
**TRIZ FOR SUSTAINABLE PRODUCT LIFECYCLE MANAGEMENT
BASED ON ISO14067
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ABSTRACTS

Within the today's rapidly changing global world, notion of sustainability has become more important to corporate operations across all industries (Kaliteevskii, Bryksin, & Chechurin, 2021). With rising concern about environmental degradation, resource depletion, and social responsibility, businesses are under increased pressure to create and manage products that reduce their environmental footprint while serving the demands of customers and stakeholders (Spreafico, 2022). In retort to these issues, the application of TRIZ (Theory of Inventive Problem Solving) concepts to Product Lifecycle Management has emerged as a potential strategy (Hameed, et al., 2022).

TRIZ, created by Genrich Altshuller in the mid twentieth century, provides a systematic approach to problem solving and creativity (Tandiono, and Rau, 2022). Its cornerstone is the detection of inconsistencies within systems and the use of creative concepts to overcome them, resulting in the development of new solutions (Kaliteevskii, Bryksin, & Chechurin, 2021).

The combination of TRIZ and sustainable product lifecycle management provides a compelling paradigm for organizations looking to improve their environmental performance while remaining competitive in the marketplace (Hameed, et al., 2022). Companies may utilize TRIZ's organized problem-solving methodologies to identify and address sustainability difficulties across their products' full lifespan, from conception and design to production, distribution, usage, and end of life disposal or recycling (Zhang, et al., 2021). Furthermore, ISO 14067, a standard developed by the International Organization for Standardization (ISO), provides guidelines for quantifying the carbon footprint of products. By integrating TRIZ principles into ISO 14067 compliance efforts, companies can enhance their environmental sustainability initiatives and further reduce their carbon footprint.

Introduction

TRIZ the Theory of Solving Inventive Problems originated in mid-20th century in the former Soviet Union in an attempt to develop a methodology to support the generation of new ideas and breakthrough solutions in a systematic way. Genrich Altshuller designed “Teorija Reschenija Izobretatel'skich Zadac” back in 1950. TRIZ is a Russian acronym for Theory of Inventive Problem Solving (TIPS). TRIZ is an inventive and powerful methodology based on empirical data developed by Genrich Altshuller back in 1946. TRIZ is also “problem solving, analysis and forecasting toolkit” derived from global patent literature, and Altshuller claimed to breakthrough quality improvement and accelerated innovation speed through design patent evaluations (Hipple, 2005).

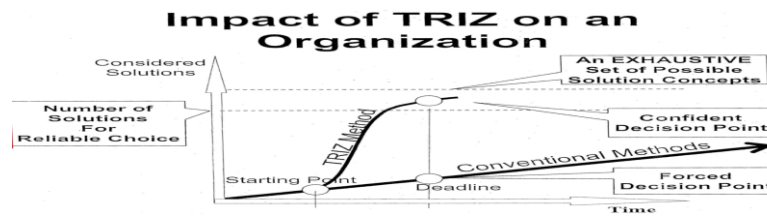


Figure 1: Extracted from *Improving Innovation through TRIZ to the Microgravity Project Managers Work Group - 2004* by Kelly McEntire, NASA – Glenn Research Center Training Material

Altshuller stated 90% and above engineering problems were addressed prior, the similar bottleneck in industry B have been resolved in industry A with different inventions or technology. Based on 40000 patents Altshuller identified and grouped into 40 Inventive Principles where the Contradiction table set to address more than 1200 contradictions with 39 standard parameters (Tong et al, 2006).

McEntire (2004) in his training indicated the benefits of TRIZ implementation in various areas - problem solving based on fixed algorithm; easy algorithm to follow which is repeatable; better and more innovative solutions; enhances credibility and wins more proposals; reduces the number of trails and error solutions; saves time, money and reduces risk; works on any type of problem; innovate new products and failure prediction (per Figure 1). Today TRIZ is taking off as more global companies and organizations are embracing TRIZ as the “best practice” for inventive problem solving and innovation. TRIZ provides solution concepts for a wide range of problems.

Research Rationale

The justification for researching the integration of TRIZ into sustainable product lifecycle management is complex. **First**, as global concerns about environmental sustainability grow, firms are under growing pressure to implement sustainable practices throughout their operations, including product design, manufacture, distribution, and disposal (Hameed, et.al, 2022). Traditional problem-solving approaches frequently fail to handle the complexity and contradictions inherent in sustainable product creation (Tandiono, and Rau 2022). TRIZ, with its organized approach to problem solving and emphasis on innovation, provides a compelling framework for methodically addressing sustainability concerns (Tandiono, and Rau 2022).

