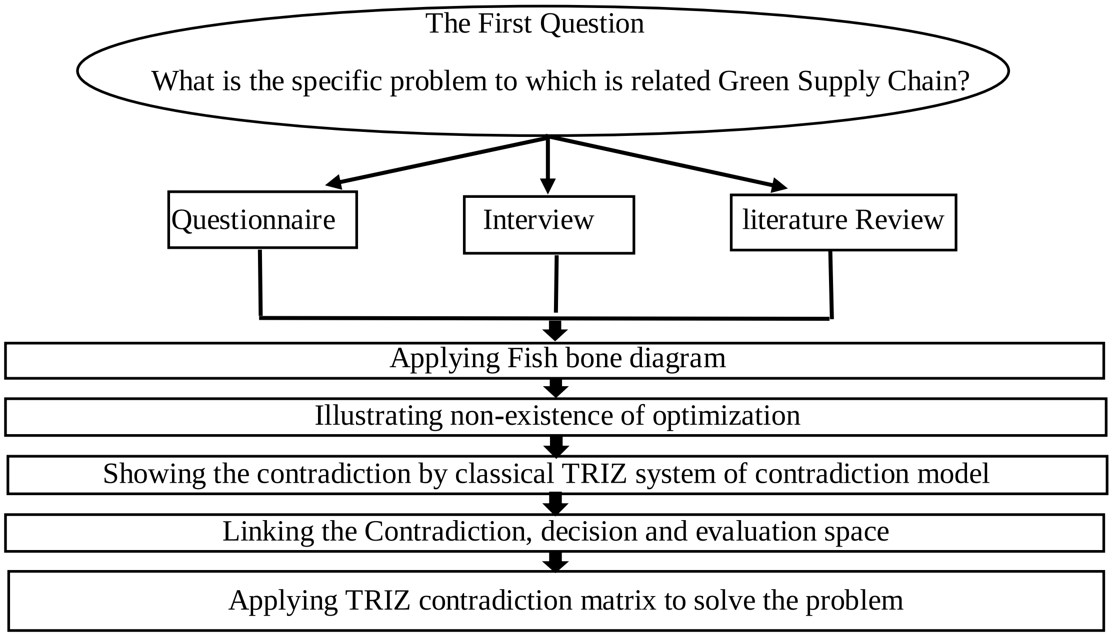

Fig 2. The summary of steps to solve the problem.

Results

These data are collected by the author at Research and Business Development Deputy of Sobhan oncology pharmaceutical firm in Tehran, Iran, by means of a web-based questionnaire which is based on the main question “in your deputy, what’s the specific problem to which is related Green Supply chain? “In response to the question posed, comprised at least 10 members of each level in the organizational chart of firm that were active, covered in the survey. In order to ensure the coverage of the sample, 10 top managers in the Sobhan oncology firm were identified and contacted.

According to the result of distributive questionnaire the problem was related to ineffective pressing process of one of tablets which is named Flu amid.

Applying Fish bone diagram

To analyze the problem, fish bone diagram proposed by Ishikawa were applied, fig 3.

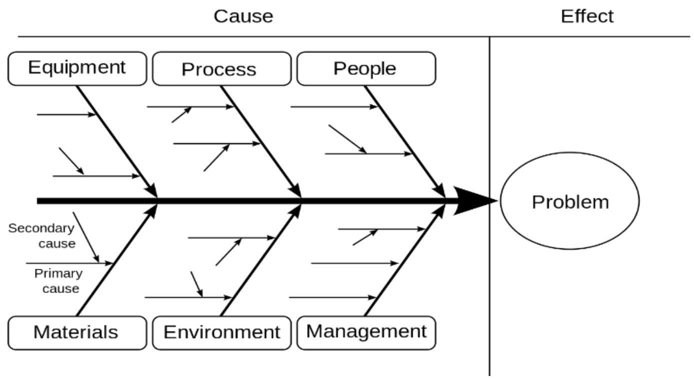

Fig3. Fish bone diagram proposed by Ishikawa (www.latestquality.com).

By applying this diagram the causes can be summarized as follows:

A: People

A-1: None existence of sufficient science

- None existence of sufficient training

A-2: None existence of sufficient experience

- Creating the false activity cycle

A-3: Visually impaired at employees' sight

A-4: Being carelessly during the activity

- Non-existence of attachment to work
- Being tired during the activity

A-5: Not to perform the exact activity which is gave command by immediate superior.

B: Process

B-1: Making incorrect schedule in activity arrangement of process

B-2: Non-existence of quality in sample of the tablet

- : Not to have fundamental information to produce the tablet

C: Material-Equipment

C-1: The Press machine doesn't have sufficient efficiency

- The power of press machine isn't enough
- The die and punch of press machine aren't even
- The die is not clean
- Inability to purchase new or highly efficient press machine
- Inefficiency of buffer in the template of die and punch
- Incorrect calculation in template of die and punch
- Measuring weight of raw materials in the incorrect way for producing granule

D: Management

D-1: Transfer of no experience from superior to employees

D-2: Creation of no motivation among employees

- Performance of no encouragement plans such as bonus or punishment

D-3: Not presenting the feedback to employees

E: Environment

E-1: Not adjusting the temperature at the environment of work

E-2: Humidity increase at the work environmental

After analyzing the all aspects, the main factor which is loss of substance was recognized by the managers and by creating brainstorming.

