



## EDITORIAL

**Citation:** Lăzăroiu, G., & Rogalska, E. (2024). Generative artificial intelligence marketing, algorithmic predictive modeling, and customer behavior analytics in the multisensory extended reality metaverse. *Oeconomia Copernicana*, 15(3), 825–835. <https://doi.org/10.24136/oc.3190>

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Article history: Received: 20.08.2024; Accepted: 10.09.2024; Published online: 30.09.2024


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## Generative artificial intelligence marketing, algorithmic predictive modeling, and customer behavior analytics in the multisensory extended reality metaverse

Generative artificial intelligence (AI) and image data-based predictive algorithms, remote sensing and geospatial mapping technologies, and visual attention modeling and socially-oriented location tracking tools (Bugaj *et al.*, 2023; Lăzăroiu *et al.*, 2019; Zvarikova *et al.*, 2023) can improve personalized shopping experiences, inquiry resolutions, product documentation, categorization, description, and recommendation, and customer support and service, building brand awareness, recall, loyalty, and retention, articulating seamless meaningful and engaging customer journeys, and increas-

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ing sale conversion rates in the multisensory extended reality metaverse. Generative AI and neural network-based recognition algorithms, holographic imaging and sentiment recognition technologies, and simulation modeling and autonomous visual object detection tools can create purchase orders, refine search functionality, streamline the shopping process, personalize customer interactions, improve backend operations and product category sourcing, shape supply chain processes, and provide tailored recommendations, detailed product information, and customized design assistance. Generative AI and 3D image processing algorithms, ambient scene detection and virtual navigation tools, and haptic and multisensory technologies can automate inventory management, create 3D metaverse engaging and smooth customer experiences, foster brand loyalty, suggest preference-based complementary items, offer predictive insights, and forecast demand accurately, configuring brand-related expectations, values, and personalized emotional significance. Generative AI and sensor path planning algorithms, augmented and virtual reality technologies, and automated perception and neuromorphic image processing systems can build and foster lasting emotional connections, support customer service, and process historical data across shared immersive and interactive journeys, creating data-driven memorable experiences and bolstering top-of-funnel brand awareness. Deep and meaningful brand-related value-driven emotional loyalty, engagement, and connections in relation to product and service purchasing expectations shape shifting shopper behaviors and streamlined customer engagement journeys.

Generative AI and predictive modeling algorithms, movement and behavior tracking tools, and networked immersive virtual reality and multimodal sensing systems (Lăzăroiu *et al.*, 2017; Lăzăroiu *et al.*, 2020; Valaskova *et al.*, 2022) can build brand trust, strong emotional connections, and loyalty to meet specific customer expectations and needs, improve content search capabilities, product cataloging processes, and personalized product recommendations, and ensure product availability, being pivotal in customer review summarization and informed purchasing decisions, balancing value and convenience while increasing conversion rates. Immersive metaverse and digital twin technologies, sensor fusion and object recognition algorithms, and Internet of Things-based decision support and geospatial big data visualization systems can further repeat purchasing behaviors and consumer feedback preferences, reduce delivery delays, and capture mobile customer value, building consistent brand identity. Machine and

deep learning-based graphics and intuitive controls can enhance brand loyalty and customer engagement through virtual reality-based interactive and immersive experiences, evoking deep emotions, creating memorable interactions, and forging lasting increased engagement, personalized customer connections, and conversion rates. The business value of building engaging multi-sensory emotion-driven digital customer experiences to increase repeat purchases and loyalty retention leads also to operational process improvement by integrating real-time behavior and preference predictions, and thus resulting in long-term customer acquisition, retention, and engagement in the multisensory extended reality metaverse. Digital twin simulation and image processing tools, generative AI and swarm computing algorithms, and immersive 3D and image-based visual computing technologies can shape improved search capabilities, offering tailored content for target audience, personalized product recommendations and marketing messages, lasting engagement times, and customer review collection and analysis.