Second, the lifetime view is critical for meeting sustainability objectives in product development. Understanding the environmental implications of each step of a product's lifetime allows organizations to find possibilities for improvement and innovation (Hameed, et.al, 2022). By integrating TRIZ principles into sustainable product lifecycle management, businesses can enhance their ability to identify and resolve contradictions, optimize resource utilization, and design products that minimize environmental impact across their entire lifecycle (Spreafico, 2021).

Additionally, the integration of TRIZ and sustainable product lifecycle management has the potential to drive competitive advantage and foster innovation within organizations (Kaliteevskii, Bryksin, & Chechurin, 2021). By adopting a systematic approach to problem-solving and innovation, companies can differentiate themselves in the market by delivering products that are not only environmentally sustainable but also innovative and user friendly (Amir, et.al, 2023). Furthermore, as sustainability becomes increasingly important to consumers and stakeholders, organizations that demonstrate a commitment to sustainable product development stand to gain reputational benefits and strengthen their brand image.

Research Questions

- How can TRIZ principles be used to sustainable product lifecycle management to solve environmental concerns and maximize resource utilization?
- What are the main hurdles and problems to incorporating TRIZ into sustainable product lifecycle management, and how can they be overcome?
- What are the possible benefits of incorporating TRIZ into sustainable product lifecycle management for firms, such as increased innovation capabilities, cost savings, and competitive advantage?
- What approaches and technologies may be utilized to successfully implement TRIZ principles in the context of sustainable product development and lifecycle management?
- Based on real world case studies and examples, what are the best practices and success criteria for organizations integrating TRIZ into sustainable product lifecycle management?

Literature Review

The introduction of TRIZ (Theory of Inventive Problem Solving) into sustainable product lifecycle management has gained traction in recent years due to its capacity to address the complex difficulties connected with sustainability in product development. This literature review will dive into the existing body of knowledge about TRIZ, sustainable product lifecycle management, and their intersection, providing light on key ideas, methodology, applications, and areas where current research falls short.

TRIZ: Principles and Applications

TRIZ, developed by Genrich Altshuller in the mid twentieth century, provides a methodical approach to problem solving and creativity (Spreafico, 2021). TRIZ is based on identifying and resolving conflicts inside systems using innovative concepts (Rau, et.al, 2023). Tools like the TRIZ contradiction matrix, creative standards, and inventive principles offer systematic techniques for developing unique solutions to complicated issues in fields such as engineering, manufacturing, and design (Tandiono, and Rau 2022, Chou, 2021).

Various studies have shown that TRIZ is effective in fostering innovation and problem solving in a variety of circumstances (Amir, et.al, 2023). For example, Altshuller and colleagues have demonstrated the use of TRIZ concepts to overcome technical conflicts, improve product functioning, and optimize production processes. Moreover, empirical research has underscored TRIZ's positive impact on organizational innovation capabilities, efficiency in product development, and competitive positioning (Kaliteevskii, Bryksin, & Chechurin, 2021).

Sustainable Product Lifecycle Management: Principles and Practices

Sustainable product lifecycle management emphasizes the integration of environmental, social, and economic considerations throughout a product's lifespan, from design and production to distribution, use, and final disposal or recycling (Rau, et.al, 2023). This strategy is based on lifecycle thinking, which involves assessing the environmental implications of each lifecycle stage and identifying opportunities for improvement and innovation (Spreafico, 2022). A growing body of literature has addressed many aspects of sustainable product lifecycle management, such as sustainable design concepts, eco-design approaches, life cycle analysis (LCA), and sustainable supply chain management. Researchers and practitioners have investigated techniques for decreasing environmental impact, conserving resources, and improving product performance while meeting the needs of customers and stakeholders (Tandiono, and Rau 2022).

Integration of TRIZ and Sustainable Product Lifecycle Management

The integration of TRIZ into sustainable product lifecycle management presents a promising framework for addressing sustainability challenges in product development. By leveraging TRIZ's systematic problem-solving techniques,

organizations can identify and address contradictions pertinent to sustainability goals, such as enhancing energy efficiency, minimizing waste generation, and reducing environmental footprint (Spreafico, 2022).

