

Fostering Tech Innovation: Exploring TRIZ and ChatGPT Integration for Developer and Entrepreneur Challenges

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Abstract: This study aimed to interpret the value of integration of TRIZ (Teoriya Resheniya Izobretatelskih Zadach; Theory of Inventive Problem Solving) and ChatGPT (Chat Generative Pre-trained Transformer) to enhance technological and entrepreneurial problem-solving and decision-making. TRIZ offers a structured approach to innovation, while ChatGPT excels in generating diverse and innovative responses through advanced natural language processing. From the combination of them, we tried to discover synergies that promote innovation in highly competitive business areas. Through the analysis of case studies, including "Imperfect Waterproof Zipper" and "Drilling a Hole in a Thin-Walled Tube", we discovered that this integration not only aligns with actual problem-solving outcomes but also enhances the quality of solutions, particularly benefiting developers with limited TRIZ knowledge. We identified that leveraging ChatGPT enables developers and entrepreneurs to approach challenges with enhanced creativity, yielding practical and innovative solutions through these case studies. Our approach, focusing on real-world applications, demonstrates the study's contribution by providing a novel strategy for combining structured problem-solving with AI capabilities. The primary motivation behind this research was to ascertain whether AI can amplify the problem-solving framework of TRIZ, thereby extending its utility beyond traditional domains. The findings underline the importance of AI in creative problem-solving, suggesting that even those unfamiliar with TRIZ can apply its principles effectively with the aid of ChatGPT. This research adds to the existing knowledge by showcasing how AI can be a powerful ally in the creative process, offering new avenues for problem-solving and strategic decision-making. In conclusion, our study demonstrates that the collaboration between TRIZ and ChatGPT not only elevates creativity but also equips developers and entrepreneurs with competitive strategies, emphasizing the role of AI in driving forward human innovation and creativity.

Keywords: AI-driven insights; ChatGPT; decision-making; entrepreneurial strategy; problem-solving; technological innovation; TRIZ

1 INTRODUCTION

In today's dynamic and highly competitive business environment, creativity is paramount to a company's survival and growth [1]. With the growing need for proactive innovation, organizations are investing heavily in fostering creativity in their workforce. Historically, creativity was once considered a trait of genius, but modern perspectives, influenced by pioneers like cognitive psychologist Guilford, recognize it as an intrinsic aspect of human intelligence.

Among the myriad methods developed for idea generation and problem solving, TRIZ (Teoriya Resheniya Izobretatelskih Zadach; Theory of Inventive Problem Solving) is one that stands out. Developed by Altshuler and his team through extensive patent analysis, TRIZ provides a systematic approach to creative problem solving and is used by many developers to solve their problems [2].

The field of artificial intelligence (AI) has grown exponentially in recent years, and ChatGPT (OpenAI's language model), a pre-trained generative transformer, has gained traction due to its machine learning algorithms based on large language models combined with a conversational interface. ChatGPT goes beyond the ability to generate human-like text responses to provide personalized interactions for users. It is being utilized in a variety of fields, including customer service, education, and healthcare, and as a versatile tool for complex problem solving and research and development efforts [3].

Entrepreneurs who need to navigate shifting market trends and manage multi-faceted business operations are faced with the challenge of mastering diverse domains and making decisions. Recognizing this, there is a growing demand for tools and methodologies that simplify and enhance the innovation process [4].

While TRIZ, entrepreneurship, and AI models are theoretically consistent, there is not enough empirical evidence of their effectiveness, and there is a need for research that examines the impact of their integrated application. This study aims to elucidate the synergistic potential of integrating TRIZ with ChatGPT to augment problem-solving and decision-making paradigms in the technological and entrepreneurial domains.

2 LITERATURE REVIEW

2.1 Creativity and Innovation in TRIZ and Entrepreneurship

Numerous studies across diverse domains have delved into the nexus between creativity and TRIZ. Studies have evaluated the effectiveness of TRIZ-based creativity training programs in enhancing employee innovativeness [5] and have demonstrated the efficacy of TRIZ training in fostering creativity across different educational contexts, including university students, secondary school students, and elementary school students [6]. The growing importance of creativity and innovation in science and engineering further emphasizes the significance of these findings [7].

Yong Won Song emphasizes that TRIZ aids in solving technical problems, particularly noting that the laws of technological development effectively predict the future and enhance creativity and technological innovation [8]. Yong Mun Jeon generated ideas using the technological evolution laws of TRIZ to derive a solution capable of minimizing the temperature effects on the probe card, a crucial device for inspecting semiconductor operation [9]. Hong Kyun Shim utilized the 40 inventive principles of TRIZ to resolve quality issues in the Equipment Front-End Module (EFEM) in the Fab etching process used for manufacturing semiconductor devices [10]. However, for those unacquainted with this distinctive methodology, which involves translating real-

world problems into general problem models and identifying corresponding solutions, TRIZ can be perceived as both complex and elusive [2].

For entrepreneurs, creativity is a crucial attribute that they must possess [11]. TRIZ, which is now being applied beyond technical domains, serves not only as a problem-solving tool that enables entrepreneurs to approach their endeavors systematically and scientifically, reducing the risks associated with intuitive decision-making, but also as a catalyst for unleashing their creative potential [12].

