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CREATIVE PROBLEM SOLVING TECHNIQUE APPLICATION AREAS OF TRIZ: SUGGESTIONS FOR USE IN HEALTHCARE SECTOR [1]

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Abstract

The aim of the study is to determine the frequency and usage of the TRIZ method, which companies have recently used in order to develop creative solutions to the problems of the sector, and to offer suggestions that will increase the use of TRIZ in the healthcare sector by emphasizing their effectiveness in practice. In the study, two separate literature scans were made. Firstly, academic publications published between 2004-2019 with the main themes of "TRIZ" and "Contradiction Matrix" were scanned through the Web of Science database and a total of 161 publications were reached. Relevant publications have been analyzed by scientific fields and the scope of the study has been expanded a bit to further detail its use in the healthcare sector, and the Google Scholar database has been examined in the second scan. As a result of the study; Although TRIZ is a method used mostly in technical fields, it has been observed that it has been used in the service sector in recent years. As the reason why TRIZ is not widely used in the service sector, it is seen that TRIZ parameters mostly evoke technical fields. In order to benefit from the effectiveness and benefits of TRIZ method in practice, the health services sector is also recommended to harmonize TRIZ methodologies for use in the service sector.

Anahtar Kelimeler: *TRIZ, Contradiction Matrix, Healthcare Industry*

Jel Sınıflandırması: *L23, M1, I19*

YARATICI PROBLEM ÇÖZME TEKNİĞİ TRIZ'İN UYGULAMA ALANLARI: SAĞLIK HİZMETLERİ SEKTÖRÜNDE KULLANIMI İÇİN ÖNERİLER

Özet

Çalışmanın amacı sektörde şirketlerin problemlerine yaratıcı çözümler geliştirmek için son zamanlarda sıklıkla başvurdukları TRIZ yönteminin akademik çalışmalar üzerinden kullanım alan ve sıklıklarını tespit etmek ve uygulamadaki etkinliklerini vurgulayarak sağlık hizmetleri sektöründe TRIZ'in kullanımını artıracak öneriler sunmaktır. Çalışmada iki ayrı literatür taraması yapılmıştır, ilk olarak 2004-2019 yılları arasında "TRIZ" ve "Contradiction Matrix" ana temaları ile yayınlanmış olan akademik yayınlar Web of Science veri tabanı üzerinden taratılarak toplam 161 yayına ulaşılmıştır. İlgili yayınlar bilim alanlarına göre ayrılarak incelenmiş ve sağlık hizmetleri sektöründe kullanımını detaylandırmak için çalışma kapsamı biraz daha genişletilerek ikinci taramada Google Scholar veri tabanı incelemeye alınmıştır. Çalışma sonucunda TRIZ'in çoğunlukla teknik alanlardaki problemleri çözmek için başvurulan bir yöntem olmasının yanında son yıllarda hizmet sektöründe de kullanılmaya başlandığı görüşmüştür. TRIZ'in hizmet sektöründe yaygın

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kullanılmama sebebi olarak, TRIZ parametlerinin çoğunlukla teknik alanları çağrıştırıyor olması görülmüştür. TRIZ yönteminin uygulamadaki etkinliğinden ve faydalarından sağlık hizmetleri sektörünün de yararlanılabilmesi için TRIZ metodolojilerini hizmet sektöründe kullanıma uygun olarak uyumlaştıracak çalışmalar önerilmektedir.

Keywords: *TRIZ, Çelişki Matrisi, Sağlık Endüstrisi*

Jel Classification: *L23, M1, I19,*

1. Introduction

While companies try to keep pace with change and development, they use various strategies and methods to achieve sustainable competitive advantage. In order for their competitive advantage to be sustainable, the methods they have developed must not be easily imitated by their competitors, and for this they benefit from creative problem solving techniques and the impact of the culture of innovation. While companies try to renew their business processes and create an innovative corporate culture, they use creative problem solving techniques to successfully evaluate the opportunities and threats they face. Although it emerged in the 1940s, the impact of TRIZ methodology on innovation has become more and more noticeable lately and nowadays, many large companies are waiting for their employees to implement TRIZ trainings in recruitment processes (Kaya, 2017; Kaya 2018). It has a systematic structure that distinguishes TRIZ methodology from other creative problem solving techniques and makes it special, as well as offering solutions based on contradictions to problems.

Our article consists of 4 parts; The importance of the subject is highlighted in the literature review section presented after the introduction section; Then, our scope of work was presented in the methodology section and the results were presented in the result section with statistical information. In the last section, our analysis results are discussed by interpreting and making inferences and suggestions are presented about the future studies.

2. Literature Review

2.1. TRIZ

The acronym TRIZ, known as Creative Problem Solving Theory, consists of the initials of the words "Teoriya Resheniya Izobreatatelskikh Zadatch". Genrich Saulovich Altshuller, who worked as a patent specialist in the Soviet Union in 1946, was a set of methods that emerged as a result of the fact that the idea put forward as a new invention during the patents examined basically contains similarities (Altshuller, 1999, 2013a, 2013b). Alsthuller expanded his studies and examined about 3 million patents and discovered that basically 40 different solution methods are used to solve the problems. These methods are named as “40 Standard Methods”. According to Altshuller, innovative solutions can be developed using one or more of these methods. TRIZ tools guide the use of these methods. Each cell of the solution matrix, known as the 39X39 Conflict Matrix, directs the decision maker to 40 relevant principles.

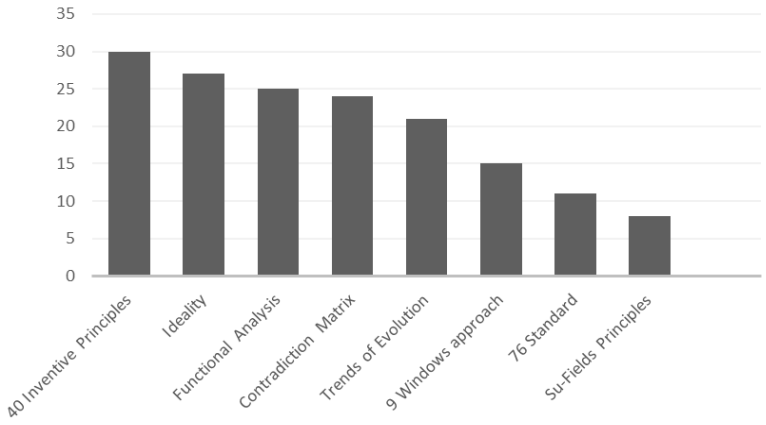
TRIZ philosophy argues that inventions do not develop randomly but are predictable with the combination of certain laws and rules that are systematically studied (Souchkov, 2013). In this respect, TRIZ is also defined as a data set consisting of systematic methods that offer all aspects of understanding and solving problems together (Gadd, 2011). Using TRIZ tools guides the decision maker in developing innovative ideas using the experience of 3 million patent databases.

