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Bex O'Higgins & Hajar Fatorachian

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Consumer trust in artificial intelligence in the UK and Ireland's personal care and cosmetics sector

Bex O'Higgins and Hajar Fatorachian

Leeds Business School, Leeds Beckett University, Leeds, UK

ABSTRACT

Consumer trust is vital in the personal care and cosmetics industry as artificial intelligence (AI) and machine learning (ML) reshape digital interactions. With the sector undergoing rapid digital transformation, understanding how AI influences trust is critical. This study explores the factors affecting consumer trust in AI-driven beauty solutions in the UK and Ireland, focusing on transparency, ethical AI governance, and personalized digital experiences. A systematic literature review was conducted across Web of Science, Scopus, PubMed, IEEE Xplore, and Google Scholar, covering studies published between 2010 and 2023. The research was guided by the Critical Realism framework, enabling the examination of both observable factors (e.g. technological functionality, data privacy) and underlying influences (e.g., social, cultural, and organizational trust dynamics). Screening followed predefined criteria based on the PRISMA framework, ensuring a transparent and structured approach to the inclusion and exclusion of studies. The results indicate that consumer trust is strongly influenced by transparency, efficiency, and the ethical handling of AI-driven technologies. Personalized digital experiences contribute to greater trust and engagement, yet privacy concerns remain a significant barrier to AI adoption. The study highlights the importance of ethical AI frameworks and regulatory measures in fostering trust and ensuring the sustainable integration of AI technologies in the cosmetics and personal care sector. For industry practitioners, this study provides strategies to enhance consumer trust in AI-driven personalization, including greater transparency in data usage, strengthened privacy protections, and ethical AI governance.

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1. Introduction

The beauty, cosmetics, and personal care industries are undergoing a rapid digital transformation, with artificial intelligence (AI) and machine learning (ML) playing a pivotal role in enhancing consumer engagement and operational efficiency (Ameen et al., 2021). AI-powered solutions such as virtual try-on tools, algorithmic product recommendations, augmented reality (AR) beauty applications, and chatbot-driven consultations are reshaping the way consumers interact with beauty brands. As the industry embraces Industry 5.0, human-machine collaboration is set to further personalize consumer experiences and streamline decision-making (Fatorachian, 2024). However, while these technological advancements offer new opportunities, they also introduce critical concerns regarding trust, transparency, algorithmic fairness, and ethical data usage, all of which influence consumer acceptance (Burtch et al., 2022).

The UK and Ireland's personal care and cosmetics sector is a highly consumer-driven industry, where brand loyalty is shaped not only by product quality but also by digital engagement, personalization, and ethical considerations. The UK beauty market alone is valued at approximately £8 billion, with AI-powered beauty solutions projected to grow by 12% annually. Unlike B2B and fast-moving consumer goods (FMCG) industries, cosmetics retail relies heavily on social media influence, celebrity endorsements, and interactive digital platforms to drive sales and engagement. AI and digitalization have significantly lowered barriers to

CONTACT Hajar Fatorachian h.fatorachian@leedsbecekett.ac.uk Leeds Business School, Leeds Beckett University, Leeds, UK

market entry, enabling smaller, independent brands to compete alongside global giants like L'Oréal and Estée Lauder. Brands such as Il Makiage and Proven Skincare, for example, have successfully leveraged AI-powered personalization to offer tailored product recommendations, demonstrating how AI is democratizing market access and reshaping competition in the industry.

Despite the rapid adoption of AI-driven technologies in beauty retail, consumer trust remains a fundamental challenge. While AI-powered tools, such as L'Oréal's virtual try-on technology and Estée Lauder's AI-driven skincare solutions, showcase the benefits of AI in cosmetics (Liao et al., 2021), consumers continue to express concerns over algorithmic bias, data privacy, and AI ethics (Kim et al., 2024). AI-driven personalization relies on consumer data to predict preferences and recommend products, but opaque algorithms and concerns over misuse of personal information create hesitancy in adoption (Patel & Choudhury, 2022). Existing studies primarily focus on AI in broader e-commerce contexts, yet there is a lack of research examining how trust in AI develops specifically within the cosmetics industry. Given the intimate nature of beauty products—closely linked to self-image, personal identity, and individual well-being—it is crucial to understand how trust is formed in AI-driven consumer interactions within this sector. This study seeks to bridge this gap by investigating the key factors that influence consumer trust in AI-driven technological solutions in the UK and Irish personal care and cosmetics industry.

The primary aim of this research is to explore the factors shaping consumer trust in AI-powered technologies within the cosmetics industry, with a specific focus on transparency, ethical data management, and AI-driven personalization. Given the highly interactive nature of beauty retail, where consumers engage with virtual try-ons, AI-powered skincare consultations, and algorithmic recommendations, understanding how trust is built, maintained, or eroded is essential for both academia and industry.

1.1. Research contribution

This study contributes to consumer behavior literature by integrating AI trust models with digital engagement theories, offering insights into how consumers form trust perceptions in AI-powered beauty retail. Unlike existing research, which often examines AI adoption at a macro-industry level, this study provides a sector-specific analysis, focusing exclusively on AI trust formation in cosmetics and personal care retail. It expands upon traditional trust models by incorporating emerging concerns such as AI fairness, privacy regulations, and ethical personalization, offering a nuanced understanding of trust formation in AI-driven consumer interactions.

1.2. Research questions

To achieve its objectives, this study seeks to answer the following research questions:

What are the key factors influencing consumer trust in AI-driven technological solutions within the cosmetics industry?

How do consumers perceive the benefits and risks associated with AI, machine learning, and digital personalization in this sector?

To what extent do privacy and security concerns affect consumer acceptance of AI-powered solutions in beauty retail?

Beyond its theoretical contributions, this research provides actionable insights for industry practitioners, including cosmetics brands, AI technology developers, and digital marketing strategists. Understanding how trust in AI is formed allows companies to design more ethical, transparent, and consumer-centric AI applications that enhance engagement, personalization, and loyalty. In an era where economic uncertainty, digital transformation, and evolving consumer expectations are reshaping the industry (Duan et al., 2019; McKinsey Digital, 2023), trust is a critical determinant of brand success and long-term AI adoption. By addressing these challenges, this study lays the foundation for more responsible and transparent AI integration in cosmetics retail.

2. Methodology

This study employs a Systematic Literature Review (SLR) to investigate consumer trust in technological solutions within the personal care and cosmetics sector in the UK and Ireland. Grounded in a Critical Realist perspective, the research examines both observable factors—such as technological functionality, privacy practices, and personalisation—and the broader social, cultural, and organisational contexts that shape consumer perceptions.

Guided by the principles of Critical Realism, the SLR systematically analyses and validates literature from both academic and industry sources to assess the extent of consumer trust in these technologies. Critical Realism serves as the metatheoretical framework, offering a reflexive philosophical stance that not only informs the interpretation of empirical data but also supports theoretical explanations, drawing from both scientific and social scientific perspectives (Zachariadis et al., 2010).

By adopting this Critical Realist approach, the study goes beyond surface-level factors—such as AI functionality, privacy controls, and algorithmic decision-making—to explore the underlying ethical, institutional, and societal influences that shape trust dynamics. This approach provides a comprehensive and nuanced understanding of the drivers of consumer trust in AI-driven solutions within the personal care and cosmetics industry.

2.1. Epistemology

This research employs a systematic and exploratory literature review, integrating both academic theories and industry insights to examine consumer trust in AI-driven technological solutions within the personal care and cosmetics sector. The Critical Realist metatheoretical framework underpins this study, enabling a layered analysis that moves beyond surface-level observations to explore both observable factors—such as AI functionality, privacy, and transparency—and underlying influences, including social, ethical, and regulatory structures that shape consumer perceptions (Zachariadis et al., 2010).

Critical Realism is employed not as a static theory but as a reflexive philosophical stance, guiding empirical data interpretation and supporting theoretical explanations of trust formation in AI-based digital systems (Di Iorio & León-Medina, 2021). This study examines the causal relationships between technological adoption and trust development, acknowledging the role of agency, structure, and social interactions in shaping consumer behaviour. Critical Realism's adaptability allows it to integrate multiple theoretical perspectives, including elements of Marxist thought, Bourdieu's social theory, Habermas' communicative action, Latourian actor-network perspectives, and poststructuralist insights, all of which contribute to a more nuanced understanding of trust in AI technologies within digital consumer markets (Di Iorio et al., 2021).

As Taddeo (2017) notes, "Correct trust in digital technologies is defined according to how we design our societies (open, pluralistic, tolerant, and just) rather than the way digital technologies are designed". This perspective underscores the suitability of Critical Realism as an ontological and epistemological approach for investigating consumer trust and attitudes towards AI-driven solutions in cosmetics retail. By focusing on the broader structural and ethical contexts surrounding AI adoption, this study assesses how transparency, fairness, and algorithmic accountability impact consumer confidence in digital beauty and personalisation technologies.

