The Role of Artificial Intelligence in Decision Support Systems of the Jewellery Industry

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ABSTRACT

Artificial Intelligence (AI) has become an essential tool for supporting decision-making processes across various domains, including the jewellery industry, healthcare, finance, logistics, and public policy. Decision support systems (DSS) powered by AI enable more accurate, efficient, and adaptive solutions to complex problems by leveraging data-driven insights and predictive models. This paper examines the role of AI in decision support in the Jewellery Industry, exploring methodologies, benefits, challenges, and future directions. The jewellery industry is both a cultural cornerstone and a significant economic contributor, particularly in India, where it accounts for nearly 7% of GDP and 15% of total exports. With global competition, rising customer expectations, and complex supply chains, the sector faces challenges that demand more intelligent and faster decision-making. Artificial Intelligence (AI)-driven Decision Support Systems (DSS) offer a transformative solution. By leveraging machine learning, predictive analytics, and real-time data processing, AI enables businesses to optimize jewellery design, manufacturing, inventory, authentication, and retail strategies. This paper explores the role of AI-based DSS in reshaping the jewellery sector, highlighting use cases such as generative design, fraud detection, virtual try-on experiences, and demand forecasting. It further discusses the benefits, challenges, and ethical considerations of integrating AI into a traditionally craft-driven industry. The study concludes that AI-powered DSS can provide the jewellery industry with a competitive edge, enhance customer satisfaction, and contribute to the broader vision of sustainable and technologically advanced economic growth.

Keywords: Artificial Intelligence, Decision Support Systems, Jewellery Industry, Generative Design, Predictive Analytics, Virtual Try-On, Supply Chain, India.


INTRODUCTION

The global jewellery industry has always been at the intersection of culture, craftsmanship, and commerce. For centuries, jewellery has carried symbolic, aesthetic, and economic significance, representing not only wealth and status but also heritage and identity. In India, jewellery is woven deeply into social customs, religious practices, and life events, making it one of the largest consumers and exporters of precious metals and gems worldwide. According to the Gem and Jewellery Export Promotion Council (GJEPC), the industry contributes nearly 7% to India's GDP and 15% of total merchandise exports, employing over 5 million people. Despite its strong foundations, the jewellery sector is experiencing a paradigm shift, shaped by globalization, evolving consumer demands, rising competition, and the need for greater efficiency and authenticity in production and retail. In this era of rapid technological transformation, Artificial Intelligence (AI) is emerging as a disruptive force across industries. AI systems, powered by machine learning, computer vision, natural language processing, and predictive analytics, enable organizations to make sense of massive data sets and derive actionable insights. When embedded in Decision Support Systems (DSS), AI enhances the ability of businesses and policymakers to analyze alternatives, forecast outcomes, and make optimal decisions. In industries like healthcare, finance, and manufacturing, AI-enabled DSS have already demonstrated the capacity to increase accuracy, reduce costs, and improve service delivery. The jewellery industry, which has traditionally relied heavily on manual expertise and intuition, now stands at the threshold of embracing such intelligent systems.

The importance of AI-driven DSS in the jewellery sector extends beyond operational efficiency. It has significant implications for sustainability, inclusivity, and competitiveness. For instance, artisans and small-scale jewellers, who form the backbone of India's jewellery ecosystem, often lack access to global markets and advanced technologies. AI-driven platforms can bridge this gap by connecting them to consumers worldwide, offering demand forecasts, and providing digital tools that augment their creativity rather than replace it. From a macroeconomic perspective, wider adoption of AI in this sector could strengthen India's position in global exports, improve compliance with international

standards, and support the broader vision of *Viksit Bharat 2047*—a developed India driven by innovation and inclusive growth.