In an ever-evolving and changing global world, businesses aim to continue their existence and gain superiority in competition. In order to achieve these goals, they have to meet customer expectations and even provide products or services that exceed expectations. In order to respond to the expectations

of customers who expect low cost and high quality of the products or services they receive, businesses are required to design their business processes close to perfection solutions quickly to their problems to follow innovations, and to provide high quality products and services. Considering the impact of this goal of the companies on the ideal, TRIZ's feature that emphasizes creativity and innovation shows that businesses show a relationship with the aim of producing high quality and low-cost ideal products or services (Şener, 2006).

Although there are many TRIZ tools, the most frequently used method is the "40 Principle" method according to the results of the study conducted with 40 TRIZ professionals in various parts of the world (Figure 1) to measure the use of TRIZ in 2013. (Ilevbare, Probert, & Phaal, 2013). Although these methods are mostly used for the solution of problems in technical fields, TRIZ parameters and principles are used in social and commercial fields such as non-technical policy, politics and business management in recent years thanks to their wide scope. (Altuntaş Serkan & Yener, 2012; Ilevbare, Probert, & Phaal, 2013; Leon, 2003; S.-P. Lin, Chen, & Chen, 2012). Thanks to the systematic solution offers offered by TRIZ, anyone who has received this training can produce effective innovative solutions in their field.

Figure 1: Frequency of use of agricultural tools according to the survey results



2.2. Healthcare Industry

The most important feature of the healthcare sector that distinguishes it from other service sectors is that a possible mistake can lead to incapacity, to spend the remaining life of the patient with poor quality and even to the loss of human life. Working with 'zero error', which is one of the basic principles of quality concept, is much more important in the health sector. In addition to providing quality service, it is important to be able to immediately offer a solution to a possible problem and to make quick decisions. For all these reasons, the concept of quality service becomes more and more specialized in the healthcare sector.

Problem solving and innovation management methods play an important role in improving the quality of health. For this reason, almost every method developed in business science has been applied in hospitals that provide a very complex and information-intensive service in a short time, and sometimes these methods have been adapted to the special needs of the hospitals.

3. Data and Methodology

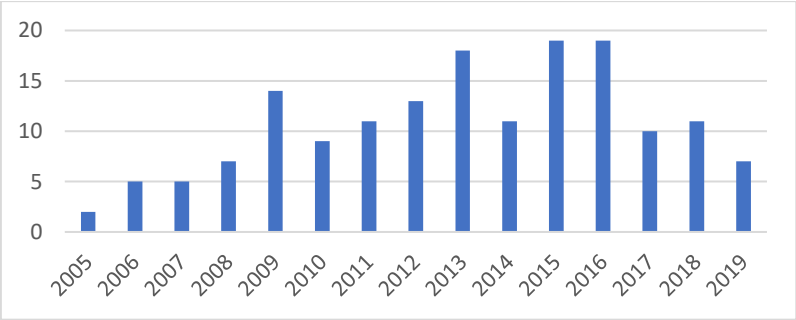
In this study, two interrelated literature reviews were conducted. In the first one, all studies conducted between 2004-2019 have been scanned with the themes "TRIZ" and "Contrudiction matrix" in the Web of Science database. As a result of our search with related constraints, a total of 161 publications

were reached and descriptive analysis was conducted by examining these studies separately. Is TRIZ a method used only in social sciences? Can creative solutions be developed by using TRIZ method in the healthcare sector more particularly in the service sector? question directed us to this research. Secondly, in order to expand the scope of the study and examine the frequency of use in the service industry, studies on TRIZ's use in the service sector between 2004-2019 have been searched and accessed in the Google scholar database with the keywords "TRIZ", "Contradiction Matrix" and "Healthcare". descriptive analysis was made by examining the publications in terms of content. The results obtained were analyzed by years, types of publications, countries and fields of science.

4. Findings and Discussions

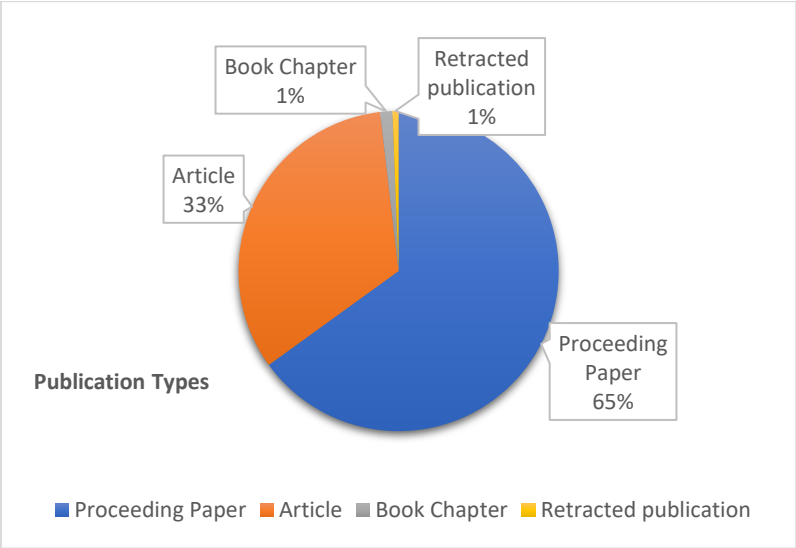
A total of 161 publications published between 2004 and 2019 have been reached with the themes of "TRIZ" and "Contrudiction matrix" in the Web of Science database. When the distribution table of publications by years is examined, it is seen that the studies in this field were published most in 2013, 2015 and 2016 (Figure 2).

