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Speculative methods for exploring data ethics in food systems

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ABSTRACT

This paper explores using design methods to examine ethical challenges in complex systems, specifically relating to technology design, policy, and governance surrounding new forms of data sharing and collaboration in food supply chains. In a research-through-design process, we developed speculative methods to examine how the incorporation of new technologies raises ethical considerations such as bias, transparency, and governance challenges in this sector. Design fiction artefacts were developed with an interdisciplinary team and assessed using the Moral-IT card deck. Through this process, we explored potential shortcomings, trade-offs, and dilemmas relating to speculative food data-sharing systems. The design methods enabled greater understanding of multifaceted challenges, supporting ethical practice in future design implementation and policy.

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Food supply chains, design fiction, ethics, card-based tools, design for policy

Introduction

The production and distribution of food in ways that are efficient and sustainable is a growing challenge in our current global landscape. Food is a significant theme running across the United Nations General Assembly's 17 Sustainable Development Goals (SDGs) (UN 2015). One approach to achieving sustainable food systems is the use of new data-driven technologies associated with the Fourth Industrial Revolution (Schwab 2017). Innovations such as sensors, distributed ledger technologies, autonomous systems and artificial intelligence (AI) can enable such transformations, for

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example minimising the use of water and fertilizer through more accurate soil-related data and decreasing food waste *via* AI supported logistics and transport.

However, system complexities mean introducing new technologies can have unintended effects and disrupt the delicate balance between ethical practice, trust, and accountability. Design can play a key role in making sense of the multi-dimensional problem space arising from the introduction of new technologies (Design Council 2021). Design research methods can support not only product and service design, but also policy and regulation processes that must necessarily accompany sectoral transformation to ensure ethical practice. The emerging field of design for policy provides fertile ground for applying these methods in a wider policy framework context. Design for policy approaches use multiple design research methods (Mortati, Mullagh, and Schmidt 2022), including speculative and participatory design. Nevertheless, there is little work applying this to governance of technology in the food sector.

In this paper, we discuss a research-through-design (RtD) approach which allowed investigation of how design research methods including speculative design can support policy and practice associated with ethical data sharing. We describe how an interdisciplinary team explored these approaches, generating insight into ethical challenges for data sharing in food supply chains. The outcome of this work provides scaffolding for new frameworks of ethical assessment where multiple, often contradictory, ethical challenges are in play. Thus, we demonstrate how design methods can bring new knowledge to food systems, and the value of design research approaches to sector-specific policy development.

This paper is structured as follows: first, context is provided for why digital collaboration in food systems is a critical issue, and relevant design approaches. We then present the three-stage process our research underwent: worldbuilding for a speculative food data trust system, designing tangible design fiction objects to elucidate ethical issues within this system, and undertaking evaluation work prompted by these objects. We close with discussion of the implications of these methods.

Context and related work

Digital collaboration in the food sector

The food industry is one of the largest sectors in the world, employing millions globally[1]. Food supply networks are complex, with multiple actors and processes contributing to the life cycle of a food product, through which food is grown, harvested, processed, distributed, sold and consumed. The generation and use of extensive, highly detailed data from multiple stages of the food supply chain promises new possibilities for

efficiency, process improvement, and sustainability, but there are barriers to the sharing of such data (Durrant et al. 2021). For example, the production of a particular food product may depend on a chain of producers, distributors and retailers who have a wide range of pressures, values and concerns. A farmer growing crops gathers data relating to weather, soil, health of plants, water usage, and activities of farm workers. Such data may be proprietary, and farmers may not be willing to share this data with others. A company producing food products has its own proprietary data. Retailers may have access to some or all of this data as well as their own data sources, which could provide significant benefits to logistical management and customer need anticipation. A trusted mechanism is required both to enable collaboration between different stakeholders and to support each stakeholder to make decisions about the credibility of the separate data sources (Jakku et al. 2019).

Regulators may also make use of this data to support and enforce standards. Such data provides insight into multiple ethical concerns including environmental sustainability, economic sustainability, human labour rights or food safety standards, but these may not all be mutually achievable. Additionally, there may be ethical implications of the introduction of technology to achieve these goals, requiring new technological, governance and societal structures (Brewer et al. 2021; Durrant et al. 2021). For example, if AI is to be used for data analysis and decision making, well-studied challenges such as bias, potential for opacity, and limited accountability must be considered. Ethical data sharing in food systems must be responsible in its implementation and must meet ethical principles including transparency, traceability, explainability, interpretability, accessibility, accountability and responsibility (Manning et al. 2022). While there is an extensive body of computer science literature on ethical concerns surrounding responsible AI (e.g. Dignum 2019) and a smaller but substantial body of literature relating to ethics of food production (see Manning, Baines, and Chadd 2006; Manning et al. 2022), there has been limited focus on specific challenges of AI and data technologies from a food supply chain perspective.

