

потребують додаткових досліджень.

Висновок. Отже, аналіз міжнародних практик дозволяє не лише виявити ефективні моделі формування капіталу, але й адаптувати їх до українських реалій з урахуванням правових, економічних та соціальних особливостей. Це відкриває перспективи для підвищення фінансової автономії територіальних громад, модернізації комунальної інфраструктури підприємств комунальної форми власності є важливим кроком на шляху до підвищення ефективності муніципального управління та реалізації стратегій місцевого розвитку.

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NEW FORMS OF OPERATIONAL AND COMPLIANCE RISKS CAUSED BY ALGORITHMIC BIAS OF AI IN THE COSMETIC INDUSTRY

The cosmetic industry increasingly uses artificial intelligence (AI) and automation to improve demand forecasting and ensure regulatory compliance. While these technologies promise increased efficiency, algorithmic bias can create hidden risks by distorting forecasts and operational decisions. This paper examines how algorithmic bias in automated management systems generates operational, compliance, and economic risks in cosmetic companies. Using the COSO ERM framework, the study identifies how reliance on “neutral” algorithms can lead to financial inefficiency and gaps in regulatory compliance.

When addressing potential risks related to algorithmic bias in AI-based personalization and forecasting, the COSO Enterprise Risk Management (ERM) framework provides a structured approach for assessing, monitoring, and mitigating these issues. Organizations’ control

environments should recognize that AI systems, despite their perceived objectivity, are susceptible to bias and require human oversight. Effective risk assessment processes should identify algorithmic bias as a material risk with financial, operational, and compliance consequences, incorporating regular bias testing and data audits. Transparent communication strengthens stakeholder trust while enhancing internal understanding of AI limitations and risks. Reliable monitoring, including periodic model validation and continuous tracking of personalization outcomes across consumer segments, is essential to detect and address bias before it escalates into broader business risks.

Analyzing the economic impact of algorithmic bias in AI-driven personalization and forecasting in the cosmetic industry requires considering multiple theoretical scenarios to capture its potential effects on operational efficiency, risk management, and compliance structures. High-risk failure scenarios, moderate-complexity scenarios, and minimal-risk scenarios provide insights into how bias can lead to tangible economic consequences across different organizational contexts and AI maturity levels.

In a high-risk failure scenario, widespread, undetected bias can create severe economic consequences. Misalignment between AI forecasts and actual demand may result in chronic overproduction of some product lines and underproduction of others, generating high inventory costs and requiring aggressive discounting that undermines profitability. Bias in personalized marketing may exclude or misrepresent customer segments, leading to inefficient campaigns, wasted advertising spend, and reputational damage that reduces trust and customer retention. Compliance risks may also rise if biased algorithms inadvertently violate anti-discrimination regulations, resulting in fines and corrective actions that further strain financial resources. Such failures can exacerbate financial instability, positioning algorithmic bias as a systemic threat to long-term profitability and competitiveness.

In a moderate-risk scenario, bias is present but detected periodically through audits or customer feedback, causing episodic operational inefficiencies rather than systemic failures. Companies may experience localized inventory imbalances, increased logistics costs, and missed sales opportunities. Marketing campaigns may yield uneven results, effectively engaging some demographic groups while underperforming with others, reducing marketing ROI. Compliance risks manifest as reputational criticism rather than legal penalties, requiring targeted PR responses and minor procedural adjustments. Economically, bias introduces friction in operations and financial flows, lowering overall efficiency and flexibility without undermining strategic market positioning.

In a minimal-risk scenario, bias is effectively controlled through robust detection, inclusive data handling, and integrated human oversight throughout the AI lifecycle. AI-based personalization and forecasting accurately reflect market dynamics, optimizing inventory levels, reducing storage costs, and enabling rapid responses to seasonal and trend-driven demand fluctuations. Marketing spend delivers high ROI through precise targeting across consumer segments, boosting conversion rates and customer lifetime value. Compliance risks are minimized through proactive monitoring, ensuring AI systems operate within regulatory and inclusivity standards. Economic outcomes highlight AI's potential to significantly improve operational efficiency and revenue growth while controlling bias-related risks, supporting strategic investments in advanced analytics and automation in the cosmetic sector.

From an operational economics perspective, these scenarios demonstrate how algorithmic bias affects supply chain flexibility, production planning, and inventory management. High-risk conditions increase sunk costs and reduce operational agility, whereas minimal-risk conditions support lean production and rapid market responsiveness. For cosmetic companies, the ability to quickly align production with fluctuating consumer demand is critical to financial performance, and algorithmic bias directly impacts the accuracy and reliability of this alignment.

With the development of AI-based personalization and forecasting systems in the cosmetic industry, new forms of operational and compliance risks are emerging that go beyond traditional risk profiles. These risks arise from the interaction of algorithmic bias, the opacity of AI decision-making, and specific operational pressures in the cosmetic market, such as short product life cycles, high seasonality, and the critical role of personalization in consumer engagement. Identifying and

managing these new risks is crucial for companies seeking to leverage AI while maintaining financial performance, regulatory compliance, and market reputation.