Figure 2: Graphs of the number distributions of the studies on "TRIZ" and "Conflict Matrix" between the years of 2004-2019



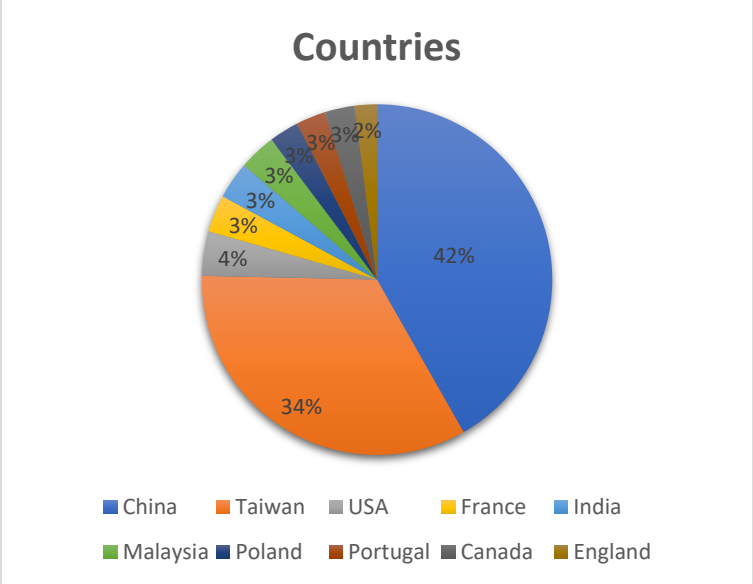
106 of these studies are papers, 54 are articles, 2 are book chapters and 1 is compilation. There is one withdrawn publication. As can be seen from the numbers, 2 publications are presented both as a book chapter and as an article. As seen in Figure 3, when we examine in percentage terms, 65% of the publications in this field are presented as papers.

Figure 3: Publication types distribution chart



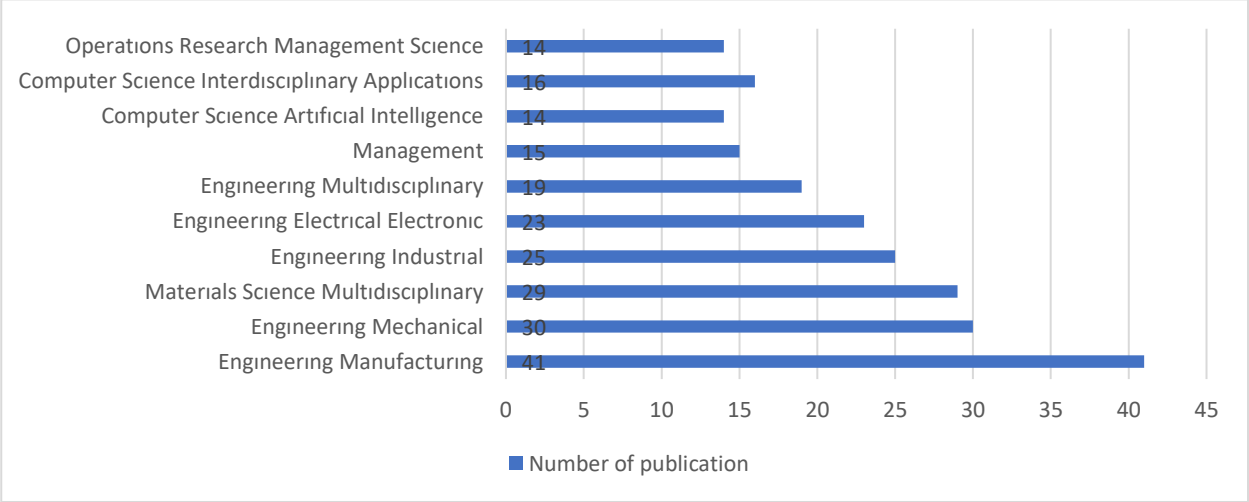
When we examine the countries of the authors who carried out TRIZ studies, it was seen that the studies in the field of TRIZ were mostly done in China and then in Taiwan. Among the relevant years, there are 61 studies from China and 49 from Taiwan. The percentages of these publications are given in figure 4.

Figure 4: Distribution of authors by country



According to the World Intellectual Property Indicators Report (WIPO) published in 2018, the top three countries that submitted the most patent applications were presented as China, USA and Japan. The Chinese patent application shows number superiority in all intellectual property fields, including the patent issued and the living patent. ("Dünya Fikri Haklar Göstergeleri," 2018, "WIPO, 2018 yılı Dünya Fikri Mülkiyet Göstergeleri Raporu," 2018, "Word Intellectual Property Organization," 2018) Considering the impact of TRIZ on innovation and the widespread use of TRIZ in China, it is thought that it may be the subject of a new study whether or not there is TRIZ behind China's patent success.

Figure 5: Number Distributions of Publications by Themes



In Figure 5, "Web of Science" category distributions of related publications on "TRIZ" and "Contradiction matrix" themes are given. 41 of the publications are engineering manufacturing, 30 are engineering mechanical, 29 are materials science multidisciplinary, 25 are engineering industrial, 23 are engineering electrical electronic, 19 are engineering multidisciplinary, 15 are management, 14 are computer science artificial Inrelligence, 16 are in the category of computer science interdisciplinary application, and 14 are in operations research management science. The details of the publications in the relevant categories are listed from the most frequently used to the least used and are given in Table 1 below. Some studies have been addressed in several categories.