Generative AI-powered predictive analytics can forecast individual customer preferences, craft compelling brand messages and tailored experiences, predict engagement patterns, influence purchasing decisions, and optimize fluctuating customer acquisition and retention costs (Bugaj *et al.*, 2023; Zvarikova *et al.*, 2023) by immersive consumer behavior and spending pattern data, building product-related emotional connections and driving long-term loyalty. Visual merchandising analytics can drive customer spending patterns and habits, behaviors, preferences, engagement, and satisfaction by large-scale historical transaction and product data collection, increasing brand awareness, retaining and optimizing customer lifetime value, reducing product returns, and configuring flexible and innovative purchasing experiences. Sentiment analysis and sale forecasting tools can create brand–customer emotional connections and customer-centric scalable experiences, being pivotal in spending habit predictions, lasting customer relationship building, shopping experience personalization, and post-purchase engagement by displaying virtual photorealistic content in immersive and interactive environments. Natural language processing and digital marketing automation tools can increase product awareness and customer lifetime value, track consumer sentiments, behaviors and expectations, impact post-purchase journeys and customer retention, and enable contextual engagement, driving trial and unplanned purchases, consumption pattern changes, and tailored post-purchase communications across

intuitive, immersive, and visual experiences by transaction data, sentiment analysis, and spending patterns. Generative AI-augmented simulation technologies can predict customer demands, behaviors, and sentiments, driving brand perception and awareness in terms of rising expectations, purchasing decisions, satisfaction, engagement, retention, and loyalty, while monitoring buying habits, streamlining shopper journeys, and minimizing return rates.

Immersive metaverse and digital twin technologies, situational awareness and machine learning algorithms, and preference tracking and geospatial mapping tools (Bugaj *et al.*, 2023; Lăzăroiu *et al.*, 2019; Zvarikova *et al.*, 2023) can be harnessed for consumer behavior modeling to articulate data-informed investment decisions across mobility retail networks, capturing value and optimizing transaction data-based convenience retail by hypergranular predictions in terms of socioeconomic pattern forecasting, customer value propositions, and past transaction analysis for stockout prediction, meaningful personalized promotions and offerings, and cross-sell bundle recommendations. Voice and gesture recognition tools, deep learning-based ambient sound processing, and generative AI and visual perception algorithms can optimize stock levels by real-time product tracking and instant inventory updates, meet customer expectations and habits, forge deep brand connections, offer personalized deals, fulfill customer orders swiftly, and ensure product availability. Generative AI and spatial computing devices, augmented and virtual reality technologies, and 3D virtual space networking and autonomous visual object detection tools can build consumer loyalty and shopping behaviors, fast delivery service convenience, product development capabilities, and order accuracy, merging product search and discovery, designing seamless touchpoints, pursuing demand creation, and reducing delivery times. Digital twinning and immersive extended reality technologies, data stream clustering and motion planning algorithms, and geospatial mapping and 3D dynamic scene modeling tools can drive consumer engagement and increased conversions throughout purchase journeys, mapping and transforming shopping behavior and customer sentiment while delivering 3D metaverse personalized and customized content and experiences by predictive synthetic traffic and purchase data for product content journey maximization value. Predictive geospatial modeling and signal processing tools, motion capture and machine perception technologies, and environment mapping and deep learning computer vision algorithms can influence socially-conscious con-

sumers by enhancing product recognition and brand perception, visibility, and performance, driving ethos and value sharing and buying behaviors and preferences by personalized customer service, purchasing decisions, and promotion-based conversion rates in the multisensory extended reality metaverse.

Haptic and biometric sensor technologies, object perception and emotion detection algorithms, and predictive algorithmic and generative AI tools (Bugaj *et al.*, 2023; Lăzăroiu *et al.*, 2017; Lăzăroiu *et al.*, 2020) can further integrated self-service capabilities, improve customer experiences and expectations by managing and leveraging a seamless flow of data, and foster lasting frictionless product discovery, journey, and post-purchase support, boosting revenue and profitability, building hyper-personalized and tailored digital products and services, and driving consumer behavior and increasing productivity by big data-driven contextual analysis and awareness creation. Cognitive enhancement and spatial computing technologies, 3D virtual environment mapping and digital twin simulation tools, and generative AI and crowd navigation algorithms can drive customer engagement, predict consumer behavior, and foster meaningful customer relationships in relation to evolving consumer spending habits, preferences, sentiments, expectations, needs, and behaviors, delivering 3D metaverse seamless shopping experiences and swift discovery-to-purchase flows, driving increased conversion rates, optimizing brand awareness and engagement, and streamlining purchasing processes. Generative AI-based real-time cross-functional support and effective data management tools can build customized user journeys, foster and maintain customer loyalty and engagement in terms of perceived value, preferences, and behaviors, predict product demand fluctuations accurately by use of purchase history data, reduce customer journey friction, and maintain brand equity. 3D computational modeling and wearable scent technologies, geolocation data processing and context awareness algorithms, and ambient intelligence and deep reinforcement learning tools can build brand loyalty, personalize 3D metaverse shopping experiences, identify customer behavior, motivation, and preference patterns, meet evolving and changing consumer demands, and assist customers in navigating product complexity, creating personalized recommendations and customized content. 3D object recognition and environment perception technologies, image processing computational and visual cognitive algorithms, and ambient scene detection and contextual awareness tools can influence repeat purchases and hyper-personalized