This paper seeks to examine the role of AI in decision support systems within the jewellery industry in depth. It begins with a review of existing literature on AI-driven DSS and its emerging applications across industries. It then examines the specific ways in which AI enhances decision-making in jewelry design, manufacturing, supply chain management, retail, and fraud detection. Real-world case studies of leading jewellery brands and startups are analyzed to provide practical insights. The paper also highlights the benefits, limitations, and risks associated with integrating AI into this sector, followed by a roadmap for implementation that considers India's economic vision and the global jewellery market. Ultimately, this study argues that AI-powered DSS can transform the jewellery industry into a technologically advanced, globally competitive, and customer-centric sector while safeguarding its cultural heritage and artisanal traditions

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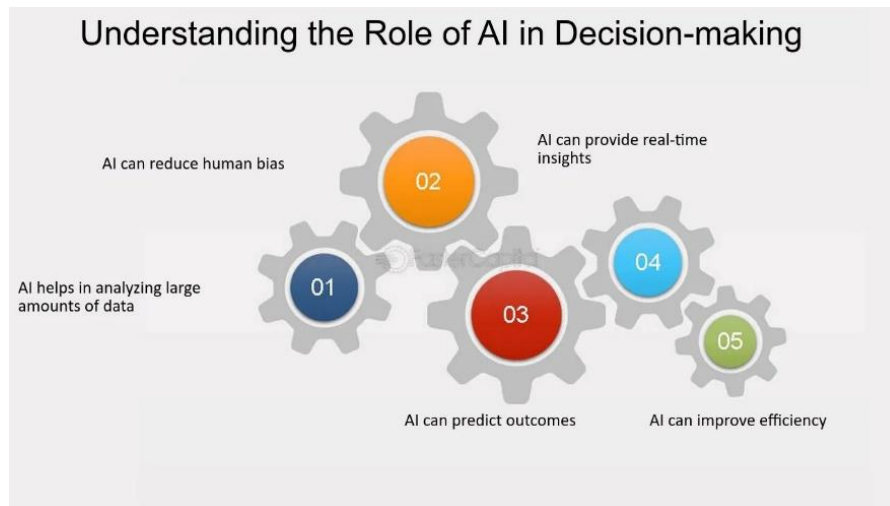
LITERATURE REVIEW

- **AI and the Jewellery Industry**

The literature on Artificial Intelligence (AI) and Decision Support Systems (DSS) has evolved considerably over the past few decades, reflecting the increasing complexity of decision-making in modern organizations. While AI and DSS have been widely studied in fields such as healthcare, manufacturing, and finance, their application in the jewellery industry remains relatively underexplored.

1) Sector context and need for AI

Jewellery is a high-value, event-driven category exposed to commodity volatility and complex, globalized supply chains—conditions that make analytics and decision support especially valuable. The World Gold Council's 2024 data show record gold prices and a steep decline in global jewellery volumes (–11% y/y), with India comparatively resilient—underscoring the need for data-driven planning, pricing, and inventory management.

2) AI for design and product development

AI-assisted generative design and CAD/CAM are migrating into jewellery workflows to explore design spaces under constraints (weight, symmetry, manufacturability). In gemstones, computer vision research has accelerated: a 2024 open-access study introduced an enhanced YOLOv8 model and dataset for synthetic diamond quality evaluation, demonstrating the feasibility of real-time automated grading/defect detection that can be integrated into shop-floor DSS.

3) Manufacturing quality and yield optimization

Vision models have long been investigated for colour/clarity assessment; early machine-vision work on diamond colour grading established the viability of repeatable optical evaluation, and newer deep-learning approaches improve robustness for inclusion detection and cut optimization—key to precious-material yield. Together, these studies frame AI as a maturing tool for automated inspection within an end-to-end DSS.

4) Retail experience: virtual try-on (VTO) and personalization

The AI+AR "virtual try-on" stack has become central to omnichannel jewellery retail. Market analysis projects strong growth for VTO platforms through 2030, while industry case studies document how mobile VTO, visual search, and recommendation engines increase engagement and reduce returns—transforming front-end experiences into back-office decision signals for assortment and merchandising.

6) Forecasting, pricing, and inventory decision support

Given record gold prices in 2024 and continued volatility in 2025, ML-driven demand and price forecasting is repeatedly cited as a high-impact use case: models that fuse macro signals (rates, FX), festival/wedding calendars, and first-party sales help right-size inventory, hedge procurement, and implement dynamic yet brand-constrained pricing. WGC's quarterly breakdown for India (Q1 2024 demand +4% y/y) illustrates how local resilience can diverge from global trends, providing evidence that region-specific models are advantageous.

7)The Jewellery Industry: Economic and Cultural Significance

The jewellery industry is a multi-billion-dollar global market characterized by high-value transactions, cultural symbolism, and intense consumer personalization. In India, the industry plays a particularly significant role. It is not only the largest consumer of gold but also one of the leading exporters of gems and jewellery, contributing **US$40 billion in exports in 2023** (GJEPC, 2023). Jewellery is also deeply tied to traditions, festivals, and social events, which creates seasonally fluctuating demand patterns.