Table 1: Distribution of Publications by Themes

CATEGORIES	PUBLICATIONS
Engineering Manufacturing	(Arlitt, Nix, & Stone, 2012a; Bao, Liu, & Bian, 2012; Brockmoeller, Mozgova, & Lachmayer, 2017; Cakir & Cilsal, 2008; H.-T. Chang, Chang, & Yang, 2013; C.-K. Chen, Shie, Wang, & Yu, 2015; J. L. Chen & Chen, 2007; Z. Chen & Tan, 2006; Cherifi, Dubois, Gardoni, & Tairi, 2015; Cherifi, Gardoni, M'Bassegue, Renaud, & Houssin, 2017; Cherifi, M'Bassègue, Gardoni, Houssin, & Renaud, 2019; Coelho, 2009a; Y. L. Cui, He, & Zhang, 2012; Frizziero, Donnici, Caligiana, Liverani, & Francia, 2018; Gao, Wei, Yang, & Liu, 2013; Han, Lv, Yang, & Zeng, 2011; Hsu, Hsu, Hung, & Xiao, 2010; Hu, Su, Chen, & Wei, 2013; Chien-Yi Huang, Lin, & Tsai, 2015; S. Huang, Liu, & Ai, 2017; Y. X. Huang, Kong, & Liu, 2014; Ivashkov, Souchkov, & Dzenisenka, 2005; T. Li, 2010; Lu, Liao, Jiang, & Liu, 2006; L. Ma & Tan, 2006; S. C. Ma, Jia, & Liu, 2010; Ogeya, Coatanea, & Medyna, 2013; Pang, Guo, & Yang, 2012; Su & Su, 2018; Tsai, Shieh, & Chuang, 2011; F. Wang, Yu, & Yao, 2012; G. Wang, Tian, Geng, Evans, & Che, 2016; X. Wang, Lu, & Hong, 2010a; Wirawan & Chandra, 2016a; Wu & Yan, 2013; Xiao & Xin, 2009; C. H. Yeh, Huang, & Yu, 2011; Yen & Chen, 2005; P. Zhang, Zanni-Merk, & Cavallucci, 2017; Zhi-gang Xu & Wen-guang Chen, 2008)
Engineering Mechanical	(Bhatnagar, 2019; W.-C. Chen & Chen, 2018; Y. Chen, 2016; S. Guo et al., 2018; Ishak, Sivakumar, & Mansor, 2018; Lan, Chuang, & Chen, 2018; S. Y. Lin & Wu, 2016; Mastura, Sapuan, Mansor, & Nuraini, 2016; Şen & Baykal, 2019; Y.-H. Wang, Trappey, Hwang, & Chen, 2016; Arlitt, Nix, & Stone, 2012; Cempel, 2013, 2014, C. P. Chang & Lin, 2013, 2014; G. H. Gao, Wei, Yang, & Liu, 2013; Y. X. Huang, Kong, & Liu, 2014; K. Y. Li, 2014; C. L. Xie & Liu, 2012; Coelho, 2009; Duc Truong Pham, Kok Weng Ng, & Mei Choo Ang, 2010; Hsu, Hsu, Hung, & Xiao, 2010; W. X. Li & Wang, 2012; J. Liu, Li, Li, & Wen, 2007; S. Liu, 2012; Cong Da Lu, Liao, Jiang, & Liu, 2006; Qiu, Liu, & Shi, 2010a; Xiao & Xin, 2009a; Zhen, Jiang, Huang, & Liang, 2008; Bao, Liu, & Bian, 2012)
Material Science Multidisciplinary	(Asyraf, Ishak, Sapuan, & Yidris, 2019; C.-P. Chang, Lin, & Lu, 2015; C. P. Chang & Lin, 2014; Chien-Yi Huang, Lin, & Tsai, 2015; Y.-H. Lin, Li, Lu, Chung, & Chen, 2016b; Mansor, Sapuan, Zainudin, Nuraini, & Hambali, 2014; Su & Su, 2018; Wirawan & Chandra, 2016; Yu & Rong, 2015; Arlitt, Nix, & Stone, 2013; C. P. Chang & Lin, 2013; G. H. Gao, Wei, Yang, & Liu, 2013; Hu, Su, Chen, & Wei, 2013; Jou, Lin, Lee, & Yeh, 2013; F. C. Kuang, Wu, & Liu, 2013; K. Y. Li, 2014; Pang, Guo, & Yang, 2012; C. L. Xie & Liu, 2012; Y. De Zhang, Liu, & Yu, 2012; Han, Lv, Yang, & Zeng, 2011; S. M. Li, Zhang, Zhao, & Gong, 2012; S. Liu,

