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Managing the Environmental Effect of AI Models

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Abstract

Artificial Intelligence (AI) is transforming the lives of billions and plays a crucial role in solving complex problems and boosting productivity across industries. However, the rapid proliferation of AI technologies also raises significant environmental concerns. Training large-scale AI models requires vast computational resources, resulting in substantial energy consumption, carbon emissions, and water use. As AI capabilities grow, energy demand doubles approximately every ten months, outpacing improvements in hardware efficiency and renewable integration. This research investigates how the environmental footprint of AI can be mitigated through the application of circular economy principles and policy interventions inspired by extended producer responsibility. We explore the potential for reusing AI models via transfer learning, distillation, and repurposing, as well as the role of open-source sharing in prolonging model lifecycles. We also draw parallels between AI systems and consumer electronics, highlighting similarities in their environmental impacts and obsolescence dynamics. We develop a game-theoretic model comparing firm-level incentives with socially optimal outcomes and evaluate the effectiveness of various policy tools, including training and operations taxes, minimum usage requirements, and decreasing eco taxes designed to extend model longevity. Our findings reveal key trade-offs in AI model development and deployment decisions and identify regulatory approaches that can align private incentives with environmental goals. This study contributes to the emerging discourse on sustainable AI by proposing a structured framework for quantifying environmental costs and assessing regulatory levers that could guide the industry toward greener practices.

Keywords
AI Sustainability, Circular Economy and AI Regulation.

Biographies
Shumail Mazahir is an Associate Professor in Operations and Supply Chain Management at SKEMA Business School. Before joining SKEMA he was a post-doctoral researcher at Desautels Faculty of Management, McGill University. He obtained his PhD in Management Sciences from HEC Paris.

Timofey Shalpegin is an Associate Professor at MBSC, specializing in Operations and Supply Chain Management. With over a decade of academic experience, Timofey has published in leading journals, including Manufacturing & Service Operations Management, Production and Operations Management, and Journal of Operations Management. His research explores the intersection of new product development, sustainability, and supply chain management, with

recent work focusing on the impact of AI technologies on operations management practice and research. Before joining MBSC, Timofey served as a lecturer and researcher in the ISOM department at the University of Auckland, New Zealand, where he was deeply involved in teaching, research, and curriculum development. His teaching portfolio includes courses on supply chain analytics, new product development, and operations management. He has also designed numerous workshops and interactive sessions, blending practical applications with theoretical insights. Timofey holds a PhD degree in Management Science from HEC Paris, France.