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I. Ishrat1, M. Hasan, etc./Int. J. Systematic Innovation, 7(7),12-46(2023)

# Unraveling the structure and trends of TRIZ approach in business and management: Bibliometric synthesis and future research directions

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## Abstract

The present study aims to bridge the gap and offer guidance for individuals without technical training to comprehend and utilize the Theory of Inventive Problem Solving (TRIZ) in the realm of business and management. It provides a comprehensive overview of TRIZ methodology, its evolution, and how it has been adapted to address managerial issues. Additionally, the paper explores the prospects of TRIZ in business and management problem-solving domains. This review will facilitate the distinction between technical and non-technical creative TRIZ applications, empowering policymakers to make informed decisions. Bibliometric analysis methodologies are incorporated in the study using 253 publications obtained from the Scopus bibliometric search following a keyword protocol. Bibliometrix-R and VOSviewer software have been used for the intellectual analysis of top contributors, co-authorship, and citation analysis. A bibliometric review followed a detailed literature review, including other relevant articles, which further provided the theoretical background, focus areas, research gaps, and future research directions. Few TRIZ studies on non-technical core business problems focus more on the technical context. Company-based research on how different companies have used TRIZ and the type of strategy making the TRIZ methodology is also unclear. Previous researchers have studied management areas such as brand management, marketing segmentation, human resource retention, and product portfolio through the lens of TRIZ. However, financial aspects such as portfolio management, risk management, and strategic areas such as pricing policies have not received attention. The originality of this paper lies in the fact that it is the first bibliometric review of TRIZ literature in the field of business management, as well as the first attempt to review TRIZ to solve and manage non-technical problems. The paper highlights the need for more research on core business problems, financial aspects such as portfolio and risk management, and strategic areas such as pricing policies.

**Keywords:** TRIZ, bibliometric, business and management

## 1. Introduction

Genrich Saulovich Altshuller originally gave TRIZ, or Inventive problem-solving theory, in the soviet union in 1946 (Dung, 1995; Souchkov & Sutcliffe, 2007) as a problem-solving tool, particularly in the field of engineering; engineers developed TRIZ for engineers only. The theory emerges from investigating and evaluating over two lakh patents to formulate 40 specific principles used as solutions to most engineering problems (Stratton & Mann, 2003). Problems and solutions are replicated across industries according to TRIZ theory, as are patterns of technical evolution. In formulating inventive solutions, effects, and solutions from one industry are used to eliminate other industries' problems by following the process of abstraction (Jones et al., 2001). With its unique application style, the theory is a successful yet robust problem-solving tool for developing novel ideas and inventions. Many companies worldwide, including Samsung, Proctor and Gamble, Ford Motors, and Mitsubishi, have recognized TRIZ as the most effective problem-solving methodology (Ilevbare et al., 2013a; Souchkov & Sutcliffe, 2007). Due to its encouraging results, TRIZ has started applying in the business and management field for several years to solve non-technical problems. Darrel Mann's book "Hands-on systematic innovation for Business and Management" (D. L. Mann, 2002) and many of his published research papers cited in this study have also

promoted the TRIZ methodology in the business and management fields.

However, classical TRIZ focuses on identifying contradictions within a system or problem within the system that may be causing or exacerbating the problem and finding innovative solutions that eliminate those contradictions. A contradiction is a situation where two opposing forces work within a system, such as the need for speed vs. the need for accuracy. BusinessTRIZ, on the other hand, is a specific application of TRIZ principles to business problems. It involves using TRIZ methodology to identify and solve complex business problems, such as improving efficiency, reducing costs, and increasing revenue. The main difference between TRIZ and BusinessTRIZ is the focus of the methodology. TRIZ is a general problem-solving methodology that can be applied to various fields, including engineering, science, and even art. BusinessTRIZ, on the other hand, is a specific application of TRIZ to business problems. In addition, BusinessTRIZ often involves using specific tools and techniques tailored to the business environment, such as value stream mapping, process optimization, and lean management. While TRIZ and BusinessTRIZ share similarities in their problem-solving approach, they differ in their specific focus and application.

Previous review articles on TRIZ have predominantly focused on its technical applications and integration with other tools for process improvement. For example, (Sojka & Lepšík, 2020) conducted a literature review that specifically examined using TRIZ and other tools for process improvement. Their review provided a year-wise analysis, showcasing the different combinations of TRIZ with other tools. Similarly, (Chechurin & Borgianni, 2016) took a different approach by reviewing other review papers to explore the scientific literature about TRIZ. They aimed to assess whether the questions posed in those reviews were adequately addressed. While their focus was also on the technical aspects of TRIZ, their study contributed to understanding the existing literature and identifying any gaps or unresolved questions.

To understand the benefits and challenges associated with TRIZ, (Ilevbare et al., 2013b) conducted a review to identify these factors through surveys and collecting first-hand information. Although their study provided valuable insights into the practical aspects of TRIZ, it did not specifically address the application of TRIZ in the business and management domain. Furthermore, (Hua et al., 2006) conducted a literature review from 1995 to 2006 to explore the integration of TRIZ with other creativity tools, methods, and philosophies. Their focus was again on the technical aspects of TRIZ and how it could be combined with different approaches to enhance problem-solving.

Despite these previous review articles, there remains a gap in the literature regarding comprehending TRIZ theory from a business and management perspective. None of the reviewed papers or other existing review articles has specifically delved into understanding TRIZ with a business and management focus or without a technical orientation. Therefore, the present study aims to fill this gap and outline how individuals without technical training can comprehend and engage with the theory of inventive problem-solving (TRIZ) in business and management.

## Existing research context

Quality Function Deployment (QFD), Six Sigma, Product Development, Product Design, Project Management, Decision-making, Conceptual Design, Ecodesign, and Eco-Innovation are all areas of research and practice that are important in business and management. However, these are technical areas of business. Each area contributes to the overall process of creating and delivering products and services that meet customer needs and add value to the organization.

**Table 1.** Existing research context of TRIZ as per literature base

| Context | References |
|---|---|
| Quality Function Deployment (QFD) | (Putri et al., 2018); (S. Kim & Yoon, 2012); (Chang, 2012); (Tursch et al., 2015); (Hsia et al., 2015); (Shanmugaraja et al., 2012); (Brad, 2009); (Shanmugaraja et al., 2013); (Ferryanto, 2015); (D. Lee et al., 2020) |
| Six Sigma | (Shanmugaraja et al., 2013); (Soti et al., 2012b); (Shanmugaraja et al., 2012); (Ferryanto, 2015); (D. Lee et al., 2020); (Soti et al., 2012a); (K. Yang, 2005); (Abu Bakar et al., 2015); (Karnjanasomwong & Thawesaengskulthai, 2019); (Gitlow et al., 2013); (Muruganantham et al., 2013); (Muruganantham et al., 2014) |
| Product Development | (Amang) Kim, 2018); (Russo et al., 2011); (F. Y. Zhang & Xu, 2007); (Akmal et al., 2018); (Guo et al., 2020); (Hua et al., 2007); (Da Silva et al., 2020); (Tursch et al., 2015); (Ferryanto, 2015) |
| Product Design | (Hsieh et al., 2016); (Bigand et al., 2011); (C. M. Yang et al., 2010); (C. J. Yang & Chen, 2011a); (Mansor et al., 2017); (OuYang & Weng, 2011); (Shahin et al., 2013); (Kandukuri et al., 2021) |
| Project Management | (Nassar & AbouRizk, 2016); (Monteiro, 2012); (Gazem et al., 2018) |
| Decision-making | (Karaulova & Bashkite, 2016); (Nikulin et al., 2018) |
| Conceptual Design | (Moehrle & Paetz, 2014); (Ai et al., 2020); (J. Zhang et al., 2005); (Cao & Tan, 2007); (Sakao, 2007a); (Wu et al., 2021) |
| Eco-design | (Negny et al., 2012); (Vidal et al., 2015); (Tsai et al., 2011); (C. J. Yang & Chen, 2011a); (Russo et al., 2014); (Russo & Birolini, 2012); (Spreafico, 2021) |
| Eco-Innovation | (Negny et al., 2012); (Vidal et al., 2015); (Tsai et al., 2011); (Jones et al., 2001); (de Jesus Pacheco et al., 2019) |

***Source:*** *Authors' interpretation*

D. Mann et al. (2000a) outline TRIZ's application to non-technical issues. He believes TRIZ can define or resolve issues in non-technical sectors like business and management. The application of TRIZ to aid businesses in surviving in the E-business space is discussed by D. Mann et al. (2001). Ruchti et al. (2002) conclude that TRIZ can be very helpful for making better business decisions. D. Mann et al. (2002) describe a new Contradiction matrix aimed at using TRIZ in business (See section 4).

TRIZ was primarily created to create products, but it has since begun to be adapted for the development of processes. The majority of research is therefore based on functional business areas, either technical or operational. Therefore, this research aims to provide a comprehensive guide demonstrating TRIZ interventions in business and management. As a result, using bibliometric analysis and subsequent in-depth review, the study offers a brief outline of how TRIZ evolved from being an engineering subject to a management subject. The study aims to demonstrate why more research is needed in the context of non-technical areas of businesses and organizations. This is because most papers have focused on the operational aspects of business, which are entirely technical.

**RQ1**: What are the current publication and citation trends in TRIZ in the business and management field?

**RQ2:** What are the most influential TRIZ articles and publication outlets (Journals) in business and management?

**RQ3:** Which are the most prominent authors and countries in the domain of TRIZ in the business and management field?

**RQ4:** What are the trending and futuristic research topics within the TRIZ research in the business and management discipline?

**RQ5:** What are the key highlights of TRIZ in a non-technical context? (Business TRIZ, application areas, tools)

## 2. Review Methodology

Synthesizing existing research is vital for expanding the corpus of knowledge (Arora & Chakraborty, 2021). Such scholarly work follows a systematic and objective approach, usually called a

'systematic literature review' (Kraus et al., 2020). Snyder (2019) stated that a systematic literature review could "serve as a basis for knowledge development, create guidelines for policy and practice, provide evidence of an effect, and, if well conducted, have the capacity to engender new ideas and directions for a particular field" (p. 339). These works also help academics to map out new research avenues for the future by taking stock of the past literature (Bacq et al., 2021). Academics who have excelled in review methods (Palmatier et al., 2018; Paul et al., 2021; Paul & Criado, 2020) have categorised several variants of domain-based (concept, context, discipline, field, outlet) (Kraus et al., 2022) systematic reviews, namely, framework-based reviews, structured theme-based reviews, bibliometric variant, hybrid reviews, and conceptual reviews, etc. (W. M. Lim et al., 2022).

A bibliometric variant of systematic literature reviews is employed for quantitatively evaluating scientific research objectively and visually presenting it (Donthu et al., 2021). It effectively maps structural and dynamic aspects of scientific research, explaining how a given subject has developed from its origins in a particular domain (Cobo et al., 2011). Two primary analytical approaches are frequently used in bibliometric analysis, namely, (1) Performance analysis, an evaluative technique for measuring productivity and impact, and (2) science mapping, a relational technique for unraveling intellectual structure (Mukherjee et al., 2022).

## 2.1 Review procedure

This review examines the performance and science (intellectual structure) of the research domain of the employment of TRIZ methodology in business and management discipline. To endow a structure in our review, we follow and adopt the framework implemented by Tiwary et al. (2021) [See Fig. 1]. We utilised Scopus and WOS databases for the literature search as these two databases cover most of the quality peer-reviewed journals in business and management (Bramer et al., 2017). We used all possible keywords related to 'TRIZ' and the boolean protocol to search the relevant literature in the purview (See Table 2). In the first level search, 4118 articles were found collectively from both databases (Scopus & WOS). After that, several filters were applied to the dataset, including document type, subject type, and language filter (English only) (See Fig. 1). The application of filters and then the removal of duplicates led to the final dataset, comprising 253 peer-reviewed journal articles.

Several bibliometric techniques like performance analysis, co-word analysis, and enrichment technique (visualisation) were applied to the retrieved dataset (Mukherjee et al., 2022). These analyses were performed using software recommended by (Donthu et al., 2021), i.e., bibliometrix-R (Aria & Cuccurullo, 2017) and Vosviewer (van Eck & Waltman, 2010).

**Table 2.** Keywords used for extracting articles

| Search keywords | Articles (final corpus) | |
|---|---|---|
| "TRIZ" OR "Business TRIZ" OR "BusinessTRIZ" | WOS | Scopus |
| | 18 | 235 |

