


Chapter 10


Forecasting for a Greener Future: Predictive Analytics in Food Waste Management

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ABSTRACT

The global challenge of food waste—nearly one-third of all food produced—is a critical issue with environmental, economic, and social impacts. In alignment with UN SDG 12.3 to halve food waste by 2030, this chapter explores how predictive analytics can transform the food supply chain. Leveraging AI, ML, IoT, and real-time data, predictive models are used to forecast demand, optimize inventory, and anticipate spoilage. Advanced solutions like digital twins, blockchain traceability, computer vision for freshness detection, and context-aware recommendation systems are discussed in this chapter. These tools adapt to variables such as seasonality,

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consumer behavior, supply chain disruptions, and climate change. The chapter also addresses ethical concerns, data management, and the scalability of predictive technologies in both developed and emerging economies. It emphasizes the need for interdisciplinary research and collaboration among governments, tech companies, and stakeholders to institutionalize predictive analytics for a sustainable and resilient global food ecosystem.

1. INTRODUCTION

Global food waste is still a problem that impacts food security, environmental sustainability, and economic stability. The Food and Agriculture Organization (FAO) of the United Nations estimates that about 1.3 billion tons, or about a third of all food produced worldwide, is wasted annually (FAO, 2022). In addition to wasting an opportunity to support the 828 million hungry people living in the world, this huge waste is a degrading factor to the environment by promoting the emission of greenhouse gases, land degradation, and water wastage (UNEP, 2024). Food waste would be the third biggest contributor of greenhouse gas emissions were it a country, following the United States and China (World Economic Forum, 2023). Food waste is a problem that is closely connected with the inefficiency of the whole supply chain of production, processing, retail, and consumer behavior. In a developed nation, the waste or garbage typically occurs at the consumption stage since consumers overbuy, store poorly, or fail to understand an expiry date. On the contrary, the losses of developing countries due to harvest occur, these are infrastructural in nature, e.g., bad harvest methods, bad transport, and cold storage systems (McKinsey & Company, 2023). Those are complex and multi-faceted reasons that need to be addressed creatively and based on evidence and foresee, control, regulate, and minimize waste prior to its occurrence. As the world works to realize Sustainable Development Goal (SDG) 12.3, which includes halving food waste at retail and consumer tiers, there is greater focus than ever on how the newest digital technologies, such as predictive analytics, can be utilised to make food systems smarter, more responsive, and more sustainable (OECD, 2023). In advanced or modern data analytics, predictive analytics is a subdiscipline that uses information or data present and in the past, combined with statistical models and machine learning (ML), to forecast. An assembly of predictive analytics and Artificial Intelligence (AI), Internet of Things (IoT), blockchain, and digital twins has triggered a new phase of smart food management (IBM, 2023). These technologies will help them

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