2.2 AI and Creativity

Over the years, various definitions of AI have emerged [13]. In essence, AI is a branch of computer science that aims to develop systems capable of performing tasks that typically require human intelligence, such as learning from experience, understanding natural language, pattern recognition, problem-solving, and decision-making. While creativity has long been considered a distinct human trait, the study of AI's creativity has gained attention.

In the field of computational creativity, Colton posited that the discipline had reached maturity, providing an overview of its development over time [14]. Boden also delved into the intersection between computational models and human creativity, discussing the application of computational models in understanding and simulating the creative process, as well as the limitations and ethical considerations associated with these models [15]. Studies have explored the application of AI techniques to evaluate human-made creative designs [16] and have shown the potential for AI to contribute to hybrid intelligence, where AI autonomously generates ideas using modern algorithms while fostering human creativity to solve creative tasks [17]. Besold explores different approaches and techniques in computational creativity, including rule-based systems, evolutionary algorithms, machine learning, and neural networks. He demonstrates how these methods can generate novel ideas, solve problems, and produce creative outputs in fields like art, music, and writing [18].

2.3 Collaboration with AI

The topic of AI and human collaboration has garnered significant attention, alongside discussions on AI creativity. Colton highlights that, rather than diminishing human thinking abilities, AI actually creates experts such as automated writers and scientists, inspiring humans to think [14].

Brynjolfsson and McAfee stress the importance of viewing AI as a complement to human capabilities rather than a replacement. They argue that successful businesses effectively integrate AI into their operations, leverage data, and adapt their strategies to changing circumstances [19]. Surveys and interviews with business executives further support this view, as AI leaders anticipate positive impacts on economic growth through revenue-generating opportunities and increased investments resulting from AI adoption [20]. The concept of Human-AI collaboration, as

proposed by Wingström, positions AI as a tool to generate ideas, support creativity, and push the boundaries of scientists' and artists' creative endeavors, rather than replacing human creativity [21]. Copley emphasizes the benefits of integrating human and artificial creativity, highlighting the significance of interdisciplinary collaboration and harnessing the unique strengths of both humans and AI to tackle complex and creative problems [22].

Considering these factors, AI manifests as a potent instrument for collaboration. Utilizing the actionable insights offered by AI enables developers to embrace a comprehensive approach to problem-solving, fostering innovation and optimizing product development. Concurrently, entrepreneurs can enhance creativity and innovation by integrating AI in promotional marketing, project management, and overarching business strategies.

3 RESEARCH METHODOLOGY

ChatGPT, developed by OpenAI, is renowned for its expansive language model and interactive interface. Its adeptness in natural language processing and ability to facilitate personalized interactions have made it a valuable tool in diverse fields, including customer service and health [26]. Previous studies have evaluated the performance of ChatGPT by scoring answers to questions extracted from test questions [3, 27].

Given the exploratory nature of the study and the need to delve deeper into the real-world application of ChatGPT, a case study design was deemed appropriate for this research, as it allowed the comparison of answers elicited from conversations with ChatGPT to real-world problems and solutions without relying solely on questionnaire-based assessments. For the purposes of this study, two patent cases authorized for experimentation with ChatGPT were handpicked: the first being a Korean patent and the second, a US patent.

This study's methodology encompasses two primary dimensions: problem-solving analyzed through a TRIZ perspective from the vantage point of a developer, and entrepreneurial strategy approached with an enterpriser's mindset. The potential of ChatGPT in aiding developers engaged in new product development and entrepreneurs striving for work efficiency were investigated in this study.

3.1 Problem-Solving from a TRIZ Perspective

This research was conducted in five steps, described below, to understand how ChatGPT approaches problem solving from a TRIZ perspective.

- a) Stating a real-world problem
- b) Analyzing the case from a TRIZ perspective and examining ways to solve the problem
- c) Identifying potential TRIZ solutions and compare them with actual problem solution
- d) Design and implement ChatGPT prompt engineering from a TRIZ perspective
- e) Evaluating the results of ChatGPT and compare them to real-world problem-solving methods.

In this study, advanced engineering techniques were employed, including the persona pattern and the flipped interaction pattern, to enhance the precision and efficiency of results derived from ChatGPT [28]. The persona patterns specify the role of ChatGPT, such as problem solver, scientist, entrepreneur, consultant, etc. The flipped interaction pattern empowers ChatGPT to initiate questions, ensuring the acquisition of accurate and fact-based responses. If the flipped interaction pattern does not yield satisfactory results, ChatGPT can be prompt to ask relevant questions by providing the ChatGPT's task in the prompt insert box and adding the statement, "Do you have any questions you would like to ask to effectively solve this problem?" This prompt instructs ChatGPT to provide the best solution or advice from a TRIZ perspective, allowing for repetition of the question if needed.

3.2 Business Strategy from an Entrepreneurial Perspective

This research was conducted in two phases as outlined below to understand how ChatGPT goes about its business strategy from an entrepreneurial perspective.

- a) Designing ChatGPT prompt engineering from entrepreneur's perspective
- b) Selecting the best viable offer.

To derive business strategies from ChatGPT using an entrepreneurial perspective, the persona pattern and the flipped interaction pattern were applied, reflecting the methodology utilized in the preceding TRIZ perspective. The persona pattern provides ChatGPT's role, incorporating a broad range of personas such as an economist, a marketer, a market analyst etc. Following this process, users then can select the option that most effectively corresponds with practical circumstances, confirms feasibility, and cost-effectiveness.

In this study, the above process was performed using ChatGPT plus (GPT4).

