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School of Computer Science & Engineering

IILM University Greater Noida

Presents

1st National Conference

on

Technologies for Sustainable Development Goals 2025 (TECH4SDG-2025)

3rd March 2025

Technically Co-Sponsored by IEEE UP SECTION (INDIA)

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Dear Author / Researcher,

On behalf of the *International Journal of Research in Modern Engineering & Emerging Technology (IJRMEET)*, I extend my heartfelt gratitude to all the authors and research scholars for choosing our platform to publish their valuable research contributions.

IJRMEET, a Refereed, Peer Reviewed, Indexed, and Monthly Journal in Electronic format, has been consistently dedicated since April 2013 to advancing scholarly work in the domains of Modern Engineering and Emerging Technologies. Your innovative and quality research is at the core of our mission to promote academic excellence and practical solutions in the ever-evolving field of engineering and technology.

We believe that publication should be based purely on the merit, originality, and relevance of the research, not on financial considerations. We ensure that every manuscript undergoes a thorough review process to maintain the integrity, reliability, and scholarly value of each published work.

Our journal aims not only to disseminate high-quality research globally but also to highlight critical engineering problems and their practical resolutions. I encourage researchers, academicians, faculty members, and industry professionals to continue contributing to IJRMEET and to inspire their peers and students to join us in this academic pursuit.

We sincerely thank our respected Editors, Reviewers, Technical Advisors, Authors, Web Developers, Subscribers, Supporters, and the extended academic community whose efforts and encouragement make each issue of IJRMEET a successful endeavor.

With warm regards,

Dr. Mylavarapu Seetharama Prasad

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डॉ. मोहम्मद रिहान / Dr. Mohammad Rihan
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MESSAGE

I am happy to know about Tech4SDG-2025, a distinguished national conference that aims to explore and highlight the transformative power of technology in achieving the United Nations Sustainable Development Goals (SDGs). This event serves as a critical platform for fostering collaboration among experts, innovators, and leaders who are dedicated to creating solutions that drive sustainable change.

As we face global challenges ranging from environmental sustainability to social equity, it is clear that technological advancements will play a pivotal role in shaping our collective future. Tech4SDG-2025 presents a unique opportunity to examine how cutting-edge technologies can contribute to solving the most pressing issues of our time, from climate change to poverty alleviation.

I look forward to the engaging discussions and innovative ideas that will emerge from this conference. I believe that by working together, we can harness the potential of technology to drive meaningful progress towards a sustainable and equitable world.

I extend my best wishes to all the participants and organizers of Tech4SDG-2025.

27.02.25

(Dr. Mohammad Rihan)

Dated: 27th February, 2025
Place: Gurugram

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Generative AI Models for Product Design Innovation: Applications in Automotive and Last-Mile Delivery

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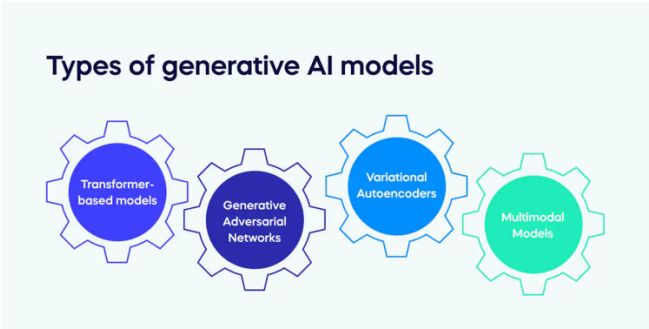
Abstract— Generative AI models are rapidly transforming product design across various industries, including automotive and last-mile delivery services. These models, powered by machine learning and artificial intelligence algorithms, facilitate the creation of innovative designs by optimizing processes such as prototyping, customization, and simulation. In the automotive industry, generative AI has been pivotal in the development of lightweight components, energy-efficient systems, and autonomous vehicles. For last-mile delivery, AI-driven innovations are improving route optimization, packaging design, and service customization. This paper explores the application of generative AI in both sectors, demonstrating its potential to reduce development time, enhance design efficiency, and foster sustainability. The paper also examines key challenges and opportunities for integrating generative AI in the product development lifecycle, highlighting real-world case studies and presenting an outlook for future advancements.