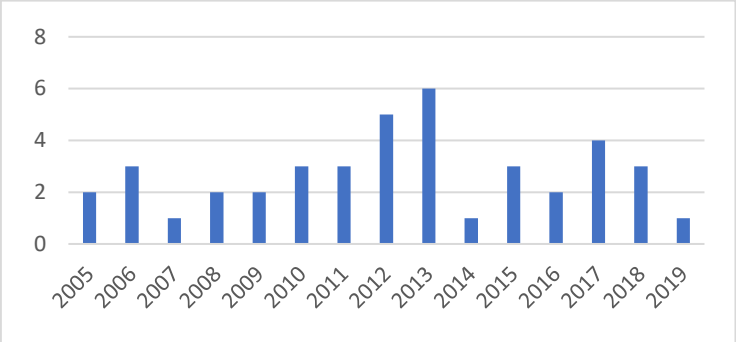
	2012; Congda Lu, Liao, Jiang, & Liu, 2006; S. C. Ma, Jia, & Liu, 2011; Tsai, Shieh, & Chuang, 2012; X. Wang, Lu, & Hong, 2010; Bao et al., 2012; Cempel, 2014)
Engineering Industrıal	(Borgianni & Matt, 2015; Brockmoeller, Mozgova, & Lachmayer, 2017; C.-H. Chen & Huang, 2015; Cherifi, Gardoni, M'Bassegue, Renaud, & Houssin, 2017; Y. X. Huang, Kong, & Liu, 2014; Karnjanasomwong & Thawesaengskulthai, 2015; C.-H. Lee, Zhao, & Lee, 2019; Lim, Park, & Yoon, 2015; C.-H. Wang, 2015; F. Zhang, Yang, & Liu, 2014; H.-T. Chang, Chang, & Yang, 2013; G. Gao, Wei, Yang, & Liu, 2013; P. Jiang, Zhai, Chen, & Tan, 2009; Liang, Tan, Wang, & Li, 2009; S. Liu, Shi, & Zhang, 2009; Lv, Zhang, & Wang, 2013; Ogeya, Coatanea, & Medyna, 2013; C.-S. Wang, Wang, Chang, & Lin, 2009; Y. Yang, Shao, & Tang, 2009; C. H. Yeh, Huang, & Yu, 2011; Ivashkov, Souchkov, & Dzenisenka, 2005; J. Ma, Zhang, Wang, & Luo, 2009; Xiao & Xin, 2009; J. Xie, Tang, & Shao, 2009; Zhang Dong-sheng, Hu Yue, & Yuan Yuan, 2007)
Engineering Electrical Electronic	(Alvarez & Hatakeyama, 2017; Y. Chen, 2016; Chien-Yi Huang, Lin, & Tsai, 2015; Jaisuk & Thawesaengskulthai, 2018; Karnjanasomwong & Thawesaengskulthai, 2015; C.-C. Lin & Chen, 2016; Min, Shanshan, & Yan, 2017; Su & Su, 2018; Vincent & Cavallucci, 2018; Yin & Dai, 2015; C. P. Chang & Lin, 2013, 2014; Daniel & George, 2015; J.-C. Jiang, Sun, & Shie, 2011; K.-Y. Li, 2014; S. M. Li et al., 2012a; Lim, Park, & Yoon, 2015; Lv, Zhang, & Zhang, 2013; Zeng & Su, 2015; T.-S. Li & Huang, 2009; Prasad & Sudha, 2011; Qiu, Liu, & Shi, 2010b)
Engineering Multidisciplinary	(H.-T. Chang, Chang, & Yang, 2013; R.-Y. Chen, 2015; Cherifi, M'Bassègue, Gardoni, Houssin, & Renaud, 2019; Dave, 2017; Ding, Jiang, Ng, & Zhu, 2017; Donnici, Frizziero, Francia, Liverani, & Caligiana, 2018; Howard, Culley, & Dekoninck, 2011; F. Kuang, Wu, & Liu, 2013; H.-S. Lee & Hsieh, 2009; Y.-H. Lin, Li, Lu, Chung, & Chen, 2016a, 2016b; Ogeya, Coatanea, & Medyna, 2013; Shih, Chen, & Li, 2013; D. Yang & Hou, 2007; C. H. Yeh, Huang, & Yu, 2011b; Chi Hao Yeh, Hsieh, & Wu, 2014; Bigand, Deslee, & Yim, 2011; C.-P. Chang et al., 2015)
Management	(Bigand et al., 2011; Cui & Zhang, 2014; Dai, Wang, & Li, 2013; Ching-Yun Huang, Lin, Chang, & Lu, 2017; Ionita, Ionescu, Visan, & Hincu, 2011; Lim, Yun, Park, & Yoon, 2018; M.-S. Liu, 2011; L. Ma, Tan, Zhang, & Zhang, 2006; Morgado, Sandiaes, & Navas, 2019; Shrotriya, Dhir, & Sushil, 2018; Su, Lin, & Chiang, 2008; Wang Shuxia, Guo Haibing, & Jia Yuncheng, 2013; Xiao & Xin, 2009; C.-H. Yeh, Wu, Wu, & Chen, 2007; Zhang Dong-sheng, Hu Yue, & Yuan Yuan, 2007)
Computer Science Artificial Intelligence	(Ang, Ng, Ahmad, & Wahab, 2013; Y.-L. Chang, Lai, & Wang, 2010; Cherifi, M'Bassègue, Gardoni, Houssin, & Renaud, 2019; N. Guo, 2016; J.-C. Jiang et al., 2011; H.-S. Lee & Hsieh, 2009; K.-Y. Li, 2014; S. M. Li, Zhang, Zhao, & Gong, 2012; T.-S. Li & Huang, 2009a; Z.-C. Lin & Chen, 2009; Liu Gequn & Liu Weiguo, 2006; Vincent & Cavallucci, 2018; Yamada, Miura, Hayama, & Kunifuji, 2009)
Computer Science Interdisciplinary Applications	(Cherifi et al., 2019; Ching-Yun Huang, Lin, Chang, & Lu, 2017; Ivashkov, Souchkov, & Dzenisenka, 2005; Lai, Chen, & Hung, 2008; C.-H. Lee et al., 2019; S. Liu, Shi, & Zhang, 2009; J. Ma, Zhang, Wang, & Luo, 2009; Prasad & Sudha, 2011; Shih, Chen, & Li, 2013; C.-H. Wang, 2015; J. Xie, Tang, & Shao, 2009; Y. Yang, Shao, & Tang, 2009; C.-H.

	Yeh, Wu, Lai, & Chen, 2007; Yu & Rong, 2015; F. Zhang, Yang, & Liu, 2014; Cakir & Cilsal, 2008)
Operatıons Research Management Science	(J.-C. Jiang et al., 2011; P. Jiang, Zhai, Chen, & Tan, 2009; T.-S. Li & Huang, 2009; Liang, Tan, Wang, & Li, 2009; Lim, Park, & Yoon, 2015; Liu Guoxin & Lang Kun, 2010; L. Ma, Tan, Zhang, & Zhang, 2006; C.-S. Wang, Wang, Chang, & Lin, 2009; C.-M. Yang, Kao, & Liu, 2010; C.-H. Yeh, Wu, Cheng, & Chen, 2007; C.-H. Yeh, Wu, Lai, & Chen, 2007; D. Zhang, Hu, & Yuan, 2007; Bigand et al., 2011; Cakir & Cilsal, 2008)

4.1. Engineering Manufacturing

In the Engineering Manufacturing category, there are 41 publications published between the relevant years. The distribution of these publications by years is given in Figure 6 below. Although the publications are concentrated in 2012-2013, it is seen that at least 1 study is published every year in the relevant range. 12 of these publications were published as articles, 29 of them were published as Proceedings Paper and 2 of them were published as book chapters. It is seen that there are more publications in the field of Manufacturing Engineering compared to other science fields in which TRIZ was used between the years of 2004-2019. From this, we can conclude that TRIZ is a method used in problem solving in the field of Manufacturing Engineering.

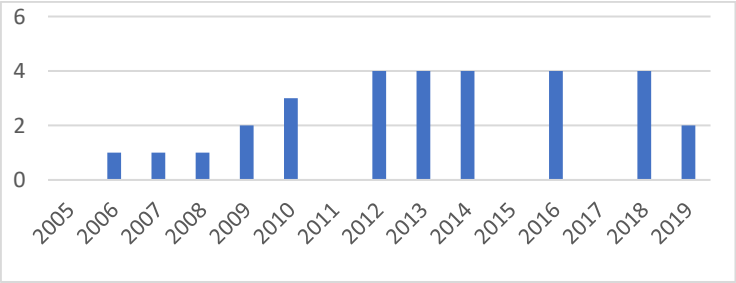
Figure 6: Number distribution of publications in the category of Engineering Manufacturing by year



4.2. Engineering Mechanical

In the engineering mechanical category, there are 30 publications published between 2004-2019. The distribution of these publications by years is given in Figure 7 below. When the chart is examined, there are 4 publications in 2012, 2013, 2014, 2016 and 2018; It is observed that there were no publications in 2005, 2011, 2015 and 2017. The second field in which TRIZ studies published according to the results of the screening with the relevant themes between the relevant years is used the most is the mechanical engineering category. 10 of the publications published in this category are articles, 1 of them is both article and book chapters and 20 of them are papers.