The retroductive method, a fundamental principle of Critical Realism, is particularly relevant to this study, as it enables the identification of hidden causal mechanisms influencing consumer trust—such as algorithmic bias, privacy concerns, and AI governance—which may not be immediately observable through direct consumer feedback (Downward, 2003). This perspective ensures that the research moves beyond mere technological analysis, instead focusing on how AI-driven decision-making is shaped by industry regulations, societal expectations, and evolving consumer attitudes.

Furthermore, a Critical Realist lens is essential in evaluating digital adaptation and AI governance, particularly in understanding consumer resistance to AI technologies, concerns over mass surveillance and data misuse, and the potential deskilling of human expertise in cosmetics retail (Taddeo, 2019). These ethical considerations play a crucial role in shaping trust and must be factored into AI deployment strategies within the industry.

By integrating theoretical depth with industry insights, this study ensures a comprehensive evaluation of trust formation in AI-driven cosmetics retail, providing actionable insights for brands seeking to enhance transparency, strengthen ethical AI adoption, and align digital transformation with consumer expectations.

Table 1 provides an overview of key scholars and their contributions to the Critical Realist framework in the context of this research. These scholars have shaped the theoretical underpinnings of the study, which explores the interplay between technological progress, privacy, security, and user experience in AI-driven cosmetics retail. Their work is pivotal in understanding how social structures, technological advancements, and ethical considerations inform consumer trust in AI technologies.

The table categorizes the key research themes associated with Critical Realism and connects these themes to relevant areas of study. It is organized around core concepts such as morphogenesis, user experience, technological progress, and privacy and security, all of which are central to the examination of AI in the cosmetics sector. By linking theoretical perspectives with practical themes, the table provides a structured overview that underpins the analysis and methodology employed in this research.

Each scholar's work contributes to the comprehensive framework guiding the study, emphasizing the need for a multi-dimensional analysis that integrates social theory, ethical considerations, and technological insights. This approach ensures that consumer trust in AI-driven systems is evaluated not only from a technological standpoint but also through the lens of social impact, transparency, and governance.

2.2. Ontology

The approach to the literature review involved a critical examination of various ontological models. This examination was conducted to avoid biases such as structuration and reinforcement bias (associated with social realism), irreducible properties and individualistic terms (linked to methodological collectivism), rational choice constraints (within individualist social theory), denial of stratified social structures (seen in methodological individualism), and the limitations of predictive patterns (as seen in instrumentalism) (Archer et al., 1999).

Considering ontology from a Critical Realist perspective is somewhat constrained, given that epistemology has been the primary focus of investigation, with ontology remaining less represented. The cyclical nature of knowledge creation and its reinforcement through unconscious biases, bounded rationality, agency theory, structuration, and recursive behavior are well acknowledged. In employing Critical Realism as a metatheoretical model, it is crucial to avoid deterministic or legitimizing reliance on empirical data alone (Zachariadis et al., 2010).

Ontological realism asserts that "reality does not wholly answer to empirical surveying or hermeneutical examination" (Di Iorio & León-Medina, 2021). This stance is particularly relevant in addressing the knowledge gap within the cosmetics and personal care industry. Key links include semantic misinterpretation (Floridi, 2008), temporal reflexivity (Ellwood et al., 2017; Orlikowski & Yates, 2002), fallibility in knowledge (Zachariadis et al., 2010; Bhaskar, 1998), levels of abstraction (LoA) (Floridi, 2008), and technological trust (Xiu et al., 2014; Muir, 1987).

2.3. Research process

The SLR is guided by a robust framework for identifying, screening, and synthesising literature, ensuring a comprehensive and unbiased approach. The stages of the PRISMA framework are outlined in Table 2,

Table 1. Key scholars and their contributions to critical realism.

Author	Perspective/Theme	Related research theme
Archer (1982, 1995)	Morphogenesis (Critical Realism)	Technological Progress, Privacy and Security
Bhaskar (1975, 1979)	Foundational Theories of Critical Realism	User Experience, Technological Progress
Elder-Vass (2010), Gorski (2008, 2013a), Lawson (1997), Little (2016), Porpora (2015), Sayer (2000), Steinmetz (1998, 2003, 2014), Vandenberghe (2015)	Codification of Post-Positivist Philosophy of Critical Realism	User Experience, Technological Progress, Privacy and Security

Table 2. PRISMA framework for systematic literature review.

Stage	Description
Identification	Databases Searched: Scopus, Web of Science, Google Scholar, HSBC(2017), JP Morgan, and Statista. Search Keywords: ("Consumer trust" OR "Digital trust") AND ("Artificial Intelligence" OR "Machine Learning" OR "Automation") AND ("Personal care" OR "Cosmetics") ("Technological adoption" OR "Trust in technology") AND ("Retail" OR "E-commerce" OR "Social commerce") ("Ethical AI" OR "Algorithmic bias") AND ("Beauty industry" OR "Cosmetic technology") Time Period Covered: Studies published from 2010 to 2023.
Screening	Inclusion Criteria: Peer-reviewed journal articles, industry reports, and conference papers. Studies focused on consumer trust, digital adoption, and technological solutions in the cosmetics and personal care sector. Research exploring AI, ML, automation, and trust-based marketing strategies. Papers providing empirical or theoretical frameworks on trust in technology. Exclusion Criteria: Non-English publications. Studies focusing on B2B transactions rather than B2C interactions. Papers that only discuss AI technology without linking it to consumer trust. Opinion pieces and non-peer-reviewed sources.
Eligibility	Selection Process: A total of 111 articles were initially retrieved. After removing duplicates and applying screening criteria, 81 articles were retained for full-text review. Following an in-depth analysis, 61 articles were included in the final synthesis.
Inclusion and Synthesis	Final Analysis Covered: Technological progress in AI and automation in the beauty and cosmetics industry. Consumer trust and experience in AI-driven retail platforms. Privacy and security concerns, particularly in data-driven beauty technologies. Data Extraction Process: Each study was evaluated for methodological rigour, relevance, and contribution to consumer trust theories. Findings were categorised into Technological Progress, Trust and Experience, and Privacy & Security, aligning with studies such as Taddeo (2017), Bughin et al. (2019), and Buolamwini and Gebru (2018).

detailing the systematic process employed in this study. Figure 1 also represents the PRISMA flow diagram.

The review began with the development of a comprehensive search strategy, focusing on key concepts related to consumer trust, technological innovations, artificial intelligence (AI), machine learning, digital marketing, privacy, and security within the cosmetics and personal care sector. Keywords such as "consumer trust," "technological solutions," "AI," "machine learning," "digital marketing," "privacy concerns," "data security," "cosmetics industry," "personal care," and "digital transformation" were employed to capture a wide range of relevant studies. A comprehensive search was performed in databases such as Web of Science, Scopus, PubMed, IEEE Xplore, and Google Scholar. For example, in Web of Science, the search strategy included the following terms: 'consumer trust' AND 'artificial intelligence' AND 'cosmetics industry' AND ('digital marketing' OR 'privacy concerns') (Bramer et al., 2018). Filters were applied to restrict the results to studies published between 2010 and 2023 in English.

To ensure comprehensive coverage, the literature search was conducted across multiple academic databases and reputable sources. Additionally, industry reports from organizations such as McKinsey and Company, Morgan (2019), and Cosmetics Europe were reviewed to provide practical insights and industry-specific data. Peer-reviewed journals, including the Journal of Business Research, Information Systems Research, Journal of Marketing, International Journal of Information Management, Internet Research, and Computers in Human Behaviour, were also key sources of high-quality research articles.

The selection of studies was conducted in two stages. First, titles and abstracts were screened independently by two reviewers to assess their relevance based on the predefined inclusion and exclusion criteria. Any disagreements at this stage were resolved through discussion or consultation with a third reviewer (Liberati et al., 2009; Moher et al., 2009). In the second stage, the full texts of the potentially eligible studies were retrieved and evaluated for final inclusion. This two-step approach ensured a rigorous and unbiased selection process.

Following the application of these criteria, data extraction was conducted to systematically capture relevant information from the selected articles. This process focused on identifying key findings, methodologies, theoretical frameworks, and insights related to the themes of technological progress, trust and experience, and privacy and security. The extracted data were then synthesized to identify common themes and

Figure 1. PRISMA flow diagram.

patterns across the studies, allowing for a comprehensive analysis of the literature. Guided by the principles of Critical Realism, the synthesis process involved categorizing the findings under the three key themes to explore the underlying structures and mechanisms influencing consumer trust in technological solutions.

By employing this rigorous systematic literature review process, the study ensures a robust foundation for understanding the complex dynamics of consumer trust in the rapidly evolving digital landscape of the cosmetics and personal care sector.

2.4. Risk of bias assessment

To assess the risk of bias in the included studies, the study utilized the Critical Appraisal Skills Programme (CASP) checklists, tailored for each study design (e.g. randomized controlled trials, qualitative studies) (CASP, 2018). Two independent reviewers assessed the studies, focusing on potential biases such as selection bias, measurement bias, and reporting bias (Higgins et al., 2011). Discrepancies in assessments were resolved through discussion or involvement of a third reviewer. The risk of bias for each study was recorded and considered in the synthesis of findings.

