AI4FoodLogistics

AI For Food Logistics aims to achieve a highly reliable, just-in-time delivery experience for fresh food through end-to-end optimization of the logistics chain.

The main objective of this project was to develop a solution capable of handling the complexity and uncertainty in the food logistics domain. A solution also that benefits all stakeholders in the logistics chain, from the farmers to the consumers.

Current solutions for food logistics are mainly Excel-based. They rely on business common sense and simple data manipulation. But solutions such as these come with a number of challenges, such as the lack of reliable and timely data, the difficulty of coordinating multiple actors, and the uncertainty and variability in the environment.

By using advanced AI techniques, we aimed to achieve the following outcomes: reduce food waste and CO_2 emissions, increase customer satisfaction, and improve the competitiveness and profitability of the food logistics actors.

FRAMING THE RESEARCH OBJECTIVE

The project's research objective was threefold:

1) To study and prototype a federated data ecosystem to tackle the lack of reliable and timely data coming from multiple actors.

2) To develop more accurate and personalized models to reduce food waste, increase customer satisfaction, and improve the competitive advantages of Delhaize and Foodmaker.

3) To optimize end-to-end logistics to reduce emissions and improve the efficiency of both the distribution centres and the transport of fresh goods, leading to a higher profitability for Delhaize and Van Moer.

THREE MAIN OUTCOMES

The AI4FoodLogisitcs brought distinct outcomes for the three commercial project partners:

For Delhaize, the project has taught us:

- How to better forecast demand and sales using statistics and machine learning. These learnings are already used for forecasting our e-commerce demand and our promotional sales.
- How to recommend recipes to customers. The system has been prototyped and is ready for further testing and improvement.
- How to optimize backhauling and truck routing using optimization methods. The system has been tested on a simulated environment.
- How to simulate e-commerce and fresh warehouse operations and performance using simulation and data analytics. A digital twin has already been implemented for these facilities and has provided useful insights for planning and management.
- We have also explored dynamic pricing (markdown) using machine learning, which we have not yet tested in real life.

For Van Moer, the project has:

- Brought the first co-development of a data product with a client.
- Highlighted the value and need of further data and infrastructure investments across the company, investments which are now ongoing.
- Provided significant insights concerning route optimization and road transport analysis. These results are planned to be rolled out across the company.

For Foodmaker, the project has:

- Brought learnings and internal knowledge on our own data, analysis techniques and how to use data to make substantiated decisions.
- Taught us the value and insights on restaurant sales forecasting, for which further steps are now being determined.
- Provided excellent insights on personalized recommendations and surrounding marketing strategies in the Foodmaker App. Next

steps on predicting and driving consumer purchase behaviour are under investigation now, based on the project (PoC) outcome.

Looking at the results of the AI4FoodLogistics project, we have observed that the new solutions sometimes outperform existing solutions (internally developed or commercial solutions). This is mainly in the scope of DC optimization. But sometimes they still underperform existing solutions, for example in the scope of Demand Forecasting for Delhaize. In general, we are convinced that most value can be gained by integrating the AI4FoodLogistics knowledge and algorithms into our existing solutions and processes.

NEXT STEPS

For Delhaize, AI4FoodLogistics provided valuable insights and knowledge on how to use AI tools for food logistics and waste reduction. This already led and will continue to lead to a higher usage of AI technologies. It will also result in further research opportunities.

For Van Moer, AI4FoodLogistics resulted in valuable learnings from data. More so: it initiated a culture of data valorisation. Some solutions within the route optimization of AI4FoodLogistics will be implemented across Van Moer's business units.

Foodmaker gained a lot of knowledge from its own data. The results will be used to further investigate practical implementations for both forecasting and hypersonalized recommender systems. Based on the proof of concept of AI4FoodLogistics, Foodmaker sees potential to implement both use cases.

AI4FoodLogistics project partners:

The AI4FoodLogistics project was co-funded by imec, with project support from Agentschap Innoveren & Ondernemen

FACTS

NAME	**AI4FoodLogistics**
OBJECTIVE	Develop smarter food logistics with the use of AI
TECHNOLOGIES USED	Spatio-temporal time series, Forecasting, Nonparametric and functional methods, Deep Learning, Graph (neural) networks and algorithms, Hyperpersonalization, Recommender systems, User behaviour modelling, Explainability, Performance evaluation, Selective and stochastic backhauling, Transport risk mitigation, E-commerce Storage Location Assignment, Reinforcement Learning, R2RML, RML, Optimization, RMLStreamer, Knowledge graph construction, Logistics, Supply Chain, Retail
TYPE	imec.icon project
DURATION	01/09/2021 – 04/07/2024
PROJECT LEAD	Xavier Valentini, Delhaize
RESEARCH LEAD	Siegfried Mercelis, imec – IDLab – UAntwerpen
BUDGET	2,589,254.17 Euro
PROJECT PARTNERS	Van Moer Logistics, Delhaize, Star Meal (Foodmaker)
RESEARCH PARTNERS	not applicable
RESEARCH GROUPS	imec – IDLab – UGent, imec – IDLab – UAntwerpen

WHAT IS AN IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and/or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.

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