The loss of substance is accumulated and by causing grimy condition on the die and punch, the productivity of pressing machine will be decreased.

4.2. Illustrating non-existence of optimization

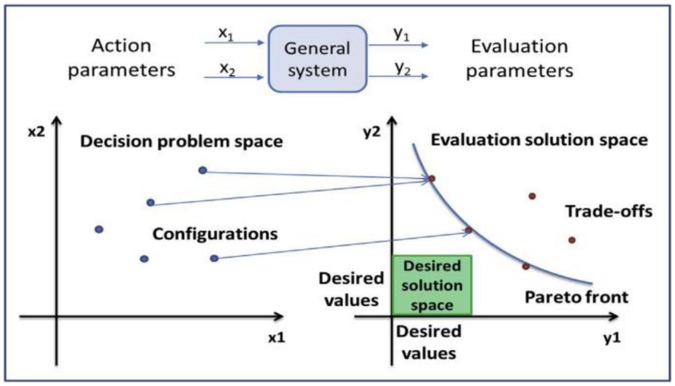

Fig 4. Illustration of search space and optimization problem (Ben Moussa et al., 2017).

Optimization or search problems concerning technical systems are usually described by two types of system parameters. The problem's objectives are described with evaluation parameters, which define the evaluation solution space. In addition, the system variables concerning different system configurations are described by action parameters that define the decision problem space. Thus, any solutions can be described in both evaluation and decision space, and each point of the decision space has a corresponding point in the solution space.Fig.4 illustrates the assertion in the case of a 2-dimensional solution and decision space problem. The goal is defined in the evaluation space by defining the expected range of the value of the evaluation parameters, which defines a desired solution space as a sub-space of the evaluation solution space.

The purpose of the optimization methods is, for a given system model, to determine whether there are points of the decision space with corresponding points in the desired solution space. When, as in Fig. 3, and according to the researches and random sample which are gained by rate of productivity and number of pressing tablets, no correspondence exists in the desired solution space, optimization techniques can be used based on the well-known concept of Pareto dominance, on the Pareto front. The points on the Pareto front represent the best trade-offs toward the desired solution (see also Fig.4). Hence, the purpose of inventive problem-solving methods such as the TRIZ is to go beyond the limit represented by the Pareto front to prompt the evaluation parameters to arrive at a desired value by changing the system model i.e., changing the action parameters, their inter relationships and their possible value range. Once a new model of a system is obtained, a new search or optimization problem, with the same evaluation solution space as previously used, can be stated. Problems in which no correspondence between the desired solution space and the decision space exist for the existing systems are occasionally called engineering design inventive problems.

In this case;

- The desired and unreachable space is in the green part which has specific features such as:

  -Loss of substance is zero

  -Wasting time is zero

- 2 parameters are in the decision problem space:

X2: Showing the number of pressing tablets

X1: Showing productivity of system

On the other hand, 2 parameters are in the evaluation solution space which are:

Y2: Wasting time

Y1: Loss of substance in the pressing machine

The appearance of environmental constraints evolves the optimization problems in the GSC by adding new evaluation parameters. Consequently, the dimensions of both evaluation and desired solution spaces are increasing, and the relationship between the decision space and the solution space is changed, as is the optimization problem. Thus, new trade-offs appear, linked to the new evaluation parameters, and the new problem becomes an inventive problem.

Showing the contradiction by classical TRIZ system of contradiction model

To show the contradiction, classical TRIZ system of contradiction model (Ben Moussa et al., 2017) were stated.

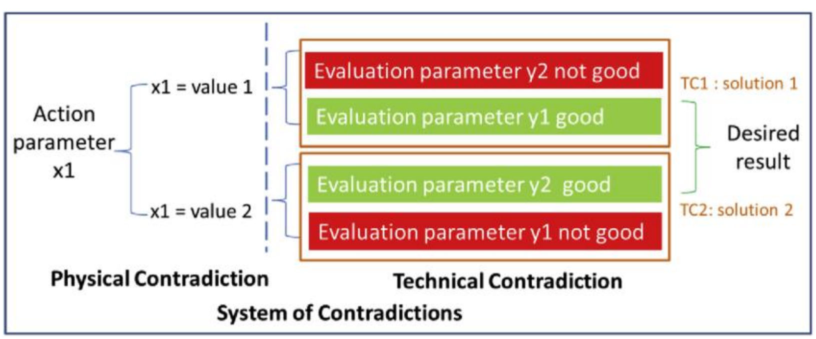

Fig 5. Classical TRIZ system of contradiction model. (Ben Moussa et al., 2017)

The generic system of the contradiction statement that is summarized in Fig. 5 is as follows. Starting with the existing system, to obtain the desired results for evaluation parameters 1 and 2, we should simultaneously assign the action parameter the values of 1 and

2. With the existing system, the goals of the two objectives are mutually exclusive. Note that these contradictions only exist because of the desired result, which itself results from the opportunities, wishes or constraints of the system's environment. If the contradictions are not overcome and the system does not evolve by overcoming the contradiction, the system might disappear

Contradiction, decision and evaluation space were linked.