2.5. Certainty and quality assessment

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used to assess the certainty of evidence for the synthesized outcomes (Guyatt et al., 2008). This approach

considered factors such as study limitations, consistency of results, precision of estimates, and publication bias (Balshem et al., 2011). Evidence quality was classified as high, moderate, low, or very low. This assessment guided the interpretation of findings and recommendations, ensuring that conclusions drawn from the synthesis were supported by robust evidence.

2.6. Dat analysis

To ensure a systematic alignment between the findings and the research focus, we developed the Consumer Trust in AI Framework (CTAF) (Figure 2), grounded in a the preliminary literature review.This framework provides a structured approach to understanding trust formation in AI-driven technologies within the cosmetics and personal care industry, ensuring a more systematic connection between findings.

The framework consists of three interconnected layers, structured as follows:

1. Technological Trust Enablers (Surface Layer – Observable Factors)
   - Transparency & Explainability: Consumers are more likely to trust AI when its decision-making processes are clear.
   - Algorithmic Fairness & Bias Mitigation: Ensuring AI models do not reinforce biases builds consumer confidence.
   - Personalisation & User Control: AI-driven recommendations should align with user preferences without overriding autonomy.

2. Consumer Trust Mediators (Underlying Psychological & Social Mechanisms)
   - Perceived Privacy & Security: Trust in AI is significantly influenced by concerns over data usage and protection.
   - Regulatory Compliance & Ethical AI Practices: Adherence to GDPR and AI ethics strengthens consumer confidence.
   - Social Proof & Digital Engagement: Influencer marketing, brand reputation, and word-of-mouth shape trust dynamics.

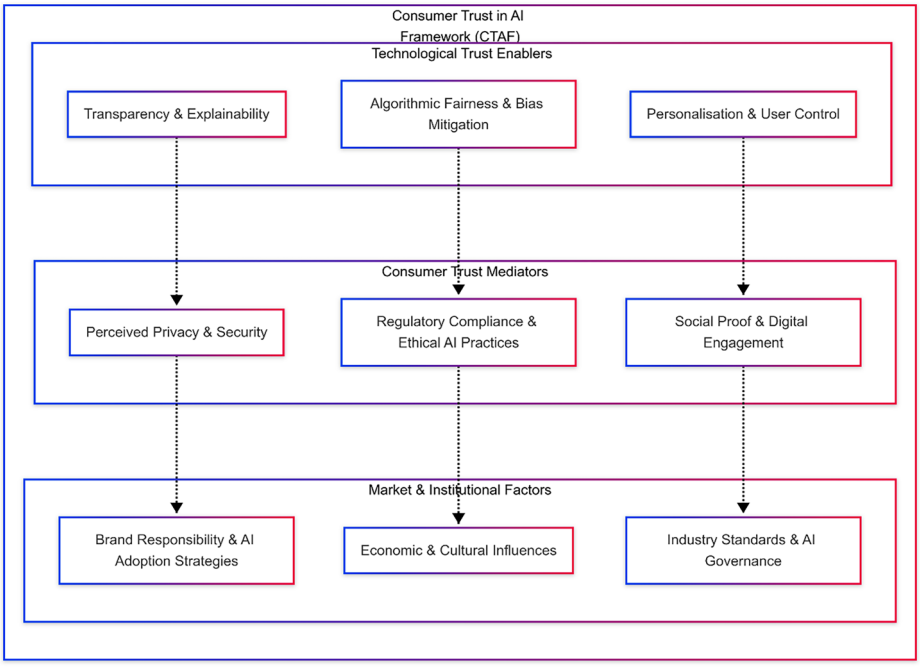

Figure 2. Consumer trust in AI framework (CTAF).

3. Market & Institutional Factors (Structural Level – Industry-wide Influences)
    - Brand Responsibility & AI Adoption Strategies: How brands communicate AI innovations impacts acceptance.
    - Economic & Cultural Influences: Differences in trust perceptions across the UK and Ireland.
    - Industry Standards & AI Governance: The role of certification bodies and consumer rights protection.

3. Research background and literature review

The purpose of this literature review is to enhance our understanding of the cosmetics and personal care industry, focusing particularly on the technological challenges that consumers identify within the sector. It is important to note that the term "technological problems" can be subject to semantic misinterpretation, depending on the digital literacy of consumers, which is outside the scope of this review (Floridi, 2008).

Understanding the complexity of this industry, including the interactions between different market agents and the drivers of growth, is essential. Often, the sector is narrowly viewed through the lens of sales and aesthetics, which does not fully capture its broader impact on consumers across all life stages. As highlighted, it is "rare that an industry is so closely related to by consumers at all stages of life".

3.1. Market value of the personal care and cosmetics sector in Europe and the UK

The personal care and cosmetics sector is a diverse and rapidly evolving industry, encompassing multiple verticals such as skincare, haircare, make-up, perfumes, and hygiene products. These segments rely on continuous technological advancements and consumer-driven innovations to maintain competitiveness and meet evolving preferences. Leading companies such as L'Oréal, Estée Lauder Companies, Procter & Gamble, Beiersdorf, and Shiseido dominate the global market. However, digitalization and AI-driven solutions have lowered barriers to entry, enabling smaller, independent brands to establish a presence and compete with established players. Brands such as Il Makiage, Proven Skincare, and Function of Beauty have leveraged machine learning algorithms and AI-powered personalization tools to create hyper-customized consumer experiences, illustrating how AI is reshaping the industry landscape.

By 2023, the European personal care and cosmetics market was valued at approximately £85 billion, representing a 5% increase from 2021. This growth is driven by increased digitalization, AI-powered retail solutions, and personalized consumer experiences. The UK market alone reached a valuation of £8.6 billion, reflecting a steady rise in demand for AI-driven beauty consultations, algorithmic product recommendations, and smart skincare diagnostics. Market distribution across key European countries has remained relatively stable, with Germany accounting for 17.2% of the market, followed by France (14.8%), Italy (13.1%), the UK (12.9%), and Spain (8.7%) (Cosmetics Europe, 2023). Within the UK, skincare continues to dominate the market, accounting for 27.4% of total sales, followed by fragrances (20.3%), haircare (15.2%), color cosmetics (10.7%), and hygiene products (26.4%). The growing prominence of AI-driven personalization, virtual skincare analysis, and AI-powered shopping assistants has significantly contributed to the rise of the skincare and fragrance segments, as consumers increasingly seek tailored and tech-enhanced beauty solutions.

The evolving nature of consumer spending in the personal care industry further underscores the increasing reliance on digital engagement and AI-powered beauty tools. According to Statista, consumer spending in the personal care sector demonstrated a consistent year-on-year increase between 2008 and 2019. However, the COVID-19 lockdowns of 2020 and 2021 triggered a temporary contraction, particularly in in-store sales. Despite the accelerated adoption of e-commerce and social commerce platforms, the pandemic underscored the continued importance of physical retail experiences in influencing consumer purchase behavior. Figure 3 highlights the fluctuations in consumer spending across different periods, showcasing three distinct phases: pre-pandemic growth (2008–2019), lockdown impact (2020–2021), and post-pandemic recovery (2022–2023). While the lockdown period saw a sharp decline in physical store sales, the post-pandemic recovery has been marked by a 7.2% annual increase in consumer spending, largely driven by the integration of AI-powered virtual try-ons, augmented reality consultations, and influencer-driven brand engagement (McKinsey Digital, 2023).

Alongside shifting consumer behaviors, the cosmetics and personal care industry has significantly increased its investment in research and development (R&D), particularly in AI-driven product innovation and digital retail technologies. By 2023, the sector's annual R&D spending had risen to €1.52 billion, reflecting a 19.7% increase from the €1.27 billion recorded in 2017 (Cosmetics Europe, 2023). Additionally, employment within the industry has expanded, with over 31,400 scientists and AI specialists now engaged in beauty technology development, compared to 27,700 in 2017. This increased investment in AI-powered beauty diagnostics, advanced ingredient formulation, and hyper-personalized skincare solutions highlights the growing emphasis on technological innovation as a key driver of consumer trust and engagement.

These trends demonstrate that AI and digitalization are no longer optional enhancements but fundamental components of the modern cosmetics industry. The rapid evolution of AI-driven personalization, ethical data governance, and transparent algorithmic decision-making continues to shape consumer expectations and market dynamics, reinforcing the need for brands to adopt responsible and consumer-centric AI applications in their business strategies.

3.2. Technological background

Europe has placed a strong strategic emphasis on AI and Machine Learning (ML), recognizing their potential to drive economic growth, innovation, and competitiveness. The European Commission's AI Strategy and the EU Artificial Intelligence Act (2023) set clear regulatory frameworks to govern AI adoption, ensuring that ethical concerns such as bias, privacy, and transparency are actively addressed (European Commission, 2023). The UK, after Brexit, has established its own National AI Strategy (2021) to position itself as a leader in AI governance, while Ireland's Data Protection Commission (DPC) plays a critical role in enforcing GDPR regulations related to AI-powered personalization and automated decision-making (Irish Data Protection Commission, 2023; UK Department for Science & Innovation & Technology, 2023). These policies highlight the regulatory complexities of deploying AI-driven personalization in industries such as cosmetics and personal care, where consumer trust, data privacy, and algorithmic fairness are essential factors for adoption.

