

Digital Technologies for Food Loss and Waste Prevention and Reduction in Agri-Food Supply Chains: A Systematic Literature Review and Research Agenda

Caterina Trevisan  and Marco Formentini 

Abstract—Despite the benefits resulting from the use of Industry 4.0 technologies in the agri-food sector, the adoption of digital technologies for preventing and/or reducing food loss and waste (FLW) across the agri-food supply chain is still under investigation. In fact, enhancing and optimizing agri-food supply chain operations through digital technologies would just represent a partial effort if FLW prevention and reduction are not effectively addressed. Although companies are starting to adopt digital technologies for eliminating FLW from their operations, the implementation process and the achieved results are generally presented at a superficial level and practical guidance is still missing. This systematic literature review contributes to theory by developing a framework analyzing the state-of-the-art of adoption of each Industry 4.0 technology across the agri-food supply chain, and providing a research agenda structured around the main themes of research design, digital technologies, contextual differences, governance, and sustainability. Eventually, the study also informs managers in the agri-food industry about the potential implementation of digital technologies for preventing and reducing FLW in across the agri-food supply chain.

Index Terms—Agri-food supply chain (AFSC), digital technologies, digitalization, food loss and waste (FLW), industry 4.0.

NOMENCLATURE

List of Abbreviations

AFSC	Agri-food supply chain.
AI	Artificial intelligence.
BDA	Big data analytics.
CRM	Customer relationship management.
DT	Digital technologies.
EIS	Enterprise information system.
ERP	Enterprise resource planning.
FLW	Food loss and waste.

FW	Food waste.
GPS	Global positioning system.
ICT	Information and communication technology.
IoT	Internet of Things.
ML	Machine learning.
PLM	Product lifecycle management.
RFID	Radio-frequency identification.
RPA	Robotic process automation.
SLR	Systematic literature review.
WMS	Warehouse management system.

I. INTRODUCTION

As a growing number of people is facing food insecurity and the global food systems have been severely tested by a combination of health crisis, climate-related issues, and conflicts, still too much food is lost or wasted throughout the AFSC. Between 25% and 50% of food produced does not reach the consumers, with the majority of losses occurring from the producers to the retailers point in the supply chain [1]. Wasting food has significant negative consequences on social, economic, and environmental sustainability: wasted food in landfills generates about 8%–10% of global greenhouse gas emissions [2], not to mention blue water footprint, land footprint, and biodiversity reduction [3]. Moreover, it leads to an economic cost of around 143 billion euros per year in the 28 European countries alone [4]. Halving per capita global food waste by 2030 is the objective of target 12.3 of UN sustainable development goal [5]; thus, reducing FLW represents a relevant and timely issue.

Several strategies of reducing FLW have been identified, depending also on the supply chain stages considered [6]. Despondi [1] individuates the adoption of technology as one key aspect for food loss reduction, especially in the upstream part of the supply chain. For instance, Industry 4.0 (I4.0) solutions, such as blockchain or IoT, allow the monitoring of the ambient conditions of food products from the harvest until the selling stage, thus detecting their deterioration stage and improving the operations along the entire AFSC [7], [8], [9]. Even in the downstream supply chain stages (i.e., consumption, food service, and food sharing), digital technologies are frequently adopted to avoid or reduce food waste, such as digital platforms

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