- **AI in Jewellery Design and Manufacturing**

Jewellery design has traditionally relied on artisanship and manual creativity. However, AI-enabled **generative design systems** are now capable of creating innovative patterns that combine traditional motifs with modern aesthetics. These systems utilize machine learning algorithms to analyze customer preferences, historical sales data, and design trends, thereby suggesting new collections that are more likely to succeed in the market (Autodesk, 2020).In manufacturing, computer vision systems integrated with AI are being used for gem cutting, polishing, and defect detection (Zhou et al., 2019). Such systems enhance precision and reduce material wastage, directly impacting profitability in a sector where raw materials are highly valuable.

- **AI in Jewellery Retail and Customer Experience**
  - Retailing in the jewellery industry faces unique challenges, including the need for personalization, authenticity, and trust-building. AI-powered DSS are being used in several ways:
  - **Virtual Try-On:** Companies such as Tanishq and Carat Lane in India use AI-driven AR applications that allow customers to virtually try jewellery before purchase (Mittal & Bansal, 2022).
  - **Personalized Recommendations:** Machine learning algorithms analyze browsing history and previous purchases to recommend jewellery pieces tailored to individual tastes.
  - **Dynamic Pricing:** AI-enabled DSS adjusts prices in real time based on gold market fluctuations and consumer demand.

These applications demonstrate the potential of AI to not only improve efficiency but also enhance customer engagement and loyalty.

- **AI in Jewellery Supply Chains and Fraud Detection**

Global sourcing of raw materials, fluctuating gold and diamond prices, and issues of fraud and counterfeiting complicate supply chain management in the jewellery industry. AI-based DSS are increasingly used for **demand forecasting**, helping companies anticipate seasonal surges, such as those during festive and wedding seasons. Blockchain integrated with AI is being employed by companies such as De Beers to track the provenance of diamonds, ensuring that they are conflict-free and authentic (De Beers, 2021).

Fraud detection is another area where AI plays a crucial role. Image recognition systems and predictive analytics can identify fake or adulterated jewellery, thereby enhancing trust in the industry (Nguyen et al., 2020).

Research gap

- **Mature threads**: provenance/traceability at scale; AR-assisted retail; computer-vision quality control.

- **Rapidly advancing**: deep-learning inspection for diamonds/gems; data-driven demand and pricing models tuned to local seasonality. **Under-researched**: end-to-end, peer-reviewed **AI-driven DSS frameworks specifically for jewellery** (integrating design→manufacturing→retail→provenance), and rigorous SME adoption studies in emerging markets.

These gaps justify your paper's contribution: specifying a jewellery-tailored DSS reference model, with metrics for forecast accuracy, yield improvement, provenance coverage, and trust outcomes.

AI Applications in the Jewellery Industry
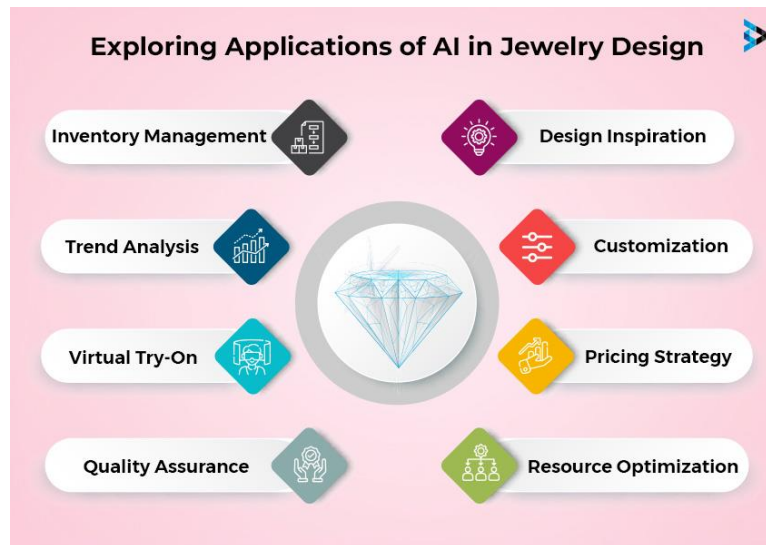
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1. **AI in Inventory Management & Supply Chain**
- **Demand Forecasting**: AI predicts demand surges during festive and wedding seasons, enabling jewellers to maintain optimal stock levels.
- **Inventory Optimization**: Algorithms help balance stock between showrooms, warehouses, and online platforms, reducing overstocking and understocking risks.
- **Logistics Efficiency**: AI-based DSS suggests the best routes and suppliers for the timely delivery of raw materials and finished products.
- **Case Example**: Titan's Tanishq uses AI-based forecasting to streamline inventory across its 350+ stores in India.