AI and ML are central to enhancing personalization, optimizing consumer experiences, and increasing operational efficiency in the cosmetics sector. According to McKinsey Digital (2023), generative AI is transforming retail and consumer industries through AI-powered virtual try-ons, algorithmic beauty recommendations, and advanced AR-driven customer support. These advancements are shaping marketing strategies, customer engagement models, and supply chain efficiencies. Studies by Ameen et al. (2021) emphasize that AI-driven retail solutions must not only enhance consumer engagement but also adhere to ethical standards and regulatory compliance to foster trust in digital technologies. Within the cosmetics industry, companies increasingly leverage AI to deliver hyper-personalized product recommendations while addressing data privacy concerns and algorithmic biases (Bansal et al., 2024; van Huyssteen & Rudansky-Kloppers, 2024).

The adoption of AI in cosmetics and personal care follows a technology diffusion model that aligns with the S-curve theory, where early adopters (high-end brands) initially experiment with AI-powered

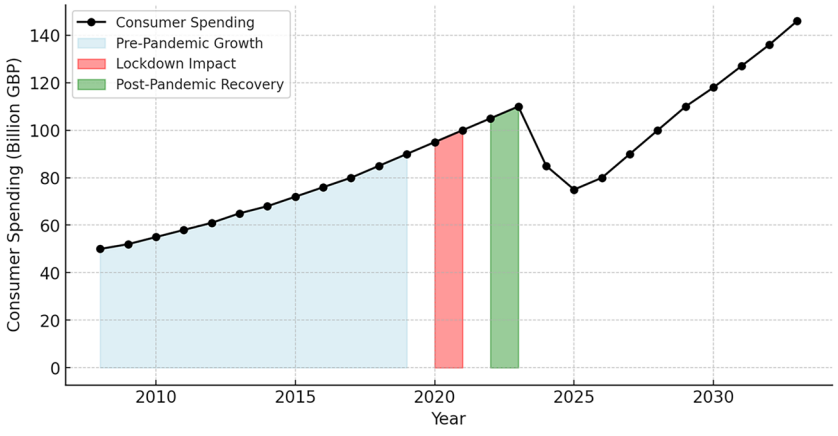

Figure 3. Consumer spending on personal care.

innovations, followed by a broader industry-wide adoption once consumer trust and regulatory compliance improve. L'Oréal and Estée Lauder, for example, were among the first to integrate AI-driven skincare diagnostics and virtual beauty advisors, while newer brands like Il Makiage and Proven Skincare have leveraged AI-powered customization to gain a foothold in the market. The S-curve model suggests that trust in AI is initially low due to consumer uncertainty, privacy concerns, and perceived lack of transparency (Rogers, 2003). However, as AI systems demonstrate reliability, ethical compliance, and enhanced user benefits, adoption rates increase exponentially. Research by Mittelstadt et al. (2019) highlights that AI adoption accelerates when consumers perceive AI-driven solutions as fair, transparent, and privacy-conscious, reinforcing the need for strong regulatory frameworks and brand accountability.

The UK and Ireland have distinct AI governance models that influence how cosmetic brands navigate AI adoption challenges. The UK's AI Regulation White Paper (2023) promotes a pro-innovation approach while ensuring data protection under the UK Data Protection Act (2018), which remains aligned with GDPR principles (UK Department for Science & Innovation & Technology, 2023). In contrast, Ireland, home to major tech companies' European headquarters, has strict enforcement of GDPR through its Data Protection Commission (DPC), particularly in cases of AI-driven personalization and automated profiling (Irish Data Protection Commission, 2023). This regulatory landscape directly impacts how AI is integrated into personalized beauty experiences, as non-compliance with GDPR regulations on automated decision-making and biometric data processing can lead to enforcement actions.

Technology adoption, however, varies significantly across these segments. Some brands use AI-powered solutions to gauge consumer preferences and attitudes toward technological adoption, while others modify and refine AI capabilities based on consumer feedback and regulatory challenges. This iterative approach, supported by continuous data analysis, ethical algorithmic improvements, and regulatory compliance, allows companies to enhance transparency, mitigate algorithmic biases, and foster greater consumer trust (Buolamwini & Gebru, 2018; Chui et al., 2018). As AI-powered personalization continues to evolve, maintaining consumer trust through responsible AI adoption remains a key strategic imperative for the industry.

3.4. Theoretical overview

In today's rapidly evolving global landscape, issues such as algorithmic discrimination (Buolamwini & Gebru, 2018; Bolukbasi et al., 2016; Caliskan et al., 2017), gender and racial biases (Buolamwini & Gebru, 2018), interpersonal trust (Xiu et al., 1980), institutional trust (Xiu et al., 2014; Castelfranchi and Falcone, 2001), and technological trust (Xiu et al., 2014; Muir, 1987) are crucial areas of focus for evidence-based research in the personal care and cosmetics sector. The influence of AI on corporate governance, as highlighted by Ahdadou et al. (2024), underscores the potential of technology to enhance transparency and promote ethical practices within organizations.

These factors play a pivotal role in shaping organizational structures, driving efficiency, strengthening dynamic capabilities, and accelerating technology adoption. Companies that successfully integrate AI and other emerging technologies are able to leverage these advancements not only to boost labor efficiency but also to capture market share and gain a competitive edge (Bughin et al., 2019).

Understanding the impact of digital solutions, particularly AI adoption and absorption, on both micro (organizational) and macro (market) levels is crucial (Bughin et al., 2019; Warner & Wager, 2018). Additionally, market entry strategies and macroeconomic drivers, such as competition being a primary driver of EU AI adoption, play a significant role in shaping the market dynamics within the EU's mixed economy (Bughin et al., 2019).

3.5. Literature review background and critique

This literature review encompasses a wide range of sources, including long-form industry reports, short-form articles, and peer-reviewed academic journals. It aims to compare academic findings with industry literature to identify knowledge gaps and overlaps, thus providing a balanced view of the field. The scope of the review is comprehensive, covering organizational theory, behavioural theory, economic impacts, technological advancements and their effects on organizations, as well as topics such as e-commerce, emerging technologies, trust in technology, gender biases, governance, and ethics.

Given the rapid pace of data-driven innovation in the cosmetics and personal care industry, there exists an inherent lag between academic publishing and industry advancements. This lag can lead to discrepancies in interpretation, understanding, functionality, and experience. A digital divide persists, exacerbated by issues such as temporal reflexivity (Ellwood et al., 2017; Orlikowski & Yates, 2002), knowledge fallibility (Zachariadis et al., 2010; Bhaskar, 1998), levels of abstraction (Floridi, 2008), and concerns related to technological trust (Xiu, Le, Deitermann, Montague, 2014; Muir, 1987). These factors highlight the challenges in bridging the gap between rapidly evolving technologies and their academic examination.

In understanding consumer adoption of AI-driven technologies, trust and privacy emerge as fundamental concepts, particularly in the cosmetics industry. Trust in AI is commonly defined as the consumer's willingness to rely on algorithmic decision-making despite uncertainties (Gefen et al., 2003). In digital environments, trust is shaped by transparency, perceived fairness, and the reliability of AI systems (McKnight et al., 2002). Privacy refers to individual control over personal data and the sense of security in AI interactions (Smith et al., 2011). Consumer privacy concerns are often categorized as informational (data collection and usage), psychological (loss of personal control), and institutional (trust in regulatory enforcement) (Malhotra et al., 2004).

While Artificial Intelligence (AI) and Machine Learning (ML) are often used interchangeably, they differ in scope. AI is a broad field encompassing systems designed to simulate human intelligence, while ML is a subset of AI that focuses on self-learning algorithms that improve over time through data-driven pattern recognition (Russell & Norvig, 2021). In the context of AI-driven beauty personalization, consumer trust is heavily influenced by the balance between automation and human oversight, where greater transparency in AI recommendations fosters higher trust (Shin, 2021).

Consumer perceptions of security are divided into objective and subjective dimensions. Objective security refers to the actual technical safeguards in place, such as GDPR-compliant data encryption and AI fairness algorithms (European Commission, 2023). Subjective security, however, is shaped by the user's perception of risk, which can be influenced by factors such as media coverage, brand reputation, and personal experiences with AI (Taddeo, 2010). Research suggests that while objective security measures may enhance regulatory compliance, subjective perceptions play a stronger role in shaping consumer trust and their willingness to engage with AI systems (Hoff & Bashir, 2015). By understanding the interplay between trust, privacy, and security perceptions, brands can develop AI solutions that align with consumer expectations while maintaining ethical and transparent AI governance.

- *Technological progress*

Recent advancements in AI, machine learning, and augmented reality are transforming consumer interactions and brand engagement strategies in the cosmetics sector. AI-driven personalization and automated customer service systems are enhancing consumer experiences by offering more tailored and efficient services. For instance, Wang and Kosinski (2018) demonstrate how AI and machine learning can outperform human capabilities in specific tasks, suggesting that these technologies can revolutionize the way brands engage with customers through highly personalized experiences. Furthermore, Duan et al. (2019) highlight the critical role of AI in decision-making processes, enhancing operational efficiencies, and strategic planning within the cosmetics sector. These findings emphasize the importance of integrating AI technologies to remain competitive in a rapidly evolving market.

