

Chapter 11

Data Governance by Design: Building Compliant and Reliable Data Engineering Workflows for Sustainable Industrial Processes

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ABSTRACT

The increasing reliance on data-driven decision-making in industrial sectors has amplified the importance of robust, compliant, and reliable data engineering workflows. With the growing demand for sustainable industrial processes, organizations must ensure that their data systems are not only efficient but also aligned with governance principles that emphasize regulatory compliance, security, and ethical responsibility. This chapter explores a data governance by design approach, embedding governance mechanisms directly into the architecture of data pipelines and workflows. By focusing on automation, standardization, and traceability, the chapter demonstrates how organizations can achieve higher reliability and accountability in managing industrial data. The integration of governance practices is analyzed through key dimensions, including compliance with data protection regulations, quality assurance, lifecycle management, and sustainable data storage. Furthermore, the discussion highlights real-world use cases where data governance frameworks have enabled energy efficiency, reduced operational risks, and ensured long-term sustainability in industrial ecosystems. The chapter concludes by outlining

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best practices and strategies to future-proof data engineering workflows, enabling industries to balance innovation with compliance in the era of sustainable digital transformation.

INTRODUCTION

In the modern digital economy, data has emerged as the lifeblood of organizations, shaping strategies, driving innovations, and enabling more informed decision-making across industries. Industrial sectors, in particular, have witnessed a dramatic transformation with the integration of data-centric technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and advanced analytics. Machines, sensors, and automated systems continuously generate vast volumes of structured and unstructured data, which—when harnessed effectively—can optimize operations, minimize energy consumption, and contribute to more sustainable industrial processes. However, as data becomes more integral to industrial workflows, so too does the challenge of managing it responsibly, securely, and in compliance with evolving regulations. This necessity has placed data governance at the forefront of digital industrial transformation.

Data governance refers to the set of policies, processes, standards, and practices that ensure an organization's data is accurate, consistent, secure, and used ethically. In traditional models, governance has often been treated as an afterthought, imposed as a reactive measure once systems are already in operation. Such an approach, while common, has proven insufficient in today's rapidly evolving regulatory landscape and data-intensive environments. Instead, organizations are increasingly adopting a "governance by design" paradigm, embedding governance principles directly into the design and development of data engineering workflows. By integrating compliance, accountability, and security considerations into the foundation of data architectures, industries can better address risks while enabling more sustainable and efficient processes.

Data in the Era of Sustainable Industrial Transformation

Sustainability has become a critical goal in industrial ecosystems, driven by global challenges such as climate change, resource scarcity, and environmental degradation. Governments, industry regulators, and consumers are demanding more eco-conscious practices, compelling enterprises to rethink how they operate. Data plays a pivotal role in this transition. For example, sensor data collected from smart manufacturing systems can be used to monitor energy consumption, optimize production schedules, and reduce waste. Predictive analytics can improve maintenance

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