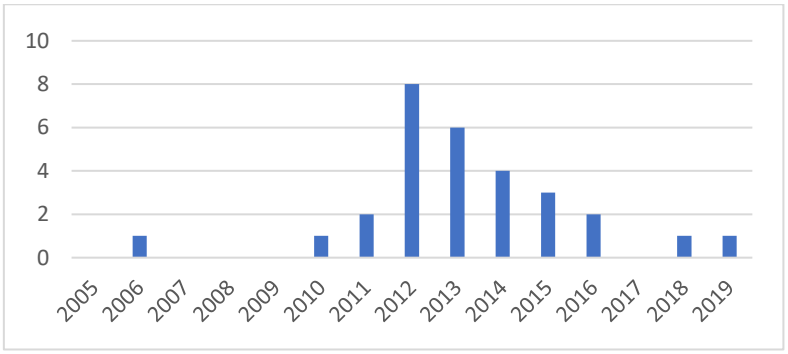
Figure 7: Distribution of publications in the Engineering Mechanical category by years



4.3. Materials Science Multidisciplinary

In the materials science multidisciplinary category, there are 29 publications published between 2004-2009. The distribution of these publications by years is given in Figure 8 below. When we examine the graphic, it is seen that the most publication was published in 2012 and the publication studies were concentrated between 2010 and 2016. Although the third field of TRIZ studies, which was published according to the results of the screening with the relevant themes between the relevant years, is the material science engineering category, it is seen that the studies in this field do not show distribution among the years and are concentrated only between certain years. 5 of the publications published in this category are articles and 24 are papers.

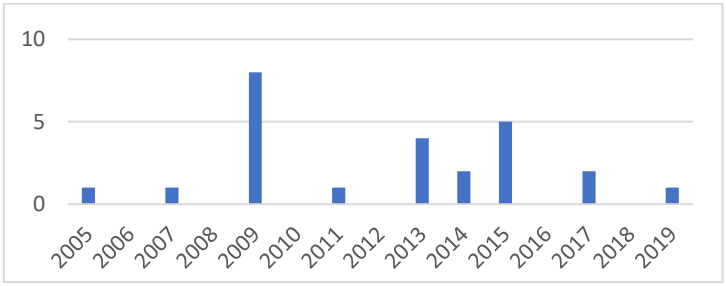
Figure 8: Distribution of publications in the Materials Science Multidisciplinary category by years



4.4. Engineering Industrial

In the Engineering Industrial category, there are 25 publications published between the relevant years. When the graphic of the distribution of these publications by years (Figure 9) is examined, it is seen that the most publication was published in 2009. The second field in which TRIZ studies published according to the results of the screening with the relevant themes between the relevant years is used the most is the mechanical engineering category. Of the 25 publications published in this category, 5 are articles, 1 is both article and book chapters, 19 are papers.

Figure 9: Distribution of publications in the Engineering Industrial category by years

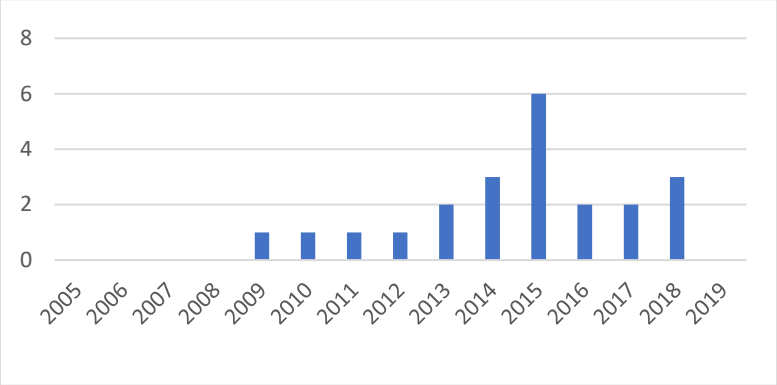


4.5. Engineering Electrical Electronic

In the Engineering Manufacturing category, there are 23 publications published between the relevant years. The distribution of these publications by years is given in Figure 10 below. While the publications were published between 2009-2018, it is seen that the most publications were published in 2015. The 5th field in which the TRIZ studies published according to the results of the screening with the relevant themes between the relevant years was used the most is the electrical electronics engineering category. 3 of the publications published in this field are articles, 19 of them are papers,

1 of them are articles and withdrawn publications. Compared to other fields of science, it is seen that TRIZ was published later in electrical and electronic engineering.

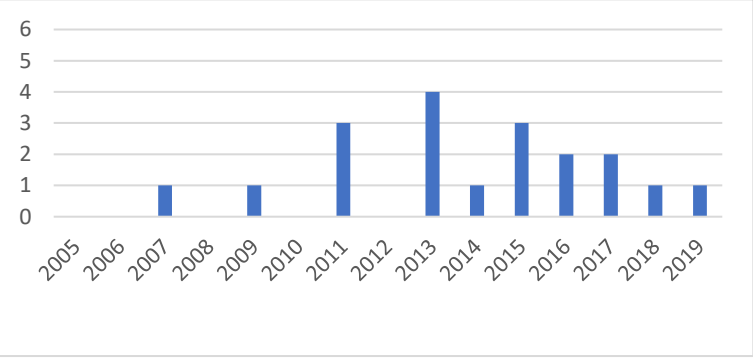
Figure 10: Distribution of publications in the Engineering Electrical Electronic category by years



4.6. Engineering Multidisciplinary

There are 19 publications published in the category of "Engineering Multidisciplinary " between 2004-2019. The distribution of these publications by years is given in Figure 11 below. When the graphic is analyzed, it is seen that the most broadcasts were published in 2013 and then in 2011 and 2015. According to the results of the screening conducted with the relevant themes between the relevant years, it is seen that the 6th field in which TRIZ studies are used the most is the "Engineering Multidisciplinary" field. Of the 16 publications published in this category, 8 are articles and 11 are papers.