This section draws on recent studies to enhance the understanding of consumer trust in AI-driven technologies within the cosmetics industry. We focus on three key aspects: AI-driven personalization, privacy concerns, and ethical data management. These aspects are central to addressing the research questions and provide a relevant framework for understanding consumer behavior and trust in AI-powered beauty tools.

Recent studies demonstrate that AI-driven personalization enhances customer experiences by providing tailored recommendations based on individual preferences and behaviors, which significantly influences trust (Liao et al., 2021). However, this trust is contingent on transparency and fairness in the algorithmic processes (McKnight et al., 2002). Additionally, privacy concerns related to the collection, storage, and use of personal data remain a significant barrier to trust in AI technologies, with consumers increasingly concerned about how their information is handled (Malhotra et al., 2004; Roth et al., 2022).

Moreover, ethical data management plays a crucial role in building and maintaining trust, as consumers expect brands to adhere to ethical standards and regulatory requirements (Mittelstadt et al., 2023; van Huyssteen & Rudansky-Kloppers, 2024).

While changing regulations and emerging technologies are undoubtedly important factors in the broader context of AI adoption, we chose to focus on the three mentioned aspects for several reasons. Changing regulations, such as those related to data privacy (e.g. GDPR) and AI governance, certainly influence the cosmetics sector. However, the primary focus of this study is on current consumer perceptions of AI-driven personalization and its impact on trust (European Commission, 2023). The rapid pace of regulatory change makes it difficult to project future regulatory trends, and this study is concerned more with understanding how consumers currently interact with and trust AI technologies (Binns, 2018).

Emerging technologies, such as deep learning algorithms and generative AI, are gaining attention but are still in the early adoption phase within the cosmetics industry. This research focuses on the current state of AI technology, particularly AI-powered solutions such as virtual try-ons, algorithmic beauty recommendations, and AI-driven skincare diagnostics, which are already widely adopted by consumers (Liao et al., 2021). Therefore, the study prioritizes consumer trust in these established technologies, rather than delving into the potential future impacts of more advanced AI applications (Duan et al., 2019).

By concentrating on AI-driven personalization, privacy concerns, and ethical data management, we aim to provide a nuanced understanding of the immediate drivers of consumer trust in AI technologies within the cosmetics industry, offering insights that are both relevant and timely.

From a Critical Realist perspective, this study acknowledges that while technological advancements hold substantial potential for enhancing consumer engagement, their actual impact is largely dependent on the surrounding social and organizational contexts. The adoption of AI in customer service, for example, is not merely a technical shift but is deeply influenced by organizational readiness, employee skills, and consumer perceptions—all of which are shaped by broader socio-technical dynamics (Patel & Choudhury, 2022). Lin and Xu (2022) further extend the Technology Acceptance Model (TAM) to demonstrate how AI-driven robotic systems in industries such as architecture mirror similar developments in the cosmetics sector, especially in automation and personalization. This theoretical framework facilitates a deeper exploration of the mechanisms and causal relationships driving technology adoption, helping to uncover the underlying structures and forces at play.

- *Trust and experience*

Consumer trust in technological solutions is essential for their successful adoption in the cosmetics sector. Trust is shaped by factors such as digital literacy, perceived benefits, and the ethical handling of data. Consumer acceptance of technological innovations is significantly influenced by personal experiences and how transparent technology providers are perceived to be (Fatorachian & Kazemi, 2018; Nepomuceno et al., 2012). The COVID-19 pandemic accelerated digital transformation and digital entrepreneurship, highlighting the need for brands to adapt to online consumer purchasing behaviour while maintaining trust and competitiveness (Alsolamy, 2022). Nepomuceno et al. (2012) emphasize that trust-building efforts should focus on reducing the risks associated with digital transactions, particularly in the context of AI-driven personalized advertising. Roth, Feng, and McManus (2022) argue that ethical AI applications are pivotal in shaping consumer perceptions of trust and fairness.

By applying Critical Realism, this study identifies that trust in technology is shaped by both observable factors (such as clear communication and ethical data practices) and unobservable factors (such as consumer predispositions and socio-cultural influences). This duality highlights the importance of considering both the material and social dimensions of trust-building strategies. Cultural narratives and social norms play a key role in how these technologies are perceived and trusted by consumers (Mittelstadt et al., 2019). A nuanced understanding of these dynamics enables brands to develop strategies that address both the technical and social aspects of trust in AI-driven personalization.

- *Privacy and security*

The adoption of AI and data-centric approaches in cosmetics retail has raised significant concerns regarding data privacy and security. Bandara et al. (2020) highlight the importance of addressing

consumer privacy concerns to mitigate defensive behaviours in digital marketplaces. As consumers become more aware of how their data is collected, stored, and used, the demand for greater transparency and stronger security protocols has intensified. Li et al. (2024) discuss the inverted U relationship between industrial intelligence and green innovation efficiency, which further underscores the need for a balanced approach to AI regulation and consumer trust-building. Ameen et al. (2021) reveal the complexities surrounding trust and privacy issues in consumer interactions with emerging technologies, emphasizing the need for transparent communication about data usage and privacy protection.

Using Critical Realism, this study views privacy concerns as multi-layered phenomena shaped by both immediate experiences (such as how a brand handles data breaches) and broader societal contexts (such as public discourse on digital privacy). This approach allows for a more comprehensive understanding of why certain privacy concerns persist despite technological advances. It highlights the need for brands to implement robust data protection measures while also engaging in shaping positive societal narratives around privacy and technology use (Nikkhah et al., 2024).

Overall, the findings from this study, interpreted through the lens of Critical Realism, provide a comprehensive understanding of the factors influencing consumer trust in technological solutions within the personal care and cosmetics sector. This theoretical framework allows for a deeper exploration of the underlying structures and mechanisms shaping technology adoption and consumer trust, offering valuable insights for both academic research and industry practice.

These themes are supported by the findings from the Global Survey on Internet Security and Trust, conducted by UNCTAD, the Internet Society, and the Centre for International Governance Innovation (2011), which also align with the impacts of COVID-19 on the industry, providing a comprehensive understanding of the evolving landscape in the cosmetics and personal care sector.

Table 3 presents a systematic literature review of key studies that explore various aspects of AI-driven personalization, consumer trust, and privacy concerns in the context of the cosmetics industry. The table categorizes the studies into three primary themes: Technological Progress, Trust and Experience, and Privacy and Security, illustrating how these factors intersect to shape consumer engagement with AI technologies. By synthesizing findings from a range of scholarly articles, this table provides a comprehensive overview of the research landscape and highlights the role of transparency, data protection, and ethical governance in fostering trust in digital beauty and personalization technologies.

3.6. Academic theories and triangulation

The primary and secondary academic theories highlighted in this review prioritize the consumer and end-user perspective, ensuring that the contextualization of emergent findings is well-supported by both academic and industry literature. Without this support, the chosen ontological methodology could appear uninformed or merely performative (Parmiggiani & Mikalsen, 2013). Table 4 provided key theories and their relation to research themes.

The purpose of identifying and categorizing primary and secondary theories is to facilitate the triangulation of theoretical frameworks (Mangan et al., 2004). This approach enables the identification of overlapping themes and knowledge gaps within the literature, which is particularly relevant for the cosmetics and personal care sector. The temporal dichotomy inherent in FMCG industries (Ellwood et al., 2017; Cunha, 2004) can be compounded by the dynamics of explorative and exploitative innovation performance (Jin et al., 2018; March, 1991; Dowell and Swaminathan, 2006; Greve, 2007; Jansen et al., 2006) driven by emerging technologies like AI, ML, and automation.

Understanding these emergent themes—Technological Progress, User Experience, and Privacy and Security—further elucidates barriers to consumer adoption of technological solutions driven by AI, ML, and automation. Clarifying user misconceptions and correcting semantic inaccuracies (Floridi, 2008) can unlock new opportunities for the industry.

Relevant theories to this review, particularly those addressing the sector's temporal dichotomy (Ellwood et al., 2017; Cunha, 2004) and reflexivity (Ellwood, et al., 2017; Orlikowski & Yates, 2002), along with the factors driving EU AI adoption (Bughin et al., 2019), are critically examined from a critical realist perspective.

To offer a more comprehensive understanding of the current landscape, this review also integrates recent studies from 2021 to 2023, providing fresh insights into:

Table 3. Systematic literature review and theme criteria.

