

# **Rethinking Food Waste in the Industry 4.0 era: A Review of Blockchain Research in the Food Supply Chain**

Stavros T. Ponis, Eleni Aretoulaki, George Plakas and Konstantinos Agalianos

*School of Mechanical Engineering, National Technical University Athens, 15780, Greece*

## **Abstract**

The challenge of reducing Food Waste (FW) is a complex social problem leading to environmental degradation and devastating economic inefficiencies. At the same time, FW is raising significant ethical challenges, since according to the Food and Agriculture Organization of the United Nations, one third of the food produced in the world for human consumption every year gets lost or wasted, whereas 870 million people globally, or one in eight, are suffering from chronic malnourishment. The realization of FWs immense negative effect on society has prompted -in the last decade- a positive shift of focus towards the establishment of a common understanding of the phenomenon and its root causes and the initiation of coordinated actions to promote citizen awareness and alleviate negative ramifications of FW at all levels of the Food Supply Chain (FSC), i.e. agricultural production and stock-farming, post-production handling, upstream distribution and storage, processing including packaging, downstream distribution and storage and finally food preparation, consumption and disposal. The complex and dynamic nature of the FSC along with the non-negotiable need for food freshness, quality and safety from harvest, slaughter or catch to the consumer's plate delimit a very demanding environment, which subsequently creates numerous information technology requirements and challenges. Fortunately, the wave of Industry 4.0, although not still mature enough, provides a set of innovative technologies, which seem capable of transforming the way the FSC operates enabling sustainable food production, distribution and consumption. This paper focuses on probably the most controversial of Industry 4.0 technologies, i.e., Blockchain and provides a detailed review of the research efforts attempting to implement blockchains for reducing food waste across the food supply complex network. In doing so, the paper will study synergies between Industry 4.0 technologies complementing blockchain potential implementations, such as IoT sensor networks widely used in upstream FSC processes, IoT sensors and telecommunication services for food transportation and condition monitoring during storage, machine learning and artificial intelligence for forecasting and better inventory management at both the supply and demand levels and finally end-consumer facing applications using blockchain for supporting efficient and responsible food consumption.

**Keywords:** Blockchain, Food Supply Chain, Food Waste, Industry 4.0, Internet of Things

**Acknowledgments:** The present work is co-funded by the European Union and Greek national funds through the Operational Program "Competitiveness, Entrepreneurship and Innovation" (EPAnEK), under the call "RESEARCH-CREATE-INNOVATE" (project code: T1EΔK-05095 and Acronym: TRACKPLAST).