4 CASE STUDIES

4.1 Problem of Imperfect Waterproof Zipper

In the first case study, the potential solutions for the issue of incomplete waterproof zippers using the TRIZ methodology were investigated while also examining business strategies from an entrepreneurial perspective.

4.1.1 Problem-Solving from a TRIZ Perspective

4.1.1.1 Statement of Real-World Problem

The first case addressed the problem of 'imperfect waterproof zippers' that does not provide a perfect seal.

4.1.1.2 Analyzing the Case from a TRIZ Perspective and Examining Ways to Solve the Problem

The problem with imperfect waterproof zipper can be described as follows:

- The enclosure secured by the zipper is not hermetically sealed, leading to the permeation of fluids.
- The zipper fails to maintain a seal when subjected to bending, and external forces can induce its loosening.
- Applying lateral force to a zipper disrupts its seal, facilitating the release of any contained fluid or air.

A zipper is basic, consisting of side-to-side interlocking teeth, a slider mechanism, and an attachment tape. These teeth interlock with each other via the slider to create a chain-like structure that acts as a barrier to the movement of fluids. However, if the inherent mutual support of the teeth is weakened, the integrity of this chain structure can be compromised, causing the zipper to fail to contain gas or fluid leaks. However, the ease of opening and closing a zipper requires that the zipper be easily disengaged.

4.1.1.3 Identifying Potential TRIZ Solutions and Compare them with Actual Problem Solution

If this case is analyzed from a TRIZ perspective, a contradiction exists: the teeth need to have a strong engagement force for an effective seal, but the engagement force needs to be weak for easy operation during the opening and closing process. The TRIZ approach to resolving this contradiction is based on the principle of time separation, which means that if the zipper is strong when it is engaged and weak when it is opening and closing, the problem of this case can be solved. Alternatively, the principle of space separation can also be a viable solution by dividing the zipper into regions of varying strength to establish both strong and weak regions.

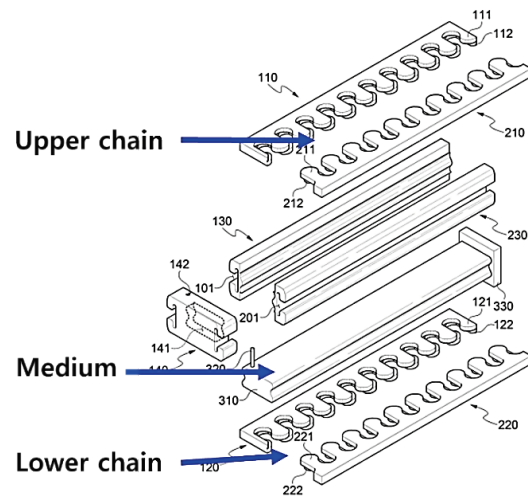


Figure 1 Korean Patent 10-2261012 (source: <http://kportal.kipris.or.kr>)

Possible TRIZ 40 Principles to solve this problem include:

- Principle 11. Preliminary Compensation: Implement measures to prevent the weakening of the fastening force.
- Principle 16, Partial or Excessive Actions, can be employed by incorporating two vertically aligned chains — one positioned at the upper and the other at the lower

end — to enhance the fastening force exerted by the zipper.

- Principle 24, Intermediate, recommends the introduction of an intermediary medium between the upper and lower chains. This medium serves to preserve the sealing efficacy during fastening operations.

Korean patent 10-2261012 solves this problem by designing a top and bottom interlocking teeth and inserting an intermediate mediator between them shown in Fig. 1.

4.1.1.4 Design and Implement ChatGPT Prompt Engineering from a TRIZ Perspective

From a TRIZ perspective, prompt engineering has meticulously crafted the persona pattern encompassing roles such as a TRIZ master, scientist, inventor, and consultants, thereby facilitating ChatGPT in offering the possible solutions or advices grounded in TRIZ principles. Moreover, the flipped interaction pattern has been instituted to permit the iterative posing of questions until the suitable responses are procured. Owing to spatial constraints, only a fragmentary view of the ChatGPT session utilized in this stage is showcased here; the comprehensive details are accessible via the following link: 'https://chat.openai.com/share/79bc817d-f387-4d39-b047-bbbedfa03d22' Fig. 2.

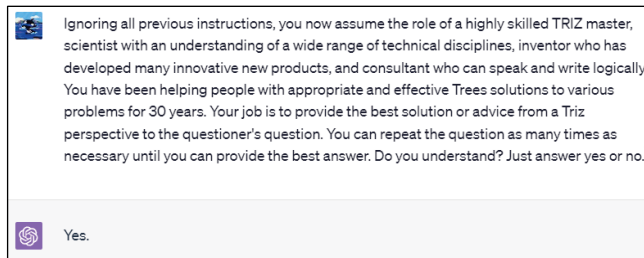


Figure 2 Prompt Engineering of a TRIZ Perspective

The problem presented to ChatGPT is the imperfect waterproof zipper, which lacks complete waterproofing. The issues related to waterproof zipper include incomplete sealing of the container, difficulty in sealing when bent, and vulnerability to external pressure. The zipper consists of left and right teeth, sliders, and tape, with the teeth engaging through the slider. The engagement force of the teeth plays a vital role in preventing fluid leakage. However, it needs to strike a balance between being strong enough to provide a good barrier and weak enough for easy opening and closing. The objective is to identify the most optimal solutions to tackle these challenges in Fig. 3.