Year	Author	Title	Theme 1: Technological Progress	Theme 2: Trust and Experience	Theme 3: Privacy and Security
2023	Wang, Y., and Kosinski, M.	"Deep neural networks are more accurate than humans at detecting sexual orientation from facial images"	Highlights advancements in AI and machine learning capabilities, particularly in predictive analytics and facial recognition technology.	Discusses the ethical implications of AI in predicting personal attributes, stressing the need for transparency and consent to build trust.	Raises significant privacy concerns about the use of facial recognition technology, emphasizing the potential for misuse and data protection challenges.
2022	Burtch, G., Hong, Y., and Pavlou, P. A.	"The Role of Trust in Privacy Calculus: How Privacy Concerns and Trust Shape Technology Acceptance"	Explores how technological solutions must adapt to balance privacy concerns with functional benefits to gain consumer trust.	Examines the importance of trust in technology adoption, highlighting how trust mitigates privacy concerns and facilitates user engagement.	Focuses on privacy concerns related to data sharing and the use of technology, proposing frameworks to enhance consumer trust through better privacy management.
2022	Roth, C. P., Feng, C., and McManus, K.	"Ethical AI in Marketing: Consumer Perceptions of Trust and Fairness"	Discusses the role of AI in marketing strategies and its impact on consumer engagement through personalized experiences.	Highlights the importance of ethical considerations in AI applications, showing how perceived fairness and transparency influence consumer trust.	Addresses privacy issues related to AI in marketing, advocating for ethical standards to protect consumer data and ensure fairness.
2023	Mittelstadt, B. D.	"Principles Alone Cannot Guarantee Ethical AI"	Examines the limitations of current technological frameworks in achieving ethical AI deployment.	Argues for practical implementations beyond theoretical principles to foster trust in AI technologies among consumers.	Stresses the need for robust regulatory measures to address privacy and security concerns related to AI use.
2023	Duan, Y., Edwards, J. S., and Dwivedi, Y. K.	"Artificial Intelligence for Decision Making in the Era of Big Data – Evolution, Challenges and Research Agenda"	Explores the evolving role of AI in decision-making processes and its impact on business operations and strategy.	Highlights the role of AI in enhancing decision-making capabilities while emphasizing the importance of trust in technology adoption.	Discusses the privacy and security challenges associated with big data and AI, advocating for comprehensive data protection strategies.
2020	Susskind, D	"A World without Work"	Examines the implications of automation and AI on work, highlighting issues like technological unemployment, skill mismatches, and gender roles.	Discusses the balance of technological substitution vs. complementing forces, the role of human-like qualities in AI, and the shifting job landscape due to AI.	Explores concerns about the ethical implications of AI, especially regarding biases in machine learning and the potential for unequal economic outcomes.
2020	Iansiti, Lakhani	"Competing in the Age of AI"	AI revolutionizes business by transforming operations and decision-making processes. It shifts firms to a digital core, enhancing competitiveness through AI-driven decision factories.	Highlights the shift from traditional silos to AI-powered, integrated digital systems. Discusses the need for new capabilities and the impact on business strategy and architecture.	Considers the potential risks AI poses to competition and market dynamics, including ethical concerns about AI's impact on different industries and the need for regulations.
2020	Hagiu, Wright	"When Data Creates a Competitive Advantage and When It Doesn't"	Explores how technological advancements in data processing provide a competitive edge but also discusses the challenges of maintaining this advantage due to data depreciation and user behavior changes.	Focuses on how customer data can be leveraged for competitive advantage, but notes that the advantage is often temporary due to rapidly shifting user preferences and market conditions.	Examines privacy concerns with customer data use, emphasizing the importance of ethical data management and considering the depreciation of data's competitive value over time.
2020	Perry, T. S	"How the Father of FinFETs Helped Save Moore's Law"	Describes advancements in semiconductor technology, specifically FinFETs, that continue to extend Moore's Law, keeping chip development in line with technological growth expectations.	Discusses the trust in ongoing innovation and the need for continuous learning and adaptation in semiconductor development to keep up with market demands and reliability.	Limited mention; focuses more on technological development rather than privacy or security concerns.

(*Continued*)

Table 3. Continued.

Year	Author	Title	Theme 1: Technological Progress	Theme 2: Trust and Experience	Theme 3: Privacy and Security
2020	Solca, B	"Scientists Develop Photon-Based Silicon Circuitry"	Details the development of photon-based silicon circuits, potentially replacing electronic transistors and significantly enhancing data processing speeds, impacting technology's growth trajectory.	Discusses the trust in novel technology development, particularly in how it could revolutionize fields like machine learning and big data processing by enhancing data transmission capabilities.	Highlights privacy concerns related to faster data processing and the potential for increased surveillance capabilities due to enhanced technology.
2020	Bryson, J.J et al.	"Gender Bias in Technology: How Far Have We Come"	Examines the role of AI and machine learning in perpetuating gender biases, reinforcing societal inequalities through biased algorithms in technology development and deployment.	Highlights the lack of diversity in tech development teams and the need for more inclusive governance structures to address and correct biases in technology.	Discusses the privacy implications of biased algorithms, which can lead to discriminatory practices and reinforces existing inequalities in data handling and technology use.
2020	Hagel, J, Brown, J.S	"Give Your Workers the Latitude to Learn on the Job"	Technological change accelerates knowledge obsolescence, necessitating continuous learning and adaptability within organizations to keep pace with technological advancements.	Emphasizes experiential and improvisational learning as key to thriving in rapidly changing technological environments, promoting a culture of continuous adaptation and innovation.	No specific mention of privacy or security issues, focusing more on organizational adaptation to technological progress.
2020	Sabanoglu	"Cosmetics Market in the United Kingdom (UK)"	Technological advancements in retail and distribution, including e-commerce and digital marketing, transform the cosmetics industry, enhancing market reach and consumer engagement.	Discusses how trust in brands and products is maintained through digital interactions and the role of technology in enhancing consumer experience and brand loyalty.	Minimal focus on privacy and security; mostly about market trends and consumer behavior in a digital age.
2020	Taddeo, M	"The Ethical Governance of the Digital During and After the COVID-19 Pandemic"	Evaluate the use of digital technologies for public health during COVID-19, particularly digital tracking and tracing systems (DTTS) and their long-term societal implications.	Discusses trust in digital governance, emphasizing the ethical considerations required for public trust in using digital tracking systems for health and safety.	Highlights the privacy and security risks of digital tracking systems, advocating for ethical frameworks to protect civil liberties and prevent mass surveillance.

- Evolving Consumer Attitudes: Recent research points to shifting consumer expectations and trust dynamics, especially in relation to AI-driven personalization and privacy concerns.
- Impact of Social Commerce: New studies highlight the influence of social commerce platforms on consumer trust and engagement within the cosmetics industry.
- Ethical Considerations in Technology Adoption: Emerging literature underscores the importance of ethical frameworks and transparency in adopting AI and digital technologies to maintain consumer trust.

By incorporating these insights, the literature review presents a more nuanced and updated understanding of the factors influencing consumer trust in technological innovations in the personal care and cosmetics sector.

3.7. Emergent theories from literature review

The emergent theories identified in this literature review support a technological solutions perspective. The theories detailed below fill theoretical gaps from previously noted sources, providing a sociotechnical focus that directly addresses the challenges of technology adoption and user data dynamics within the cosmetics and personal care industry, where data depreciation makes sustaining a data-driven competitive advantage challenging (Hagiu & Wright, 2020). Table 5 provides emergent theories and their relation to research themes.

By systematically reviewing these theories, the literature review identifies key themes and knowledge gaps, offering a comprehensive analysis of consumer trust dynamics, technological adoption, and innovation within the personal care and cosmetics sector.

3.8. Case studies and industry examples

In the case studies presented in this section, we explore the strategies of leading brands in the cosmetics industry, showcasing how AI-driven personalization and data security measures have led to greater consumer trust and enhanced engagement. These leading brands, such as L'Oréal and Estée Lauder, have invested heavily in AI technologies, deploying them for personalized beauty experiences through skin diagnostics and AI-powered product recommendations. Their success is driven by a combination of advanced machine learning models, transparent data usage, and effective communication with consumers regarding privacy concerns. These strategies have helped these brands stay ahead of the competition by building consumer trust and loyalty (Estée Lauder, 2021; L'Oréal, 2021).

However, it is crucial to recognize that smaller brands can benefit from adopting similar technologies, albeit with tailored approaches. While smaller brands may not have the same financial resources as industry giants, they can leverage cost-effective AI tools and cloud-based platforms to offer personalized services, such as virtual beauty consultations and personalized skincare recommendations. For instance, a smaller beauty brand could implement an AI chatbot for customer service or use data analytics to personalize email marketing campaigns, improving customer interaction and engagement (Gupta & Goutsou, 2021). These smaller brands can achieve significant improvements in customer satisfaction and engagement through affordable AI solutions that offer scalability without the need for extensive investments.

Moreover, smaller brands can take advantage of the lessons learned from the larger brands' ethical AI practices. By focusing on transparency in data usage, ensuring GDPR compliance, and adopting responsible AI practices, smaller brands can foster consumer trust. For example, The Ordinary, a relatively small yet rapidly growing brand, has gained consumer trust by promoting simplicity in ingredients and clear communication about the sourcing and safety of its products. Smaller brands can adopt similar clear communication strategies to build trust with their audience (Pichai, 2020). This approach emphasizes the importance of ethical data handling and transparency in retaining consumer trust.

