Considering the ethical implications of digital collaboration in the Food Sector

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Summary

The Internet of Food Things Network[+] (IoFT) and the Artificial Intelligence and Augmented Intelligence for Automated Investigation for Scientific Discovery Network[+] (AI3SD) brought together an interdisciplinary multi-institution working group to create an ethical framework for digital collaboration in the food industry. This will *enable the exploration of implications and consequences (both intentional and unintentional) of using cutting-edge technologies to support the implementation of data trusts and other forms of digital collaboration in the food sector. This article describes how we identified areas for ethical consideration with respect to digital collaboration and the use of Industry 4.0 technologies in the food sector and describes the different interdisciplinary methodologies being used to produce this framework. The research questions and objectives that are being addressed by the working group are laid out, with a report on our ongoing work. The article concludes with recommendations about working on projects in this area.*

Keywords

Food, supply chains, fourth industrial revolution, ethics, transparency, trust, design fiction, digital collaboration, card-based tools

Introduction

With the increasing focus on food in today's modern world, from farm to table and everything in between, it is unsurprising that food production is the largest sector in the United Kingdom (UK) manufacturing industry[1]. The food sector is facing several overarching challenges, such as continuing to feed the ever-expanding population, reducing food waste, reducing environmental impacts of activities, and addressing different dietary and nutritional requirements[2].

The so-called 'fourth industrial revolution'[3] offers a wealth of opportunities in the food sector, especially through the implementation of novel technologies such as distributed ledger technologies[4] and artificial intelligence (AI)[5]. However, for these opportunities to be fully realised, there is a need to be able to securely collaborate, share, and access a wide variety of data sources across the entire food sector[6,7]. Meeting this need requires a trusted mechanism both to enable collaboration between the different parties throughout the supply chain and to support each party to make decisions about the credibility of the separate data sources[8]. There is a plethora of data associated with and generated by each stage of the food supply chain. However, use of this data may currently be limited, with the result being that its innate value is not used productively or delivered equitably to actors across the food system.

To create such a data collaboration would require the integration of both cutting-edge technologies and surrounding social, institutional, and policy elements to ensure that the system works equally well and equitably for all parties involved. As with the advent of any new technology or system, this data collaboration brings a wealth of ethical implications to consider. For example, if AI is to be implemented, we need to address ethical challenges that are well known in this area, such as bias and accountability, to create systems that are responsible in their implementation and prioritise human well-being[9,10]. Such complex challenges can be considered as 'wicked problems'[11] and require an interdisciplinary approach. Additionally, by using holistic, speculative methods[12] that explore potentialities as well as current solutions it is possible to consider both novel solutions, and emergent risks that may not be evident purely by considering the current context.

This article first sets out the key areas in which the ethical implications need to be considered in the context of digital collaboration in the food sector with a particular focus on the use of AI in shared data management and utilisation, and the importance of responsible innovation. We have chosen AI as a representative example of the type of fast-moving Fourth Industrial Revolution data technologies that are bringing particular ethical challenges to this field[3]. Furthermore, AI can be seen as a converging socio-technical system which consist of many interlinked ecosystems used by different actors interacting in complex ways (Stahl, 2021)[13]. Secondly, we report on ongoing work to define and contextualise emergent ethical questions. We present how the use of interdisciplinary research practices and methodologies, such as design fiction, can help to frame the transdisciplinary issues involved, assist in gathering expert perspectives on how to address such complex challenges and support wider engagement of a range of stakeholders including industry and communities. This paper is based on work currently in progress as part of an interdisciplinary, multi-institution working group who are in the process of developing an ethical framework to enable the exploration of the implications and consequences (both intentional and unintentional) of using cutting-edge technologies to support the implementation of data trusts in the food sector. This is one of a number of working groups undertaking focused research on issues around the challenges of data trusts in food systems. This research is aligned to work funded by the Food Standards Agency (FSA) and led by the University of Lincoln to create a data trust related to food safety[1].

Digital collaboration in the food sector

Schwab[3] has described the Fourth Industrial Revolution (also called Industry 4.0) as being characterised “by more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and machine learning.”. The backbone of the integration of these technologies is the data that they utilise. This data is collected and generated in many ways, including by Internet of Things (IoT) sensors and other sources, creating large data sets on which machine learning algorithms and other AI tools can be used to generate valuable insight. To facilitate deriving economic, environmental and social value from such large and diverse quantities of data, digital collaboration among supply chain actors and wider stakeholders is necessary.