Responsible Innovation

These complex ethical and sustainability technology challenges place this current work within the wider discourse of Responsible Innovation (RI). Although the associations and definitions of RI are flexible and considerable in scope (Fisher et al. 2024) it can usefully be summarised as working to align Innovation with the values of society to ensure that it is ethical, societally desirable and sustainable (von Schomberg 2011) by 'taking care of the future through collective stewardship of science and innovation in the

present' (Stilgoe, Owen, and Macnaghten 2013, 1570). To this end, tools, approaches and frameworks have been developed advocating, for example, Anticipation, Reflexivity, Inclusion and Responsiveness (Owen et al. 2013; Stilgoe, Owen, and Macnaghten 2013).

Key to this research is deliberative inclusion, an element of RI that Owen et al. (2013, 38) describe as 'inclusively *opening up* visions, purposes, questions, and dilemmas to broad, collective deliberation through processes of dialogue, engagement, and debate, inviting and listening to wider perspectives from publics and diverse stakeholders'.

Design approaches and methods

Research-through-Design (RtD) is a methodological approach Gaver (2012) defines as being where the 'practice of making is a route to discovery'. In this methodology, knowledge emerges as an iterative process through the creation of design outputs. This methodology underpins our research, as design approaches were introduced to an interdisciplinary team through an emergent, iterative process, who hence created knowledge through design practice, as outlined below.

Also guiding our research was the use of speculative design methods (Dunne and Raby 2013). Speculative methods align with critical design, and use speculation to anticipate and examine future potentialities. These methods, which may involve developing provocative scenarios, prototypes or specifications, are well suited to address fast-moving areas; by moving examination of ethical implications into the speculative, we can circumvent the Collingridge Dilemma (Collingridge 1982). This posits that by the time technologies are fully developed and social consequences become apparent, it is costly and slow to control them. Speculative design methods are used 'not to show how things will be but to open up a space for discussion' (Dunne and Raby 2013, 51). Lutz (2020) describes how speculative design reframes perspectives to reveal 'unseen trajectories of cultural, technological, environmental, socio-political trends'.

One particular manifestation of speculative design is the use of design fiction. This method involves the creation of 'diegetic prototypes', physical objects that manifest a fictional world: a speculated future or an alternative present (Bleeker et al. 2022). Coulton et al. (2017) have described how design fiction can be conceptualised as part of a practice of worldbuilding, where these speculations contribute to a wider narrative world rather than standing as individual objects. In this paradigm, the design fiction objects function as 'entry points' to the story world, serving as a convergence of narrative and design to give a perspective through which potential futures can be interrogated and examined. Futures of food has frequently been a topic explored in speculative design and design fiction (Pollastri 2022, Wathelet and Minvielle

2023), with provocative scenarios including symbiotic algae that allow us to photosynthesise (Burton 2010). What is less common are 'future mundane' (Coulton et al. 2019) near-future food speculations. We ground and expand this work, placing equal focus on food supply chains, technology implications, and policy and governance.

This method maps to Fisher et al. (2024) 'intervention' and 'assessment' around 'ethics and futures appraisal'. Thus, we are contributing to speculative design and RI scholarship, in relation to food systems, but with wider applicability to other emerging complex socio-technical systems.

Project context

In early 2020, an interdisciplinary group convened to explore the use of data trusts and frameworks in food supply chains. Home disciplines of the researchers included AI applications and ethics, Semantic Web and IoT technologies, ethics and law, responsible research and innovation, food safety, food integrity, food sustainability risk assessment and risk mitigation, and design research. The group was tasked with considering ethical concerns around future implementations of data sharing mechanisms in the food sector. The design researchers proposed a speculative approach that began with collaborating to imagine a scenario of how a future food data trust might operate. To ground this speculation in a particular concrete use case, an example function was chosen: allergy tracking. The resulting diagrammed system was imagined to use data from a variety of food supply chain stakeholders to provide information on allergen content for food products at different stages of the production, distribution and retail process (Craigon et al. 2023). Based on this initial speculation, the group developed a 10-month pilot project to explore how speculative methods, including design fiction, could inform data sharing ethics questions for future food systems. All subsequent work was granted ethical approval by the University of Southampton FEPS Ethics Committee.

Stage 1: Scenarios and worldbuilding

The first stage of the project was led by Design Research members of the team. It took place in parallel with activities relating to defining ethical AI in food systems which resulted in identification of the following key themes: accountability, automation, bias, data quality, governance, interoperability, labour ethics power, sustainability, systems impact, transparency, trust, and value. (Manning et al. 2022).