***Source:*** *Authors' interpretation*

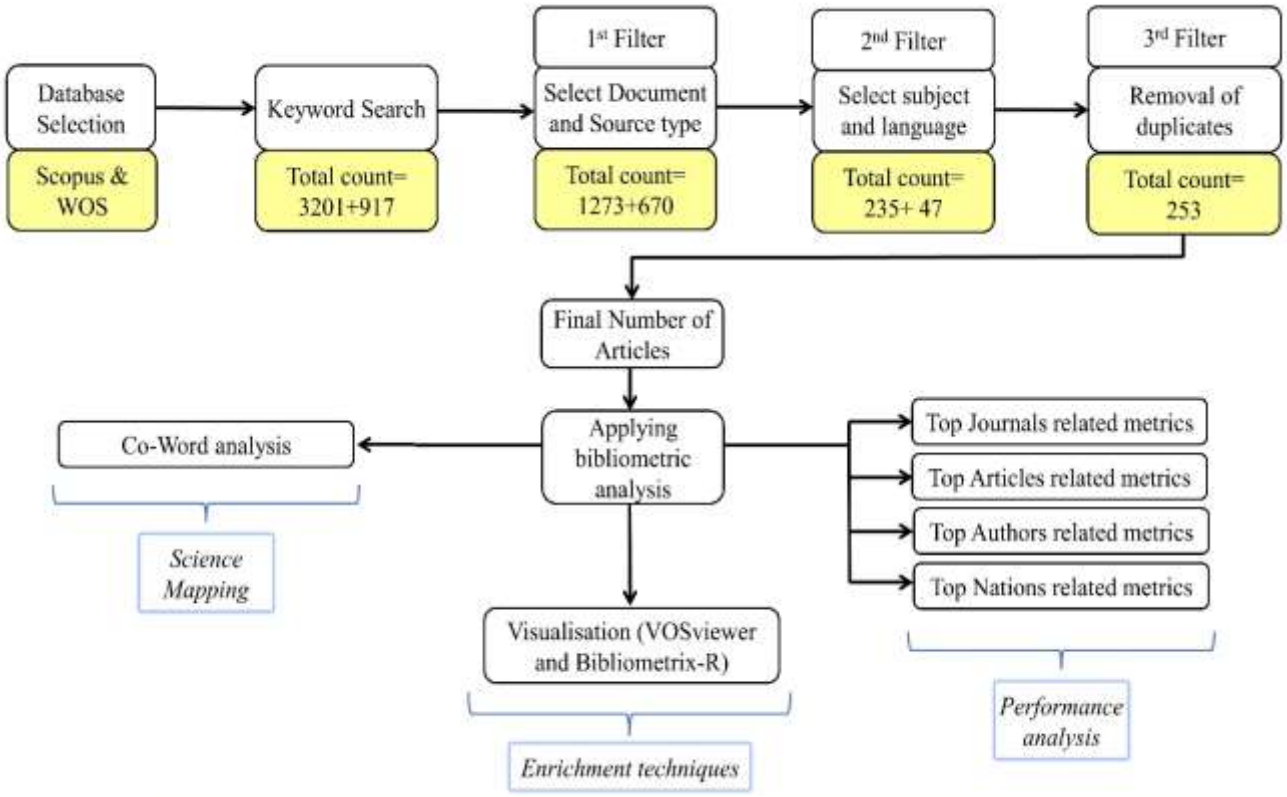


**Fig. 1.** Search and filtration strategy; ***Source:*** *Adapted from* Tiwary et al. (2021)

## 3. Results

### 3.1 Citation and publication trends (RQ1)

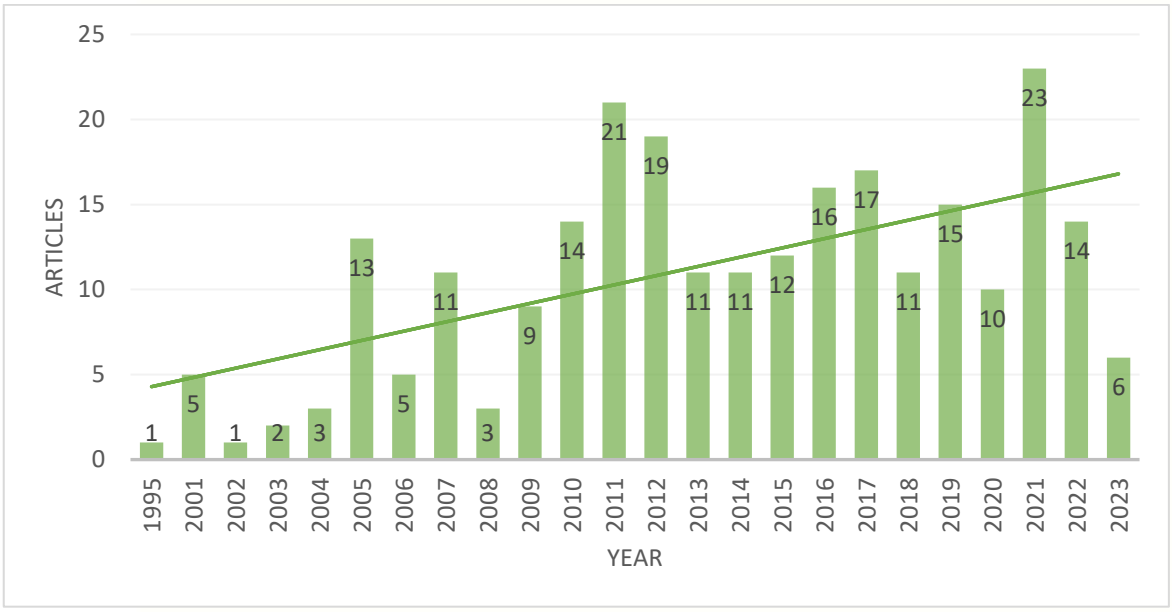


**Fig. 2.** Annual scholarly production; ***Source:*** *Authors' interpretation*

The publication and citation trends of TRIZ in business and management research are presented in Table 3.

In terms of publication, Panel A of Table 3 specifies that the coverage of TRIZ in business and management research spans 24 years (1995–April 2023) (NAY), comprising 253 articles (TP) that have been published in 78 different journals (outlets), with a production average of 6.61 publications per year (PAY). The significant percentage of total cited articles can be explained by the annual scientific production shown in Fig. 2, which shows that 196 articles have only been published in the last twelve years.

In terms of citation, the Panel B of Table 3 shows that the coverage of TRIZ in business and management research published between 1995 and April 2023 has garnered 3919 citations (TC), with a mean of 15.49 citations per publication (TC/TP), leading to the h index of 31, which indicates that 31 publications have garnered at least 31 citations.

Considering the above trend, it's evident that research work around TRIZ methodology has gained appreciation in recent years, especially in the year 2021. Businesses are now reimaging themselves after COVID-19, and the role of TRIZ becomes important in devising long-term sustainable strategies.

**Table 3.** Trends for citations and publications

| Description | Results |
|---|---|
| *Panel A. Publication metrics* | |
| | |
| Total Publications (TP) | 253 |
| Total Cited Publications (TCP) | 210 |
| Total Sources (Journals) | 78 |
| Article (e.g., conceptual and empirical) | 232 |
| Review (e.g., critical and systematic reviews) | 21 |
| Number of active years (NAY) | 18 |
| Productivity per active year (PAY) | 6.61 |
| *Panel B. Citation metrics* | |
| Total Citations (TC) | 3919 |
| Average citations per publication (TC/TP) | 15.49 |
| *h*-index | 31 |

Note: Period of coverage = 1995– April 2023
**Source**: Adapted from (Donthu et al., 2021)

## 3.2 Top Journals (RQ2)

**Table 4.** Top Journals publishing TRIZ research in Business and Management

| Journal | Total publications | *h* | Total citations |
|---|---|---|---|
| International Journal of Systematic Innovation | 56 | 5 | 86 |
| Creativity and Innovation Management | 21 | 11 | 337 |
| Journal of Cleaner Production | 16 | 12 | 547 |
| Technological Forecasting and Social Change | 13 | 8 | 380 |
| International Journal of Product Development | 13 | 6 | 288 |
| International Journal of Production Research | 8 | 7 | 502 |
| International Journal of Productivity and Quality Management | 8 | 5 | 78 |
| International Journal of Six Sigma and Competitive Advantage | 7 | 4 | 45 |
| International Journal of Business Innovation and Research | 6 | 5 | 51 |
| Journal of Construction Engineering and Management | 4 | 4 | 72 |

***Source:*** *Authors' interpretation*

The top 10 Journals that have published the most articles on TRIZ in business and management research are presented in Table 4.

The table indicates that the 'International Journal of Systematic Innovation' has published the most articles (n= 56) with significant citations (n= 86). The second highest number of articles (n= 21) are published by the journal, 'Creativity and Innovation Management', garnering a high number of citations (n= 337). Other significant journals disseminating TRIZ research include the 'Journal of Cleaner Production', the 'International Journal of Business Innovation and Research' and the 'International Journal of Production Research'.

## 3.3 Top Articles (RQ2)

**Table 5.** Top Articles on TRIZ research in Business and Management

| Article title | Author(s) | Total Citations |
|---|---|---|
| "A review of TRIZ, and its benefits and challenges in practice" | (Ilevbare et al., 2013c) | 201 |
| "A QFD-centred design methodology for environmentally conscious product design" | (Sakao, 2007b) | 169 |
| "Innovative product development process by integrating QFD and TRIZ" | (Yamashina et al., 2002) | 161 |
| "Enabling open innovation in small- and medium-sized enterprises: how to find alternative applications for your technologies" | (Bianchi et al., 2010) | 146 |
| "Computer-aided analysis of patents and search for TRIZ contradictions" | (Cascini & Russo, 2007) | 119 |
| "Accelerating preliminary eco-innovation design for products that integrates case-based reasoning and TRIZ method" | (C. J. Yang & Chen, 2011b) | 118 |
| "A TRIZ-based method for new service design" | (Chai et al., 2005) | 111 |
| "From TRIZ to OTSM-TRIZ: Addressing complexity challenges in inventive design" | (Cavallucci & Khomenko, 2007) | 106 |
| "Topic analysis and forecasting for science, technology and innovation: Methodology with a case study focusing on big data research" | (Y. Zhang et al., 2016) | 103 |
| "The theory of inventive problem solving (TRIZ) as option generation tool within cleaner production projects" | (Fresner et al., 2010) | 90 |

***Source:*** *Authors' interpretation*

The top ten articles for TRIZ in business and management research are presented in Table 5.

The table indicates that the article titled "A review of TRIZ, and its benefits and challenges in practice" by (Ilevbare et al., 2013c) is the TRIZ article from business and management discipline based on global citations (n= 201), followed by the article titled "A QFD-centred design methodology for environmentally conscious product design" by (Sakao, 2007b) (169 citations), and the articles titled "Innovative product development process by integrating QFD and TRIZ" by (Yamashina et al., 2002) and "Computer-aided analysis of patents and search for TRIZ contradictions" by (Cascini & Russo, 2007), each receiving over 100 citations.

## 3.4 Top Authors (RQ3)

**Table 6.** Top authors publishing TRIZ research in Business and Management

| Author | Author's Affiliation | *h* | Total publications | Total citations |
|---|---|---|---|---|
| Tzong-Ru Lee | Marketing Department, National Chung Hsing University | 4 | 8 | 40 |
| D. Daniel Sheu | National Tsing Hua University | 3 | 7 | 83 |
| Martin G. Moehrle | University of Bremen | 4 | 6 | 124 |
| Darrell Mann | Systematic Innovation Network, Bideford, United Kingdom | 3 | 6 | 97 |
| Chun-Hsien Chen | Nanyang Technological University | 2 | 6 | 9 |
| Davide Russo | University of Bergamo, Italy | 4 | 5 | 183 |
| Arash Shahin | Department of Management, University of Isfahan | 4 | 5 | 68 |
| Runhua Tan | Hebei University of Technology | 4 | 5 | 61 |
| Yi Zhang | University of Technology Sydney, Australia | 4 | 5 | 198 |
| Alan L. Porter | Georgia Institute of Technology, Atlanta | 3 | 5 | 171 |

***Source:*** *Authors' interpretation*

Table 6 indicates that Tzong-Ru Lee from the National Chung Hsing University (UNM) is the most prolific author, with eight articles on TRIZ in business and management published in top journals. Martin G. Moehrle of the University of Bremen, Darrell Mann of Systematic Innovation Network and Chun-Hsien Chen of the Nanyang Technological University have six articles each, placing them third on the list of top contributing authors. On the list, the remaining authors have written five articles each. The domain has an immense scope to develop, particularly in terms of unique and rigorous research published in top-notch journals, as seen by the comparatively small number of publications linked with the top authors.

## 3.5 Top Countries (RQ3)

**Table 7.** Top countries disseminating TRIZ research in Business and Management

| Country | Total Publications | Total Citations |
|---|---|---|
| China | 75 | 928 |
| USA | 15 | 95 |
| India | 11 | 99 |
| United Kingdom | 9 | 343 |
| Iran | 8 | 78 |
| Italy | 8 | 339 |
| Malaysia | 8 | 98 |
| Germany | 7 | 345 |
| Korea | 7 | 103 |
| Brazil | 4 | 40 |

Source**:** *Authors' interpretation*

The top ten countries for TRIZ in business and management research are presented in Table 7.

As per the country metrics of 253 articles on TRIZ in business and management research retrieved from the Scopus and WOS databases, the top five countries disseminating research in the domain are

China (Seventy-Five articles), the United States (Fifteen articles), India (Eleven articles), United Kingdom (Nine articles), and Iran (Eight articles).

Based on the seminal papers and the above trends, it has been observed that TRIZ is being applied and integrated across a wide range of contexts and domains to foster innovation, improve problem-solving, and address challenges. Applied to various fields, including design, open innovation, patent analysis, complexity handling, and research forecasting, its versatility and a systematic approach make it suitable for many different applications. However, none of the papers specifically address business TRIZ or nontechnical domains.

## 3.6 Co-word analysis of keywords (RQ4)

The justification for employing co-word analysis is that an author's keywords adequately describe the topic of an article and reveal major topics of interest (Callon et al., 1983; Comerio & Strozzi, 2019). (Donthu et al., 2021) describe the assumption of Co-word analysis by stating that "words that frequently appear together have a thematic relationship with one another" (p. 289).

Fig. 3. presents the co-word analysis that displays our dataset's most recurring keywords. Using a threshold of 5 recurrences, We identified the 27 most frequently occurring terms out of 1275 keywords. As per our expectations, 'TRIZ', which forms the conceptual and theoretical background of all TRIZ-based research, arises as the most occurring term (n = 131). The current domain under review observes that the term 'TRIZ' is complemented by keywords related to business and management, such as 'product design' (n = 25), 'product development' (n = 13), 'quality function deployment' (n = 09), 'customer satisfaction' (n = 05), and 'decision making' (n = 08) (see Fig. 3). These terms appear together to show the relevance of TRIZ to business and management.

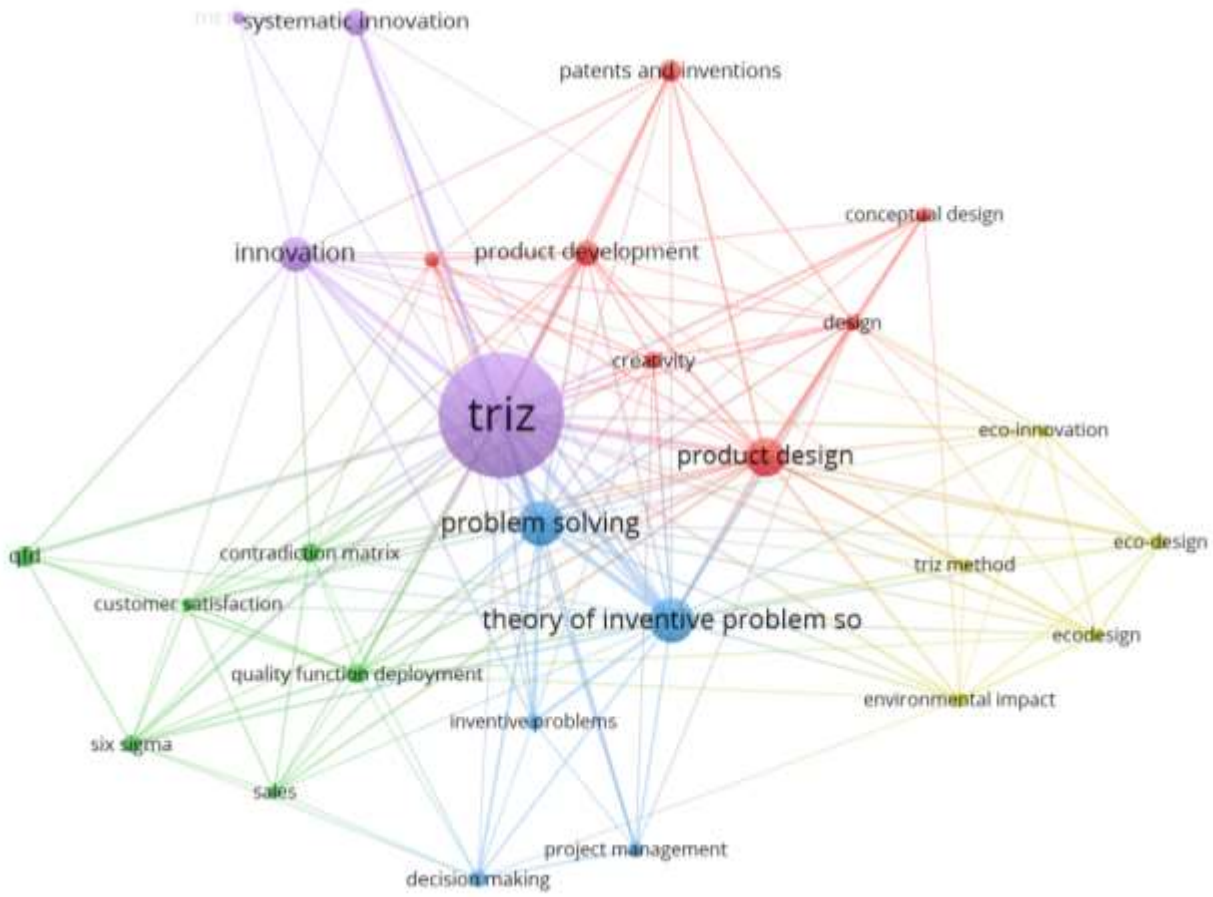


**Fig. 3.** Visualisation of Co-word network; ***Source:*** *VOSviewer*

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I. Ishrat1, M. Hasan, etc./Int. J. Systematic Innovation, 7(7),12-46(2023)

Moreover, we complement our co-word analysis with a word cloud formed using title keywords. This review employed the bibliometrix-R software to generate a word cloud.