Link between contradictions, decision and evaluation space

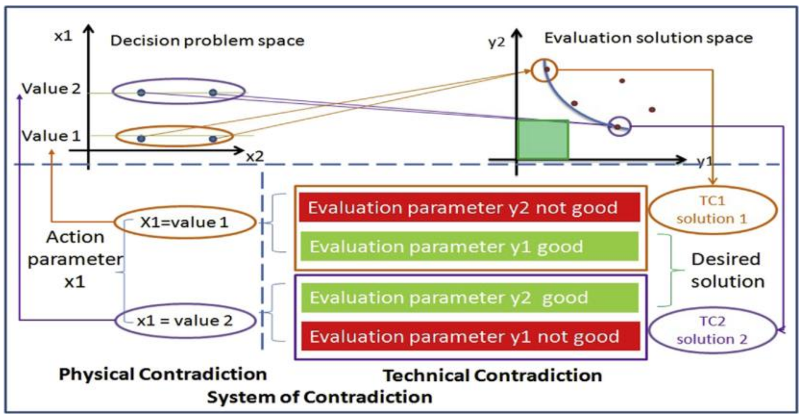

Fig 6. Link between contradictions, decision and evaluation space (Ben Moussa et al., 2017).

There is also a link between the TRIZ model of contradiction and the correspondence model of the optimization or search problem. This link will lead us, in 2.3, to state research questions and hypotheses concerning the use of the TRIZ in GSC.

The desired solution space is in green, and we are faced with an inventive problem because no points of the evaluation space belong to the desired solution space. More precisely, let us focus on the 2 points encircled in orange and purple, which belong to the Pareto front in the evaluation solution space. When comparing these two solutions, one can observe that solution1 is acceptable from the point of view of evaluation parametery1 but not y2, and vice versa for solution2.

This conflict in the evaluation solution space is a limit of the existing system performance expressed by the so-called technical contradictions TC1 and TC2 in the TRIZ.

The TRIZ theory then makes the hypothesis that the conflict between the two parameters in the evaluation space (technical contradictions in TRIZ terminology)can be depicted in the decision space by a conflict between two different values of one action parameter (physical contradiction in TRIZ terminology).

Applying TRIZ contradiction matrix to solve the problem

According to the problem which is technical and has technical contradiction, TRIZ contradiction matrix is chosen. The process should be realized as follows:

Analyzing technical system

All the parts of pressing machine and process of pressing are analyzed by formulating improvement features.

Clarifying technical contradiction

In this case, two features are in conflict:

- Characteristic to be improved: productivity of tablet pressing machine by decreasing or omitting loss of substance.

- Characteristic that deteriorate: loss of times by characteristic 1.

By formulating technical contradiction which must be decreased or omitted, technical contradiction is clarified.

In an ideal situation, the production of high quality flu amid should be realized in a simple process. However, if one tries to improve high quality of flu amid tablet, a very sophisticated procedure is required which would waste process time.

Solving technical contradiction

To solve the problem, TRIZ contradiction matrix is used and the suggested inventive principles are: 10,15,18,35 (Karimi, 2007)

Principle 10 recommends to "Prior Action"

Principle 15 recommends to "Dynamicity"

Principle 18 recommends to "mechanical vibration"

Principle 35 recommends to "transformation of properties"

After analyzing the principles, according to comparison of profit and loss, following the principle 35, by changing physical state in process condition could be made to resolve problem.

Instead of granule powder, the liquid one can be applied which will be formed in low temperature to solid one.

As a result, no wasting time could be happened.

Conclusion

The aim of this paper was to apply TRIZ for solving the GSC problems in Sobhan oncology pharmaceutical firm. According to the articles and in current organizational studies to control the significant increase in pollution a green incentive has started, aiming to moderate the adverse effects of environmental pollution, (mumtaz et al., 2018).

Moreover, innovation is realized as a panacea for organizational survival, (Weixu Ding et al., 2018).

In this research TRIZ technology for innovation was applied through TRIZ innovation roadmaps for GSC problems in Chemical Process Industry (CPI).

The TRIZ contradiction matrix tool which was applied to the specific problem brings many benefits e.g.: being rapid acceleration in solving the problem.

Moreover provides repeatability, predictability, reliability and also cut costs and times due to its structure.

To this end, although TRIZ contradiction matrix provides 39 general parameters to solve technical contradiction (Karimi, 2007), none offers a specific framework which includes details for each parameters e.g.: In this case loss of substance could be classified according to its properties such as its materials and the factors which create this parameter, therefor can be useful to researchers and organization administrators in general fields and problems.

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