This stage aimed to develop the initial speculation into a coherent model future data trust. Expertise within the group contributed to collaboratively designing a 'world' in which to situate interrogation of ethical questions

relating to this system. This RtD based worldbuilding activity aimed to elucidate the following information:

- How group members visualised the data trust underpinning the scenario.
- How group members visualised stakeholder expectations/engagement.
- Gaps between mental models.
- How these models could be synthesised into a coherent world.

Pre-event preparation and mapping

In preparation for the workshop, team members each wrote a short description of how they thought the future food data trust in the initial scenario might work. The goal was not to design a realisable future implementation of this system, but to identify agreements and uncover divergent thinking within the group. This definition stage was critical in order to interrogate a *possible future* coherently addressing plausible challenges, without attempting to consider practical technological specifications or limitations. Responses were diverse in form and content, as expected given the interdisciplinary nature of the group. For example, some participants centred their scenarios on how data was shared and protected as it moved through different actors in the food supply chain. Others focused on the value of the system for the end consumer and how a customer might interact with allergen data at retail. While the responses were distinct, there was less contradictory information than anticipated. Rather, it was a case of differing lenses being applied, with focus on different key aspects of the scenario.

The facilitators combined responses with the previous discussions to produce a skeleton structure (Figure 1) mapping key features of a fictional data trust. This figure represents, in abstract: key actors interacting with the data trust, potential flows of data (including open vs limited access), and types of AI that might perform different functions as part of the system. At this stage, the level of detail was quite low, with no explication of how such processes might function or the exact nature of the systems and processes involved in the hypothetical model.

Stakeholder mapping

The first group task aimed to identify potential stakeholders who might be impacted by the fictional food data trust, directly or indirectly. A large range of potential stakeholders were identified and grouped into the following categories through a collective sorting exercise:

> Medical professionals, Businesses, Finance and marketing specialists, Logistics and infrastructure, Power brokers (high level suppliers), Governance, Production, and Citizens/consumers.

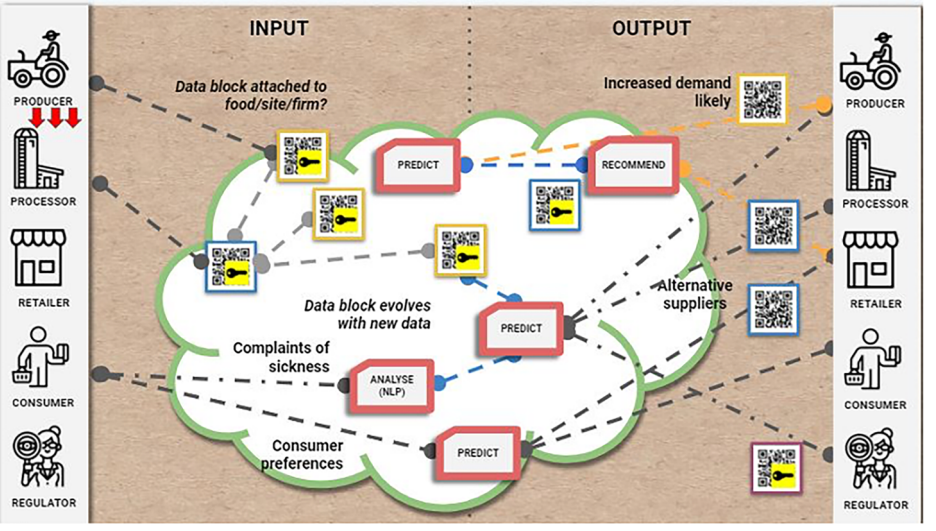

Figure 1. Mapping the fictional worldbuilding scenario.

The group selected the latter four stakeholder categories for further interrogation, as these were felt likely to be the most directly impacted by such a system. Thinking from the perspective of each stakeholder category, participants were asked to consider:

- What do you want the system to do?
- What do you expect the system to do?
- How does the system benefit you?

A summary of the responses from the discussions are presented in Table 1.

Feature identification

Finally, the participants undertook an in-depth exploration of features of the system. This activity was intended to shape the underlying worldbuilding, supporting design fiction entry point artefacts to be constructed to represent aspects of a future data trust. It should be noted that these features are not the only possibilities for a food data trust, but represented choices made in how to represent one possible future.

Prompt questions were presented in four of the ethical themes, data quality, governance, transparency, and accountability (see Table 2), selected as particularly related to concrete aspects of the data trust's functionality.

A wide range of answers were provided for the data related questions, and consensus was not always reached on what our representative system should include. For example, in the discussion around the question 'what data is collected', over 30 suggested data types were mentioned (Figure 2).