1. Data-driven discrimination risks in personalized marketing

Integrating AI into personalized marketing creates potential for algorithmically induced discrimination, where certain demographic groups are systematically excluded or misrepresented in campaigns due to biases embedded in training datasets or model architecture. Such bias can result in disproportionate targeting of some consumer segments while ignoring others, leading to inefficient allocation of marketing resources and lost revenue opportunities. Economically, uncontrolled bias reduces marketing ROI, increases customer acquisition costs, and limits market expansion, directly affecting revenue growth trajectories.

2. Product quality liability risks related to algorithms in personalized formulations

The shift to AI-based personalized formulations, such as individualized skincare or color matching, introduces new forms of product quality liability if AI systems recommend inappropriate products that may cause allergic reactions or ineffective results. This generates operational risks related to customer dissatisfaction, product returns, and potential reputational damage. Within the COSO ERM framework, these risks are mitigated through measures such as human oversight of AI recommendations, transparent communication of AI limitations to manage customer expectations, and continuous monitoring of adverse events to quickly minimize impact and improve AI-driven processes. Proactive management of these risks transforms AI-based personalization from a potential source of problems into a valuable factor for customer safety and trust.

3. Supply chain fragility due to overreliance on AI forecasting

The cosmetic industry's dependence on AI for demand forecasting and supply chain management can cause operational instability if models fail to accurately predict demand across product lines or regions. Algorithmic errors or data inaccuracies can lead to inventory imbalances, overproduction in some areas, and shortages in others, increasing storage costs, markdowns, or lost sales. Risk management systems must account for the systemic nature of these vulnerabilities, as forecasting errors can disrupt production planning and distribution logistics in global supply chains. The economic consequences include higher operational costs, revenue losses during peak demand, and reduced margins due to discounting excess inventory. Under COSO ERM, managing this risk involves treating algorithmic forecasting as a critical business risk, implementing double-check mechanisms, and continuously monitoring forecast performance with market-driven model adjustments.

4. Non-compliance risks from unjustified AI decisions ("black-box" AI)

Using AI as a "black box" for marketing personalization and demand forecasting generates compliance risks related to transparency and accountability, particularly under data protection laws (GDPR, KISA) or consumer rights regulations. COSO ERM guidance includes establishing a control environment, implementing Explainable AI (XAI) frameworks, and clear communication protocols for AI decisions to consumers and regulators. By analyzing these risks within COSO ERM, cosmetic companies can transform potential integration challenges into managed risks while maintaining operational efficiency, regulatory compliance, and consumer trust.

Managers should regularly audit AI algorithms for bias and use representative datasets to detect hidden discrimination by age, skin tone, or region. Early detection of such errors reduces financial losses and reputational risks. Implementing XAI enhances transparency and accountability of AI decisions, facilitating internal audits, customer interactions, and regulatory compliance (e.g., GDPR), while building consumer trust. Algorithmic bias should be recorded in corporate risk registers. Periodic model testing and audits increase AI reliability, and open communication within the company and with customers fosters a culture of transparency.

AI improves forecasting accuracy, but excessive reliance without human oversight is risky. Hybrid models combining AI analytics with expert judgment help avoid overproduction or stock shortages, minimizing financial and operational risks.

Actively addressing algorithmic bias strengthens brand reputation and consumer trust. Clear communication about AI processes differentiates the company in the market, reducing negative reactions and enhancing ethical brand perception.

KPI tracking for AI accuracy and fairness provides early warning of systemic failures and errors, while continuous monitoring supports operational excellence.

Forecasting errors increase storage costs and lost sales, and incorrect personalization raises customer acquisition costs. Understanding these consequences helps justify investments in improving AI models.

Cross-functional collaboration among technical, marketing, compliance, and finance teams improves risk management, ensures practical controls, and aligns AI with business objectives, reducing the likelihood of systemic errors.

Managers and teams need to understand AI functionality and limitations to increase process resilience and reduce the risk of errors. Developing employee literacy enables prompt responses to deviations.

AI practices should align with future transparency and fairness standards, as proactive regulatory compliance prevents costly adjustments and helps companies lead ethically while maintaining competitive advantage.

In conclusion, as AI-based personalization and forecasting continue to transform the cosmetic industry, managing algorithmic errors will be critical to ensuring these technologies fulfill their promise of enhancing operational flexibility and market responsiveness without introducing hidden risks that could undermine organizational objectives. By adopting a proactive, risk-based approach to AI management aligned with the COSO ERM framework, cosmetic companies can leverage AI as a sustainable driver of competitive advantage, financial resilience, and consumer trust in an increasingly digital and personalized market.

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ІНТЕЛЕКТУАЛІЗАЦІЯ ЕКОНОМІЧНИХ СИСТЕМ: ВІД РЕАКТИВНОГО УПРАВЛІННЯ ДО ПРОАКТИВНОЇ ПАРАДИГМИ

Сучасна економіка функціонує в умовах високої турбулентності, непередбачуваних глобальних збурень та структурних трансформацій, що вимагає пошуку нових підходів до управління економічними процесами. Традиційні реактивні методи, які ґрунтуються на аналізі минулих подій та прийнятті рішень на основі історичних даних, не здатні забезпечити необхідну швидкість адаптації, ефективне прогнозування ризиків і своєчасне реагування на зовнішні та внутрішні шоки. У цьому контексті особливого значення набуває концепція інтелектуалізації економічних систем, яка передбачає не лише цифровізацію процесів, а