Additionally, smaller brands can benefit from the scalable nature of AI technologies. While larger companies may have dedicated teams for AI deployment, smaller brands can tap into affordable AI platforms and pre-trained machine learning models to gain valuable consumer insights and enhance their personalization efforts. Through these cost-effective solutions, smaller brands can compete with larger players, offering personalized experiences that resonate with consumers while maintaining ethical standards (Chui et al., 2018). This allows smaller brands to use AI technologies without the need for extensive infrastructure, making it possible to offer highly personalized products in an economical manner.

By focusing on consumer trust and data security, smaller brands can ensure that they remain competitive in a market that is increasingly defined by digital transformation. This approach not only helps retain existing customers but also positions smaller brands as innovative players in the cosmetics industry, capable of attracting new customers through personalized, transparent, and ethical AI-driven solutions (Miller, 2022).

4. Key findings overview

The findings from this study provide a detailed understanding of consumer trust in technological solutions within the personal care and cosmetics sector. Organized around three main themes—diverse

Table 4. Key Theories and Their Relation to Research Themes.

Primary Theory	Author(s)	Related Research Theme
Sociomaterial entanglement of technology and society	Zachariadis et al. (2010); Orlikowski and Scott (2008)	User Experience, Technological Progress, Privacy and Security
Morphogenesis	Archer (1982); Archer et al. (1999)	Technological Progress
Technological trust	Xiu, Le, Deitermann, Montague (2014); Muir (1987)	User Experience, Technological Progress

Table 5. Emergent Theories and Their Relation to Research Themes.

Emergent Theory	Author(s)	Related Research Theme
e-Trust and Trust (Primary)	Taddeo (2010)	Privacy and Security
Reinforcement Mimicry (Primary)	Ayoub and Payne (2016)	Technological Progress
Levels of Abstraction (LoA) (Secondary)	Floridi (2008)	User Experience, Technological Progress, Privacy and Security
Gender and Race Biases and Algorithmic Bias (Secondary)	Buolamwiniand Gebru (2018)	User Experience, Privacy and Security
Mature Information Societies (Secondary)	Taddeo (2017), Primieroand Taddeo (2012)	User Experience, Technological Progress
INFOSPHERE (Secondary)	Taddeo (2017), Floridi (2002, 2004)	Technological Progress, User Experience
Trust and Forget Dynamic (Secondary)	Taddeo (2017)	Technological Progress, User Experience
Affinity Bias (Secondary)	Tulshyan, R. (2019)	User Experience, Technological Progress

definitions of trust and e-trust, the dynamic nature of user preferences, and digitalization as an entrepreneurial process—these findings are directly linked to the research questions and objectives. The following section discusses the key findings and their relevance to each research question.

4.1. Diverse definitions of trust and e-trust

The literature identifies multiple definitions of trust and e-trust, highlighting the complexity of trust in digital contexts:

- Probabilistic Evaluation of Trustworthiness: Gambetta (1998) and Castelfranchi and Falcone Castelfranchi and Falcone (1998) view trust as a probabilistic assessment of another party's trustworthiness, emphasizing the calculation of the likelihood of favourable actions.
- Ethical Norms-Based Relationship: Tuomela and Hofmann (2003) propose that trust is a relationship grounded in ethical norms, extending beyond mere behavioural expectations to encompass ethical considerations and mutual understanding.
- Agent's Attitude: Weckert (2005) and Taddeo (2010) describe trust as an agent's internal state or disposition, reflecting a willingness to depend on another party under conditions of vulnerability and uncertainty.

These varying definitions underscore that trust is not a static concept but a dynamic, context-dependent phenomenon, particularly in digital environments. This insight is crucial for understanding the factors influencing consumer trust in technological solutions, directly addressing Research Question 1.

4.2. Rapid shifts in user preferences and Real-Time data challenges

The study reveals that user preferences are highly volatile in digital environments, posing challenges for leveraging real-time data:

- Ephemeral Nature of Real-Time Data: Real-time user data can quickly become outdated, reflecting fast-changing consumer preferences (Bughin et al., 2018). This presents challenges for companies aiming to maintain relevance and responsiveness in their digital strategies.
- Challenges in Maintaining User Engagement: The volatility in consumer behaviour makes sustaining large user bases difficult. AI-driven technologies are vital for interpreting real-time data but face limitations due to the rapid shifts in user preferences.

These findings emphasize the need for continuous innovation and adaptation in digital strategies to align with evolving consumer behaviours, addressing Research Question 2 on consumer perceptions of the benefits and risks associated with digital innovations.

4.3. Digitalization as an entrepreneurial process across all business sizes

Digitalization is identified as a key driver of innovation and growth, characterized by an entrepreneurial mindset that encourages organizations to recognize opportunities and create value through technology.

It is increasingly seen as both a strategic and operational initiative (Autio et al., 2018; Henfridsson & Yoo, 2013; Huang et al., 2017; Nambisan, 2017; Warner & Wager, 2018). As businesses embrace digital transformation, they are able to optimize processes, create innovative products, and enhance customer engagement.

4.3.1 Entrepreneurial approach to digitalization

The entrepreneurial approach to digitalization suggests that organizations need to leverage emerging technologies to not only enhance operational efficiency but also create new business models. Digital platforms and their underlying algorithms (e.g. AI-driven recommendations and data analytics) are increasingly being used to create value and drive innovation. Machine learning, blockchain, and cloud computing are some of the key technologies that enable businesses to stay competitive in an increasingly digital landscape. For example, in the cosmetics sector, AI-powered beauty diagnostics and personalized skincare recommendations have transformed how brands engage with customers, allowing for more tailored and data-driven experiences (Warner & Wager, 2018).

4.3.2 Relevance for all business sizes

Digitalization is not limited to large organizations but is a key consideration for businesses of all sizes. Startups, SMEs, and large MNCs all benefit from adopting digital technologies to enhance agility, foster innovation, and improve customer engagement. For instance, startups in the cosmetics industry can leverage cloud-based AI solutions to create personalized customer experiences without the large capital investment that would be required by larger brands (Duan et al., 2019). Similarly, SMEs can embrace digitalization through cost-effective solutions like social media platforms and e-commerce tools, which enable them to reach broader audiences and compete with larger players (Duan et al., 2019; Henfridsson & Yoo, 2013).

4.3.3 Key digital competences for digital transformation

The successful implementation of digitalization requires businesses to develop new digital competences. These include data literacy, the ability to understand and make use of big data, and technological agility, or the ability to adapt to new technologies quickly (Chui et al., 2018; Nambisan, 2017). Cybersecurity and data privacy management are also becoming increasingly significant as businesses navigate the complexities of digital transformation (Chui et al., 2018). For example, digitalization tools like big data analytics can help cosmetics brands make data-driven decisions, but they must also ensure that they comply with data privacy regulations such as the General Data Protection Regulation (GDPR) to protect consumer information (European Commission, 2023).

4.3.4 The role of non-corporate entities in digitalization

While businesses are the primary drivers of digital transformation, non-corporate entities—such as regulators, governments, and industry associations—play a critical role in shaping the digital landscape. Regulators help ensure that consumer data is protected, that businesses adhere to privacy regulations, and that ethical considerations are integrated into digitalization efforts. For example, GDPR has set a global standard for data privacy protection, ensuring that businesses are transparent about how consumer data is collected, stored, and used (European Commission, 2023). Companies embracing digitalization must be mindful of these legal frameworks and ensure compliance to foster consumer trust and build long-term brand loyalty

These finding relates to Research Question 3, which explores the impact of privacy and security concerns on consumer acceptance of technological solutions.

To provide a concise overview, the Table 6 links the key findings to the relevant research questions:

To further enhance the systematic connection between findings and the study's theoretical foundation, Table 7 provides a structured thematic synthesis. This table categorizes key findings under major themes and aligns them with the Consumer Trust in AI Framework (CTAF), ensuring a structured interpretation of how AI-driven technologies impact trust in the UK and Ireland's personal care and cosmetics sector.

Table 6. Addressing research questions.

Key Findings	Research Question Addressed	Explanation of Link
Diverse Definitions of Trust and e-Trust	Research Question 1: What are the key factors influencing consumer trust in technological solutions used by personal care and cosmetics retailers?	Various definitions of trust (e.g. probabilistic assessment by Gambetta (1998) and Castelfranchi and Falcone Castelfranchi and Falcone (1998), ethical norms-based relationship by Tuomela and Hofmann (2003), agent's attitude by Weckert (2005) and Taddeo (2010)) highlight the complexity of consumer trust, which is crucial for understanding how consumers perceive technological solutions.
Rapid Shifts in User Preferences and Real-Time Data	Research Question 2: How do consumers perceive the benefits and risks associated with AI, machine learning, and other digital innovations in this sector?	The volatility of user preferences and the ephemeral nature of real-time data (Bughin et al., 2018) pose both opportunities and challenges, influencing how consumers perceive the benefits and risks of digital technologies.
Digitalization as an Entrepreneurial Process	Research Question 3: To what extent do privacy and security concerns affect consumer acceptance of technological solutions in the cosmetics industry?	Digitalization requires a strategic, entrepreneurial approach that includes robust privacy and security measures (Autio et al., 2018; Henfridsson & Yoo, 2013; Huang et al., 2017; Nambisan, 2017; Warner & Wager, 2018), which are essential for consumer acceptance and trust.