ChatGPT proposed several solutions from a TRIZ perspective, including separation in time, separation in space, parameter changes, and the utilization of fields in Fig. 4.

In response to inquiries about the utilization of fields, ChatGPT had suggested various solutions, including mechanical fields, thermal fields, shape memory materials, hydraulic or pneumatic fields, chemical fields, and the piezoelectric effect. By further questioning ChatGPT's

provided responses, a more comprehensive investigation can be conducted, exploring specific and specialized domains. In this case study, ChatGPT recommended additional fields in addition to the MACHEM framework derived from TRIZ, thereby expanding the user's cognitive perspectives shown in Fig. 5.

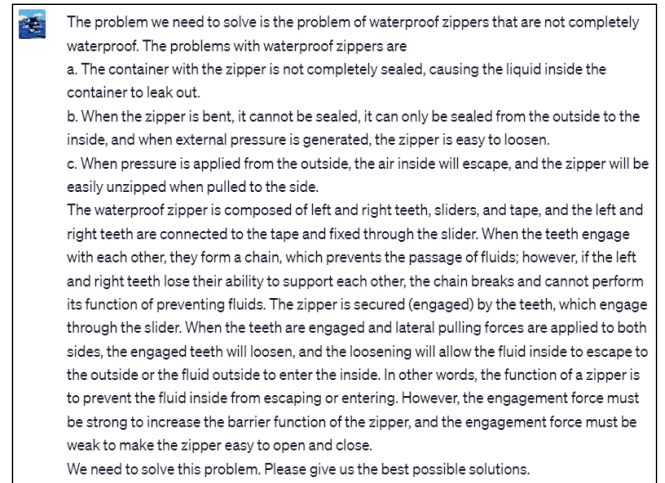
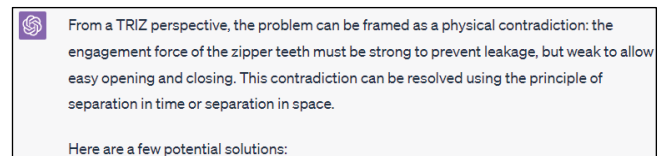
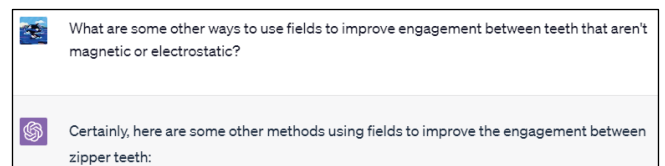


Figure 3 Type the Problem to be Solved at Prompt



****Use of fields**** - Apply an external field or force to assist in engagement when waterproofing is necessary and reduce it when easy opening/closing is required. This could be achieved by implementing a magnetic or electrostatic mechanism that enhances the engagement force between teeth when activated.

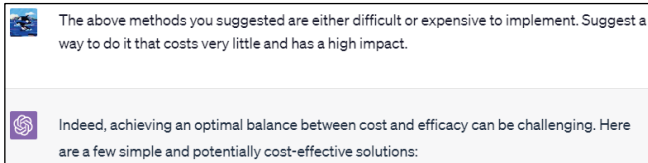
Figure 4 ChatGPT's Answer



1. ****Mechanical fields:**** This could involve adding a spring mechanism or elastic material to the zipper teeth to increase the force with which they engage.
2. ****Thermal fields:**** Utilize materials for the zipper teeth that expand or contract with changes in temperature to alter the level of engagement. For instance, a thermally responsive material could be used that causes the teeth to engage more firmly in cooler conditions (such as when in contact with cold water), thus improving waterproofing.
3. ****Shape memory materials:**** These are materials (like certain alloys or polymers) that can "remember" their original shape and return to it when subjected to a specific stimulus, often heat. They could provide stronger engagement when needed and relax when not.

Figure 5 ChatGPT's Answer Additional Question about using 'Fields'

Given the intricate nature of 'Fields' utilization and the substantial costs concomitant with its implementation, ChatGPT was prompted to come up with an alternative that would be cost-effective and optimally effective presented in Fig. 6.



3. ****Secondary Physical Barrier:**** Add a thin, flexible rubber or silicone strip along the length of the zipper. When the zipper is closed, this strip would be compressed between the teeth, creating an additional barrier to water. This is akin to the gaskets used in water-resistant watch cases or diving equipment.

Figure 6 ChatGPT's Answer to Cost-Effective Solutions

4.1.1.5 Evaluating the Results of ChatGPT and Compare them to Real-World Problem-Solving Methods

ChatGPT had provided a series of cost-effective solutions, namely Hydrophilic Coating, Layered Fabric Seals, Secondary Physical Barrier, and Zipper Cover. Notably, the suggested Secondary Physical Barrier aligns with the approach described in the development of the Korean Patent 10-2261012.

4.1.2 Business Strategy from an Entrepreneurial Perspective

4.1.2.1 Design ChatGPT Prompt Engineering from an Entrepreneurial Perspective

A prompt engineering was designed to elicit insights from the entrepreneurial perspective. The persona patterns embodying roles such as economist, marketer, market analyst, etc. were incorporated to enhance the support provided to entrepreneurs. Concurrently, the flipped interaction patterns were used. Due to space constraints, only a portion of the ChatGPT sessions used in this phase was presented, which can be found at the following link: 'https://chat.openai.com/share/0b65edfd-672b-49a9-8447-8a3ff669eea0' in Fig. 7.