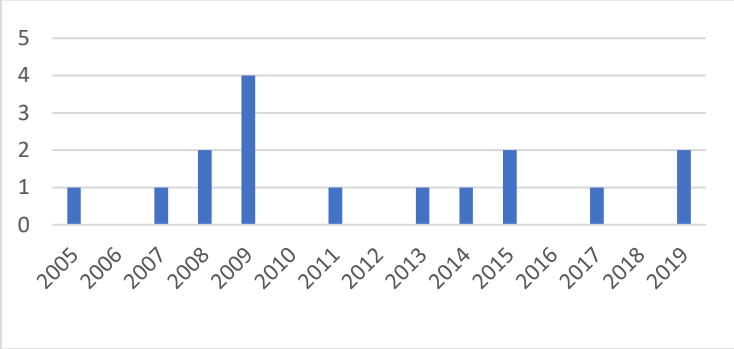
Figure 11: Distribution of publications in the Engineering Multidisciplinary category by years



4.7. Computer Science Interdisciplinary Applications

Computer Science Interdisciplinary Applications engineering category has 16 publications published between 2004-2019. The distribution of these publications by years is given in Figure 12 below. When the graphic is analyzed, it is seen that the most broadcasts were published in 2009 and then in 2011 and 2015. According to the results of the screening made with the relevant themes between the relevant years, it is seen that the 7th field of TRIZ studies published is the Computer Science Interdisciplinary Applications area. Of the 16 publications published in this category, 6 are articles and 10 are papers.

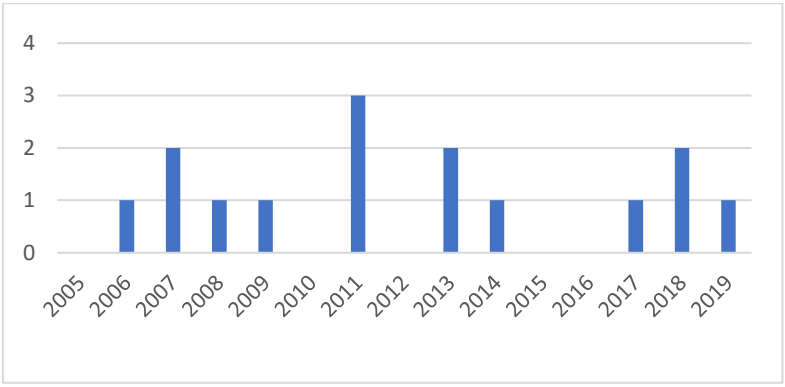
Figure 12: Distribution of publications in the category of "Computer Science Interdisciplinary Applications" by years



4.8. Management

In the management category, there are 15 publications published between 2004-2019. The distribution of these publications by years is given in Figure 13 below. It can be seen that the 8th area where TRIZ studies are published the most according to the results of the screening with the relevant themes between the relevant years is the management area. 5 of the publications published in this field were published as articles, 9 as papers and 1 as both articles and papers.

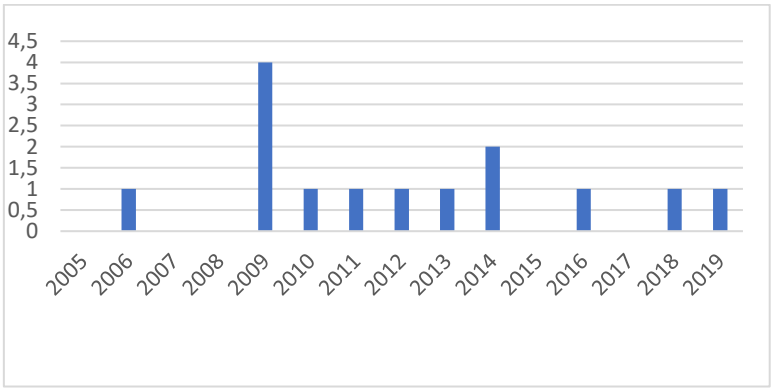
Figure 13: Distribution of publications in the management category by years



4.9. Computer Science Artificial Intelligence

There are 14 publications published between 2004-2019 in the category of Computer Science Artificial Intelligence. The distribution of these publications by years is given in Figure 14 below. When the graphic is analyzed, it is seen that the most broadcasts were published in 2009 and then in 2011 and 2015. According to the results of the screening made with the relevant themes between the relevant years, it is seen that the 8th area in which TRIZ studies are used most frequently is the Computer Science Artificial Intelligence area. 4 of the publications published in this field are articles and 10 of them are papers, one of the articles is a withdrawn publication.

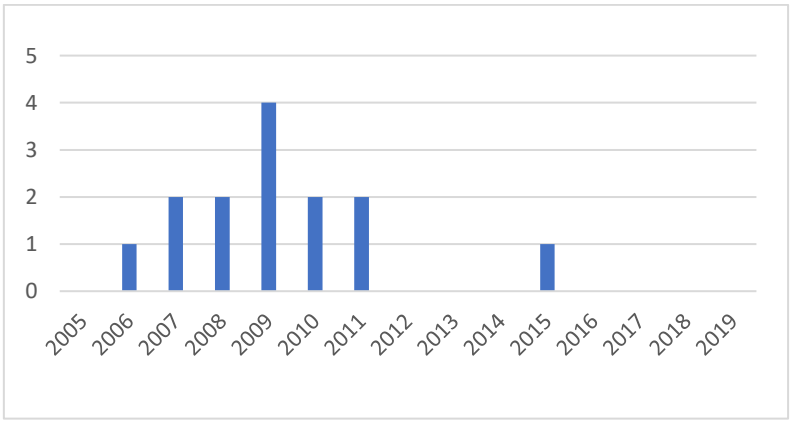
Figure 14: Distribution of publications in the category of "Computer Science Artificial Intelligence" by years



4.10. Operations Research Management Science

There are 14 publications published between 2004-2019 in the category of Operations Research Management Science. The distribution graph of these publications by years is given in Figure 15 below. It is seen that there are no studies published in this field in recent years, when publications concentrated between 2006-2011. It is seen that the 8th field in which TRIZ studies published according to the results of the screening with the relevant themes between the relevant years was used the most was Operations Research Management Science. 4 of the publications published in this field are articles, 10 of them are papers, 1 of the articles is withdrawn publications.

