The American Journal of Engineering and Technology
ISSN 2689-0984 | Open Access

TYPE Original Research
PAGE NO. 237-242
DOI 10.37547/tajet/Volume07Issue03-21

Check for updates

Application of Modern Technologies and Hybrid Solutions in Manicure

Kseniia Pereshliuga

Founder of the educational project in the beauty service industry - NailMentor Pro Aventura, USA

OPEN ACCESS

SUBMITED 26 January 2025
ACCEPTED 27 February 2025
PUBLISHED 27 March 2025
VOLUME Vol.07 Issue03 2025

CITATION

Kseniia Pereshliuga. (2025). Application of Modern Technologies and Hybrid Solutions in Manicure. The American Journal of Engineering and Technology, 237–242. https://doi.org/10.37547/tajet/Volume07Issue03-21

Abstract: This study provides a comprehensive analysis of the implementation of modern technologies and hybrid solutions in the manicure industry. Innovative trends are examined, including AI-powered nail printers, augmented reality applications, 3D printing, robotic manicure systems, and the unique characteristics of hybrid manicure techniques that combine the advantages of traditional and contemporary coatings. The research is based on an analysis of existing studies as well as publicly available data from online sources. The applied methodological approaches allow for an assessment of the potential of digital innovations in improving the quality, durability, and safety of manicure procedures. The findings demonstrate that the integration of innovative technologies and hybrid techniques can not only fundamentally transform the aesthetic aspects of nail application but also optimize technological processes in the beauty industry. This study presents an interdisciplinary approach that merges cosmetology with advanced technological solutions, fostering the development of new business models, educational programs, and technological breakthroughs in nail application. The insights provided in this article will be valuable for professional nail technicians, beauty salon owners, researchers, entrepreneurs, technology developers, and educational institutions, as modern technologies and hybrid solutions contribute to workflow optimization, service quality enhancement, and the advancement of innovation in the beauty industry.

Keywords: innovative technologies, hybrid manicure, nail art, artificial intelligence, augmented reality, 3D printing, robotic manicure, laser engraving, aesthetic cosmetology.

Introduction:

In recent years, the advancement of digital technologies has significantly transformed the beauty industry. Innovative solutions such as AI-powered nail printers, augmented reality applications, 3D printing, and robotic manicure systems are expanding possibilities for personalization and automation of procedures. At the same time, hybrid manicure techniques, which combine the advantages of traditional coatings with advanced formulations, are gaining popularity due to their durability and minimal impact on nail health.

The relevance of this topic is determined by the necessity of an interdisciplinary analysis of the influence of high-tech solutions on the quality of results and the safety of procedures in the context of the rapid development of both the beauty industry and digital technologies.

An analysis of previous studies indicates an active implementation of modern technologies and hybrid solutions in the manicure industry, leading to interdisciplinary research aimed at bridging the gap between traditional aesthetic procedures and high-tech innovations. The electronic resources "The Intersection of Technology and Nail Art: How Tech is Revolutionizing the Manicure Industry" [1] from itechsummary and "Advantages and Disadvantages of Hybrid Manicure" [2] from madamelie provide a foundation for understanding technological transformation. They identify a research gap related to the insufficient integration of digital tools with traditional manicure techniques. Their objective is to assess the effectiveness and perception of innovative approaches, while their novelty lies in the comprehensive analysis of digital trends. The authors hypothesize that high-tech solutions can enhance service quality and personalization, with the methodology based on comparative analysis and industry expert surveys.

Another group of sources focuses on broader trends in cosmetology and aesthetic therapy, as exemplified in the study by Skiba R. [3]. This research demonstrates that modern cosmetology is increasingly incorporating technological advancements into beauty procedures. The research gap is attributed to the lack of a systematic analysis of how new methods impact traditional service models. The study aims to systematize contemporary technological trends, with the author's hypothesis suggesting that the synergy of innovative methods with sustainable practices could lead to a qualitative leap in aesthetic services. The methodology involves market analysis and comparative studies of innovative technologies.