The word cloud in Fig. 4 shows the frequency of terms gathered from the titles of the 253 chosen articles. When the displayed keywords are observed in the word cloud, the top keywords were all found to be connected to the research domain (TRIZ, innovation, design, service industry etc.).


**Fig. 4.** Word Cloud; ***Source:*** *Bibliometrix-R*

Furthermore, we also complement our co-word analysis with a treemap formed using abstract keywords. This review employed the bibliometrix-R software to generate a treemap.

The treemap in Fig. 5 shows the importance and occurrence of terms gathered from the abstract of the 253 chosen articles. Fig. 5 also displays the treemap depicting that “TRIZ” has 15% occurrences, whereas the keywords “problem-solving” and “product design” have 10% and 7% occurrences, respectively.

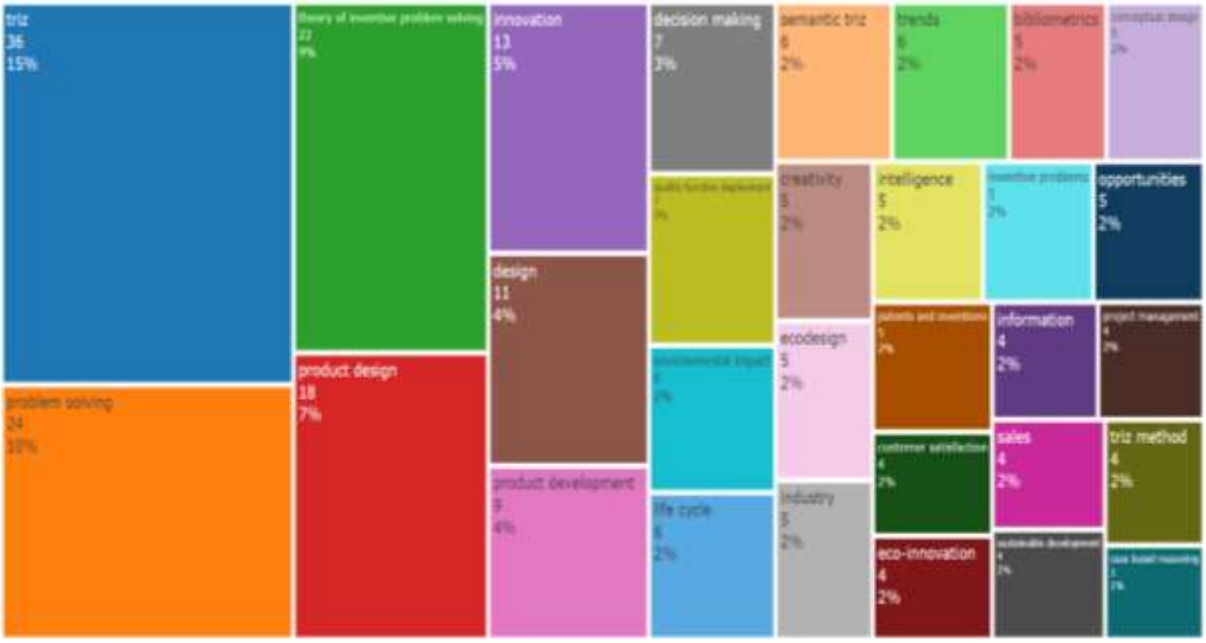


**Fig. 5.** Tree Map: ***Source:*** *Bibliometrix-R*

An analysis of the bibliometric data on TRIZ reveals that the focus of TRIZ is in the technical or engineering domain, with the majority of words (Fig. 4 and 5) showing usage in product design, product development, and innovation. To comprehend how TRIZ began as a problem-solving strategy in the business and management spheres, a thorough review of BusinessTRIZ has been done.

## 4. Conceptual Review (RQ5)

The hit-and-trial method is most commonly used to solve problems creatively. However, the method has significant limitations that limit its ability to generate innovative ideas, such as functional fixedness (psychological inertia), time waste, low ideas per unit of time, and, most importantly, no direct mechanism (Dung, 1995; Hentschel, 2009). TRIZ proposes overcoming these limitations, and compromise-based thinking approaches (D. Mann, 2001a). TRIZ is an idea-generation technology that supports creativity and innovation (Wang, 2019). The use of TRIZ is dependent on the nature of the problem. The TRIZ methodology is based on five problem-solving principles: contradiction, ideality, functionality, resource use (resource is anything in the system that is not being used to its maximum potential) and space-time interface (C. Lim et al., 2018). TRIZ works best in groups and prevents conceptual conflicts in individual reasoning.

Furthermore, it is appropriate for problems of a higher level of difficulty. The methodology is based on heuristics previously proven as certified solutions to problems associated with various categories (Schöfer et al., 2018). TRIZ involves systematically constructing system thinking through specified application methods (Da Silva et al., 2020; Dung, 1995). TRIZ is based on an abstraction process in which specific problems are abstracted into general problems, and then solutions are identified for those generic problems. Then, to meet the demand of the specific problem, these generic solutions are abstracted into specific solutions (Stratton & Mann, 2003).

Altshuller organized his knowledge of global patent literature into inventive problems by organizing them into contradiction tables, sets of inventive principles, and standard solutions to solve problems scientifically and innovatively in any field (Hipple, 2005). Based on the problem investigated, the methodology can be further classified into three major categories:

1. Standard Solutions: This category of Altshuller's methodology involves identifying and applying solutions successfully implemented in the past for

similar problems. These solutions are documented and cataloguised in a "standard solutions" database, which can be used to solve problems quickly.

2. Inventive Principles: This category involves using a set of 40 inventive principles developed by Altshuller to systematically generate new ideas for solving problems. These principles can be applied to various fields and industries to generate innovative solutions.
3. Contradiction Matrix: This category involves identifying and resolving contradictions that exist within a problem. Altshuller developed a matrix that contains 39 parameters, each with its own set of inventive principles to solve contradictions. By identifying the parameters and applying the appropriate principles, one can systematically generate solutions to complex problems.

## 4.1 Business TRIZ

The TRIZ toolkit originally comprised 40 principles to solve contradictions by matching 39 parameters. However, to apply the theory to business and management problems, Darrel Mann has proposed a generic matrix for technical, business, and software applications. Mann re-articulated the 39 parameters into 48 business parameters and re-explained the classical contradiction matrix based on "physical parameters", "performance-related parameters", "efficiency-related parameters", "ility (reliability, durability, etc.) related parameters", "manufacture-cost reduction parameters", "measurement related parameters" (D. Mann, 2005a). W. Edward Deming's concept that the production of goods and services is termed as a process, and the entire process is segmented based on certain attributes was acknowledged while formulating the business version of the contradiction matrix; "physical attributes", "time attributes", "risk attributes", "cost attributes", and "interface attributes" were selected to draw out 31 business-related parameters for the business contradiction matrix (D. Mann & Spain, 2008).

## 4.2 Business Contradiction Matrix

The 'Matrix for Resolving Technical Contradictions' was initially released as a 39x39 version in 1971 and was made freely accessible (Table 7; 1st column). It remained unchanged until the late 1990s when CREAX decided to update the tool. This effort resulted in the 2003 version, which notably expanded the matrix's parameters from 39 to 48 (Table 7; 2nd column). In 2006, a decision was made to reissue the Matrix once its accuracy dropped below 95% (D. Mann et al., 2005). This occurred in 2010, leading to the publication of Matrix 2010. By then, a significant part of the research had been automated, enabling the development of software tools to identify conflicts and contradictions. Matrix 2010 incorporated two additional parameters, reflecting the growing importance of addressing 'intangibles'. In 2018, the latest version (D. Mann, 2018a), Matrix 3.0 for business situations, was released, redefining the matrix's parameters from 31 to 45 (Table 7; 3rd column). And now, the most recent release, Matrix 2022, is an app. This app allows users to access the relevant frequency-impact graph for each matrix box, offering a more advanced and interactive experience (D. Mann, 2021).

However, the business version of the contradiction matrix works similarly to the traditional TRIZ contradiction matrix. The user is urged to consider the parameter they want to enhance and the parameter that will suffer due to the improvement. The numbers in the boxes that indicate the junction of the improving and deteriorating characteristics represent the creative techniques as TRIZ concepts that other management professionals have applied. The symmetrically constructed matrix also assisted in the abstraction process. The parameters for the business version of the contradiction matrix are segmented using "physical attributes", "time attributes", "cost attributes", "risk attributes", and "interface attributes" (D. Mann & Spain, 2008).

The business version of the Contradiction Matrix is a variation of the TRIZ Contradiction Matrix specifically designed to help businesses solve problems related to improving their processes, increasing efficiency, and reducing costs. While the traditional TRIZ Contradiction Matrix is focused on engineering and technical problems, the business version considers the unique challenges businesses face. It provides solutions that are more applicable to the business world.

The business version of the matrix also includes a different set of parameters than the traditional matrix. For example, instead of parameters related to mechanics or physics, it includes parameters such as "time," "information," and "cost."

Furthermore, the business version of the matrix emphasizes the importance of finding solutions that not only solve the problem at hand but also add value to the business. This is achieved by considering each solution's potential benefits and drawbacks and selecting the one that offers the best overall outcome for the business. Overall, while the business version of the Contradiction Matrix is based on the same principles as the traditional TRIZ matrix, it is adapted to meet businesses' specific needs and challenges and provides more relevant and applicable solutions to the business world.

## 4.3 TRIZ parameters

TRIZ parameters refer to a system's specific characteristics or attributes that can be modified or optimized to solve a problem. Several sets of TRIZ parameters exist, including the 40 Principles of TRIZ and the Contradiction Matrix. In the 1960s, the Soviet TRIZ research team created the Contradiction Matrix. It was merely a 39x39 matrix, as opposed to a 48x48 matrix, and it has quite a few empty squares where the study team lacked sufficient data to produce a statistically significant ranking of Principles. It has also been reported that Darrel Mann and Simon DeWulf updated the contradictions matrix with 50 parameters (D. Mann & Dewulf, 2016). Thirty-one parameters have also been rearticulated into 45 parameters per the updated business contradiction matrix.

Generic TRIZ parameters apply to various fields, including engineering, science, and arts & humanities. These parameters focus on improving a system's functionality and efficiency, including characteristics such as weight, shape, speed, and material properties. Business TRIZ parameters, on the other hand, are tailored specifically to business problems and processes. They focus on improving the efficiency and effectiveness of business processes and may include characteristics such as lead time, cycle time, cost, quality, and customer satisfaction. While both sets of parameters share some similarities, such as the emphasis on improving efficiency and functionality, they differ in their specific focus and application. Generic TRIZ parameters are more broad-based and can be applied to various fields. In contrast, Business TRIZ parameters are more tailored to the specific needs and challenges of the business environment.

**Table 8.** TRIZ parameters

| **Classical Contradiction Matrix Parameters (Domb et al., 2011)** | **Re-sequencing Matrix Parameters (D. Mann & Dewulf, 2016)** | **Parameters identified for Business Matrix (D. Mann, 2005a)** |
|---|---|---|
| 1. “Weight of moving object” | 1. “Weight of moving object” | 1. R&D Spec/Capability/Means |
| 2. “Weight of stationary object” | 2. “Weight of stationary object” | 2. “R&D Cost” |
| 3. “Length of moving object” | 3. “Length of moving object” | 3. “R&D Time” |
| 4. “Length of stationary object” | 4. “Length of stationary object” | 4. “R&D Risk” |
| 5. “Area of moving object” | 5. “Area of moving object” | 5. “R&D Interfaces” |
| 6. “Area of stationary object” | 6. “Area of stationary object” | 6. Production Spec/Capability/Means |
| 7. “Volume of moving object” | 7. “Volume of moving object” | 7. “Production Cost” |
| 8. “Volume of stationary object” | 8. “Volume of stationary object” | 8. “Production Time” |
| 9. “Speed” | 9. “Shape” | 9. “Production Risk” |
| 10. “Force” | 10. “Amount of Substance” | 10. “Production Interfaces” |
| 11. “Stress or Pressure” | *11. Amount of Information* | 11. Supply Spec/Capability Means |
| 12. “Shape” | 12. “Duration of action - moving object” | 12. “Supply Cost” |
| 13. “Stability of the object's composition” | 13. Duration of action - stationary object | 13. “Supply Time” |
| 14. “Strength” | 14. “Speed” | 14. “Supply Risk” |

| | | |
|---|---|---|
| 15. “Duration of action by a moving object” | 15. Force/Torque | 15. “Supply Interface” |
| 16. “Duration of action by a stationary object” | 16. Use of energy by moving object | 16. “Product Reliability” |
| 17. “Temperature” | 17. Use of energy by a stationary object | 17. “Support Cost” |
| 18. “Illumination intensity” *(jargon) | 18. Power | 18. “Support Time” |
| 19. “Use of energy by moving object” | 19. Stress/Pressure | 19. “Support Risk” |
| 20. “Use of energy by stationary object” | 20. Strength | 20. “Support Interfaces” |
| 21. “Power” * (jargon) | 21. Stability | 21. Customer Revenue/Demand/ Feedback |
| 22. “Loss of Energy” | 22. Temperature | 22. “Amount of Information” |
| 23. “Loss of substance” | 23. Illumination Intensity | 23. “Communication Flow” |
| 24. “Loss of Information” | *24. Function Efficiency* | 24. System-affected harmful effects |
| 25. “Loss of Time”<br>26. “Quantity of substance/the matter” | 25. Loss of Substance | 25. System-generated side effects |
| 27. “Reliability” | 26. Loss of Time | 26. “Convenience” |
| 28. “Measurement accuracy” | 27. Loss of Energy | 27. Adaptability/Versatility |
| 29. “Manufacturing precision” | 28. Loss of Information | 28. “System Complexity” |
| 30. “External harm affects the object” | 29. Noise | 29. “Control Complexity” |
| 31. “Object-generated harmful factors” | *30. Harmful Emissions* | 30. Tension/Stress |
| 32. “Ease of manufacture” | 31. Object-Generated Side Effects | 31. “Stability” |
| 33. “Ease of operation” | 32. Adaptability/Versatility | |
| 34. “Ease of repair” | *33. Compatibility/Connectability* | |
| 35. “Adaptability or versatility” | 34. Ease of Operation | |
| 36. “Device complexity” | 35. Reliability | |
| 37. “Difficulty of detecting and measuring” | 36. Repairability | |
| 38. “Extent of automation” | 37. Security | |
| 39. “Productivity” * | *38. Safety/Vulnerability* | |
| | 39. Aesthetics | |
| | 40. Object-affected harmful effects | |
| | 41. Manufacturability | |
| | 42. Accuracy of manufacturing | |
| | 43. Automation | |
| | 44. Productivity | |
| | 45. System Complexity | |
| | *46. Control Complexity* | |
| | 47. Ability to Detect/Measure | |
| | 48. Measurement Precision | |

Note: There are a number of parameters in the classic contradiction matrix that offer insights into optimizing the weight, length, area, volume, speed, force, stress, shape, stability, and strength of objects. As a business management tool, these parameters can be used to optimize product weights, process lengths, resource volumes, and speed and force of operations. They are useful for understanding business management strategies. They may help analyze and improve company operations, product development, supply

chain management, customer satisfaction, and overall performance.