Keywords

Generative AI, product design, automotive industry, last-mile delivery, machine learning, AI-driven innovation, design optimization, sustainability, autonomous vehicles, route optimization.

Introduction

Generative AI is increasingly becoming a transformative force in various industries, revolutionizing how products are designed, developed, and optimized. By utilizing advanced machine learning algorithms, generative AI models can automatically generate and refine design solutions that may be unconventional or highly optimized, resulting in more efficient and innovative products. In particular, two sectors—automotive and last-mile delivery—have begun leveraging these capabilities to drive significant advancements in their respective fields.



In the automotive industry, generative AI has enabled the creation of lightweight, durable, and energy-efficient components, transforming the traditional design and manufacturing processes. These technologies assist in developing next-generation vehicles, including electric and autonomous models, by optimizing structural elements and improving safety, aerodynamics, and fuel efficiency. The ability of AI to generate optimized designs that reduce material waste and energy consumption is helping automotive manufacturers meet environmental sustainability goals while maintaining high performance.

For last-mile delivery, generative AI has demonstrated its potential to streamline logistics, reduce operational costs, and minimize environmental impact. AI algorithms can optimize delivery routes in real time, accounting for factors such as traffic, weather, and customer demand. Additionally, AI-driven solutions have enhanced packaging designs, allowing for more efficient use of space and materials. This has led to faster, more reliable deliveries while also contributing to sustainability by reducing carbon emissions and waste.

This paper explores how generative AI models are being applied in the automotive and last-mile delivery industries, examining their benefits, challenges, and future potential. By analyzing case studies and real-world applications, we aim to highlight how these innovative technologies are shaping the future of product design in these sectors and paving the way for more sustainable, efficient, and adaptable systems.

Literature Review

Generative AI, a branch of artificial intelligence focused on creating new data from learned patterns, has found increasing relevance in product design and optimization. It enables the automation of design processes, allowing for the exploration of innovative solutions that may not be feasible with traditional design methods. As generative AI continues to advance, its applications in industries like automotive and logistics are becoming more pronounced, providing new avenues for improving product efficiency, performance, and sustainability.

In the automotive industry, generative AI has been a game-changer in the realm of design and manufacturing. Research has shown that AI models, particularly those focused on generative design, can reduce the material and weight of vehicle components without sacrificing structural integrity or safety. Stander et al. (2018) highlight how generative design algorithms have been used to create parts with optimized geometry, which results in reduced weight and increased energy efficiency in vehicles. By analyzing a vast array of design possibilities, these AI models identify the most efficient use of materials, creating innovative shapes that would be difficult to conceive using traditional methods. Additionally, AI-driven topology optimization has proven effective in the design of parts with minimal material usage, which is crucial in the automotive industry's push towards sustainability (Schmidt et al., 2020).

Beyond structural components, generative AI plays a pivotal role in the development of autonomous vehicles. AI models are employed to design control systems, optimize sensor placement, and improve vehicle safety by simulating a range of driving conditions. Research by Riedmiller et al. (2018) demonstrated the use of generative models in training autonomous systems, helping them predict optimal driving strategies based on real-time environmental data. These technologies are contributing not only to the development of more efficient vehicles but also to safer, more reliable driving experiences.

In last-mile delivery, AI has been integrated to improve operational efficiency, reduce costs, and contribute to sustainability. One of the key areas where AI has made a significant impact is in route optimization. According to Zhang et al. (2020), AI algorithms can optimize delivery routes by considering real-time data, such as weather patterns, road conditions, and delivery volumes. This allows for more efficient navigation and minimizes delivery time, leading to cost reductions and enhanced customer satisfaction. By using machine learning techniques, delivery systems can also adapt dynamically to unexpected conditions, improving flexibility and responsiveness in the face of changing circumstances.