experiences, foster brand loyalty, extend customer lifetime value, and improve return rates, being pivotal in customer feedback tracking and processing, automated customer preference data collection and analysis, and real-time product and service offering customization.

Generative and predictive AI technologies can foster brand loyalty and perceptions, boost customer lifetime value, enhance multi-sensory immersive customer engagement and experiences, capture customer intent, and forecast conversion rates (Valaskova *et al.*, 2022; Zvarikova *et al.*, 2023), shaping big data-driven customer interaction and post-purchase product suggestion personalization with regard to shopping behaviors, lifestyles, sentiments, buying decisions, preferences, attitudes, and expectations. Customer data and analytics technologies can create meaningful and authentic brand interactions by multi-step customer engagement processes along shopping journeys, configuring shopping decisions, purchasing behaviors, sentiments, and preferences, while boosting product awareness. Natural language processing and sentiment analysis can shape customer shopping behavioral shifts, changing sentiments, emotions, and attitudes, satisfaction, retention, engagement, expectations, loyalty, buying habits, personalized purchase journeys, thus building long-term brand equity, creating product connections, and optimizing the immersive nature of metaverse content. Generative AI and computer vision systems can drive purchasing decisions and brand awareness, elevate customer engagement, and create deep emotional connections by behavioral experience and transaction data, individual shopping histories, past purchase pattern analysis, comprehensive product descriptions, product review summarization, and social and semantic data sharing. Generative AI algorithms and big data analytics automation are instrumental in trust-based relationship building, sale capability augmentation, future demand forecast, and customer lifetime value and frictionless experience creation. Generative AI marketing, algorithmic predictive modeling, and customer behavior analytics can design empathetic experiences and genuine connections, understand individual contexts, meet evolving expectations, and provide tailored product and service recommendations by extensive data assessment, emotional attachment predictors, and deep personalized feedback and preference analysis in the multisensory extended reality metaverse.

Immersive metaverse and digital twin technologies, deep learning-based image processing and object tracking algorithms, and generative AI demand forecasting and computer vision techniques in the retail business

(Lăzăroiu *et al.*, 2017; Valaskova *et al.*, 2022; Zvarikova *et al.*, 2023) can optimize sales conversion rates and purchasing decisions by past seller behavior and expanded shopping capabilities, building memorable customer journeys, improving customer relationships and production processes, and driving customer engagement, decisions, behaviors, acquisition, and retention. Consumers can browse and purchase products across virtual stores, experiencing customizable 3D immersive digital shopping by generative AI cognitive abilities, brain-inspired neural networks, remote visual data mining, and environment mapping and path consistency algorithms. Virtual reality engaging simulations can improve customer acquisition, engagement, loyalty, satisfaction, and retention, brand perceptions, and buying habit data, forging emotional connections in relation to immersive shopping, tailored and enriched customer journey and experience mapping, and hyperrealistic avatars (or customer persona digital twins) and events in the multisensory extended reality metaverse. Immersive extended reality and geospatial artificial intelligence technologies, predictive modeling and path planning algorithms, and deep reinforcement learning and digital twin simulation tools can foster consumer behavior, conversion rates, and purchasing intent and decisions, build consumer value proposition, personalize shopping experiences, unlock customer acquisition, retention, and value, and deliver emotional uplift, while measuring customer loyalty and tracking retention. Bio-inspired artificial vision and motion capture systems, 3D object detection and tracking algorithms, and semantic-based cognitive and tactile sensing technologies can predict customer behavior and brand loyalty, improve retention and engagement proactively, meet evolving needs, and reduce churn, delivering 3D metaverse consistent and seamless hyper-personalized customer experiences by personalized product recommendations and post-purchase interactions, together with proactive assistance.