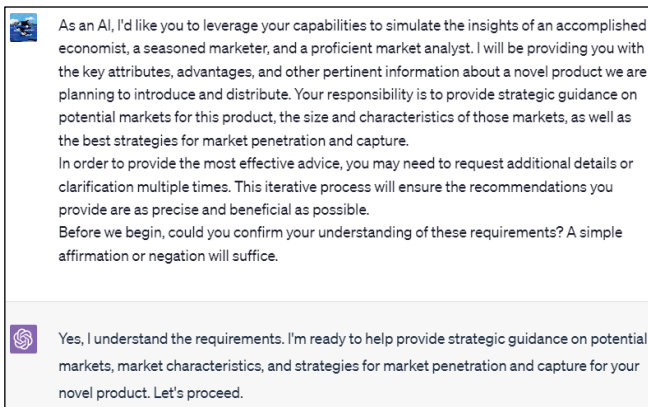


Figure 7 Prompt Engineering from an Entrepreneurial Perspective

Guidance from ChatGPT pertaining to a waterproof zipper as delineated in Korean patent 10-2261012 was solicited. To ensure an informed consultation from ChatGPT on this matter, it is imperative to furnish comprehensive details about this product shown in Fig. 8.

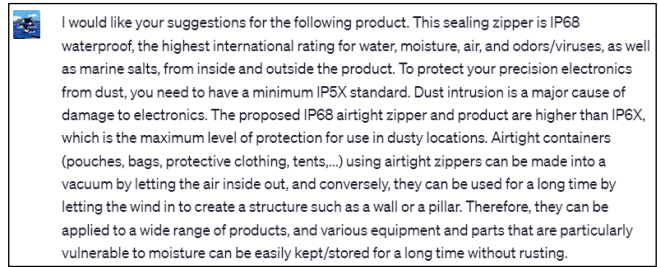
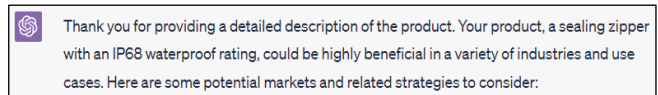


Figure 8 Type the Product Description at Prompt

ChatGPT provided a comprehensive analysis of potential markets and strategies associated with waterproof zippers, encompassing sectors such as Outdoor Gear and Equipment, Construction, and Military industry shown in Fig. 9.

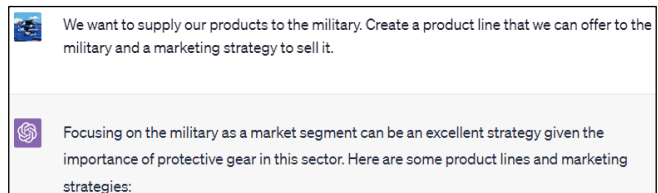


3. ****Industrial Applications**:** There are many industries where protective clothing and equipment are crucial, such as construction, healthcare, and the military. Approaching companies in these sectors and demonstrating the benefits of your product could be a successful strategy.

Figure 9 ChatGPT's Answers Customized to Support Entrepreneurs

4.1.2.2 Selecting the Best Viable Offer

Among ChatGPT's proposals, suggestions on product offerings that could be sold in the military market and effective business strategies were sought. ChatGPT provided a comprehensive product line that includes Protective Gear for Electronics, Storage Bags, Tents, and Temporary Shelter. Additionally, ChatGPT recommended implementing tailored strategies to effectively target the military market, taking into consideration their job nature and unique requirements in Fig. 10.



****Product Lines****

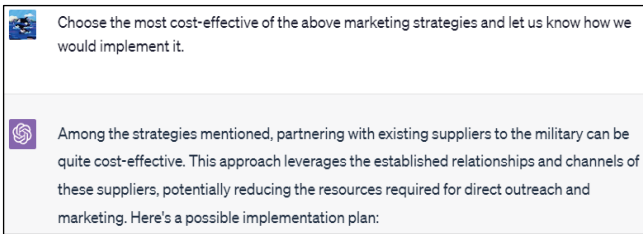
1. ****Protective Gear for Electronics**:** You can offer protective pouches or bags for various military electronics, such as radios, GPS devices, night vision goggles, and more. These pouches would utilize your IP68 sealing zippers, providing an unmatched level of protection against dust, water, and other harsh conditions often encountered in military operations.

****Business Strategies****

1. ****Direct B2B Approach**:** To effectively penetrate the military market, it's important to identify and reach out directly to military procurement officers and related decision-makers. Present the unique benefits of your product line and how it can enhance their operations. Attending military-focused trade shows or other industry events can also provide opportunities to establish these connections.

Figure 10 ChatGPT's suggestion for the Military Market

The next inquiry focused on identifying the most cost-effective business strategy and formulating an efficient execution plan (Fig. 11).



1. ****Identify Potential Partners****: Conduct thorough research to identify companies that currently supply products similar or complementary to those used by the military, specifically focusing on companies that offer protective gear, storage solutions, tents, or clothing.
2. ****Develop a Value Proposition****: When approaching these companies, clearly articulate the unique advantages that your zipper technology can bring to their product line. Highlight benefits such as enhanced durability, superior protection against environmental elements, and prolonged product lifespan. It is crucial to prepare evidence or demonstrations to support these claims and showcase the effectiveness of your zipper technology. This can include test results, case studies, or samples of products featuring your zippers. By effectively communicating the value proposition of your zipper technology and providing concrete evidence of its benefits, you can establish credibility and increase the likelihood of collaboration with these companies.