**Table 9.** Following are the core articles focusing on conceptual learning of TRIZ in a Non-technical context

| | | | |
|---|---|---|---|
| "An introduction to TRIZ: The theory of inventive problem solving" | 2001 | Creativity and Innovation Management | (D. Mann, 2001b) |
| "What is TRIZ? From conceptual basics to a framework for research" | 2005 | Creativity and Innovation Management | (Moehrle, 2005) |
| "The place of TRIZ in a holistic design methodology" | 2001 | Creativity and Innovation Management | (Knott, 2001) |
| "TRIZ: A creative breeze for quality professionals." | 2006 | Quality Progress | (Dew, 2006) |
| "TRIZ as an innovation management tool: Insights from academic literature" | 2017 | International Journal of Technology Marketing | (Teplov et al., 2017) |
| "TRIZ: Inventive Creativity Based On The Laws of Systems Development" | 1995 | Creativity and Innovation Management | (Dung, 1995) |
| "How Problems Are Solved in TRIZ Literature: The Need for Alternative Techniques to Individuate the Most Suitable Inventive Principles" | 2018 | Advances and Impacts of the Theory of Inventive Problem Solving: The TRIZ Methodology, Tools and Case Studies | (Borgianni et al., 2018) |
| "Can Altshuller's Matrix Be Skipped Using CBR and Semantic Similarity Reasoning?" | 2018 | Advances and Impacts of the Theory of Inventive Problem Solving: The TRIZ Methodology, Tools and Case Studies | (P. Zhang et al., 2018) |
| "TRIZ evolutionary approach: Main points and implementation" | 2016 | Research and Practice on the Theory of Inventive Problem Solving (TRIZ): Linking Creativity, Engineering and Innovation | (Berdonosov and Redkolis, 2016) |
| "Using TRIZ in management problems solving" | 2021 | Studies on Interdisciplinary Economics and Business | (Göçmen, 2020) |
| "Two Aspects of Function for Technical Systems" | 2021 | International Journal of Systematic Innovation | (Yong Won Song, 2021) |
| "Quantifying and Leading Innovation with TRIZ Within Competitiveness Strategies" | 2018 | Advances and Impacts of the Theory of Inventive Problem Solving: The TRIZ Methodology, Tools and Case Studies | (Brad & Brad, 2018) |
| "Using TRIZ in the social sciences: Possibilities and limitations" | 2016 | Research and Practice on the Theory of Inventive Problem Solving (TRIZ): Linking Creativity, Engineering and Innovation | (Schut, 2016) |
| "Systematic innovation for the retention and development of human talent" | 2014 | International Journal of Systematic Innovation | (C. Y. Huang & Abrego, 2014) |
| "An exploring of the path of management innovation based on conflict solving" | 2007 | Proceedings of 2007 International Conference on Management Science and Engineering, ICMSE'07 (14th) | (Dong-sheng et al., 2007) |
| "Someone, somewhere, really did already invent the wheel you're about to re-invent" | 2005 | 7th International Value Conference 2005: Why Re-Invent the Wheel? | (D. Mann, 2005b) |
| "A or B' to 'A and B" | 2001 | Creativity and Innovation Management | (D. Mann, 2001a) |

| | | | |
|---|---|---|---|
| "Application of TRIZ Tools in a Non-Technical Problem Context" | 2000 | Systematic Innovation for Business Leaders' at TRIZCON2000. | (D. Mann et al., 2000a) |
| "Breakthrough Thinking With TRIZ For Business And Management: An Overview" | 2007 | ICG Training and Consulting | (Souchkov & Sutcliffe, 2007) |
| "Innovative Product Development and Theory of Inventive Problem Solving" | 2008 | TriSolver Consulting and TriS Europe GmbH | (Livotov, 2008a) |
| "Systematic Win-Win Problem Solving In A Business Environment" | 2008 | | (D. Mann & Spain, 2008) |
| "TRIZ and Systematic Business Model Innovation" | 2010 | ETRIA Conference "TRIZ Future 2010" | (Souchkov, n.d.) |
| "TRIZ For Business: Application Of Rca+ To Analyse And Solve Business And Management Problems" | 2007 | TRIZ Journal | (Souchkov et al., 2007) |
| "TRIZ-based Innovation Principles and a Process for Problem-Solving in Business and Management" | 2002 | European TRIZ Association | (Ruchti et al., 2002) |
| "Using TRIZ to Overcome Business Contradictions: Profitable E-Commerce" | 2001 | Proceedings of TRIZCON2001 | (D. Mann et al., 2001) |

***Source:*** *Authors' interpretation*

TRIZ provides 12 principles that address non-technical challenges encountered in business and management tasks. They serve as invaluable guideposts, illuminating the path to problem-solving mastery. These principles, rooted in the TRIZ methodology, provide a roadmap for navigating the complexities of business and management problem-solving. Individuals can better approach challenges creatively and strategically by engaging in these activities, resulting in innovative solutions and better decision-making (Ruchti et al., 2001). These include

1. **Combination and separation:** Combining and separating elements to achieve desired results.
2. **Symmetry and asymmetry:** Creating symmetry and asymmetry in elements is key to unlocking innovation.
3. **Homogeneity - Diversity:** Making the most of differences as a basis for ingenious problem-solving.
4. **Expansion - Reduction:** Optimal outcomes are driven by strategically expanding or reducing elements.
5. **Mobility - Immovability:** Applying immovability to elements to solve problems innovatively.
6. **Consumption - Regeneration:** Discovering new avenues by balancing element consumption and regeneration.
7. **Standardization - Specialization:** Achieving a solid problem-solving foundation by balancing standardizing and specializing elements.
8. **Action - Reaction:** Breakthrough solutions can be achieved by interplaying action and reaction within elements.
9. **Continuous action - Interrupted action:** Strategic lever between continuous and interrupted actions.
10. **Partial action - Excessive action:** Stimulating innovation by balancing partial or excessive action in elements.
11. **Direct action - Indirect action:** Investigating transformative possibilities in problem-solving via direct and indirect action.
12. **Preliminary action - Preliminary counteraction:** Finding effective pathways to desired results by navigating between preliminary action and counteraction.

The 40 inventive principles are further put into five categories providing a more streamlined and organized framework for understanding the different principles and their respective areas of focus.

**Table 10.** Inventive principles (Bozbura & Ersin, 2009)

| Organizational Structure and Design | Talent Development and Empowerment | Change and Adaptability | Continuous Improvement and easurement | Strategic Alignment and External Considerations |
|---|---|---|---|---|
| • Segmentation<br>• Taking Away<br>• Local Quality<br>• Asymmetry<br>• Combining | • Universality<br>• Nesting<br>• Dynamicity<br>• Equipotentiality<br>• Self-Service | • Prior Counteraction<br>• Prior Action<br>• Early Cushioning<br>• Otherway Round<br>• Sphericity | • Partial or Excessive Action<br>• Mechanical Vibrations<br>• Periodic Action<br>• Useful Action Continuity<br>• Feedback | • Intermediary<br>• Pneumatic and Hydraulic Structures<br>• Changing Color<br>• Strong Oxidizers<br>• Inert Atmosphere<br>• Composites |

***Source:*** *Authors' interpretation*

### CreaTRIZ

CreaTRIZTM for Managers is a software tool for managers and businesses to eliminate contradictions (D. Mann & Dewulf, 2016). The underlying principle of the tool is that it abstracts and codifies the successful solutions or strategies of every field and makes them available to others for solving similar problems quickly (D. Mann, 2001a); (Zouaoua et al., 2010). Nevertheless, the problem with the tool is that it is not accessible openly to beginners of the TRIZ.

## 4.4 How has TRIZ been incorporated into different management functions?

Due to TRIZ's widespread applicability and strong potential for invention, the theory started applying to non-technical areas such as business and management (Ruchti & Livotov, 2001).

**Table 11.** Application of TRIZ in a non-technical context

| | | | |
|---|---|---|---|
| "Collaborative tool for solving human factors problems in the manufacturing environment: The Theory of Inventive Problem Solving Technique (TRIZ) method" | 2008 | International Journal of Production Research | (Akay et al., 2008) |
| "Evaluating the impact of TRIZ creativity training: An organizational field study" | 2012 | R and D Management | (Birdi et al., 2012b) |
| "TRIZ for reverse inventing in market research: A case study from Wittenstein Ag, identifying new areas of application of a core technology" | 2009 | Creativity and Innovation Management | (Glaser & Miecznik, 2009a) |
| "Managing business model innovation: an innovative approach towards designing a digital ecosystem and multi-sided platform" | 2021 | Business Process Management Journal | (Hoch & Brad, 2021) |
| Applying TRIZ principles to construct creative universal design | 2010 | International Journal of Systematic Innovation | (Chun-Ming Yang et al., 2010) |
| "Developing a comprehensive brand evaluation system with the support of TRIZ to formulate brand strategies" | 2017 | International Journal of Business Excellence | (T.-R. Lee et al., 2017) |
| "TRIZ and the difficulties in marketing management applications" | 2010 | PICMET '10 - Portland International Center for Management of Engineering and Technology, Proceedings - Technology Management for Global Economic Growth | (Zouaoua et al., 2010) |

| | | | |
|---|---|---|---|
| "Marketing strategies of fishery products for supermarkets and farmers' markets in Taiwan" | 2011 | Journal of Food Products Marketing | (T.-R. (Jiun-S. Lee et al., 2011) |
| "TRIZ problem-solving model for multiple-to-multiple parameter contradictions using case-based reasoning" | 2011 | International Journal of Systematic Innovation | (D. Daniel Sheu & Chia Hung Chen, 2011) |
| "Negotiation of needs towards halal talents sustainability" | 2022 | Journal of Islamic Marketing | (Abdul Rahim et al., 2022) |
| "Design for the adjustable high heel" | 2019 | International Journal of Systematic Innovation | (Jyhjeng Deng & Teng-Hsuan Lin, 2019) |
| "The Effect of a Program Based on TRIZ Theory to Develop the Creative Thinking Skills Among Male Students with Mild Intellectual Disability" | 2022 | International Journal of Systematic Innovation | (Meshal Bader MalAllah et al., 2022) |
| "The sequence of strategies when establishing Taiwanese restaurant in Thailand" | 2021 | European Business Review | (T.-R. Lee et al., 2021) |
| "Application of TRIZ in Literature; an Algorithm for Systematic Story Writing Based on Mega Problems" | 2021 | International Journal of Systematic Innovation | (Ali Mohammadi & Ahmad Forouzanfar, 2021) |
| "Exploring the formulation of book pricing strategies in economics with a TRIZ approach to business management" | 2020 | International Journal of Systematic Innovation | (Su-Chen Huang, 2020) |
| "TRIZ/CrePS Approach to the Social Problems of Poverty: 'Liberty vs Love' Is Found the Principal Contradiction of the Human Culture" | 2018 | Advances and Impacts of the Theory of Inventive Problem Solving: The TRIZ Methodology, Tools, and Case Studies | (Nakagawa, 2018) |
| "Research on the strategy and implementation in stages of organizational learning based on TRIZ theory" | 2009 | IE and EM 2009 - Proceedings 2009 IEEE 16th International Conference on Industrial Engineering and Engineering Management | (Sui et al., 2009) |
| "Teaching disadvantage as an appearance of contradiction in basic TRIZ education" | 2014 | International Journal of Systematic Innovation | (Yuriy Danilovskiy et al., 2014) |
| "Innovative design of customized fashion handbags" | 2013 | International Journal of Systematic Innovation | (Lin Chin-Min et al., 2013) |
| "Enhancing workplace safety with TRIZ" | 2012 | 2012 IEEE 6th International Conference on Management of Innovation and Technology, ICMIT 2012 | (Thanabalu et al., 2012) |
| "Business model innovation of enterprises by physical contradiction means of TRIZ" | 2009 | Proceedings - 2009 International Conference on Electronic Commerce and Business Intelligence, ECBI 2009 | (Yonghai & Jianhua, 2009) |

Source: Authors' interpretation

Note; Based on the analysis of applications of TRIZ in non-technical contexts, the following insights emerge: Traditional TRIZ has been used in technical fields but has increasingly been applied to non-technical fields such as manufacturing, marketing, literature, education, fashion, workplace security, and business models. The tool promotes innovation in these fields as well as solving problems. The application of TRIZ in non-technical domains includes enhancing creative thinking, inspiring innovative designs, improving workplace safety, facilitating organizational learning, addressing cultural and social challenges, and formulating strategies. Researchers found that TRIZ is effective and versatile beyond technical

applications, demonstrating its adaptability and potential in non-technical contexts.

Darrel Mann 1999 identified the need for TRIZ theory for solving business and management problems as the technical and non-technical fields are two sides of a single coin (Slocum & Lundberg, 2001). In his study, D. Mann (2001a) presented the concept of 'win-win' situations for the business environment to overcome limiting contradictions by eliminating them rather than making compromises by giving an example of a contradictory situation between mass customisation and mass production. The different management functions that have harnessed the potential of TRIZ methodology are as follows:

- **Marketing:** TRIZ has also been used for marketing and branding strategies. (T. R. Lee et al., 2017) developed a brand evaluation system by combining TRIZ theories and brand-building theories such as Keller's brand-building stages, brand equity pyramid, brand report card, and balanced scorecard.
- **Sales and advertising:** A brief methodological description of TRIZ theory in marketing, sales, and advertising was given by (T. R. Lee et al., 2011). They performed a SWOT analysis to identify contradictions and understand the stores and their situation and then applied TRIZ to develop sound strategies for the commercial district. A questionnaire-based survey was also conducted to assess the viability of the proposed strategies.
- **Product customization:** From technology forecasting and placing products in the product lifecycle category according to technical or physical contradictions, TRIZ has now been used in customized fashion accessories such as handbags (Chin-Min et al., 2013) and pivotal high-heel shoes with dual functionality (Deng & Lin, 2019)
- **Human resource management:** C. Y. Huang & Abrego (2014) have even used TRIZ for human resource retention and development of human talent. A business contradiction matrix solved the human retention issues, abstracting problems through business parameters. Several tools of TRIZ were utilized, such as "nine windows' for problem analysis, function-attribute analysis for problem modelling and formulation, contradiction analysis to find cause and effect relationships and root problems, and finally, 40 inventive principles to formulate strategies for human retention and talent development.
- **Patent and inventions:** (Glaser & Miecznik, 2009b) harnessed the strength of reverse inventing to find additional business segments through patent literature databases. The company's core strengths and competencies have been identified in the process. Then by utilizing 39 TRIZ parameters, these strengths and competencies are matched with those principles to identify keywords for searching the patent database. Then target markets are selected according to the identified databases or customer segments included under those IPs. A similar case of patents and inventions was practised by D. Mann & Cole (2010) to forecast the worth of intellectual property by focusing on dynamization trends and evolution maps that would help companies to find out where their intellectual property is standing in the present and how will be its future trends and assessing the potential of future evolutions. The study is highly technical in assessing 3 million data points to develop algorithms for studying future evolution trends of IP held within the particular industry.
- **Business model innovation:** (Hoch & Brad, 2021) proposed an architectural framework for systematic business model innovations by combining a design science approach (DSR) and TRIZ to advance innovations by considering factors that affect the business internally and externally. Semi-structured interviews were conducted with professionals associated with the construction business to gain feasible solutions. The System operator technique (SOT) of TRIZ and the blue ocean framework were used for problem analysis, solution generation, and outcasting competition to conceptualize a framework for the business model.
- **Design and strategy:** The design domain provides a sequential picture of the innovation process and highlights the major innovation activities but does not show the strategic influences. TRIZ fills this gap. The strategic framework is addressed by models from the business and management domains, but they are too abstract to benefit business people. (Frobisher, 2021) bridged this gap through IDEFØ modelling proved in the electric car market. Fast Moving Consumer Goods (FMCG), Automotive, Agriculture, Fisheries, City Planning, and Sustainability can apply the innovation approach.