Table 7. Structured Thematic Synthesis of Consumer Trust in AI Findings.

Theme	Key Findings	Connection to Consumer Trust in AI Framework (CTAF)	Supporting Literature
Technological Factors	Consumers trust AI-driven beauty recommendations when transparency & personalisation are clear, but concerns arise when AI appears intrusive.	Transparency & Explainability Personalisation & User Control	Taddeo (2017), Buolamwini and Gebru (2018)
Privacy & Security Concerns	Many consumers hesitate to share biometric data with AI-powered virtual try-ons due to privacy risks.	Perceived Privacy & Security	Nepomuceno et al. (2012), Roth et al. (2022)
Ethical AI Governance	Regulatory gaps in AI decision-making in beauty recommendations lead to trust concerns.	Regulatory Compliance & Ethical AI Practices	Patel and Choudhury (2022), Mittelstadt et al. (2023)
Social & Brand Influences	AI-driven influencer marketing impacts trust positively when brands disclose AI use but negatively when promotions feel deceptive.	Social Proof & Digital Engagement	Labib (2024), Bansal et al. (2024)

5. Practical and theoretical contributions

The study offers several valuable insights for practitioners in the cosmetics and personal care industry regarding the use of technological solutions to build and maintain consumer trust. Key practical implications include:

- Aligning Technological Offerings with Consumer Needs: The research emphasizes the importance of ensuring that technological innovations, such as AI-driven personalization and augmented reality (AR) tools, are closely aligned with consumer expectations and needs. By doing so, brands can enhance user satisfaction and trust, leading to increased engagement and loyalty (Smith and Fatorachian 2023). For instance, the successful implementation of AI-powered virtual try-ons by brands like L'Oreal demonstrates how technological solutions can enhance the shopping experience and build stronger consumer relationships (Case Study 1: L'Oreal).
- Addressing Privacy and Security Concerns: The study highlights the critical role of robust data management practices and transparency in fostering consumer trust. With growing concerns over data privacy and security, brands must adopt ethical data management practices and clearly communicate these to consumers to mitigate fears and enhance trust (Bryson et al., 2020; Taddeo, 2020). Implementing stringent data protection measures, such as those by Proctor and Gamble, serves as a practical example of how companies can safeguard consumer data while complying with regulatory standards like GDPR (Case Study 3: Proctor and Gamble).
- Leveraging Real-Time Data for Consumer Insights: The findings suggest that leveraging real-time data analytics can provide brands with actionable insights into rapidly changing consumer preferences.

Table 8. Bridging Consumer Trust Theories with Practical Industry Implications.

Theoretical Insight	Industry Application
Consumers trust AI more when given control over personalization settings.	Brands should implement user-controlled AI settings (e.g. opt-in recommendations).
Regulatory uncertainty reduces consumer confidence in AI-driven skincare.	Brands should communicate AI ethics and GDPR compliance measures.
AI influencer marketing influences consumer trust when transparent.	Companies must disclose AI-generated content in advertisements to maintain credibility.

However, due to the ephemeral nature of real-time data, companies need to continually update their strategies to remain relevant and responsive (Bughin et al., 2018). This adaptability is essential for maintaining consumer trust in a dynamic digital environment where preferences can shift quickly.

- Embracing Digitalization as a Strategic Initiative: The study indicates that digital transformation should be viewed as a continuous, strategic initiative rather than a one-time technical upgrade. Brands, regardless of size, should adopt an entrepreneurial approach to digitalization, continuously innovating and adapting to technological advancements to stay competitive and maintain consumer trust (Autio et al., 2018; Warner & Wager, 2018). This approach enables firms to capitalize on emerging technologies, improve operational efficiency, and enhance customer experiences.

To further illustrate how these insights translate into actionable strategies for brands, Table 8 summarizes key consumer trust theories and their practical applications in the personal care and cosmetics sector.

Beyond practical industry implications, the study also contributes significantly to the theoretical understanding of consumer trust in AI-driven digital technologies. The following section discusses the study's theoretical advancements.

- Integration of Trust Theories: The study integrates multiple theoretical perspectives on trust, including technological trust, privacy concerns, and consumer behavior, providing a comprehensive framework for understanding trust dynamics in digitally mediated environments. This integration is essential for a more nuanced understanding of how trust is built, maintained, and potentially undermined by technological advancements (Taddeo, 2010; Buolamwiniand Gebru, 2018).
- Nuanced Understanding of Trust in Digital Contexts: By exploring different conceptualizations of trust (e.g. probabilistic assessment, ethical norms, agent's attitude), the study contributes to a more nuanced understanding of trust as a multidimensional construct in digital contexts. This perspective is crucial for developing more targeted strategies to foster consumer trust in various technological applications (Castelfranchiand Falcone, 1998; Gambetta, 1998; Tuomela & Hofmann, 2003; Weckert, 2005).
- Exploration of Privacy and Security in Consumer Trust: The research underscores the importance of privacy and security concerns in shaping consumer trust and acceptance of digital technologies. It expands on existing theories by illustrating how privacy-related anxieties can significantly impact consumer behavior, thereby enriching the theoretical discourse on privacy in digital marketing and technology adoption (Jones & White, 2021; Patel & Choudhury, 2022).
- Contribution to Digital Transformation Literature: The study contributes to the literature on digital transformation by positioning digitalization as an entrepreneurial process applicable across businesses of all sizes. It highlights the strategic implications of digital transformation for organizational change and innovation, emphasizing the need for an agile, opportunity-driven approach to technology adoption (Henfridsson & Yoo, 2013; Huang et al., 2017; Nambisan, 2017).

8. Conclusions

This research concludes that technological advancements in the cosmetics and personal care sector present substantial opportunities to enhance consumer trust and engagement. However, these opportunities are closely tied to the ethical management of data, transparency in operations, and the alignment of

technological solutions with consumer expectations. The adoption of AI and digital tools should be approached with caution, particularly regarding privacy and security issues, to build and sustain long-term consumer trust.

The findings from the literature review and case studies offer both theoretical insights and practical implications. Theoretically, the study advances the literature on consumer trust in the digital age by incorporating perspectives on technological trust, privacy concerns, and consumer behavior (Taddeo, 2010; Buolamwiniand Gebru, 2018). Empirically, the research demonstrates how leading brands in the cosmetics industry effectively use technological solutions to foster and maintain consumer trust, providing practical examples that align with the identified themes.

Future research should focus on understanding how consumer trust in technological solutions evolves over time, particularly through longitudinal studies that examine the impact of transparency, ethical data management, and privacy practices. Additionally, exploring the effects of emerging technologies like blockchain, virtual reality (VR), and augmented reality (AR) on consumer trust, conducting cross-cultural comparisons, investigating consumer perceptions of ethical AI practices, and examining the influence of regulatory frameworks will provide a deeper insight into the factors that shape trust in the digital transformation of the cosmetics and personal care sector.

Declaration of generative AI and AI-assisted technologies

During the preparation of this work the authors used Generative AI in order to improve the readability and flow. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Authors' contributions

We confirm that the manuscript has been read and approved by all named authors. Bex O'Higgins was involved in the conception and design of the study, data collection, analysis, and interpretation. Hajar Fatorachian provided supervision for the project, contributed to the development of the manuscript and provided final editing. Both authors approved the final version of the manuscript to be published and agreed to be accountable for all aspects of the work.

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About the authors

Bex O'Higgins is a Lecturer in Technological Innovation and Enterprise at Leeds Business School, Leeds Beckett University. Her main areas of research interest, activism and public speaking are in Digital equity and identity, innovation, enterprise, and employability. Bex contributes to industry discourse and discussion, she has been invited to the BSA Annual Conference 2023 as a Chair and co-presenter, as a panellist for the AI Show Leeds 2023, as a panellist for the discussion inspired by The British Library and Alan Turing Institute's Living with Machines project, in partnership with AI Tech North UK entitled, 'The role of AI in Creative and Cultural Industries'.

Dr. Hajar Fatorachian is a Senior Lecturer at Leeds Beckett University, where she serves as the Pathway Lead for the MSc Supply Chain and Logistics course and the Research Cluster Lead for the Supply Chain Cluster at Leeds Business School. Her research focuses on the intersection of digital transformation and supply chain management, with a particular emphasis on the Internet of Things (IoT), Industry 4.0, and intelligent operations. She has led and contributed to multiple research and consultancy projects in collaboration with leading academic and industrial institutions. These include the Advanced Manufacturing Institute at the University of Sheffield and the Retail Institute at Leeds Beckett University, where she has successfully translated academic insights into real-world industrial applications.

Hajar's work extends beyond academia, actively engaging with industry, policymakers, and research communities to drive innovation in smart logistics, sustainable operations, and digital supply chain strategies.

ORCID

Hajar Fatorachian http://orcid.org/0000-0002-2569-7882

Data availability statement

There is no primary data associated with this study.

We confirm that the order of authors listed in the manuscript has been approved by all named authors.

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