Table 1. Summary of responses considering the system from the perspective of different stakeholder groups.

Stakeholder group	What do you want the system to do?	What do you expect the system to do?	How does the system benefit you?
Consumers/citizens, including individuals, consumer groups, activist campaigns	Inform about key information without having to understand all of the details – reduce decision fatigue. Influence behaviour/ outcomes to improve standards. Be independent – not influenced by any (biased) actors or single group.	Alert if there is a problem e.g. contamination.	Increased transparency. Improved safety. Real-time responses.
Power brokers: e.g. first tier suppliers and retailers e.g. large restaurant chains	Provide transparency for food production if desired.	Protect data Provide access to other people's data. Help manage risk. Help drive efficiency. Provide immutable data records for an audit trail.	Greater control Timeliness of data, i.e. real-time signals especially in cases of problems
Governance: regulators, governments and certification bodies	Manage who can see what Data may be restricted but available to, for example, governing bodies and regulators.	Provide high quality, accurate data. Integrate different sources of data. Provide data in an accessible format.	Provide data that allows design of policies (e.g. health). Make it easier to audit Identify patterns of good practice. Identify bad practices.
Production – farmers, wholesalers, restaurants etc	Provide a closer relationship between farmers and regulators. Provide more choices. Make practices stronger based on evidence – from other farmers, 'producer community'. Community of practice.	Provide more power. Enable profit *via* economically viable choices.	Enable fairness. Allow more choices, on ethical issues. Improve lifestyle and health – mental, physical, livelihood stability. Help farmers to future-proof practices e.g. climate change, pandemic.

In discussing these questions, the participants identified expansive possibilities for the food data trust before narrowing down to select one for further interrogation in the form of design fiction. For example, participants suggested that data storage in such a system might operate either as a centrally operated or distributed system. It was agreed that in the potential future world being built, individual stakeholders would retain their own data, requiring interoperability and maintenance of individual data stores.

Discussions expanded beyond the technical to the governance of the system; for example, how the food data trust might be governed and funded. There was agreement that the worldbuilding include an independent management board, with representatives from a range of stakeholders. Less clear in these initial discussions was the precise composition of this board and the relative power of different stakeholder groups. For example, would there be representatives of farmer co-operatives, consumers, supermarkets, smaller commercial suppliers?

Table 2. Representative questions relating to feature identification.

Theme	Representative questions
Data	What data is being collected? Who is providing the data? How is data made accessible? Is data stored in a distributed or centralised system? Is access and use limited to certain organisations or individuals, and if so how?
Governance	Who manages the trust? What is the governance structure? Is there a data steward and if so who? How is the system paid for? Who pays for it and how much does it cost? Who benefits from the value created by the system?
Transparency	What is the transparency of the system? Including a) transparency aspects of the food data trust system itself (i.e. how much of the data was visible/available and to which actors) And b) transparency of the governance processes and management structure
Accountability	Who is held accountable? How are they held accountable if the system does not function as intended? How is accountability maintained over time?

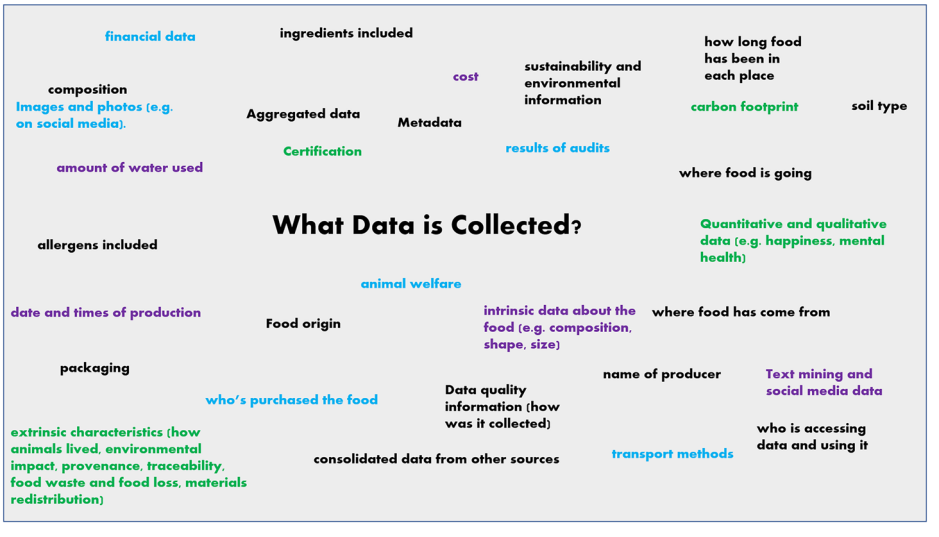

Figure 2. 'What data is collected' responses.