A third group of studies examines diagnostic and imaging technologies used for the assessment of nail structures. Sechi A. et al. [4] in a study on image-based diagnostics of nail disorders and Dogdu M. et al. [6] in research on dermatoscopic evaluation of capillary structures highlight a research gap in the limitations of current diagnostic tools for accurate and early detection of nail pathologies. These studies aim to develop and test new visual diagnostic methods based on modern image processing algorithms to improve diagnostic objectivity and accuracy. Their novelty lies in the use of automated analysis systems, and the authors hypothesize that integrating computer vision into dermatological practice can significantly reduce the time required for diagnosis. The methodology includes clinical trials, comparative analysis with traditional methods, and machine learning applications for data interpretation.

A fourth group of sources explores the application of machine learning in related fields, which, despite its broader scope, is relevant for understanding the potential of digitalization. Vanrolleghem P. A. et al. [5] discuss the use of machine learning algorithms in data analysis. The research gap stems from the lack of consideration for the specific needs of the cosmetic industry. The study aims to adapt algorithmic solutions for new applications, with its novelty reflected in its interdisciplinary approach. The authors hypothesize that machine learning methods can be effectively adapted to optimize business processes and improve service quality in the manicure industry. The methodology relies on analytical modeling and experimental validation of algorithms.

Finally, the fifth group includes publications addressing managerial and entrepreneurial aspects of the beauty industry. Nguyen B. [7], in a business plan for a beauty salon in Helsinki, identifies a research gap in the lack of integrated models that combine traditional services with innovative cross-cultural elements. The study aims to develop a model that merges aesthetic and culinary innovations, reflecting the author's hypothesis about the potential synergy between different industries. The methodology is based on strategic market analysis, case studies, and business trend forecasting.

The presented analysis highlights successful examples of the application of nanotechnology and digital diagnostics in nail application. However, a research gap remains due to the lack of a systematic study of the interaction between digital technologies and hybrid manicure solutions, which hinders the development of optimal recommendations for improving procedure

quality and minimizing adverse effects on the nail plate.

The objective of this study is to analyze the potential applications of digital technologies and hybrid methods in the manicure industry, assessing their effectiveness in terms of personalization, coating durability, and nail health safety.

The scientific novelty of this study lies in its first-time exploration of modern technological solutions and hybrid methodologies in nail application, based on a broad analysis of diverse scientific perspectives. This approach establishes a foundation for further research in the field.

The authors hypothesize that the integration of modern technologies with hybrid manicure techniques enhances the aesthetic quality and durability of coatings while reducing the risk of damage to the natural nail plate compared to traditional methods.

The methodology is based on an analysis of previous studies as well as data available from online sources.

1. Modern technologies used in manicure application

The advancement of digital technologies has a direct impact on various fields, including the beauty industry. In manicure application, new methods and devices are emerging that not only expand design possibilities but also enhance precision, speed, and durability. For a clearer representation, Figure 1 illustrates the existing modern technologies utilized in the manicure process.