Although little research has specifically focused on combining TRIZ with sustainable product lifecycle management, some studies have identified possible synergies between both techniques. For example, academics have developed frameworks for incorporating TRIZ principles into eco-design processes, identified parallels between TRIZ innovative ideas and sustainable design techniques, and investigated TRIZ's relevance in addressing sustainability related paradoxes (Spreafico, 2022).

40 Inventive Elements of TRIZ in Sustainable Product

These are 40 Inventive Elements of TRIZ in Sustainable Product.

- Segmentation
- Taking Out
- Local Quality
- Asymmetry
- Merging
- Universality
- Nested Doll
- Anti-Weight
- Preliminary Anti-Action
- Preliminary Action
- Beforehand Cushioning
- Equipotentiality
- 'The Other Way Around'
- Spheroidality
- Dynamics
- Partial or Excessive Actions
- Another Dimension

- Mechanical Vibration
- Periodic Action
- Continuity of Useful Action
- Skipping
- 'Blessing in Disguise'
- Feedback
- 'Intermediary'
- Self-Service
- Copying
- Cheap Short-Living
- Mechanics Substitution
- Pneumatics and Hydraulics
- Flexible Shells and Thin Films
- Porous materials
- Color changes
- Homogeneity
- Discarding and Recovering
- Parameter Changes
- Phase Transitions
- Thermal Expansion
- Strong Oxidants
- Inert Atmosphere
- Composite Materials

Gaps and Future Directions

Despite the growing interest in combining TRIZ with sustainable product lifecycle management, numerous gaps remain in the available literature. Empirical study is required to determine the practicality and usefulness of incorporating TRIZ into sustainable product development procedures. Furthermore, more research is needed to develop tailored methodologies and tools for applying TRIZ principles to the field of sustainability, addressing challenges associated with cultural barriers, and identifying best practices for organizations seeking to improve their sustainability performance through systematic problem solving and innovation.

Conclusion

This literature study provided an overview of the existing research on TRIZ, sustainable product lifecycle management, and their confluence. While incorporating TRIZ into sustainable product development shows promise for tackling sustainability issues, further study is needed to fully realize its potential and aid organizations in meeting their sustainability goals. Researchers and practitioners may help to create more creative, ecologically sustainable products and systems by closing identified gaps and increasing understanding of the synergies between TRIZ and sustainable product lifecycle management.

References

1. Amir, K. M., Houssin, R., Zouari, A., Dhouib, D., & Renaud, J. (2023, August). Integrating TRIZ and MCDM for innovative and sustainable decisionmaking: a case study in the life cycle of olive oil. In International TRIZ Future Conference (pp. 226236). Cham: Springer Nature Switzerland.
2. Chou, J. R. (2021). A TRIZbased productservice design approach for developing innovative products. *Computers & Industrial Engineering*, 161, 107608.
3. Hameed, A. Z., Kandasamy, J., Aravind Raj, S., Baghdadi, M. A., & Shahzad, M. A. (2022). Sustainable product development using FMEA ECQFD TRIZ and fuzzy TOPSIS. *Sustainability*, 14(21), 14345.
4. Kaliteevskii, V., Bryksin, M., & Chechurin, L. (2021). TRIZ application for digital product design and management. In *Creative Solutions for a Sustainable Development: 21st International TRIZ Future Conference, TFC 2021, Bolzano, Italy, September 22–24, 2021, Proceedings 21* (pp. 245255). Springer International Publishing.
5. Rau, H., Wu, J. J., & Procopio, K. M. (2023). Exploring green product design through TRIZ methodology and the use of green features. *Computers & Industrial Engineering*, 180, 109252.
6. Spreafico, C. (2021). Quantifying the advantages of TRIZ in sustainability through life cycle assessment. *Journal of Cleaner Production*, 303, 126955.
7. Spreafico, C. (2022). Can TRIZ (Theory of Inventive Problem Solving) strategies improve material substitution in ecodesign?. *Sustainable Production and Consumption*, 30, 889915.
8. Spreafico, C. (2022). Can TRIZ (Theory of Inventive Problem Solving) strategies improve material substitution in ecodesign?. *Sustainable Production and Consumption*, 30, 889915.
9. Tandiono, Y., & Rau, H. (2022). An Enhanced Model Using the Kano Model, QFDE, and TRIZ with a ComponentBased Approach for Sustainable and Innovative Product Design. *Sustainability*, 15(1), 527.
10. Zhang, P., Jing, S., Nie, Z., Zhao, B., & Tan, R. (2021). Design and development of sustainable product service systems based on designcentric complexity. *Sustainability*, 13(2), 532.