Figure 11 Chat GPT's response to the cost-effective business strategy and its execution strategy

In addressing this query, ChatGPT pinpointed "Partnerships with Existing Suppliers" as a cost-effective business strategy and has provided detailed recommendations for its implementation.

4.2 Drilling a Hole in a Thin-Walled Tube [26]

The objective of the second case study is to explore a feasible solution for effectively drilling a hole in a thin-walled tube without compromising its structural integrity, guided by ChatGPT. Additionally, the study aims to analyze business strategies from an entrepreneurial perspective to discover effective approaches for promoting a product or service in the marketplace.

4.2.1 Problem-solving from a TRIZ Perspective

4.2.1.1 Statement of Real-World Problem

The concern with drilling holes in thin-walled tubes is the potential deformation of the tube's structure or the infliction of damage to its walls.

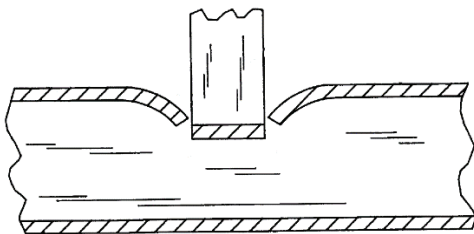


Figure 12 Dents in the Tube Wall [26]

4.2.1.2 Analyzing the Case from a TRIZ Perspective and Examining Ways to Solve the Problem

Outlined below are some ideas for solving the problem of drilling holes in thin-walled tubes, along with their potential limitations:

- One feasible solution is to place a solid material within the tube to effectively support the tube walls. While this approach could potentially prevent the tube from being crushed, complications arise when dealing with curved tube shapes, making it difficult to insert the solid material properly.
- Another possible solution is drilling the hole before bending the tube. However, this approach has a significant drawback, as subsequent bending of the tube would distort the previously round hole. To address this, a viable solution requires a support structure that is both solid enough to uphold the integrity of the tube walls and flexible enough to be conveniently inserted into the tube.

4.2.1.3 Identifying Potential TRIZ Solutions and Compare them with Actual Problem Solution

Solving the problem of drilling a hole thin-walled tube presents a contradiction: the process necessitates both a solid material inside the tube to support the drilling and a material in a soft state that can be easily inserted or ejected. This contradiction can potentially be resolved through the application of the 40 principles of TRIZ.

Principle 24, Intermediate, suggests the introduction of supports within the tube. These supports serve to stabilize and reinforce the tube walls during operations.

Principle 36, Phase Transformation, suggests altering the state of the support material—whether to a solid, liquid, or gas—based on specific conditions encountered during the drilling process.

As delineated in US Patent No. 5,974,846 [27], a specific solution to address this problem involves filling the tube with a liquid medium, such as water. Prior to the drilling process, this liquid is frozen, thereby providing solid support to the tube walls during drilling. Following the completion of the drilling, the solid medium can be reverted to its liquid state through melting, facilitating easy removal from the tube.

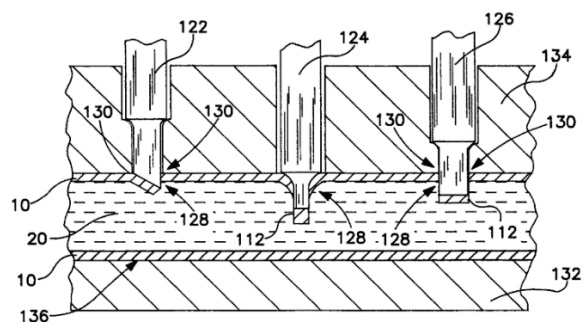


Figure 13 Ice Supports Tube Walls to Prevent Dents [27]

4.2.1.4 Design and Implement ChatGPT Prompt Engineering from a TRIZ Perspective

The identical Prompt Engineering methodology was employed to address this issue as was utilized in the 'problem of imperfect waterproof zipper' case study. Due to spatial constraints, only a fragmentary representation of the ChatGPT session utilized in this phase is presented herein; comprehensive details can be accessed through the following

link: 'https://chat.openai.com/share/1f9d174a-07cc-45cd-abf9-424ce6753dc6'.

To conduct this research, the problem, 'drilling a hole in a thin-walled tube', was described in a ChatGPT prompt.

Drilling a hole in a thin-walled tube can be difficult because the tube wall can become distorted, making it difficult to drill the desired hole well. Supporting the tube wall with a solid can prevent the tube from crushing. However, in a tube with many bends, it is difficult to place solids inside the tube to support the tube. The solution of drilling the hole before bending the tube is not ideal because when the tube is bent, the hole may be distorted.

Figure 14 Type the Problem to be solved at Prompt

The preliminary step in tackling the issue involved a meticulous analysis of the intrinsic contradictions tied to the task at hand. Following this analysis, ChatGPT preceded to identifying relevant invention principles from 40 Principles. Among the principles considered applicable, 'Principle 1: Segmentation', 'Principle 10: Prior Action', 'Principle 15: Cushion in Advance', 'Principle 17: Another Dimension', 'Principle 26: Copying', and others were proposed as potential solutions to the problem.

From a TRIZ perspective, we can approach this problem by analyzing the contradictions and conflicts and utilizing inventive principles to resolve them.