In discussions on transparency, the group agreed it was important that anyone should be able to view and understand the processes associated with the data trust. Also discussed was the importance of considering questions of transparency and fairness at multiple stages.

Discussions around accountability were limited by time constraints and continuing uncertainty about the specific technical details of the system being considered. Accountability aspects were difficult to clearly define because they were dependent on multiple additional factors. For example, the question of how accountability is maintained over time led to

discussion of bad actors and how they can be removed from the system or otherwise penalised. This discussion also touched on issues of proprietary data and intellectual property, as well as considerations of interoperability and permissions.

Stage 2: Creating design fiction entry point artefacts

The goal of the second stage was to move the outcomes of the group work from a speculative scenario to tangible design fiction outputs. This facilitated a deeper ethical interrogation of potential futures to uncover unforeseen challenges in such systems. To begin this process, the design facilitators analysed outputs from the worldbuilding workshop, developing concepts for design fiction entry point artefacts each highlighting one or more of the ethical themes. Seven potential ideas were generated giving broad coverage across multiple themes:

1. Minutes from a board meeting of a food data trust management body (exploring governance, power, bias, accountability, and value).
2. Online launch for an allergen app (exploring interoperability, bias, transparency, governance, and value).
3. Media coverage of a fictional product recall (exploring accountability, bias, data quality, governance, and trust).
4. 'Data Foundation' documentary describing a fictional allergen contamination incident (exploring value, systems impact, interoperability, bias, and transparency).
5. Retraining materials for those displaced by automation (exploring labour ethics and automation).
6. Adaptive ready-meal packaging (exploring sustainability, transparency, and data quality).
7. Processing facility audio tour (exploring power, transparency, and value).

These artefact concepts represented possible avenues for exploration. Four were selected – board meeting minutes, allergen app, documentary, and adaptive ready-meal packaging – *via* a blind voting exercise during which each participant ranked the artefact concepts based on which they were most interested in seeing fully developed. Groups of two or three researchers took ownership of designing each artefact. This process took place online due to COVID-19 restrictions. This design activity was a key part of the RtD process; the development of each design fiction object required those participating in the activity to consider multiple aspects of the imagined system and its functionality, making tangible how the ethical questions might emerge.

Design fiction 1: Board meeting minutes

The first entry point artefact was a text document representing records of a meeting of the fictional Food Data Foundation Council, a governance board providing oversight of the food data trust known as the Food Data Foundation (FDF). The initial draft was prepared by members of the working group with expertise in food supply chains and the legal and governance aspects of data trusts. The object consisted of a document, headed by the FDF logo, recording details of a meeting held at a notional future date (Figure 3). The minutes began with an attendance list for the fictional meeting including representatives from the Office for Ingredients (a fictional government body), the data protection officer, regulators, and business and consumer representatives. This text was intended to prompt consideration of who should be present at such meetings and on governance boards in order for appropriate governance to be exercised.

FOOD DATA FOUNDATION

Minutes of the Food Data Foundation Council Governance Meeting

RESTRICTED IN DRAFT | MEETING DATE: 01 NOVEMBER 2020

MEETING ATTENDEES

Chair of the Council (LP); Government Representative from Office for Ingredients (EL); CEO of Waitfield - Retailer representative (RK); CEO of Tezburys - Retailer representative (IB); Data Guardian for the Food Data Foundation (SS-B); Consumer representative from Consumerwatch (SY); National Farmers Union (PB) - representative from producers

IN ATTENDANCE

Food Standards Agency - Regulatory Representative (EM)
Expert Advisor on Modern Slavery - Human Rights Observatory Lead (AH)
Expert Adviser on Distributed Ledger Technology - CEO Indelible (AW)
Data Protection Officer (RW)
Secretary to the Data Foundation - Lovell Secretaries (BT)

AGENDA ITEMS

1. Approval of minutes of the last meeting (02 September 2020)
2. Matters arising from these minutes

Figure 3. Minutes of the fictional Food Data Foundation Council meeting.

The first section of the main minutes, which included matters arising from the previous meeting, described a prior application for a provenance tracing application that requested access to the FDF dataset relating to fruit-picking. The board notes that 'The Council' received a Data Protection Impact Assessment and the Data Protection Officer's (DPO) summary and raised concerns about personally identifiable data being included in this dataset, which could put individual workers at risk if inappropriately accessed or used, reflecting concerns regarding modern slavery. The minutes raised concerns regarding data quality and the proposal's lack of clear governance structure, including a recommendation that this issue be referred to the Ethics Committee. This first section demonstrates a wide range of potential implications for the use of data, which may include personal data use, raising questions around wider issues such as sustainability and human rights beyond the direct impacts of such a system. The topics that were incorporated included consideration of data traceability, personal data capture, and ethics regarding wearable technology.