The 31 parameters explicitly designed for the business and management field have also been practised. (S. C. Huang, 2020) developed e-book pricing solutions by resolving contradictions based on 31 business parameters. However, the idea includes flaws, such as a company's financial inability because entrepreneurs must finance the price of outsourced R&D to bring scientific organizations on board. Likewise, Chybowska et al. (2019) illustrated the concept of Biz-TRIZ and demonstrated it through an SME and its associated challenges. TRIZ has a high potential in the creation phase of any service or product development, which creates a factor that necessitates investment. Rolls-Royce has picked TRIZ as one of 11 fundamental tools for Integrated Project Teams; the goal is to change people's minds, with around 200 people taught thus far. As a result, TRIZ is frequently done in groups at Rolls-Royce (Knott, 2001).

## 4.5 TRIZ methodology description for business and management-related problems:

Referring to T. R. Lee et al. (2011) and Moehrle & Wenzke (2006), the steps that are involved in applying the TRIZ technique to create inventive solutions to the problems are as follows:

1. The primary and foremost requirement is to analyze problems properly; there are also situations where appropriate data is unavailable. Then, in such situations, questionnaires-based surveys or in-depth interviews can be conducted better to understand the problems and target population concerning the problem. In addition to surveys and interviews, collecting data and information from various sources, including market research, customer feedback, and industry reports, is essential. This data can be used to understand the problem better and identify potential solutions.
2. However, as far as this review is concerned, TRIZ works on specific problems. Therefore, there has to be a refined problem statement formulated.
3. For further problem analysis, several tools are available (function analysis, su-field analysis, root conflict analysis, and cause-and-effect analysis). However, they require expert guidance to get accurate results and work best in teams. While expert guidance is necessary for some more complex analysis tools, online resources, and software programs can assist with problem analysis. These tools can help identify the problem's root cause and uncover hidden opportunities for innovation.
4. During problem analysis, contradictions are found. Business and management problems mainly contain physical or technical contradictions.
5. When contradictions are made available, one can relate them to the 31 parameters of business and management given by Darrel Mann (D. Mann, 2005a). In addition to physical or technical contradictions, business and management problems may involve contradictions between stakeholders, conflicting priorities, or resource constraints. Identifying these contradictions is essential to finding effective solutions.
6. Then, a business matrix based on 31 business parameters proposed by Darrel Mann can be referred to find out the suggested TRIZ principles as solutions. All the 40 TRIZ principles are explained in business terminology by (*The TRIZ Journal – TRIZ Methodology, Tools, Articles and Case StudiesThe TRIZ Journal | TRIZ Methodology, Tools, Articles and Case Studies*, n.d.). The 31 business parameters proposed by Darrell Mann cover a wide range of areas, including quality, cost, speed, innovation, and sustainability. Selecting the parameters most relevant to the problem being addressed is essential.
7. After identifying the relevant TRIZ principles, evaluating and prioritising them is essential based on their potential effectiveness in solving the problem. This requires understanding the resources available, the feasibility of implementing the solution, and the potential impact on the business. This step involves weighing the potential benefits of each TRIZ principle against the costs and risks of implementing them. It may be necessary to conduct a cost-benefit analysis or other feasibility studies to evaluate the potential impact of each solution.
8. Once the most promising TRIZ principles are identified and prioritized, developing and implementing a solution plan is essential. This involves determining the necessary resources, assigning responsibilities, and establishing a timeline for implementation. The implementation plan should be comprehensive and include details on how the solution will be executed, who will be

responsible for each task, and when each task will be completed. It is also essential to establish a system for monitoring progress and making adjustments as necessary.

9. Finally, evaluating the solution's effectiveness and making necessary adjustments is crucial. This may involve measuring the solution's impact on key performance indicators, soliciting stakeholder feedback, and making changes based on feedback and analysis. Regular evaluation and adjustment are critical to ensuring the solution remains effective. This may involve gathering feedback from stakeholders, analyzing performance metrics, and making necessary changes to the solution.
10. It is also important to note that TRIZ methodology is not a one-time solution but an ongoing process of innovation and continuous improvement. As such, businesses should incorporate TRIZ into their overall innovation strategy and regularly revisit and refine their solutions based on changing business needs and market conditions.

## 4.6 How can the data be collected to find out contradictions?

Lin Y.-J. and Deng J. (2018) used questionnaire-based interviews to find out the service quality required to be improved in convenience stores, in-depth interviews conducted to observe the problems faced by older people in taking off their shoes, interview experiments and usage of anthropometric data by (Hu S.-J., 2019) are some of the methods used to find contradictions. Where contradictions were known, value or functional analysis was used to improvise product usage (Lin M.-C., Hung Y.-C., 5 C.E.). Analyzing documents such as reports, financial statements, or customer feedback can provide insights into the challenges and contradictions within the business process. Benchmarking involves comparing a business process's performance to other similar processes in the industry. This can help identify areas where the process is falling behind and provide insights into potential solutions. Collecting data for finding contradictions in non-technical areas such as business and management requires a combination of quantitative and qualitative methods and an understanding of the process's specific challenges and goals.

## 4.7 Types of Tools

Two categories of tools are used to identify and solve problems: analysis and knowledge-based. Analysis tools and knowledge-based tools are used in different stages of problem-solving and innovation. Here's a brief overview of when each type of tool is typically used:

- Analysis Tools: Analysis tools are used primarily in the problem identification and definition stage of problem-solving. They are used to gather and analyze data about the problem and to identify its underlying causes and contributing factors. Common tools include root cause analysis, fishbone diagrams, Pareto charts, and statistical process control charts (Mueller, 2005).
- Knowledge-based Tools: Knowledge-based tools are used primarily in the problem-solving solution generation and selection stage. They are used to generate and evaluate potential solutions to the problem based on established knowledge and principles. Knowledge-based tools include techniques such as TRIZ, a systematic innovation methodology based on the analysis of patterns of problems and solutions, and design heuristics, which are rules of thumb for designing products and systems that have been effective in practice. TRIZ contains a strong knowledge base from different fields of science, such as geometry, chemistry, physics, and even biology (Dung, 1995). The most well-known creative thinking tools are creative problem solving, Synectics, TRIZ, and Six thinking hats (Puccio et al., 2006). TRIZ is applicable in problems that cannot be solved in a simple procedural way.

**Table 12.** TRIZ Tools in Non-technical Context

| | | | |
|---|---|---|---|
| "The integration of TRIZ with other ideation tools and processes as well as with psychological assessment tools" | 2005 | Creativity and Innovation Management | (Hipple, 2005) |
| "Improving new product development innovation effectiveness by using problem-solving tools during the conceptual development phase: Integrating Design Thinking and TRIZ" | 2020 | Creativity and Innovation Management | (Da Silva et al., 2020) |
| "MorphoTRIZ - solving technical problems with a demand for multi-smart solutions" | 2010 | Creativity and Innovation Management | (Moehrle, 2010) |
| "The TRIZ resource analysis tool for solving management tasks: Previous classifications and their modification" | 2005 | Creativity and Innovation Management | (Mueller, 2005) |
| "Cause-and-effect function analysis" | 2010 | 5th IEEE International Conference on Management of Innovation and Technology, ICMIT2010 | (H. Kim et al., 2010) |
| "Lessons for TRIZ from Design Thinking and Lean 3P" | 2018 | Advances and Impacts of the Theory of Inventive Problem Solving: The TRIZ Methodology, Tools, and Case Studies | (Halas, 2018) |
| "New and emerging contradiction elimination tools" | 2005 | Creativity and Innovation Management | (D. Mann, 2005a) |
| "Systematic organizational conflicts identification and resolution using perception mapping and function relationship analysis" | 2014 | International Journal of Systematic Innovation | (Sheu & Tsai, 2014) |
| "A method for applying TRIZ to enhance brainstorming" | 2011 | 51st Annual Conference of SAVE International 2011 | |

Source: Authors' interpretation

- Su-field (substance) analysis - This tool belongs to the Contradiction Matrix category, which identifies and resolves contradictions in a problem. This technique (also known as vepol analysis in Russia) is used to define problems into standard (Familiar) and non-standard (Unfamiliar) problems (Dung, 1995; Regazzoni & Russo, 2011).
- Functional analysis - This tool also belongs to the Contradiction Matrix category, as it is used to identify the functions required by a system and the potential conflicts that may arise between them. Function analysis assesses identifying contradictions within the system by presenting an interconnected diagram depicting the harmful and useful functions of the system (Moehrle, 2010). For companies' smooth application of function analysis, Ideation International (2000) has developed a software tool called 'Problem Formulator™' (Moehrle & Wenzke, 2006). Functionality is used in the early stages of the problem-solving process. The primary goal of functional analysis is to identify the functions a system requires and the potential conflicts that may arise between them. This process involves breaking down the system into its components and analyzing how each part contributes to its overall function.
- Algorithm for inventive problem solving (ARIZ) - This tool is part of the Inventive Principles category and is a systematic approach for generating innovative solutions to problems. Algorithm for inventive problem solving (ARIZ): When the problem is non-standard or unfamiliar, ARIZ is used as the technique also includes an element of psychology not just based on laws of evolution and technical systems (Dung, 1995; Navas et al., 2015).
- 76 Standard Solutions; 76 standard rules of TRIZ - These tools belong to the Standard Solutions category, which involves identifying and applying solutions that have been successfully implemented in the past for similar problems (Da Silva et al., 2020; Dung, 1995).

- 40 Inventive Principles - This tool is also part of the Inventive Principles category and involves using a set of 40 principles to generate new and innovative solutions to a problem. The tool comes under the idea generation phase and follows a divergent thinking style (Birdi et al., 2012a).
- Contradictions - This tool is part of the Contradiction Matrix category and involves identifying and resolving contradictions that exist within a problem. TRIZ works with three types of contradictions: administrative contradictions (where the problem is only known), technical contradictions (where a change in one characteristic degrades the other), and physical contradictions (where two mutually contradictory states are present within a system) (Dung, 1995; Ilevbare et al., 2013a). Contradictions can already be established where problems are known or articulated using any problem analysis technique, such as function analysis, cause and effect diagram, force field analysis, or root cause analysis (RCA).

**Contradictory conditions:** The main task of problem analysis is to identify contradictions and to do so, three conditions must be met:

- What is the desired problem characteristic?
- There is an established method for achieving that characteristic.
- Some deteriorating characteristics must result from using the traditional method (Moehrle, 2005).

"Contradiction's examples for e-business: I want lots of inventory to have many choices for my customers ready to ship as soon as the customer orders something, but I want no inventory to have no carrying costs, no warehousing costs, and no surplus inventory if a particular product is not popular.

Solution: A b-web consists of customers, suppliers, and the organizing company, linked so that a customer order triggers suppliers to provide the parts needed to build that specific order".

- Ideality - This tool also belongs to the Contradiction Matrix category. It involves identifying a system's ideal state and the contradictions between the current and ideal states. TRIZ methodology works on the principle of ideality (J. Zhang et al., 2005) and works for achieving ideal final results (IFR) without the least negative effects (Hipple, 2005). "The degree of ideality is defined as useful functionality of a system minus all negative factors that diminish its value and divided by costs" (Souchkov & Sutcliffe, 2007). Systems evolved to the level of ideality by resolving contradictions and using system resources (Hipple, 2005). The ideal final result in customer terms can be "ease of accessing products a service without harm and cost" (D. Mann et al., 2000b).
- Patterns of evolution or Evolutionary trends - This tool belongs to the Patterns of Evolution category, which involves identifying the trends and patterns of how systems evolve and using this knowledge to generate innovative solutions. According to TRIZ, the technical system operates on clearly defined patterns that evolve through time, allowing for predicting trends and optimum solutions to issues (Ilevbare et al., 2013a; Livotov, 2008b). Biological evolution, increasing ideality, dynamisation and controllability, complexity-simplicity, evolution with matching and mismatching elements, non-uniform development, the evolution toward micro-level and the use of the field, and decreased human involvement are among the eight original trends identified by Altshuller (Slocum & Lundberg, 2001).
- Perception Mapping Method - This tool belongs to the Functional Analysis category, which is used to identify the functions required by a system and the potential conflicts that may arise between them. Perception mapping is an exploration of how different perceptions interact with each other. According to Darrell Mann, "lead to" relationships and establishing "Perception Mapping" can link various perceptions from different departments. Perception Mapping differentiates three chain modes: loop, collector, and conflict, giving individual perceptions different weights. Finally, creative concepts and a contradiction matrix are employed to settle conflict using weights to forecast the importance of such viewpoints to the situation (Sheu & Tsai, 2014).
- Root Conflict Analysis - This tool also belongs to the Functional Analysis category and is used to identify the root causes of conflicts within a system. Root conflict analysis is also a tool that is quite effective for business and management problems. RCA+ provides all possible causal chains associated with a single problem statement and draws out the conflicts hidden within a single situation (Souchkov, 2005). RCA+ is a powerful

and direct technique for mapping contradictions. The RCA+ is a cause-effect tree diagram, with nodes stating positive and negative effects/causes. They are usually constructed in a top-down mode, starting with a generally negative effect and then moving downwards by unfolding a chain of causes that leads the broad negative causes until a conflict/contradiction is achieved (Hsieh et al., 2016, 2016; C. Y. Huang & Abrego, 2014; Sheu & Tsai, 2014; Souchkov et al., 2007).

### 4.8 How can TRIZ methodology be combined with other problem-solving tools?

Researchers have made substantial efforts to complement the hit-and-trial method to create innovative solutions through psychological operators that enable thinking outside the box (Dung, 1995). For, e.g. creativity tools like 'brainstorming', 'cause and effect relationship', 'morphological analysis' (Moehrle, 2010), 'six thinking hats', 'smart little people' (Ilevbare et al., 2013a) these tools stimulate solutions that already exist. However, these psychology-based tools can be combined with TRIZ tools to accelerate the idea-generation phase by incorporating 40 inventive principles; contradiction tables would help eliminate contradictions identified in the idea-generation phase (Hipple, 2005).

(Moehrle, 2010) developed the concept of MorphoTRIZ for solving technical problems by combining the properties of morphological analysis, which dissects a system into subsystems and finds solutions by combining these subsystems. In contrast, TRIZ assesses finding contradictions within a system and gives solutions by eliminating them. Function analysis served to connect tools between the two problem-solving methodologies.