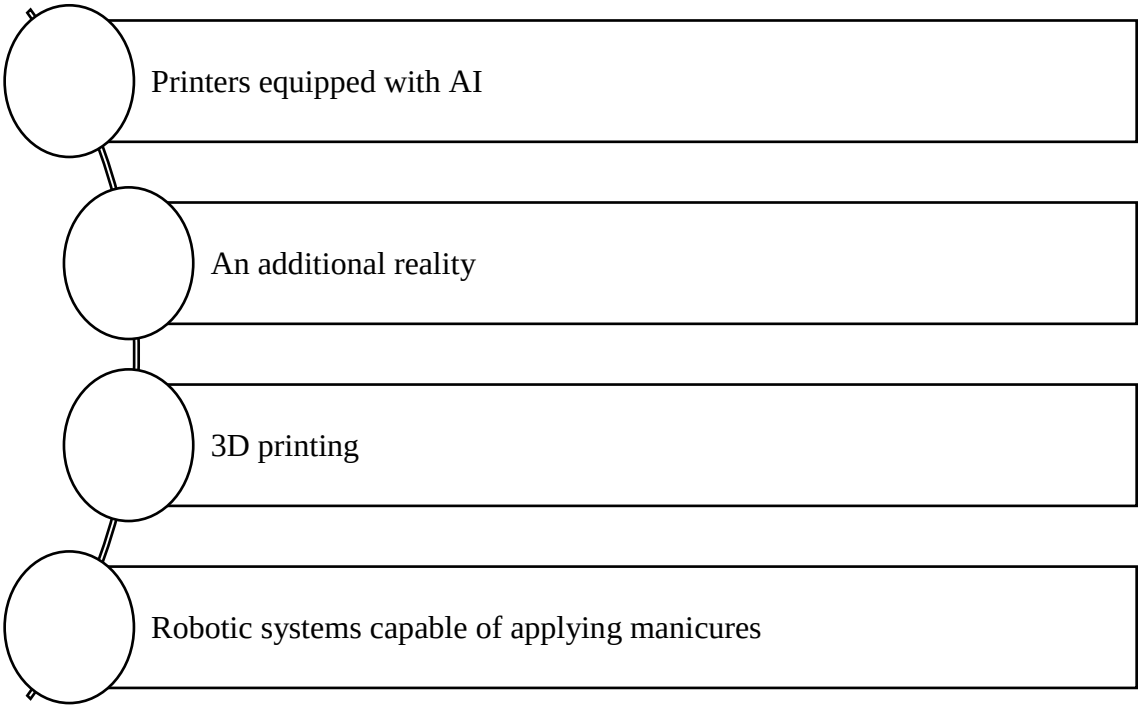

Fig.1. Modern technologies used in the process of applying manicure [1,2].

One of the significant advancements is the development of AI-powered nail printers. These devices operate by scanning the shape and size of the nail and then using image recognition algorithms to create intricate patterns. The use of UV radiation to cure printed ink ensures the durability and precision of the design application. This technology allows users to select or upload images from extensive databases, enabling full personalization of manicure designs.

Augmented reality (AR) also plays a role in the manicure industry by allowing virtual previews of nail designs before their actual application. AR applications enable users to visualize different styles on their nails using mobile devices or tablets. This technology reduces the risk of dissatisfaction with the final result and helps optimize design selection by considering color combinations and proportions [2,3].

3D printing enables the creation of intricate textured patterns that are difficult or impossible to achieve manually. By using safe materials such as gels and acrylics, specialists can program printers to produce highly detailed textures and ornaments, expanding the

aesthetic possibilities for customization [4,7].

Robotic manicure integrates automated tools capable of applying polish, preparing the nail plate, and even creating basic designs with high speed and precision. This approach minimizes human error and improves the overall quality of the final result [3,6].

For a more detailed overview, Table 1 presents the key modern technologies used in manicure application.

Table 1. The main modern technologies used in applying manicure [1,2].

Technology	Features	Advantages	Limitations and prospects
AI-powered nail printers	Nail plate scanning, image recognition algorithms, UV curing	High precision, personalization, fast application	High cost, limited design database
AR applications for virtual previews	Instant 3D modeling, interactive design display	Reduced risk of unsatisfactory selection, convenient pre-evaluation	Limitations in color and texture accuracy, device requirements
3D printing in nail art	Automated creation of complex textured patterns, use of safe materials	Unique textures, high level of detail	Requires specialized equipment, technological complexity
Robotic manicure	Automated polish application, programmable procedures	Standardization of procedures, minimized errors, high speed	Limited creative freedom, dependence on software capabilities

Modern manicure technologies demonstrate significant potential for transforming traditional aesthetic procedures. The integration of artificial intelligence, augmented reality, 3D printing, and robotic systems not only expands creative possibilities for professionals but also enhances the quality, precision, and durability of manicure applications. Further research in this field will contribute to optimizing these technologies and expanding their implementation in both professional and consumer settings.

2. Hybrid solutions in manicure

Hybrid solutions in manicure represent a method that combines the advantages of traditional nail polishes and gel technologies. This approach aims to achieve enhanced durability and aesthetic appeal while minimizing the negative impact on the natural nail structure. The foundation of hybrid solutions lies in comprehensive nail plate preparation, optimized use of coating materials, and improved application techniques, ensuring an extended lifespan of the manicure.