2. **AI in Jewellery Design**
- **Generative Design**: AI-powered platforms (e.g., Autodesk, RhinoGold) analyze design parameters such as weight, symmetry, cultural motifs, and customer preferences to generate multiple innovative jewellery designs.
- **Customization & Personalization**: Algorithms recommend personalized designs based on individual customer profiles, purchase history, or even social media trends.
- **Rapid Prototyping**: AI integrated with CAD/CAM software accelerates 3D modelling and prototyping of jewellery.
- **Case Example**: Carat Lane in India uses AI-based design tools to create collections tailored to younger, fashion-conscious customers.

3. **AI in Quality Assurance & Manufacturing**
- **Gemstone Grading**: Computer vision systems powered by AI identify inclusions, clarity, and cut quality in diamonds and coloured gemstones with greater accuracy than manual grading.
- **Precision Manufacturing**: AI-driven machines automate polishing, engraving, and casting, reducing error rates and material wastage.
- **Defect Detection**: AI-based inspection systems scan jewellery pieces for scratches, structural defects, or anomalies, ensuring higher quality control.
- **Example**: De Beers uses AI systems to improve diamond cutting precision and optimize yield.

4. **AI in Trend analysis & Marketing.**
- **Social Media Analysis**: AI tracks jewellery trends on platforms like Instagram and Pinterest, helping brands launch timely collections.
- **Sentiment Analysis**: AI evaluates customer reviews and feedback to refine products and services.
- **Predictive Consumer Behaviour**: Models predict the lifetime value of customers, enabling targeted loyalty programs

5. **AI in Virtual Try-On (AR + AI)**, **Retail & Customer Experience**
- **Virtual Try-On (AR + AI)**: Customers can visualize jewellery pieces on themselves through smartphone cameras or in-store mirrors. This reduces hesitation and enhances online shopping experiences.
- **Personalized Recommendations**: Recommendation engines suggest jewellery based on browsing history, style preferences, and festive/wedding calendars.
- **AI Chatbots & Virtual Assistants**: 24/7 customer support powered by natural language processing helps answer queries, check order status, and assist in purchase decisions.
- **Dynamic Pricing Models**: AI analyses gold/silver market trends, customer demand, and competitor pricing to suggest real-time price adjustments.

6. **AI in Authentication & Fraud Detection**

- **Blockchain + AI Integration**: Ensures transparency of gemstone sourcing, guaranteeing conflict-free diamonds and ethically mined gold.
- **Image Recognition**: AI systems verify authenticity by comparing jewellery images with certified reference databases.
- **Counterfeit Detection**: Algorithms detect anomalies in hallmarking or gemstone certificates.

Benefits of AI in Jewellery
- Enhances design innovation while preserving cultural heritage.
- Reduces material wastage and increases precision.
- Improves customer satisfaction with personalized experiences.
- Strengthens transparency and trust in authenticity.
- Boosts global competitiveness of jewellery exporters.

Challenges in AI Adoption
- **High Implementation Cost**: Small jewellers and artisans struggle to afford AI technologies.
- **Skill Gap**: Lack of AI training among traditional craftsmen.
- **Data Privacy**: Concerns about consumer data collection and profiling.
- **Resistance to Change**: Fear of job displacement among artisans.

Future Prospects of AI in the Jewellery Industry
The integration of Artificial Intelligence (AI) into the jewellery industry is still in its early stages, but the potential for future growth is immense. With advancements in AI, data analytics, robotics, and immersive technologies, the jewellery sector can evolve into a highly efficient, transparent, and customer-centric industry by 2047. This aligns directly with India's Viksit Bharat 2047 vision, where technology becomes a driver of sustainable economic growth, global competitiveness, and cultural preservation.