Another systemic innovation technique is design thinking. Alternative product concepts are produced and assessed for further development and testing when the target market is defined during the new product development phase; due to their complementarity, Design Thinking (DT) and TRIZ are the problem-solving approaches of choice. TRIZ is best known for its idea generation and selection processes, where TRIZ has a robust set of analytical tools to guide teams toward the final product concept. While design thinking is the most widely used methodology for directing project teams toward end-users, it is best known for its idea generation and selection processes (Da Silva et al., 2020). However, TRIZ has gained an overriding advantage among all the tools and techniques for solving abstract problems with specified directing mechanisms (J. Zhang et al., 2005). Combining TRIZ methodology with other problem-solving tools can result in a more comprehensive approach to innovation and problem-solving. By leveraging the strengths of each tool, businesses can develop solutions that are both creative and technically feasible.

## 5. Discussion and Conclusion

TRIZ is primarily and commonly utilized in technical fields; it is used less frequently in business and management issues. The analysis of highly cited articles (RQ2) reveals that they primarily focus on technical areas of TRIZ, highlighting the dominance of such topics in the existing literature. While these seminal articles and reputable journals are valuable resources for researchers, practitioners, and educators seeking insights into TRIZ's applications, it is evident that the number of publications in purely non-technical fields is relatively limited (RQ1, RQ2). Despite applying the subject filter of 'business and management,' the retrieved articles mostly pertain to technical aspects of these fields. This underscores the importance of not solely relying on standard matrices but instead gathering ground-level information to understand the specific applications of TRIZ in non-technical contexts.

The analysis of prominent authors and countries in the domain of TRIZ in business and management (RQ3) provides valuable insights into the global impact and contributions made by various researchers and institutions. However, a concern arises regarding the unequal distribution of impact, especially in India, the country of origin of some authors. In India, TRIZ remains relatively unknown and exclusive, despite its proven effectiveness and usefulness in the business and management domain. The keyword occurrence (RQ4) and the prominence of generic terms such as "Design," "product design," and "problem-solving" may mislead researchers in identifying relevant articles in the non-technical context of TRIZ. Therefore, in Section 4 (RQ5), we made a deliberate effort to assist beginners in comprehending TRIZ in non-technical areas by providing a basic description of the methodology applicable in these domains. By doing so, we aim to bridge the gap between technical and non-

technical applications of TRIZ and enable a better understanding of its potential in various business and management scenarios.

There are several challenges associated with the application of TRIZ, including the fact that it is difficult to learn due to its structure, that it requires an unusual amount of time commitment, and that there is a great deal of ambiguity about how to apply the theory because every field has used it according to their field requirements (Ilevbare et al., 2013a). To solve problems with TRIZ methodology, one must draw the right conflicts in terms of industry parameters. That further poses a problem in applying TRIZ methodology in management (Pang et al., 2012). The management field is more complex and human-centric, which makes the application of TRIZ more complex (ZHANG & LI, 2015). Therefore, translating management conflicts in TRIZ parameters is a challenge for many.

After analyzing and reviewing the literature based on TRIZ, it has become evident that TRIZ has been modified and used in every field per the requirements. Due to its strong problem-solving and innovative idea-generation capability, TRIZ holds immense potential in almost every field. However, there is less research on core business problems, more of which are related to the technical context. Company-based research is also unavailable on how different companies have applied TRIZ and the type of strategy the methodology used. Studies have been conducted lately in some of the core business domains such as human resources (C. Y. Huang & Abrego, 2014) and customization of women's fashion accessories (Chin-Min et al., 2013); (Deng & Lin, 2019), but still, there is a dearth of studies following central business methodologies, 31 business parameters, and business contradiction matrix. For a brief understanding of TRIZ parameters in business and management, one can refer to the ( TRIZ Journal – TRIZ Methodology Tools, Articles and Case StudiesThe TRIZ Journal | TRIZ Methodology, Tools, Articles and Case Studies, n.d.).

Experts can help beginners understand the nuances of TRIZ to make a non-technical person understand how the same 40 inventive principles can be used for solving non-technical contradictions analogously, which can be difficult to grasp without proper training and guidance. By working with an expert, beginners can gain a deeper understanding of the TRIZ methodology and learn how to use it in more complex and challenging situations. Subsequent research has thus far confirmed that the same 40 strategies are being used in achieving successful contradiction-breaking, win-win solutions in a business context; however, parameters have changed over time. Many TRIZ practitioners and experts continue to use and adapt the matrix for various industries and problem-solving contexts, and it remains an important part of the TRIZ methodology.

## 6. Future Research Directions

TRIZ is a core engineering methodology, while business is a human-centric approach. Therefore, there is difficulty in identifying the TRIZ contradictions in companies. Furthermore, because of this reason, we find a scarcity of research in understanding how businesses implement TRIZ applications. Therefore, future researchers can perform case studies on companies that use TRIZ methodology in their operations and provide an in-depth description of its application. The focus should therefore be on problem construction. Since business involves people and human-centred processes, human-centric approaches should be combined with TRIZ methodology to solve business and strategic management problems. A combination of design thinking with TRIZ would be the next big thing for innovations in business and management (Da Silva et al., 2020). As mentioned in the study, these approaches could include design thinking, six-hat thinking, and morphological analysis. To further explore the combination of TRIZ with human-centric approaches such as design thinking, six-hat thinking, and morphological analysis, future research could focus on the development of integrated problem-solving frameworks that blend TRIZ with these methodologies. The effectiveness of such frameworks could be tested in real-world business and management contexts through case studies and empirical research.

Root contradiction analysis or cause-effect chain analysis has been introduced to find contradictions in business and management problems. However, there is still a scarcity of papers in these areas. Through root cause analysis perception mapping, we can identify company and customer expectations and form a chain analysis describing the underlying issues. Research

could also focus on developing new techniques for identifying contradictions in business and management problems. For instance, researchers could explore the use of data mining and machine learning algorithms to automatically detect patterns and inconsistencies in large datasets related to business operations and decision-making. These approaches could be combined with root cause analysis and perception mapping to view the underlying issues comprehensively.

Brand management, marketing segmentation, human resource retention, and product portfolio are areas that previous researchers have studied. However, areas including financial aspects like portfolio management, risk management, or strategic areas like pricing policies have not been focused on yet. Future researchers can work on these areas as well.

Finally, future research could explore the role of TRIZ in facilitating organizational innovation and change. This could involve examining the use of TRIZ to identify opportunities for process improvement, organizational restructuring, and strategic innovation. Case studies of companies that have successfully used TRIZ to drive innovation and change could provide valuable insights into the potential of this methodology to transform businesses and management practices.

## References

Abdul Rahim, N. R., Abdullah, I., Yahya, N. A., Awang, M. N., Muhammad, S. Z., Ahmad Sabri, S., & Ahmad, N. N. (2022). Negotiation of needs towards halal talents sustainability. Journal of Islamic Marketing, 13(1), 20–44. https://doi.org/10.1108/JIMA-11-2019-0245

Abu Bakar, F. A., Subari, K., & Mohd Daril, M. A. (2015). Critical success factors of Lean Six Sigma deployment: A current review. International Journal of Lean Six Sigma, 6(4), 339–348. https://doi.org/10.1108/IJLSS-04-2015-0011

Ai, X., Jiang, Z., Zhang, H., & Wang, Y. (2020). Low-carbon product conceptual design from the perspectives of technical systems and human use. Journal of Cleaner Production, 244(xxxx), 118819. https://doi.org/10.1016/j.jclepro.2019.118819

Akay, D., Demıray, A., & Kurt, M. (2008). Collaborative tool for solving human factors problems in the manufacturing environment: The Theory of Inventive Problem Solving Technique (TRIZ) method. International Journal of Production Research, 46(11), 2913–2925. https://doi.org/10.1080/00207540600969774

Akmal, S., Hashim, N., Yahaya, S. H., Sihombing, H., & Yaakob, Y. (2018). Problem identification using function, mechanism, and attributes of product. Management Science Letters, 8(11), 1207–1214. https://doi.org/10.5267/j.msl.2018.8.004

Ali Mohammadi & Ahmad Forouzanfar. (2021). Application of TRIZ in Literature; an Algorithm for Systematic Story Writing Based on Mega Problems. International Journal of Systematic Innovation, 6(4). https://doi.org/10.6977/IJoSI.202106_6(4).0001

Kim, S. K. (2018). Effective new product development by using inventive problem solving tools in systematic innovation method. International Journal of Systematic Innovation, 5(2), 18–24.

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Arora, S. D., & Chakraborty, A. (2021). Intellectual structure of consumer complaining behavior (CCB) research: A bibliometric analysis. Journal of Business Research, 122, 60–74. https://doi.org/10.1016/j.jbusres.2020.08.043

Bacq, S., Drover, W., & Kim, P. H. (2021). Writing bold, broad, and rigorous review articles in entrepreneurship. Journal of Business Venturing, 36(6), 106147. https://doi.org/10.1016/j.jbusvent.2021.106147

Berdonosov, V. D., & Redkolis, E. V. (2016). TRIZ Evolutionary Approach: Main Points and Implementation. In Research and Practice on the Theory of Inventive Problem Solving (TRIZ) (pp. 95–111). Springer International Publishing. https://doi.org/10.1007/978-3-319-31782-3_6

Bianchi, M., Campodall'Orto, S., Frattini, F., & Vercesi, P. (2010). Enabling open innovation in small- and medium-sized enterprises: How to find alternative applications for your technologies. R&D

Management, 40(4), 414–431. https://doi.org/10.1111/j.1467-9310.2010.00613.x

Bigand, M., Deslee, C., & Yim, P. (2011). Innovative product design for students-enterprises linked projects. International Journal of Technology Management, 55(3–4), 238–249. https://doi.org/10.1504/IJTM.2011.041950

Birdi, K., Leach, D., & Magadley, W. (2012a). Evaluating the impact of TRIZ creativity training: An organizational field study. R and D Management, 42(4), 315–326. https://doi.org/10.1111/j.1467-9310.2012.00686.x

Birdi, K., Leach, D., & Magadley, W. (2012b). Evaluating the impact of TRIZ creativity training: An organizational field study: TRIZ training evaluation. R&D Management, 42(4), 315–326. https://doi.org/10.1111/j.1467-9310.2012.00686.x

Borgianni, Y., Frillici, F. S., & Rotini, F. (2018). How Problems Are Solved in TRIZ Literature: The Need for Alternative Techniques to Individuate the Most Suitable Inventive Principles. In S. Koziołek, L. Chechurin, & M. Collan (Eds.), Advances and Impacts of the Theory of Inventive Problem Solving (pp. 93–100). Springer International Publishing. https://doi.org/10.1007/978-3-319-96532-1_9

Bozbura, F. T., & Ersin, F. (2009). TRIZ (THEORY OF SOLVING INVENTIVE PROBLEMS) IN HUMAN CAPITAL MANAGEMENT.

Brad, S. (2009). Concurrent multifunction deployment (CMFD). International Journal of Production Research, 47(19), 5343–5376. https://doi.org/10.1080/00207540701564599

Brad, S., & Brad, E. (2018). Quantifying and Leading Innovation with TRIZ Within Competitiveness Strategies. In S. Koziołek, L. Chechurin, & M. Collan (Eds.), Advances and Impacts of the Theory of Inventive Problem Solving (pp. 65–73). Springer International Publishing. https://doi.org/10.1007/978-3-319-96532-1_6

Bramer, W. M., Rethlefsen, M. L., Kleijnen, J., & Franco, O. H. (2017). Optimal database combinations for literature searches in systematic reviews: A prospective exploratory study. Systematic Reviews, 6(1), 1–13. https://doi.org/10.1186/s13643-017-0644-y

Callon, M., Courtial, J. P., Turner, W. A., & Bauin, S. (1983). From translations to problematic networks: An introduction to co-word analysis. Social Science Information, 22(2), 191–235. https://doi.org/10.1177/053901883022002003

Cao, G., & Tan, R. (2007). FBES model for product conceptual design. International Journal of Product Development, 4(1–2), 22–36. https://doi.org/10.1504/IJPD.2007.011531

Cascini, G., & Russo, D. (2007). Computer-aided analysis of patents and search for TRIZ contradictions. International Journal of Product Development, 4(1–2), 52–67. https://doi.org/10.1504/IJPD.2007.011533

Cavallucci, D., & Khomenko, N. (2007). From TRIZ to OTSM-TRIZ: Addressing complexity challenges in inventive design. International Journal of Product Development, 4(1–2), 4–21. https://doi.org/10.1504/IJPD.2007.011530

Chai, K. H., Zhang, J., & Tan, K. C. (2005). A TRIZ-based method for new service design. Journal of Service Research, 8(1), 48–66. https://doi.org/10.1177/1094670505276683

Chang, W. J. (2012). A new perspective on EFL teaching: Applying fuzzy QFD in TRIZ for teaching quality improvement. International Journal of Systematic Innovation, 2(2), 43–53.

Chechurin, L., & Borgianni, Y. (2016). Understanding TRIZ through the review of top cited publications. Computers in Industry, 82, 119–134. https://doi.org/10.1016/j.compind.2016.06.002

Chin-Min, L., Wang, W. Y. C., & Ying-Li, L. (2013). Innovative design of customized fashion handbags. International Journal of Systematic Innovation, 2(4), 01–19.

Chun-Ming Yang, Ching-Han Kao, Thu-Hua Liu, & Fu-Hsien Yang. (2010). Applying TRIZ Principles to Construct Creative Universal Design. International Journal of Systematic Innovation, 1(1). https://doi.org/10.6977/IJoSI.201001_1(1).0004

Chybowska, D., Chybowski, L., Wiśnicki, B., Souchkov, V., & Krile, S. (2019). Analysis of the opportunities to implement the BIZ-TRIZ mechanism. Engineering Management in Production and

Services, 11(2), 19–30. https://doi.org/10.2478/emj-2019-0008

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science Mapping Software Tools: Review, Analysis, and Cooperative Study Among Tools. Journal of the American Society for Information Science and Technology, 62(7), 1382–1402. https://doi.org/10.1002/asi

Comerio, N., & Strozzi, F. (2019). Tourism and its economic impact: A literature review using bibliometric tools. Tourism Economics, 25(1), 109–131. https://doi.org/10.1177/1354816618793762

D. Daniel Sheu & Chia Hung Chen. (2011). TRIZ Problem-solving Model for Multiple-to-Multiple Parameter Contradictions Using Case-based Reasoning. International Journal of Systematic Innovation, 1(3). https://doi.org/10.6977/IJoSI.201101_1(3).0002

Da Silva, R. H., Kaminski, P. C., & Armellini, F. (2020). Improving new product development innovation effectiveness by using problem solving tools during the conceptual development phase: Integrating Design Thinking and TRIZ. Creativity and Innovation Management, 29(4), 685–700. https://doi.org/10.1111/caim.12399

de Jesus Pacheco, D. A., ten Caten, C. S., Jung, C. F., Navas, H. V. G., Cruz-Machado, V. A., & Tonetto, L. M. (2019). State of the art on the role of the Theory of Inventive Problem Solving in Sustainable Product-Service Systems: Past, Present, and Future. Journal of Cleaner Production, 212(2019), 489–504. https://doi.org/10.1016/j.jclepro.2018.11.289

Deng, J., & Lin, T. H. (2019). Design for the adjustable high heel. International Journal of Systematic Innovation, 5(3), 1–16.

Dew, J. (2006). TRIZ: A Creative Breeze for Quality Professionals. PROBLEM SOLVING.

Domb, E., Miller, J., MacGran, E., & Slocum, M. (2011). Explanation of the 39 Parameters of the Contradiction Table ( Matrix ). 1–12.