Before applying hybrid polish, the following steps must be completed:

- Dead skin must be removed, and the cuticle should be pushed back to create a clean and smooth surface for the application.
- The nail plate should be buffed to enhance microporosity, improving adhesion between the polish and the nail [2].

Thorough cleansing with specialized products ensures strong bonding between the hybrid formula and the nail. Improper nail preparation can lead to chipping, nail damage, and a reduction in the overall durability of the coating, emphasizing the importance of adhering to all preparation stages [4,6]. Although the application process of hybrid coatings requires more time and specialized equipment, such as a UV lamp and professional nail preparation tools, it represents a

reasonable balance between long-lasting wear and nail health preservation.

The future development of hybrid solutions is associated with material optimization, advancements in application techniques, and the integration of digital tools for quality control. The implementation of digital diagnostics for assessing the nail plate condition and customizing formulations can help reduce the risk of allergic reactions and nail damage. Additionally, ongoing research in material science suggests the potential emergence of new, less aggressive formulas that provide high durability and aesthetic appeal while minimizing harm to the nails [2,3]. A comparative analysis of manicure application methods is presented in Table 2.

Table 2. Comparative analysis of manicure methods [1,2].

Parameter	Hybrid manicure	Gel manicure	Acrylic manicure	Traditional polish
Durability	Up to 1 month	3–4 weeks	3–4 weeks	Up to 1 week
Impact on nail plate	Moderate (with proper preparation)	High (contains more aggressive chemicals)	High (requires frequent maintenance and corrections)	Low (minimal impact)
Application complexity	High (requires thorough preparation and equipment)	Medium (standard application methods)	Medium (specific mixing techniques)	Low (simple application)
Cost	Medium	High	High	Low

Hybrid solutions in manicure demonstrate the potential to integrate the aesthetic and functional benefits of various coating methods. Proper execution of the procedure, from nail plate preparation to the optimization of application techniques, ensures long-lasting results while preserving nail health. Future research in this field should focus on improving materials and incorporating digital tools, which may lead to the development of even safer and more effective nail care techniques.

CONCLUSION

In summary, the modern manicure industry is undergoing a phase of qualitative transformation driven by the integration of digital technologies and hybrid solutions. A review of the literature indicates that AI-powered nail printers, AR applications, 3D printing, and robotic systems expand the creative possibilities for professionals while ensuring high precision and durability of manicure coatings. At the same time, hybrid manicure techniques, which combine traditional and modern methods, demonstrate an optimal balance between aesthetics and the safety of the natural nail plate, as confirmed by a comparative analysis of various approaches.

Thus, the integration of high-tech solutions into traditional manicure practices not only enhances service quality but also lays the foundation for the sustainable development of the beauty industry, which is essential for both professionals and consumers. Further research in this area should focus on the development of new, less aggressive formulations and the improvement of digital tools to enable even safer and higher-quality manicure services.

REFERENCES

The Intersection of Technology and Nail Art: How Tech is Revolutionizing the Manicure Industry . [Electronic resource] Access mode:https://www.itechsummary.com/the-intersection-of-technology-and-nail-art-how-tech-is-revolutionizing-the-manicure-industry / (date of access: 03.02.2025).

Advantages and disadvantages of hybrid manufacture. [Electronic resource] Access mode: https://madamelie.com/advantages-and-disadvantages-of-hybrid-manicure / (date of access: 03.03.2025).

Skiba R. Advances in Cosmetology: Beauty Therapy Technology, Treatments, Sustainability, and Holistic Wellness. – After Midnight Publishing, 2025. – pp.25-57.

Sechi A. et al. Advances in image-based diagnosis of nail disorders //Journal of the European Academy of Dermatology and Venereology. – 2024.

Vanrolleghem P. A. et al. Machine learning in wastewater: opportunities and challenges—"not everything is a nail!" //Current Opinion in Biotechnology. – 2025. – Vol. 93. – pp. 2-9.

Dogdu M. et al. Dermatoscopic assessment of nailfold capillary structures in connective tissue diseases //Archives of Dermatological Research. – 2024. – Vol. 316 (10). – pp. 679.

Nguyen B. Business plan for a beauty salon in Helsinki: a combination of the beauty spa model and Vietnamese cuisine. – 2024. – pp. 1-38.