1. Hyper-Personalized Jewellery Design
In the future, jewellery will become more deeply personalized, reflecting not only a customer's cultural heritage but also their lifestyle, fashion preferences, and even emotional connections.
- AI will analyse biometric data (e.g., wrist size, facial structure) along with social media activity and past purchases to suggest unique designs tailored to individual customers.
- Generative AI will create "co-designed" jewellery, where customers interact with digital design platforms and modify suggestions in real time.
- Mass personalization at scale will become possible, enabling even small jewellers to offer bespoke experiences without excessive costs.

2. Smart Manufacturing and Automation
Manufacturing in the jewellery industry will be revolutionized by intelligent automation.
- AI-powered robotics will handle delicate processes like gemstone setting, polishing, and engraving with near-perfect precision.
- AI-driven quality control systems will ensure that every piece of jewellery meets international grading standards without manual inspection delays.
- Factories will evolve into smart manufacturing hubs, where AI coordinates machinery, materials, and workflows, reducing wastage of precious metals like gold and platinum.

This will empower India's MSMEs (micro, small, and medium enterprises) to compete globally with large jewellery conglomerates.

3. Sustainable and Ethical Jewellery

As global customers become more conscious about sustainability and ethical sourcing, AI will play a crucial role in ensuring transparency:

- AI integrated with blockchain will track the provenance of gemstones and metals from mines to retail stores.
- Predictive algorithms will recommend eco-friendly alternatives, such as lab-grown diamonds or recycled metals, based on consumer preferences.
- Smart DSS will enable companies to reduce carbon emissions by optimizing supply chains and logistics.

4. Immersive Retail Experiences

The retail landscape is set to undergo a digital renaissance:

- **AI + AR/VR Integration** will allow customers to enter virtual jewellery showrooms, try on ornaments through avatars, and make purchases from anywhere in the world.
- Voice-enabled AI assistants will provide real-time guidance, explaining gemstone quality, cultural symbolism, and customization options.
- Hybrid retail models, where physical showrooms integrate with AI-powered digital platforms, will dominate.

5. Predictive Market Intelligence

AI will strengthen the strategic capabilities of jewellery businesses by providing advanced market intelligence:

- AI models will forecast gold and diamond price trends by analysing macroeconomic indicators, currency fluctuations, and consumer sentiment.
- Jewellery brands will predict festival-specific or wedding-related demand months in advance, ensuring supply chain readiness.
- Competitive intelligence tools will analyse global jewellery trends, enabling Indian brands to launch timely, innovative collections.

6. Empowerment of Artisans and MSMEs

A unique feature of India's jewellery sector is its dependence on millions of artisans, many of whom work in small, unorganized units. Future AI systems will not replace these artisans but augment their creativity:

- AI design tools will help artisans modernize traditional patterns for global appeal.
- Digital platforms powered by AI will connect rural artisans directly with international buyers, bypassing middlemen.
- Decision support platforms will help small jewellers optimize material usage, pricing strategies, and inventory management.

7. Risk Management and Fraud Prevention

As the jewellery sector is a high-value one, fraud prevention will remain a key concern. Future AI applications will:

- Detect counterfeit products instantly through advanced image recognition and chemical composition analysis.
- Monitor financial transactions for fraud and money laundering risks.
- Create secure, tamper-proof certification systems for gemstones and ornaments.

8. Contribution to Viksit Bharat 2047

By 2047, AI-enabled DSS in the jewellery industry will contribute to India's national vision in multiple ways:

- **Economic Growth**: Strengthen exports, generate jobs, and increase GDP contribution beyond the current 7%.
- **Cultural Diplomacy**: Blend tradition with innovation, making Indian jewellery a global symbol of heritage and modernity.
- **Technological Leadership**: Establish India as a hub for AI-driven luxury industries, attracting global investments.
- **Social Inclusion**: Empower women artisans, rural communities, and MSMEs through AI democratization.

CONCLUSION

The future of AI in the jewellery industry lies in a balance between innovation and tradition. While AI will streamline decision-making, enhance precision, and unlock global markets, it must also preserve the cultural essence of jewellery, which remains a deeply human expression of identity and celebration. By leveraging AI responsibly, India can transform its jewellery industry into a global leader, aligning with the grand vision of Viksit Bharat 2047.

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