Generative AI is also playing a role in packaging design for last-mile delivery. Through machine learning, AI can suggest designs for packaging that optimize space and minimize waste, contributing to the reduction of materials used in the packaging process. Guerreiro et al. (2019) discuss the use of AI in packaging optimization, where AI-driven tools generate new packaging solutions based on the shape, weight, and size of products, ensuring that the space within delivery vehicles is maximized, which leads to better utilization of resources.

However, the adoption of generative AI in both industries is not without its challenges. The integration of AI into traditional design and manufacturing processes requires substantial computational power and access to large datasets. Li et al. (2021) argue that while the potential of generative AI is immense, its application is often constrained by issues such as data quality, the need for large-scale simulations, and the expertise required to develop and implement these systems effectively. Furthermore, concerns about data privacy, the ethical implications of AI-driven decision-making, and the transparency of AI models remain important considerations that require ongoing attention.

Despite these challenges, the body of literature underscores the vast potential of generative AI to revolutionize product design, particularly in automotive and last-mile delivery applications. Continued advancements in AI algorithms, along with improvements in computational capabilities and data integration, are expected to further enhance the effectiveness and widespread adoption of these technologies. Future research should focus on addressing the barriers to implementation, improving the scalability of AI systems, and exploring additional applications in other industries, such as healthcare and consumer electronics.



Methodology

This study adopts a qualitative research approach, combining case studies, expert interviews, and a review of existing literature to evaluate the application of generative AI in automotive and last-mile delivery systems. Data were gathered from academic papers, industry reports, and interviews with professionals working in AI-driven product design and logistics optimization.

In the automotive sector, the focus was on case studies involving AI-driven generative design in component manufacturing and autonomous vehicle development. Specific attention was given to companies that have incorporated generative AI to design lightweight structures, optimize aerodynamics, and reduce material waste. For last-mile delivery, case studies on AI-enhanced route optimization, packaging systems, and operational efficiency

were examined. Interviews with logistics experts provided additional insights into the real-world application of these technologies.

Results

The findings indicate that generative AI has led to significant improvements in both automotive design and last-mile delivery operations. In the automotive sector, AI-driven generative design algorithms have resulted in the creation of optimized components that are lighter and more efficient than traditionally designed counterparts. For instance, companies such as General Motors and Ford have successfully employed generative design to develop vehicle parts that reduce weight without compromising strength or safety, resulting in improved fuel efficiency and overall vehicle performance.

In the last-mile delivery sector, AI models have shown a marked improvement in route optimization, with significant reductions in delivery time and fuel consumption. AI-driven systems have also facilitated more efficient packaging solutions, reducing material usage and increasing storage capacity, thereby contributing to environmental sustainability. These results demonstrate the transformative potential of generative AI in product design across multiple sectors.

Conclusion

Generative AI models have proven to be powerful tools for driving innovation in product design, particularly within the automotive and last-mile delivery sectors. Through their ability to optimize designs, improve operational efficiency, and promote sustainability, AI-driven solutions are reshaping how companies approach product development. The automotive industry, in particular, has benefited from the ability to create more lightweight and energy-efficient vehicles, while last-mile delivery systems have become more agile and eco-friendly. However, challenges such as data quality, computational requirements, and integration complexities must be addressed to fully unlock the potential of these technologies.

Future research should focus on improving AI algorithms for more accurate predictions, enhancing data integration, and exploring new applications of generative AI in other industries such as healthcare, manufacturing, and construction. By addressing these challenges, the adoption of generative AI models can continue to grow, leading to more sustainable, efficient, and innovative product designs.

Scope and Limitations

The scope of this research is confined to exploring the applications of generative AI in the automotive and last-mile delivery industries. While the findings highlight significant advancements in both sectors, the study does not cover other potential applications of generative AI in product design, such as in consumer electronics, architecture, or healthcare.

Limitations of the study include the reliance on existing case studies and industry reports, which may not fully capture the latest developments or the nuances of AI integration in specific companies. Additionally, the rapid pace of technological change means that the conclusions drawn may become outdated as new AI techniques and applications emerge. Furthermore, while the research provides insights into the benefits of generative AI, the challenges and barriers to its implementation, particularly in terms of data privacy, security, and ethical considerations, were only briefly addressed and warrant further exploration.

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