The minutes then focus on a new allergen app called Allert and note a requirement for more information before approval, including whether the option to share health information with a fitness provider is aligned with the purpose of the FDF. These aspects were intended to provoke conversations around accountability and data sharing.

Design fiction 2: Allert app website

This artefact was a website for digital app called Allert, as per the proposal in the minutes described above. It is dated later than the minutes, after the app has received approval and is in production. The website features the company logo and a video demonstrating the functionality of the app. Other pages on the site include a Frequently Asked Questions page and a Privacy Policy (Figure 4).

The app allows a user to set their own sensitivity level to a range of food allergens. By scanning the barcode on a product, the app provides a risk rating for how likely the product is to cause an allergic reaction. The app also allows the user to report any allergies experienced, feeding additional data back into the system. Wireframes were created to demonstrate app function and flow. Functionality was based on that of existing (particularly health-based) mobile apps. The web front page also includes a promotional demonstration video.

The key themes this entry point object explores are transparency, interoperability, and value. The app analyses real-time data collected during the food production process and provides this data to the data trust. AI prediction algorithms, trained on prior allergen exposure, provide the risk rating, which in turn incorporates information from multiple organisations involved

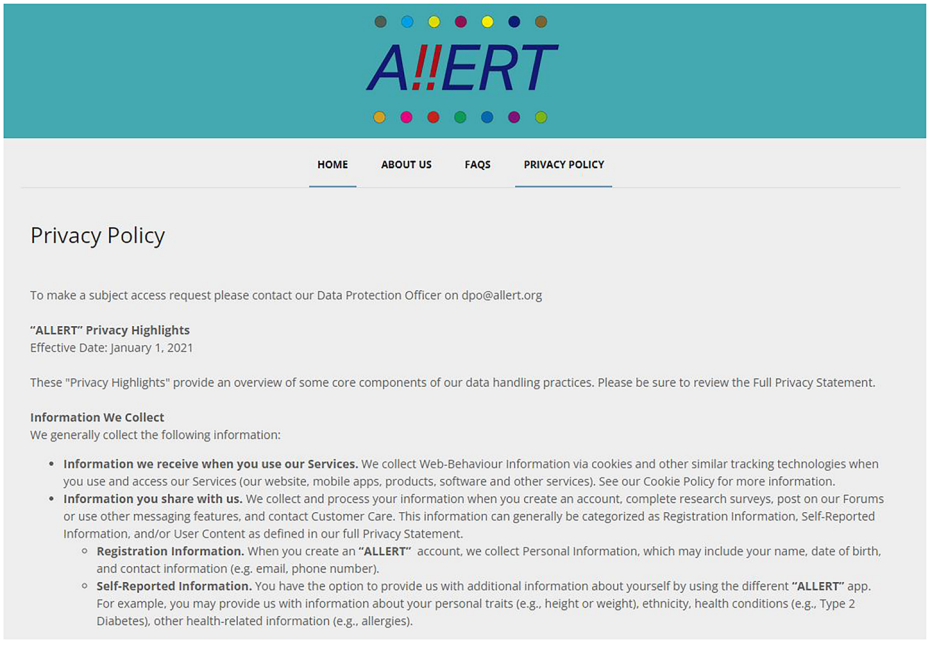

Figure 4. Privacy policy for the fictional Allert app.

in the food supply chain. This aspect of the artefact was intended to prompt discussion around data quality, the accountability of algorithmically generated warnings, and the provision and use of sensitive information such as health data.

The website was created to provide further information about the app and to demonstrate what a privacy policy for such an app might look like. The privacy policy, which is intended to provoke questions rather than provide a model privacy policy approach, was adapted from existing privacy terms on websites that capture sensitive data (Figure 4).

Design fiction 3: Documentary

This artefact was a three-minute video 'excerpt' of a documentary film. The script was based on consideration of the key themes of accountability, bias, data quality, governance, and trust. Actors read lines assigned to four 'characters' and a narrator. The four characters represented fictional organisations (some of which were included in design fiction 1) as follows:

- Director of the Office for Ingredients (a government body responsible for food regulation).
- Director of GoodProve Baking Company (an SME producing baked goods).

- VP Innovation, Tezbury's (a national supermarket chain who stock GoodProve products).
- Founder, Lancaster Mill (a small business producing flour who supply GoodProve).

