Food waste as a complex social system: How computational social science can help

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Researchers in Norway use computer modeling to understand the social complexities of food waste and to test potential interventions that could be part of the solution. How can computational social science contribute to this understanding?

Addressing complex social issues like food waste are not just about individual decisions or technical inefficiencies. They are entangled within social norms, human motivations, and situational constraints that interact in unpredictable ways. Traditional research methods can measure correlations or test limited interventions, but they struggle to capture the richness of these dynamic social systems.

This is where computational social science (CSS) can make a difference. By building simulation models that reproduce patterns of human behaviour, researchers can test hypotheses and explore strategies in silico before applying them in the real world. Computational methods have long been employed in physics, engineering, and computer science, and are now being increasingly utilised by social scientists to address complex societal challenges.

The Center for Modeling Social Systems (CMSS) at NORCE specialises in such approaches. As one of Europe's leading teams in CSS, we combine techniques such as agent-based modeling, microsimulation, system dynamics, and participatory modeling with stakeholders. Our work demonstrates that detailed, complex systems can be represented with scientific rigour and generate insights that are unavailable through simpler methods.

Why computational social science for food waste?

Food waste is a pressing global problem: it wastes resources, accelerates climate change, and undermines food security. Reducing waste is not only a technical challenge – it also requires paying attention to social norms, including:

- Injunctive norms (what people think they are expected to do) shape how households interpret "best before" dates or react to food waste messages.
- Descriptive norms (what people see others doing) affect choices at family dinners or buffets.

Because norms and behaviours interact in complex ways, simple surveys or experiments can only reveal part of the picture. Simulation models, however, allow us to capture social dynamics, test different conditions, and identify strategies that minimise waste. This was

the rationale behind our contribution to the CHORIZO Project, a Horizon Europe initiative focused on reducing food waste across the supply chain.

The CHORIZO Project: A case study

CMSS developed two simulation models for CHORIZO: one focusing on hotels, the other on households. Together, these models demonstrate how computational modeling can shed light on social behaviours that produce food waste and inform strategic designs for effective change.

1. The Establishment Diner Model (Hotel Settings)

In partnership with a European hotel chain, researchers at CMSS designed an agent-based model to simulate breakfast buffet behaviour. Guests were represented as simulated individual "agents," and varied by gender, travel purpose, and attitudes toward food. Agents' choices about portion size and waste were shaped by injunctive norms (hunger, indulgence, sustainability awareness), opportunities (plate size, available time), and abilities (self-control). Descriptive norms such as social influence between guests were also modeled.

After verification and validation of the model, 36 scenarios were tested, with 150 simulation runs each, testing out differences between leisure/business guests, varying plate sizes, and positive or provocative messaging strategies. Results were striking:

- Sustainability awareness was the strongest driver of waste reduction.
- Positive messages about reducing food waste led to a decrease in waste.
- Provocative messages (e.g., shaming) increased waste.

These insights could not have been obtained without the use of simulation. Conducting such experiments in a real hotel would have been costly, reputationally risky, and practically infeasible. Instead, the model allowed safe exploration of strategies, with outcomes grounded in real-world data.

2. The Home Cook Model (Household Settings)

The second model focused on food waste within households, calibrated with real-world data from Belgium and Spain. A microsimulation model was built to represent household food management, consumption, and waste generation. Each household in the model was unique, varying in composition, dietary habits, and storage practices. Two findings stood out from simulations of 24 scenarios with 100 simulation runs each:

- Failure to observe best-before dates can lead to poor management of pantry inventory, which can result in increased food waste due to spoilage.
- Storage conditions mattered: optimal storage (such as better fridges) significantly reduced spoilage.

This model demonstrated that small behavioural shifts within households can lead to significant reductions in waste across populations.

Why these methods matter to computational social science

The two models underscore why CSS is a valuable and necessary approach:

- Scale:
  Once the model is validated, we can swiftly test a large number of what-if scenarios and assess related data uncertainties, which is virtually impossible in physical settings.
- Flexibility:
  Models can be tailored to specific contexts, whether hotel buffets, households, schools, or even national food policies.
- Safety:
  Stakeholders can explore risky or sensitive strategies in a simulated environment without reputational harm.
- Discovery:
  Several findings would not have emerged through simpler methods.
- Timing:
  Modeling and simulation approaches can compress many years of real-world experimentation into weeks or days of computational runs.

CMSS: Expertise and impact

This project is just one example from CMSS's portfolio. Based in Norway, we are widely recognised for our multidisciplinary team and participatory modeling approach. We have worked with governments, industries, and international organisations to apply CSS to issues such as green transport, climate change mitigation, sustainable fisheries, and democratic innovation.

Our philosophy is that stakeholders should be part of the modeling process from the beginning. By combining their knowledge with our computational expertise, we create models that are both scientifically robust and practically relevant.

Conclusion: Simulating a better future

Reducing food waste is one of the world's most urgent social and environmental challenges. Addressing it requires not just technical fixes but an understanding of the social patterns that drive waste. CSS offers the ability to model, simulate, and test interventions across hundreds of scenarios in a manner that cannot be replicated in real life.

As the CHORIZO project shows, the payoff is substantial. From hotel buffets to household kitchens, computational simulations reveal effective, scalable, and socially informed strategies. At CMSS, we are committed to expanding this work and demonstrating that the same computational methods that revolutionised physics and computer science can also transform the way we study society.

Or, as we like to say: A better world isn't found, it's built.