Dong-sheng, Z., Yue, H., & Yuan, Y. (2007). An Exploring of the Path of Management Innovation Based on Conflicts Solving. 2007 International Conference on Management Science and Engineering, 855–860. https://doi.org/10.1109/ICMSE.2007.4421953

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. Journal of Business Research, 133, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Dung, P. (1995). TRIZ: Inventive Creativity Based On The Laws of Systems Development. Creativity and Innovation Management, 4(1), 19–29. https://doi.org/10.1111/j.1467-8691.1995.tb00198.x

Ferryanto, L. (2015). Structuring a design for Six Sigma project: Paper helicopter robust and optimal design. International Journal of Six Sigma and Competitive Advantage, 9(2–4), 150–173. https://doi.org/10.1504/IJSSCA.2015.074962

Fresner, J., Jantschgi, J., Birkel, S., Bärnthaler, J., & Krenn, C. (2010). The theory of inventive problem solving (TRIZ) as an option generation tool within cleaner production projects. Journal of Cleaner Production, 18(2), 128–136. https://doi.org/10.1016/j.jclepro.2009.08.012

Frobisher, P. (2021). A Strategic Model of Innovation. International Journal of Systematic Innovation, 6(3), 19–29. https://doi.org/10.6977/IJoSI.202103_6(3).0003

Gazem, N., Rahman, A. A., Saeed, F., & Iahad, N. A. (2018). Design science research roadmap model for information systems projects: A case study. International Journal of Information Technology Project Management, 9(3), 1–19. https://doi.org/10.4018/IJITPM.2018070101

Gitlow, H., Zuo, Q. “amy,” Ullmann, S. G., Zambrana, D., Campo, R. E., Lubarsky, D., & Birnbach, D. J. (2013). The causes of never events in hospitals. International Journal of Lean Six Sigma, 4(3), 338–344. https://doi.org/10.1108/IJLSS-03-2013-0016

Glaser, M., & Miecznik, B. (2009a). TRIZ for Reverse Inventing in Market Research: A Case Study from WITTENSTEIN AG, Identifying New Areas of Application of a Core Technology. Creativity and Innovation Management, 18(2), 90–100. https://doi.org/10.1111/j.1467-8691.2009.00516.x

Glaser, M., & Miecznik, B. (2009b). TRIZ for reverse inventing in market research: A case study from Wittenstein Ag, identifying new areas of application of a core technology. Creativity and Innovation Management, 18(2), 90–100. https://doi.org/10.1111/j.1467-8691.2009.00516.x

Göçmen, F. D. (2020). Using TRIZ in Management Problems Solving. In Studies on Interdisciplinary Economics and Business - Volume III.

Guo, J., Peng, Q., Zhang, L., Tan, R., & Zhang, J. (2020). Estimation of product success potential using product value. International Journal of Production Research, 0(0), 1–17. https://doi.org/10.1080/00207543.2020.1788733

Halas, M. (2018). Lessons for TRIZ from Design Thinking and Lean 3P. In S. Koziołek, L. Chechurin, & M. Collan (Eds.), Advances and Impacts of the Theory of Inventive Problem Solving (pp. 159–168). Springer International Publishing. https://doi.org/10.1007/978-3-319-96532-1_15

Hipple, J. (2005). The integration of TRIZ with other ideation tools and processes as well as with psychological assessment tools. Creativity and Innovation Management, 14(1), 22–33. https://doi.org/10.1111/j.1476-8691.2005.00322.x

Hoch, N. B., & Brad, S. (2021). Managing business model innovation: An innovative approach towards designing a digital ecosystem and multi-sided platform. Business Process Management Journal, 27(2), 415–438. https://doi.org/10.1108/BPMJ-01-2020-0017

Hsia, T. C., Liao, R. C., & Huang, S. C. (2015). Enhancing the quality of rice milling by systematic innovation techniques. International Journal of Systematic Innovation, 3(4), 27–36.

Hsieh, W. L., Ou, Y. S., & Pai, T. Y. (2016). Application of TRIZ in inventive product design: A case study on baking tray rack. International Journal of Systematic Innovation, 4(2), 30–38.

Hu S.-J., Y. L.-Y. (2019). Application of ergonomics and TRIZ to designing a device to assist putting on and taking off shoes. International Journal of Systematic Innovation, 5(4). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084747147&partnerID=40&md5=eecc6cc6552933247a3aec2e1097d09c

Hua, Z., Huang, F., & Wang, W. (2007). A method of product improvement by integrating FA with TRIZ software tools. International Journal of Product Development, 4(1–2), 122–135. https://doi.org/10.1504/IJPD.2007.011538

Hua, Z., Yang, J., Coulibaly, S., & Zhang, B. (2006). Integration TRIZ with problem-solving tools: A literature review from 1995 to 2006. International Journal of Business Innovation and Research, 1(1/2), 111. https://doi.org/10.1504/IJBIR.2006.011091

Huang, C. Y., & Abrego, R. B. (2014). Systematic innovation for the retention and development of human talent. International Journal of Systematic Innovation, 3(2), 32–43.

Huang, S. C. (2020). Exploring the formulation of book pricing strategies in economics with a TRIZ approach to business management. International Journal of Systematic Innovation, 6(1), 46–54.

Ilevbare, I. M., Probert, D., & Phaal, R. (2013a). A review of TRIZ, and its benefits and challenges in practice. Technovation, 33(2–3), 30–37. https://doi.org/10.1016/j.technovation.2012.11.003

Ilevbare, I. M., Probert, D., & Phaal, R. (2013b). A review of TRIZ, and its benefits and challenges in practice. Technovation, 33(2–3), 30–37. https://doi.org/10.1016/j.technovation.2012.11.003

Ilevbare, I. M., Probert, D., & Phaal, R. (2013c). A review of TRIZ, and its benefits and challenges in practice. Technovation, 33(2–3), 30–37. https://doi.org/10.1016/j.technovation.2012.11.003

Jones, E., Mann, D., Harrison, D., & Stanton, N. (2001). An eco-innovation case study of domestic dishwashing through the application of TRIZ tools. Creativity and Innovation Management, 10(1), 3–14. https://doi.org/10.1111/1467-8691.00186

Jyhjeng Deng & Teng-Hsuan Lin. (2019). Design for the Adjustable High Heel. International Journal of Systematic Innovation, 5(3). https://doi.org/10.6977/IJoSI.201903_5(3).0001

Kandukuri, S., Günay, E. E., Al-Araidah, O., & Okudan Kremer, G. E. (2021). Inventive solutions for

remanufacturing using additive manufacturing: ETRIZ. Journal of Cleaner Production, 305, 126992. https://doi.org/10.1016/j.jclepro.2021.126992

Karaulova, T., & Bashkite, V. (2016). Decision-making framework for used industrial equipment. Engineering Economics, 27(1), 23–31. https://doi.org/10.5755/j01.ee.27.1.8618

Karnjanasomwong, J., & Thawesaengskulthai, N. (2019). Dynamic sigma-TRIZ solution model for manufacturing improvement and innovation, a case study in Thailand. International Journal of Six Sigma and Competitive Advantage, 11(2–3), 114–156. https://doi.org/10.1504/IJSSCA.2019.101405

Kim, H., Choi, S., Jeong, C., & Kim, K. (2010). Cause-and-effect function analysis. 2010 IEEE International Conference on Management of Innovation & Technology, 518–523. https://doi.org/10.1109/ICMIT.2010.5492765

Kim, S., & Yoon, B. (2012). Developing a process of concept generation for new product-service systems: A QFD and TRIZ-based approach. Service Business, 6(3), 323–348. https://doi.org/10.1007/s11628-012-0138-x

Knott, D. (2001). The place of TRIZ in a holistic design methodology. Creativity and Innovation Management, 10(2), 126–133. https://doi.org/10.1111/1467-8691.00213

Kraus, S., Breier, M., & Dasí-Rodríguez, S. (2020). The art of crafting a systematic literature review in entrepreneurship research. International Entrepreneurship and Management Journal, 16(3), 1023–1042. https://doi.org/10.1007/s11365-020-00635-4

Kraus, S., Breier, M., Lim, W. M., Dabić, M., Kumar, S., Kanbach, D., Mukherjee, D., Corvello, V., Piñeiro-Chousa, J., Liguori, E., Palacios-Marqués, D., Schiavone, F., Ferraris, A., Fernandes, C., & Ferreira, J. J. (2022). Literature reviews as independent studies: Guidelines for academic practice. Review of Managerial Science, 16(8), 2577–2595. https://doi.org/10.1007/s11846-022-00588-8

Lee, D., Kim, T., Lee, D., Lim, H., Cho, H., & Kang, K. I. (2020). Development of an advanced composite system form for constructability improvement through a design for Six Sigma process. Journal of Civil Engineering and Management, 26(4), 364–379. https://doi.org/10.3846/jcem.2020.12188

Lee, T. R., Choy, K. L., Hsu, M. C., & Cassia, F. (2017). Developing a comprehensive brand evaluation system with the support of TRIZ to formulate brand strategies. International Journal of Business Excellence, 11(1), 38–57. https://doi.org/10.1504/IJBEX.2017.080603

Lee, T. R., Hsieh, Y. W., Dadura, A. M., & Wu, J. W. (2011). Applying TRIZ theory for industry development strategies under dynamic environment—The case of Taiwanese Jing-Ming commercial district a. International Journal of Value Chain Management, 5(1), 25–51. https://doi.org/10.1504/IJVCM.2011.041166

Lee, T.-R. (Jiun-S., Liao, Y.-C., & Li, J.-M. (2011). Marketing Strategies of Fishery Products for Supermarkets and Farmers' Markets in Taiwan. Journal of Food Products Marketing, 17(4), 420–440. https://doi.org/10.1080/10454446.2011.583185

Lee, T.-R., Sinnarong, N., Hsu, Y.-H., Lan, H.-Y., Yeh, C.-H., & Hilletofth, P. (2021). The sequence of strategies when establishing Taiwanese restaurants in Thailand. European Business Review, 33(2), 181–203. https://doi.org/10.1108/EBR-03-2017-0050

Lim, C., Yun, D., Park, I., & Yoon, B. (2018). A systematic approach for new technology development by using a biomimicry-based TRIZ contradiction matrix. Creativity and Innovation Management, 27(4), 414–430. https://doi.org/10.1111/caim.12273

Lim, W. M., Kumar, S., & Ali, F. (2022). Advancing knowledge through literature reviews: 'What', 'why', and 'how to contribute.' The Service Industries Journal, 42(7–8), 481–513. https://doi.org/10.1080/02642069.2022.2047941

Lin Chin-Min, Wang Yue-Chi, & Liu Ying-Li. (2013). Innovative Design of Customized Fashion Handbags. International Journal of Systematic Innovation, 2(4). https://doi.org/10.6977/IJoSI.201312_2(4).0001

Lin Y.-J., Deng J., P. T.-Y. (2018). A case study of using TRIZ for business and management to facilitate innovation and improvement of the convenience stores, an example of seven-eleven convenience

stores in Hsinchu County. International Journal of Systematic Innovation, 5(1).

Livotov, P. (2008a). Innovative Product Development and Theory of Inventive Problem Solving. I SSN.

Livotov, P. (2008b). TRIZ and Innovation Management. Value Engineering, April, 1–30.

Mann, D. (2001a). 'A or B' to 'A and B.' Creativity and Innovation Management, 10(2), 134–138. https://doi.org/10.1111/1467-8691.00214

Mann, D. (2001b). An Introduction to TRIZ: The Theory of Inventive Problem Solving. Creativity and Innovation Management, 10(2), 123–125. https://doi.org/10.1111/1467-8691.00212

Mann, D. (2005a). New and emerging contradiction elimination tools. Creativity and Innovation Management, 14(1), 14–21. https://doi.org/10.1111/j.1467-8691.2005.00321.x

Mann, D. (2005b). SOMEONE, SOMEWHERE REALLY DID ALREADY INVENT THE WHEEL YOU'RE ABOUT TO RE-INVENT.

Mann, D. (2021). Matrix 2022: Re-imagining the Contradiction Matrix. In Y. Borgianni, S. Brad, D. Cavallucci, & P. Livotov (Eds.), Creative Solutions for a Sustainable Development (Vol. 635, pp. 197–208). Springer International Publishing. https://doi.org/10.1007/978-3-030-86614-3_16

Mann, D. (2018a). Business Matrix 3.0. IFR Press.

Mann, D., & Cole, A. C. (2010). Connecting real IP value to business strategy. International Journal of Systematic Innovation, 1(2), 2–9.

Mann, D., & Dewulf, S. (2016). Updating the Contradiction Matrix. Matrix, 44(1275).

Mann, D. L. (2002). Hands-on Systematic Innovation. 471.

Mann, D., Park, A. Y.-B. B., & Road, K. (2000a). Application of TRIZ Tools in a Non-Technical Problem Context.

Mann, D., Park, A. Y.-B. B., & Road, K. (2000b). Application of TRIZ Tools in a Non-Technical Problem Context.

Mann, D., Park, A. Y.-B. B., & Road, K. (2002). Systematic Win-Win Problem Solving In A Business Environment.

Mann, D., Park, A. Y.-B. B., Road, K., Bs, C., & Domb, E. (2001). Using TRIZ to Overcome Business Contradictions: Profitable E-Commerce.

Mann, D., & Spain, E. (2008). Systematic win-win problem solving in a stakeholder-conflict business environment. 9th International Value Management Conference - Achieving Sustainable Values through Collaboration.

Mansor, M. R., Shaharuzaman, M. A., Tahir, M. M., Akop, M. Z., Salim, M. A., & Zainudin, A. Z. (2017). Product design improvement Of water dispenser tap using TRIZ method. Journal of Advanced Manufacturing Technology, 11(1 Special Issue), 101–111.

Meshal Bader MalAllah, Maryam Isa Alshirawi, & Fatima Ahmad AL-Jasim. (2022). The Effect of a Program Based on TRIZ Theory to Develop the Creative Thinking Skills Among Male Students with Mild Intellectual Disability. International Journal of Systematic Innovation, 7(2). https://doi.org/10.6977/IJoSI.202206_7(2).0001

Moehrle, M. G. (2005). What is TRIZ? From conceptual basics to a framework for research. Creativity and Innovation Management, 14(1), 3–13. https://doi.org/10.1111/j.1476-8691.2005.00320.x

Moehrle, M. G. (2010). MorphoTRIZ - solving technical problems with a demand for multi-smart solutions. Creativity and Innovation Management, 19(4), 373–384. https://doi.org/10.1111/j.1467-8691.2010.00582.x

Moehrle, M. G., & Paetz, H. (2014). Using TRIZ inventive principles for the analysis of similarities and differences in inventive thinking: A case study of inventions in the field of solar cell modules comparing Japanese and European engineers. International Journal of Technology Intelligence and Planning, 10(2), 150–165. https://doi.org/10.1504/IJTIP.2014.068019

Moehrle, M. G., & Wenzke, S. (2006). Exploring Problems with Function Analysis. Experimental Insights for Team Management. Creativity and Innovation Management, 15(2), 195–206. https://doi.org/10.1111/j.1467-8691.2006.00382.x

Monteiro, J. J. (2012). TRIZ supporting the project management effectiveness. International Journal of Systematic Innovation, 2(2), 24–42.