The film depicts journalistic coverage of an incident where use of the app described in design fiction 2 has become common. Large commercial sellers such as supermarkets strongly encourage the use of the app by their suppliers, who are therefore required to collect data throughout the production process and join the data framework. In this scenario, AI prediction is used to identify potential contamination incidents, such as products containing undeclared gluten. The documentary begins with praise for the system by the Director of the Office for Ingredients but takes a more critical turn as the Director of GoodProve, the producer in the middle of the supply chain, complains that their products were blacklisted by supermarkets for containing ingredients from Lancaster Mill. The founder of Lancaster Mill argues that the 'contamination incident' was based on inaccurate data or prediction models, and no gluten was present.

This artefact was intended to demonstrate how the data foundation and associated data use may have knock-on effects on a range of organisations. It highlights how data quality and algorithmic transparency factor into wider considerations of accountability and unintended negative consequences. It was also intended to prompt discussion about bias. The smaller producers described high costs for compliance (i.e. installing the necessary sensors) but note that non-compliance might mean business failure, mentioning similar companies whose products were no longer stocked by supermarkets.

Design fiction 4: Product packaging

The final entry point artefact consisted of a series of packaging designs simulating 'digital paper' product labels, updated in real-time to display information drawn from the FDF. As the most speculative of our design fictions, to present this as believable and tangible technology it was necessary to consider how a user currently interacts with food packaging, and how that interaction differs between use cases. It was important to determine where data might originate, what information would enrich the user's experience, and how that information could be usefully displayed. The researchers created packaging for several products to consider these aspects and to incorporate a variety of different information types:

- Ready-meal packaging – a cardboard sleeve recreated packaging for a ready-meal lasagne. Its size, structure, appearance, and content were based on a real example, and development of the label details was

conducted in consultation with a legal expert in food regulation and governance.

- Salad bar – a label to be printed at point of purchase and affixed to a personalised salad at a salad bar, with the label listing the chosen components and associated data for each item.
- Loose fruit and vegetables – a label that would be affixed to a bag of fruit or vegetables picked and bagged by an individual.

These three use cases cover a range of food types with different food supply chain features. Each information label (Figure 5) cycles through a variety of visualisations, representing the following data: sustainability index (including carbon footprint data), cost (where payment for the product ultimately goes), and allergen risk (for the 14 notifiable allergens in the Allert app). In some cases, the label displays an indication that the relevant data is not currently available, highlighting transparency challenges. For example, in some use cases, a notification of missing data might be more useful than inaccurate, outdated information. There were also screens that activated in

Figure 5. Fictional smart packaging on a supermarket ready-meal.

particular circumstances, such as an allergen contamination incident or a recall notification urging the user to discard the food.

The ready-meal packaging was presented in the form of a point-of-view perspective video in which a user interacts with the object and views 'cycling' data screens that end with disposal of the product due to a recall notification. A slideshow presented the labels on the other food items.

Stage 3: Design fiction evaluation

The third stage of the project built on RRI and design experience of members of the team. While participants in the research up to this point had been members of the interdisciplinary research team, this stage expanded the knowledge base to include experts in technology ethics, food systems and supply chains.

At a December 2020 workshop (conducted online due to COVID-19 restrictions) the facilitators conducted an adapted version of the Moral-IT card-based method described in Urquhart and Craigon (2021) to ethically assess the data trust model. These cards were designed to support technology developers in 'ethics by design'. By reflecting on ethical questions, ethical requirements can be incorporated into design specifications throughout the entire product development process.

The workshop opened with a showcase of the design fiction entry point artefacts. Each offered a limited perspective of the speculative world built by the research team, so participants had to consider these artefacts and conduct the subsequent evaluation with incomplete information. For example, the documentary excerpt did not fully explain how the presence of gluten was determined, even though the project team discussed and mapped out this incident in detail. This approach provided verisimilitude, allowing participants to engage at face value with each artefact, as if the objects were real and encountered for the first time. The four entry point artefacts combined to provide lenses into a coherent representation of the potential future data trust system.

The participants were divided into three sub-groups and asked to discuss their initial reaction to the artefacts by responding to three questions in an open facilitated discussion:

- What questions do these fictions raise?
- What do they tell you about the data trust concept?
- What are the potential benefits and harms?

Participants then browsed a digital version of the Moral-IT cards[2] to identify, for each artefact, one card representing a potential benefit or positive feature of the particular technology, and one card to represent a potential

Figure 6. Moral-IT cards selected as part of the evaluation process.

harm or negative feature. Each sub-group collated the chosen cards as overall benefits/positives and overall harms/risks and decided, by picking 3–5 cards/concepts (Figure 6), which benefits and harms were most important to the whole data trust system rather than just the individual artefacts. Participants were asked to consider ways to maximise the identified benefits and minimise the identified harms. Finally, prompted by the cards, they were asked to consider the practical challenges of implementing safeguards against harms and maximising benefits.