Contradiction #1: The tube needs to be rigid (to prevent distortion during drilling) and flexible (to allow for bending).

Contradiction #2: The hole needs to be drilled before bending (to ensure the hole is not distorted) and after bending (to maintain the hole's shape).

To resolve these contradictions, we can apply some inventive principles:

1. **Principle of Segmentation (1)**:** One potential solution is to utilize a flexible, yet rigid material that can be easily inserted and removed, providing support to the tube during the drilling process. This material should have the ability to accommodate bending without compromising the structural integrity of the tube. An example of such a material could be a two-part epoxy or a similar substance that hardens into a solid state but can be softened or dissolved when no longer required.

Figure 15 ChatGPT's suggestion

In response to ChatGPT's initial suggestion, further insights regarding the feasibility of employing alternative materials as opposed to the epoxy referenced in 'Principle 1: Segmentation' was further inquired.

In your proposed solution #1, 'Principle of Segmentation', what materials can be used other than epoxy?

Absolutely, there are other materials that can be used instead of epoxy based on the specifics of your situation. Here are some possibilities:

1. **Thermoplastic materials**:** These materials, such as polyethylene or polypropylene, can be heated to soften and reshape, and then cooled to solidify. This property enables easy insertion when the material is soft and provides necessary support when it solidifies.

2. **Low melting point metals or alloys**:** Alternatively, metals like Gallium or alloys such as Wood's metal or Field's metal, which have low melting points, can be melted and used to fill the tube. Once solidified, they provide support during the drilling process. These metals can be remelted and removed after the drilling is complete.

3. **Water or other fluids**:** In certain scenarios, the tube can be filled with a fluid, such as water, which is then frozen to provide support during drilling. After the drilling process, the ice can be melted and removed from the tube.

Figure 16 ChatGPT's Answer Additional Question about using Materials other than Epoxy

4.2.1.5 Evaluating the Results of ChatGPT and Compare them to Real-World Problem-Solving Methods

ChatGPT proffered an array of practical solutions, including thermoplastic materials, low melting point metals or alloys, water or other fluids, inflatable bladders or balloons, and soft solid materials. Notably, the suggestion to use water or other fluids aligns with the approach outlined in the development of US Patent No. 5,974,846. The outcomes of this case serve as a compelling testament to ChatGPT's capacity to augment practical problem-solving capabilities.

4.2.2 Business Strategy from an Entrepreneurial Perspective

4.2.2.1 Design ChatGPT Prompt Engineering from an Entrepreneurial Perspective

The identical prompt engineering methodology was employed as was utilized in the preceding case study. The complete ChatGPT session relevant to this phase can be accessed via the following link: 'https://chat.openai.com/share/58332325-6c29-475b-b20c-b7dc07a3e439'.

The specifics of U.S. Patent No. 5,974,846, titled "Method of forming and piercing a tube," was delineated and suggestions from ChatGPT were solicited.

When drilling holes in thin-walled tubes, there is a problem of damaging the walls or deforming the shape of the tube. The problem at hand entails the prevention of damage and deformation to the wall of a thin-walled tube when drilling a hole into it. Several key challenges arise within this context:

- The placement of a solid material within the tube that can effectively support the tube wall. Although such an approach could potentially prevent the tube from being crushed, complications arise when dealing with curved tube shapes, as it becomes challenging to insert the solid material in a suitable manner.

Our technique, U.S. Patent No. 5,974,846 fills a tube with a liquid, such as water, and then freezes it before drilling a hole in the tube. The solidified liquid, or ice, supports the walls of the tube while the hole is being drilled. After drilling the holes in the tube, we melted the ice to allow the liquid to drain out of the tube. We want to use this technology to generate a lot of sales.

Figure 17 Type the Patent Description at Prompt

ChatGPT offered some advice from the perspectives of an economist, a marketer, and a market analyst.

It's an interesting technology that you've patented and it could certainly have significant applications. Here are my initial thoughts from the perspective of an economist, a marketer, and a market analyst.

Economist: From an economic perspective, potential market segments can be categorized based on industries that frequently engage in operations involving thin-walled tubing. These industries may include construction, aerospace, plumbing, medical device manufacturing, and various types of machinery manufacturing. These sectors offer substantial market opportunities, particularly if the patented technology significantly reduces the risk of damaging or deforming tubes during the drilling process. This can potentially result in significant cost savings for companies by minimizing material waste and reducing time spent on rework.

Marketer: To effectively penetrate these markets, it is crucial to effectively communicate the benefits of your product in a manner that resonates with potential customers. Understanding the pain points that these industries face with current methods of drilling holes in thin-walled tubes is essential. By positioning your product as the solution to these challenges, you can demonstrate how it addresses their specific needs and provides a more efficient and reliable drilling process.

Market Analyst: Market size and segmentation will be key to your success. You will need to conduct market research to understand the size of the potential markets, the number of companies that could benefit from your product, and the amount they currently spend on similar operations. This

research will allow you to forecast potential revenues, which will be crucial for business planning and investor presentations.

Figure 18 ChatGPT's Answer as a Relevant Expert with a View to Helping Entrepreneurs

4.2.2.2 Selecting the Best Viable Offer

Analogous to the initial case, users have the option to solicit further elucidation on specific facets of the preceding response or to request an alternative viewpoint from ChatGPT. Moreover, in instances where a user finds the furnished response unsatisfactory or wishes to explore a divergent line of thought, they have the recourse to employ the 'Regenerate response' feature situated beneath the ChatGPT response field. This tool grants ChatGPT the capability to craft a novel response, distinct from its predecessor, thereby facilitating a more exhaustive exploration of the topic at hand.