Generative AI and image processing computational algorithms, synthetic data-based autonomous production and neuromorphic computing systems, and cognitive modeling and multi-sensory extended reality technologies (Lăzăroiu *et al.*, 2019; Lăzăroiu *et al.*, 2020; Valaskova *et al.*, 2022) can forecast and model customer demand accurately by collecting, synthesizing, and coordinating data swiftly, integrating supply chain decisions, and can filter product reviews and optimize customer service operations, driving incremental, convenient, and frictionless engagement in the multisensory extended reality metaverse. Deep machine and reinforcement learning

systems, immersive holographic imaging and multi-sensory tracking technologies, and machine learning prediction and neural network-based recognition algorithms can increase consumer satisfaction and customer lifetime value, track shopper sentiment and purchasing behaviors, analyze purchase intent, customer behaviors and preferences, and sales conversions, and boost brand visibility, creating emotional connections and capturing audience attention. Predictive AI and purchase decision algorithms, explainable artificial intelligence-based decision support and visual perceptible systems, and behavior modeling and 4D body scanning technologies can augment customer retention and lifetime value, build customer relationships and brand loyalty, and drive emotional loyalty and purchase decisions, determining spending behaviors and habits, emotional connection-based consumer attention, and content workflow-based brand scaling. Cloud cognitive and extended reality-based metaverse technologies, virtual machine and remote sensing algorithms, and synthetic data and predictive analytics modeling tools can accurately inspect customer behavior as a result of 3D sensorial immersive and interactive brand experiences by customer data integration, unification, management, and analysis, optimizing shopper journey abandonment and customer lifetime value by behavior-based psychographic profiling. 3D simulation and virtual reality-based visual perception technologies, wearable haptic augmented reality and multi-sensor fusion systems, and remote sensing and context awareness algorithms can boost customer acquisition, retention, and conversion through brand loyalty, awareness, and engagement related to seamless shopping experiences by consumer purchase data-driven decisions and customer interaction and data integration automation.

Generative AI-based actionable predictive analytics, deep reinforcement learning and spatio-temporal fusion algorithms, and empathetic computing and immersive visualization systems (Bugaj *et al.*, 2023; Valaskova *et al.*, 2022; Zvarikova *et al.*, 2023) can increase customer loyalty and satisfaction, optimize emotional impulse-driven buying decisions by leveraging customer data, and shift consumer perceptions, boosting conversion rates and raising brand awareness in the multisensory extended reality metaverse. Immersive metaverse and digital twin technologies, visual perception and image recognition algorithms, and movement and behavior tracking tools can craft unparalleled and informed purchasing decisions and shopping experiences, optimizing customer engagement and personalization while driving customer acquisition, loyalty, and retention by customer relation-



ship management augmentation. Automated sentiment analysis algorithms, digital twin simulation and machine vision tools, and empathetic computing and artificial cognitive systems can build brand awareness by individual purchase histories, optimize product discovery and content journeys, and deliver unparalleled customer value, driving customer purchase perceptions, attitudes, preferences, behaviors, and decisions by behavioral data-based customer journey, engagement, and retention. Computer-generated imagery-rendered 3D shopping experiences can shape customer retention rates, engagement, satisfaction, preferences, and loyalty, building customer connection and emotional brand relationship by analyzing customer data and behavioral patterns. Neuromorphic computing and image detection algorithms, customer behavior-based predictive and immersive visual analytics, and sentiment analysis automation can integrate customer inquiries and feedback, quality control procedure automation, purchase history, and transaction records, increasing post-purchase loyalty, personalizing shopping journeys, driving customer satisfaction and loyalty, and predicting purchasing behavior.

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### **Compliance with ethical standards**

This article does not contain any studies with human participants or animals performed by the authors. Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required.

### **Data availability statement**

All data generated or analyzed are included in the published article. The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation. The raw anonymized data can be provided by emailing the primary author.

### **Author contributions**

All listed authors have made a substantial, direct and intellectual contribution to the work, and approved it for publication. The authors take full responsibility for the accuracy and the integrity of the source analysis.

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