Evaluation outcomes

The discussions resulting from the in-depth ethical assessment of such complex and considered artefacts were rich and detailed, and enabled further work in understanding ethical challenges of future food systems beyond the scope of this paper (Craigon et al. 2023). Some key insights and themes are presented here as examples. Initially, participants were asked 'what do [these fictions] tell you about the data trust concept'. A common response was 'not enough' demonstrating participants' confusion about the nature of the food data trust system presented to them and emphasising how they came to this consideration 'cold'. This response serves as a useful reminder that multiple elements important to the functioning and usage of a system/technology are hidden from users. While poor access to information can compromise ethical assessment, this reflects the real circumstances in which such systems and

Table 3. Moral-IT card selections in the workshop.

Benefits	Areas of ethical disagreement	Concerns
Consumer protection	Accessibility	Fairness and Justice
	Legibility and comprehension	Liability
Duty of care Due process	Meaningful transparency	Overt bias and prejudice
	Participation	Resilience and low redundancy
Physical safety	Power asymmetry	Special categories of data
Wellbeing	Trust	Taking responsibilities
	User empowerment and negotiability	Trustworthiness

their associated technologies are often encountered; ethical considerations may be assessed despite potentially problematic elements being obscured. A harm or benefit may go unrealised by the user, who may have an unrealistic view of how the technology operates.

Table 3 shows the aggregation of card selections made by the participants during the Moral-IT card evaluation process, as per Figure 6.

Identified concerns include bias or unfairness in a system with questionable trustworthiness, perhaps due to a lack of clarity about who may be liable or responsible for the system. This concern is especially important for people who might rely on such technology to provide information about potentially life-threatening allergen exposure. Respondents also questioned system resilience and how special categories of data, such as private health information, might be addressed.

Discussion

In this paper, we described how a RtD process enabled the testing of speculative methods for exploring ethical issues in the context of complex food systems. This work forms part of a growing body of work that can be considered 'research through design fiction' (Coulton et al. 2017), which combines speculative methods with RtD. Developing the artefacts was as much a part of the research as the subsequent evaluation, and much implicit knowledge was uncovered through the design process leading to new connections and understandings of the context.

A novel aspect of this inclusive deliberative method (Owen et al. 2013) is that it included non-designers participating in processes including generative reflection, shared creativity, and shared authorship, at a level which might be considered a 'collaborative level of engagement' according to the typology developed by Farias, Bendor, and Van Eekelen (2022). Although led by design researchers, the participant-researchers in this work came from various disciplinary backgrounds and were mostly unfamiliar with design methods. While the central project team was by nature self-selecting, the third stage included a wider group of participants including sector practitioners. However, this was still a limited process. Future work should expand inclusion for a wider range of stakeholders and at multiple stages of the project.

By using such approaches, a more complete, reflexive and nuanced understanding can be gained of the complex, multifaceted and often highly contextual ethical challenges relating to data, technology, and food supply chains. The outcomes of applying such technologies depend on specific behaviours by multiple actors, as well as choices made in how to balance ethical factors that may have incompatible demands, such as privacy and transparency. The methods explored in this paper do not solve this problem or provide solutions for balancing these incompatible factors. Nevertheless, they provide a novel approach to anticipating these challenges and facilitating considered deliberation moving beyond simple scenarios to provide immersive, multidimensional understandings of the consequences of technology adoption.

Another key aspect uncovered by this research is the value that design approaches can bring to groups and disciplines outside of Design Research. While having little previous experience with such methods, the participant-researchers have come to appreciate their value. We hope such value is demonstrated to others with interest in the future of technology and food supply, including policymakers, so these methods are made available to a wider audience.

Notes

1. https://www.statista.com/forecasts/758620/revenue-of-the-food-market-worldwide-by-country.
2. Due to the online nature of the workshop, a novel, digital method for using the cards was developed (see Jacobs et al. 2024).

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Samuel Munday is a Research Assistant at the University of Southampton. He is currently part of the Future Worlds Founders Cohort 2022, a business startup accelerator at Southampton, developing the commercial proposition for his unique AI chemistry data structuring and retrieval technology. More generally, his research focus is in the digital economy space, interviewing and working with industry to assess the need for systems that can automatically curate and contextualise information from unstructured inaccessible records. Samuel graduated from the University of Southampton in 2018 with an MChem in Chemistry and Maths, and prior to undertaking his recent position, he worked as a Research Technician at the University. He led the development and implementation of a machine learning platform for the polymeric materials sector, aiding them in bringing new products to market faster. He has also developed and helped deliver a Python programming course for undergraduate Chemists as well as being involved in assessing the ethical implications of implementing AI and data sharing across the food supply chain.

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