5 RESULTS AND DISCUSSION

In this study, which explored the integration of TRIZ and ChatGPT, strong synergies that strengthened both problem-solving and decision-making processes were found. These synergies have substantial implications for technical and entrepreneurial domains, and were illustrated through case studies. The specific findings of this study are as follows:

a) ChatGPT's Problem-Solving Capabilities from a TRIZ Perspective

In the domain of inventive problem-solving, TRIZ has emerged as a preeminent methodology. Yet, its integration with ChatGPT heralds a novel frontier for bolstered creative solutions. Viewed through a TRIZ perspective, the problem-solving capability of ChatGPT becomes manifest.

The cases in this study, namely 'Imperfect Waterproof Zipper' and 'Drilling a Hole in a Thin-Walled Tube', revealed that ChatGPT not only provided solutions that were actually applied, but also suggested solutions that could be sufficient for practical applications.

Furthermore, this synergy facilitates developers in harnessing TRIZ via AI models, independent of their prior knowledge or expertise.

b) Business Strategy Insights

From an entrepreneurial perspective, ChatGPT has proven its competence in offering market analyses from various angles and providing strategic insights. In the cases of Korean patent 10-2261012 and U.S. patent 5,974,846, ChatGPT demonstrated its ability to furnish comprehensive market analyses and strategies. It went beyond merely offering a thorough market analysis; it also proposed actionable strategies, thereby highlighting its applicability in real-world entrepreneurial scenarios.

This prompt engineering design thus unveils a rich vein of opportunities for entrepreneurs. It enables them to harness insights from various standpoints, facilitating informed decision-making and strategic planning.

c) Mutual understanding between developers and entrepreneurs

The collaboration of ChatGPT affords developers the prospect of crafting more successful products by delving into the non-technical facets from an entrepreneurial standpoint, encompassing an understanding of market trends, and consumer demands. Concurrently, entrepreneurs stand to benefit by navigating their enterprises and sales more efficiently, armed with an awareness of the spectrum of viable technologies and an insight into the developmental methodologies employed by developers.

The integration of TRIZ's structured problem-solving with ChatGPT's capability offers a novel approach to tech innovation, as demonstrated by the above results. For developers, this means a dynamic shift in problem-solving techniques, while entrepreneurs can harness this fusion for enhanced market analysis and product innovation. The AI's competence to provide diverse market strategies, combined with TRIZ's systematic methodology, can revolutionize both technical problem-solving and entrepreneurial strategy formulation. As technology evolves, this collaborative approach sets new directions and domains for innovation, highlighting the potential of combining human ingenuity with AI capabilities.

In conclusion, this case study stands as a testament to ChatGPT's prowess in fostering multifaceted and efficacious problem-solving initiatives, particularly when viewed through the prism of the TRIZ methodology. Furthermore, it endeavors to equip entrepreneurs with invaluable business acumen and strategic insights.

6 CONCLUSION

Numerous studies have raised inquiries regarding the extent of creativity exhibited by AI and acknowledged its presence in general [28]. Prognostications by both laypersons and experts indicate that AI will not solely augment human work efficiency but also pose a potential threat to human capabilities [29]. Nonetheless, AI is progressively permeating various aspects of our lives, and its integration is projected to escalate substantially in the future.

This engagement with AI extends beyond mere utilization; it entails collaborative synergy. A mounting body of research attests to the remarkable outcomes derived from such collaborative endeavours [30].

Aligned with this prevailing trajectory, this study explored problem-solving approaches from a perspective of TRIZ and elucidated business management considerations from an entrepreneurial standpoint through the employment of ChatGPT.

Despite the individual strengths of TRIZ and ChatGPT, their combined application remains rarely explored in existing literature. This study bridges that gap, demonstrating how the integration of TRIZ methodologies with ChatGPT's AI capabilities can address contemporary technological and business challenges more effectively. This bridging of theoretical methodologies with practical AI applications offers a novel strategy for leveraging technology to foster creativity and innovation.

The practical applications demonstrated through the "Imperfect Waterproof Zipper" and "Drilling a Hole in a

Thin-Walled Tube" case studies serve as concrete examples of how integrating TRIZ and AI can lead to innovative solutions that closely mirror real-world outcomes. Our research revealed that the confluence of TRIZ and ChatGPT not only aligns with actual problem-solving outcomes but also significantly augments the quality of solutions. This is particularly beneficial for developers with limited exposure to TRIZ, indicating that the complex methodology of TRIZ can be made accessible through AI facilitation. Moreover, the study underscores the versatility of ChatGPT as a tool not just for developers but also for entrepreneurs, providing strategic insights for market entry and product success. By highlighting the collaborative synergy between human creativity and artificial intelligence, this research contributes to the broader discourse on the role of AI in amplifying human problem-solving capabilities. This study highlights that AI not only reaffirms its potential to improve human efficiency, but also can provide a competitive advantage in a rapidly evolving industrial environment as a catalyst for innovative problem solving and strategic planning and proposes to adopt and integrate AI tools such as ChatGPT more widely in creative and strategic thinking processes to expand AI-human collaboration in different domains.

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