Mueller, S. (2005). The TRIZ resource analysis tool for solving management tasks: Previous cError: Failed to load citeproc-js enginelassifications and their modification. Creativity and Innovation Management, 14(1), 43–58. https://doi.org/10.1111/j.1467-8691.2005.00324.x

Mukherjee, D., Lim, W. M., Kumar, S., & Donthu, N. (2022). Guidelines for advancing theory and practice through bibliometric research. Journal of Business Research, 148, 101–115. https://doi.org/10.1016/j.jbusres.2022.04.042

Muruganantham, V. R., Krishnan, P. N., & Arun, K. K. (2014). Integrated application of TRIZ with lean in the manufacturing process in a machine shop for productivity improvement. International Journal of Productivity and Quality Management, 13(4), 414–429. https://doi.org/10.1504/IJPQM.2014.062220

Muruganantham, V. R., Navaneetha Krishnan, P., & Arun, K. K. (2013). Performance improvement and cost minimisation for manufacturing components in a fabrication plant by the application of Lean with TRIZ principles. International Journal of Productivity and Quality Management, 12(4), 449–465. https://doi.org/10.1504/IJPQM.2013.056737

Nakagawa, T. (2018). TRIZ/CrePS Approach to the Social Problems of Poverty: 'Liberty vs. Love' Is Found the Principal Contradiction of the Human Culture. In S. Koziołek, L. Chechurin, & M. Collan (Eds.), Advances and Impacts of the Theory of Inventive Problem Solving (pp. 179–188). Springer International Publishing. https://doi.org/10.1007/978-3-319-96532-1_17

Nassar, N., & AbouRizk, S. (2016). Introduction to Techniques for Resolving Project Performance Contradictions. Journal of Construction Engineering and Management, 142(8), 04016027. https://doi.org/10.1061/(asce)co.1943-7862.0001140

Navas, H. V. G., Tenera, A. M. B. R., & Cruz Machado, V. A. (2015). Integrating TRIZ in project management processes: An ARIZ contribution. Procedia Engineering, 131, 224–231. https://doi.org/10.1016/j.proeng.2015.12.381

Negny, S., Belaud, J. P., Cortes Robles, G., Roldan Reyes, E., & Ferrer, J. B. (2012). Toward an eco-innovative method based on a better use of resources: Application to chemical process preliminary design. Journal of Cleaner Production, 32, 101–113. https://doi.org/10.1016/j.jclepro.2012.03.023

Nikulin, C., Solis, P., & Mónica, L. C. (2018). A methodology to improve the decision-making process: Integration of system dynamics models and decision theory with TRIZ. International Journal of Knowledge and Systems Science, 9(1), 59–81. https://doi.org/10.4018/IJKSS.2018010104

OuYang, K., & Weng, C. S. (2011). A New Comprehensive Patent Analysis Approach for New Product Design in Mechanical Engineering. Technological Forecasting and Social Change, 78(7), 1183–1199. https://doi.org/10.1016/j.techfore.2011.02.012

Palmatier, R. W., Houston, M. B., & Hulland, J. (2018). Review articles: Purpose, process, and structure. Journal of the Academy of Marketing Science, 46(1), 1–5. https://doi.org/10.1007/s11747-017-0563-4

Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? International Business Review, 29(4), 101717. https://doi.org/10.1016/j.ibusrev.2020.101717

Paul, J., Merchant, A., Dwivedi, Y. K., & Rose, G. (2021). Writing an impactful review article: What do we know and what do we need to know? Journal of Business Research, 133, 337–340. https://doi.org/10.1016/j.jbusres.2021.05.005

Puccio, G. J., Firestien, R. L., Coyle, C., & Masucci, C. (2006). A Review of the Effectiveness of CPS Training: A Focus on Workplace Issues. Creativity and Innovation Management, 15(1), 19–33. https://doi.org/10.1111/j.1467-8691.2006.00366.x

Putri, N. T., Sutanto, A., & Bifadhlih, N. (2018). The improvement of thresher design by using the integration of TRIZ and QFD approach.

International Journal of Productivity and Quality Management, 25(4), 459–479. https://doi.org/10.1504/IJPQM.2018.096083

Regazzoni, D., & Russo, D. (2011). TRIZ tools to enhance risk management. Procedia Engineering, 9, 40–51. https://doi.org/10.1016/j.proeng.2011.03.099

Ruchti, B., Ag, D., & Livotov, P. (2001). TRIZ-based Innovation Principles and a Process for Problem Solving in Business and Management. 9.

Ruchti, B., Ag, D., & Livotov, P. (2002). TRIZ-based Innovation Principles and a Process for Problem Solving in Business and Management.

Ruchti, B., & Livotov, P. (2001). TRIZ-based innovation principles and a process for problem solving in business and management. The TRIZ Journal, November, 1–9.

Russo, D., & Birolini, V. (2012). A TRIZ based method for making systematic innovation in Ecodesign. International Journal of Systematic Innovation, 2(1), 22–32.

Russo, D., Regazzoni, D., & Montecchi, T. (2011). Methodological enhancements for concept exploration in product design. International Journal of Product Development, 15(1–3), 26–53. https://doi.org/10.1504/IJPD.2011.043660

Russo, D., Rizzi, C., & Montelisciani, G. (2014). Inventive guidelines for a TRIZ-based eco-design matrix. Journal of Cleaner Production, 76, 95–105. https://doi.org/10.1016/j.jclepro.2014.04.057

Sakao, T. (2007a). A QFD-centred design methodology for environmentally conscious product design. International Journal of Production Research, 45(18–19), 4143–4162. https://doi.org/10.1080/00207540701450179

Sakao, T. (2007b). A QFD-centred design methodology for environmentally conscious product design. International Journal of Production Research, 45(18–19), 4143–4162. https://doi.org/10.1080/00207540701450179

Schöfer, M., Maranzana, N., Aoussat, A., Bersano, G., & Buisine, S. (2018). Distinct and combined effects of disciplinary composition and methodological support on problem solving in groups. Creativity and Innovation Management, 27(1), 102–115. https://doi.org/10.1111/caim.12258

Schut, J. (2016). Using TRIZ in the Social Sciences: Possibilities and Limitations. In L. Chechurin (Ed.), Research and Practice on the Theory of Inventive Problem Solving (TRIZ) (pp. 237–241). Springer International Publishing. https://doi.org/10.1007/978-3-319-31782-3_14

Shahin, A., Shahrestani, H. V., & Iraj, E. B. (2013). Proposing a contradiction matrix by developing KANSEI engineering based on theory of inventive problem solving (TRIZ). International Journal of Business Innovation and Research, 7(6), 717–729. https://doi.org/10.1504/IJBIR.2013.056743

Shanmugaraja, M., Nataraj, M., & Gunasekaran, N. (2012). Total performance excellence—A model to implement Six Sigma in service organisations. International Journal of Six Sigma and Competitive Advantage, 7(2–4), 209–242. https://doi.org/10.1504/IJSSCA.2012.053471

Shanmugaraja, M., Nataraj, M., & Gunasekaran, N. (2013). Total performance excellence—A model for successful implementation of Six Sigma. International Journal of Procurement Management, 6(3), 297–328. https://doi.org/10.1504/IJPM.2013.053651

Sheu, D. D., & Tsai, M. H. (2014). Systematic organizational conflicts identification and resolution using perception mapping and function relationship analysis. International Journal of Systematic Innovation, 3(2), 16–31.

Slocum, M. S., & Lundberg, C. O. (2001). Technology Forecasting: From Emotional to Empirical. Creativity and Innovation Management, 10(2), 139–152. https://doi.org/10.1111/1467-8691.00215

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Sojka, V., & Lepšík, P. (2020). Use of TRIZ, and TRIZ with Other Tools for Process Improvement: A Literature Review. Emerging Science Journal, 4(5), 319–335. https://doi.org/10.28991/esj-2020-01234

Soti, A., Shankar, R., & Kaushal, O. P. (2012a). Six sigma in manufacturing for micro, small and medium enterprises in India. International Journal of Productivity and Quality Management, 9(1), 61–81. https://doi.org/10.1504/IJPQM.2012.044012

Soti, A., Shankar, R., & Kaushal, O. P. (2012b). Six Sigma with innovation tool kit of TRIZ. International Journal of Business Innovation and Research, 6(2), 220–237. https://doi.org/10.1504/IJBIR.2012.045638

Souchkov, V. (n.d.). TRIZ and Systematic Business Model Innovation.

Souchkov, V., Hoeboer, R., & Van Zutphen, M. (2007). TRIZ for business: Application of RCA+ to analyse and solve business and management problems. TRIZ Journal, 1–9.

Souchkov, V., & Sutcliffe, R. (2007). BREAKTHROUGH THINKING WITH TRIZ FOR BUSINESS AND MANAGEMENT: AN OVERVIEW BREAKTHROUGH THINKING WITH TRIZ FOR BUSINESS AND MANAGEMENT: AN OVERVIEW In conflict rooted, With inventive principles A problem solved! March.

Spreafico, C. (2021). Quantifying the advantages of TRIZ in sustainability through life cycle assessment. Journal of Cleaner Production, 303. https://doi.org/10.1016/j.jclepro.2021.126955

Stratton, R., & Mann, D. (2003). Systematic innovation and the underlying principles behind TRIZ and TOC. Journal of Materials Processing Technology, 139(1-3 SPEC), 120–126. https://doi.org/10.1016/S0924-0136(03)00192-4

Su-Chen Huang. (2020). Exploring the Formulation of Book Pricing Strategies in Economics with a TRIZ Approach to Business Management. International Journal of Systematic Innovation, 6(1). https://doi.org/10.6977/IJoSI.202003_6(1).0004

Sui, J., Hu, Y., & Yu, J. (2009). Research on the strategy and implementation in stages of organizational learning based on TRIZ theory. 2009 16th International Conference on Industrial Engineering and Engineering Management, 665–669. https://doi.org/10.1109/ICIEEM.2009.5344506

Teplov, R., Chechurin, L., & Podmetina, D. (2017). TRIZ as innovation management tool: Insights from academic literature.

Thanabalu, K. S., Lee, C., & Danni, C. (2012). Enhancing workplace safety with TRIZ. 2012 IEEE International Conference on Management of Innovation & Technology (ICMIT), 652–657. https://doi.org/10.1109/ICMIT.2012.6225883

The TRIZ Journal – TRIZ Methodology, Tools, Articles and Case StudiesThe TRIZ Journal | TRIZ Methodology, Tools, Articles and Case Studies. (n.d.). Retrieved April 10, 2021, from https://TRIZ-journal.com/

Tiwary, N. K., Kumar, R. K., Sarraf, S., Kumar, P., & Rana, N. P. (2021). Impact assessment of social media usage in B2B marketing: A review of the literature and a way forward. Journal of Business Research, 131, 121–139. https://doi.org/10.1016/j.jbusres.2021.03.028

Tsai, J. P., Lee, R. S., & Wang, M. C. (2011). Development of eco-innovative framework and methodology for product design. International Journal of Systematic Innovation, 1(3), 42–51.

Tursch, P., Goldmann, C., & Woll, R. (2015). Integration of TRIZ into quality function deployment. Management and Production Engineering Review, 6(2), 56–62. https://doi.org/10.1515/mper-2015-0017

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

Vidal, R., Salmeron, J. L., Mena, A., & Chulvi, V. (2015). Fuzzy Cognitive Map-based selection of TRIZ (Theory of Inventive Problem Solving) trends for eco-innovation of ceramic industry products. Journal of Cleaner Production, 107, 202–214. https://doi.org/10.1016/j.jclepro.2015.04.131

Wang, K. (2019). Towards a Taxonomy of Idea Generation Techniques. Foundations of Management, 11(1), 65–80. https://doi.org/10.2478/fman-2019-0006

Wu, C., Chen, T., Li, Z., & Liu, W. (2021). A function-oriented optimising approach for smart product

service systems at the conceptual design stage: A perspective from the digital twin framework. Journal of Cleaner Production, 297, 126597. https://doi.org/10.1016/j.jclepro.2021.126597

Yamashina, H., Ito, T., & Kawada, H. (2002). Innovative product development process by integrating QFD and TRIZ. International Journal of Production Research, 40(5), 1031–1050. https://doi.org/10.1080/00207540110098490

Yang, C. J., & Chen, J. L. (2011a). Accelerating preliminary eco-innovation design for products that integrates case-based reasoning and TRIZ method. Journal of Cleaner Production, 19(9–10), 998–1006. https://doi.org/10.1016/j.jclepro.2011.01.014

Yang, C. J., & Chen, J. L. (2011b). Accelerating preliminary eco-innovation design for products that integrates case-based reasoning and TRIZ method. Journal of Cleaner Production, 19(9–10), 998–1006. https://doi.org/10.1016/j.jclepro.2011.01.014

Yang, C. M., Kao, C. H., Liu, T. H., & Yang, F. H. (2010). Applying TRIZ principles to construct creative universal design. International Journal of Systematic Innovation, 1(1), 49–60.

Yang, K. (2005). Design for Six Sigma and value creation. International Journal of Six Sigma and Competitive Advantage, 1(4), 355–368. https://doi.org/10.1504/IJSSCA.2005.008502

Yong Won Song. (2021). Two Aspects of Function for Technical Systems. International Journal of Systematic Innovation, 6(6). https://doi.org/10.6977/IJoSI.202112_6(6).0001

Yonghai, L., & Jianhua, L. (2009). Business Model Innovation of Enterprises by Physical Contradiction Means of TRIZ. 2009 International Conference on Electronic Commerce and Business Intelligence, 529–532. https://doi.org/10.1109/ECBI.2009.28

Yuriy Danilovskiy, Sergei Ikovenko, & Alexander Priven. (2014). Teaching Disadvantage as an Appearance of Contradiction in Basic TRIZ Education. International Journal of Systematic Innovation, 3(2). https://doi.org/10.6977/IJoSI.201409_3(2).0002

Zhang, F. Y., & Xu, Y. S. (2007). Research on technical strategy for new product development based on TRIZ evolution theory. International Journal of Product Development, 4(1–2), 96–108. https://doi.org/10.1504/IJPD.2007.011536

Zhang, J., Chai, K. H., & Tan, K. C. (2005). Applying TRIZ to Service Conceptual Design: An Exploratory Study. Creativity and Innovation Management, 14(1), 34–42. https://doi.org/10.1111/j.1467-8691.2005.00323.x

Zhang, P., Ghabri, S., Cavallucci, D., & Zanni-Merk, C. (2018). Can Altshuller's Matrix Be Skipped Using CBR and Semantic Similarity Reasoning? In S. Koziołek, L. Chechurin, & M. Collan (Eds.), Advances and Impacts of the Theory of Inventive Problem Solving (pp. 27–37). Springer International Publishing. https://doi.org/10.1007/978-3-319-96532-1_3

Zhang, Y., Zhang, G., Chen, H., Porter, A. L., Zhu, D., & Lu, J. (2016). Topic analysis and forecasting for science, technology and innovation: Methodology with a case study focusing on big data research. Technological Forecasting and Social Change, 105, 179–191. https://doi.org/10.1016/j.techfore.2016.01.015

Zouaoua, D., Crubleau, P., Mathieu, J. P., Thiéblemont, R., & Richir, S. (2010). TRIZ and the difficulties in marketing management applications. PICMET '10 - Portland International Center for Management of Engineering and Technology, Proceedings - Technology Management for Global Economic Growth, January, 807–816.

Zouaoua, D., Crubleau, P., Mathieu, J.-P., Thiéblemont, R., & Richir, S. (2010). TRIZ and the Difficulties in Marketing Management Applications.