Figure 15: Distribution of publications in the category "Operations Research Management Science" by years



4.11. Use of TRIZ in the Healthcare Industry

In the first stage of our literature review, when we distinguish the publications examined on the "Web of Science" according to their fields of science, it is seen that there are mostly engineering science, that is, technical fields. In addition, there are 15 studies published in management science, that is, in the field of social sciences. In this respect, is TRIZ a method used only in social sciences? Can creative solutions be developed especially in the service sector by using TRIZ method in the health sector? question led us to a new research. In the second stage of the literature review, in addition to the studies in the database of "Web of Science", TRIZ in the service sector by searching "TRIZ", "contradiction matrix" and "healthcare" constraints in the same year interval (2004-2019). Studies using 'have been identified (Borgianni & Matt, 2015; Chiou, 2014; Chun Chiou, Ju Liu, & Tsai, 2012; Endsley, 2010; Gazem & Rahman, 2014; LariSemnani, Mohebbi Far, Shalipoor, & Mohseni, 2015; S.-P. Lin, Chen,

& Chen, 2012, 2012; H. L. Yang & Hsiao, 2009). While some of the related studies tried to use the existing TRIZ matrices and methods, some tried to harmonize the matrices for use in the service industry. The studies emphasized that TRIZ is used systematically to develop innovative solutions in the fields of engineering and management, as well as very few studies that implement TRIZ in improving the quality of health care (Chiou, 2014; Guner, 2020; S.-P. Lin et al., 2012; H. L. Yang & Hsiao, 2009).

In the 2009 study, they tried to solve the problems they detected through the existing TRIZ matrix and as a result; The introduction of TRIZ to innovative service development is just the beginning They stated that they are at the stage, and that additional research is needed to match the parameters of conflict matrices and creative principles to service concepts. (H. L. Yang & Hsiao, 2009). In the study carried out in 2014; It was emphasized that TRIZ can also be used to deal with problems in the field of service development. (Chiou, 2014). In addition to these studies, there are also studies that make matrix harmonization studies specific to the healthcare sector and develop innovative solutions to their problems with the matrices they recommend. (Altuntaş & Yener, 2012; S.-P. Lin et al., 2012; Guner, 2019).

According to the results of their study, Shu-Ping et al. It was emphasized that the use of TRIZ in studies to improve health service quality will be a guide in decision making (S.-P. Lin et al., 2012). In this study, Parasuraman (Parasuraman et al., 1985) and their friends aimed to develop a new matrix by matching the service quality parameters with TRIZ parameters to determine the themes to be improved in the service sector. It is not mentioned in detail in the study what this matching is made or how it is tested. This match While they match some parameters with 1 and some parameters with 2 TRIZ parameters, they could not offer a complete matrix suggestion. In addition, by interpreting the principles of 40 principles guided by their matching, in general, not problem-specific they tried to develop a solution proposal. The basic usage principle of TRIZ is by separating each problem into parameters and into the TRIZ matrix to place and to try to improve the solutions offered by the matrix at the intersection cell by examining them in relation to the specific problem. The basic usage principle of TRIZ is to place each problem into parameters by placing it in the TRIZ matrix and trying to develop it by examining the solution suggestions offered by the matrix in the intersection cell.

Also in another study conducted by Altuntaş and Yener (Altuntaş & Yener, 2012) in 2012; 10 service quality dimensions proposed by Parasuraman were discussed. These 10 service quality were matched with TRIZ parameters and 10 experts were asked if they participated in this matching. Since 2 matches were not approved by half of the experts, they were discarded and a new matrix was introduced with the remaining 8 matches. However, in this study, it was not based on an explanation of what they did in the first match and the experts were asked only their opinions against "1" matching. In this study, it is thought that if more than 1 parameter was presented to the experts for each mapping, a TRIZ parameter could be found against 2 dimensions excluded, thus the matrix could be more extensive.

In the study carried out in 2019, firstly Parasuraman (Parasuraman et al., 1985) and friends' service sector quality criteria and parameters in the contradiction matrix of TRIZ were matched with AHP method and 16x16 matrix was obtained in line with the opinions of experts. Then, a problem pool was created with brainstorming with experts in the health sector, and the problems obtained were eliminated, and technical and systemic problems suitable for TRIZ were selected. During the solution of these problems, the features of the 16x16 matrix proposed as a result of the study have been identified and solutions have been developed. Although this study is set out with a matrix and methodology proposal suitable for use in the service sector, it offers solutions to problems with technical dimensions in the service sector. It is recommended to emphasize the effectiveness of the proposed matrix by using it to solve non-technical problems in the service sector.

5. Conclusion

While companies try to keep pace with change and development, they use various strategies and methods to achieve sustainable competitive advantage. For their competitive advantage to be sustainable, the methods they have developed must not be easily imitated by their competitors, and for this, they benefit from creative problem-solving techniques and the impact of the culture of innovation. While companies try to renew their business processes and create an innovative corporate culture, they also use creative problem-solving techniques to successfully evaluate the opportunities and threats they face. Although it emerged in the 1940s, the impact of TRIZ methodology on innovation has started to become more noticeable lately and nowadays, many large companies are waiting for their employees to implement TRIZ training in recruitment. It has a systematic structure that distinguishes TRIZ methodology from other creative problem-solving techniques and makes it special, as well as offering solutions based on contradictions to problems. As a result of the comprehensive literature review we conducted in the first part of our study, the studies carried out under the themes of "TRIZ" and "Contradiction Matrix" between 2004-2019 were examined and it was seen that the TRIZ method was mostly used in technical fields. While the studies in the technical fields constitute 90.7% of all publications in the related years, the studies in the management field constitute 9.3%. When we examine the studies conducted in the field of management, it has been determined that the importance of its use in the service sector and more particularly in the health care sector in recent years has been emphasized and there are few studies compared to the technical fields. According to the results obtained from the literature review in the second part of the study; While some of the related studies in the health care sector tried to use the existing TRIZ matrices and methods, some were trying to harmonize the matrices for use in the service sector. As the reason why TRIZ is not used widely in the service sector, it is observed that the parameters of the most used TRIZ methods, "40 Principles" and "39X39 contradiction matrix" mostly evoke technical fields. Also; TRIZ tools and methods can be used as a creative problem-solving technique in the service sector. However, it has been observed that the basic TRIZ matrix and its parameters should be adapted to be suitable for use in the service sector, to obtain more efficient results and develop them for everyone. In addition, larger examples need to be examined to review matrix development studies in the service sector so far and to confirm the effectiveness of the results proposed in these studies.

The most important limitation of this study is focusing only on the data in the Web of Science database. In new studies to be conducted within this framework, it is recommended to increase the number of databases and conduct an investigation. In addition to the literature studies to be carried out in the future, it is recommended to carry out studies that will facilitate and expand the use of TRIZ in the service sector, and it is believed that these studies will make serious contributions to both the industry and the academy.

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