The collaborative use of these new technologies has the potential to address some of the major challenges facing the food sector. These challenges include adopting processes to deliver efficiency, productivity, sustainability, traceability, transparency and information disclosure, as well as assuring food safety, improving diets and health, minimising food fraud, and reducing food loss and food waste[5,14]. For example, there have been several recent

[1] www.foodchain.ac.uk

high-profile incidents where the unforeseen or unacknowledged presence of allergens within food products has caused illness or death, leading to calls for regulatory changes in mandatory labelling requirements[15] and improvements in the integrity of data used in supply chains.

The use of sensors and machine learning to predict and manage cross-contamination incidents in factories could reduce some of these risks[16]. However, the data that could contribute to solving these problems may be commercially and personally sensitive, is resource intensive to capture, and may lead to disproportionate advantages for some chain actors, for example large agri-food conglomerates who own and exploit 'big data' with negative ecological, economic and health consequences [17]. For this reason, digital collaboration and the sharing of data require a degree of openness and trust. Trust and trustworthiness are already key factors in delivering integrated food supply chains and food networks[4,18]. How this trust is created and then evolves, is a complex process. These trust-based challenges become even more complex, and more pressing, when new technologies are introduced to either the food supply chain or the data sharing process.

It has been proposed that new data governance and organisation structures may be needed to facilitate trusted data sharing, in order to fully take advantage of the opportunities that the fourth industrial revolution can bring to society[19]. One such avenue for this is to establish data trusts. A report produced for the UK Department for Digital, Culture, Media & Sport and Department for Business, Energy & Industrial Strategy in 2017 suggested that: "To facilitate the sharing of data between organisations holding data and organisations looking to use data to develop AI, Government and industry should deliver a programme to develop Data Trusts – proven and trusted frameworks and agreements – to ensure exchanges are secure and mutually beneficial."[20]. It has been suggested that such frameworks could function effectively where other mechanisms such as commercial agreements would be unsuitable[21].

There are many definitions of data trusts, which cover a range of concepts from formal legal agreements to more conceptual framings [22]. The Open Data Institute (ODI) defines a data trust as: "a legal structure that provides independent stewardship of data"[23]. The Internet of Food Things Network[+] is exploring the concept of data trusts in the context of food production supply and has taken the ODI work as a foundation. Network members, including authors of this paper have contributed to developing a working definition of a data trust as part of the network's research activities, which we are using for the purposes of this research. This definition is as follows: *"The concept of a data trust is a mechanism to collate data from multiple sources, either physically, or virtually, to be managed or orchestrated in some way on behalf of all of the parties through independent, fiduciary stewardship of data".*

This digital collaboration framework could include a range of fourth industrial revolution technologies, such as distributed ledger technologies (e.g. blockchain) and Artificial Intelligence (AI technologies).

Ethical challenges of data sharing and AI

There are many well-known examples where autonomous systems that use AI and machine learning result in unintended and harmful consequences. Such systems are popular because they are efficient, flexible and are quick to react to complex systems; however, this in turn can lead to unanticipated, undesirable outcomes. Examples include unintended bias[24], violations of privacy[25], and fatal accidents[26]. Consequences can arise from the behaviour of the systems or as a result of the ways in which they are conceived, designed, deployed, or used. It is important that all parts of the application life cycle are considered to ensure responsible and ethical use in the design and deployment of these technologies. Despite significant discussion on these ethical issues across many fields of academic study, and a plethora of ethical guidelines being published by businesses, governments, professional organisations and others, there are still few binding regulations and mutually agreed normative standards for ethical use of AI[27]. However, this work is ongoing, for example, in the development of a new set of standards for ethical autonomous and AI systems[10].

Many of these ethical challenges relate to issues of trust and transparency, which as previously highlighted in this paper are also key considerations with regard to the operation of the food supply chain more generally. In the case of systems that use AI, it is important that the function and decision-making capabilities of the systems are transparent in order that accountability and auditability can be ensured. We must understand how the ethical concerns are framed and operationalized, in order to identify where the use of such systems may introduce new risks and challenges. Examples include areas such as bias and privacy, as well as wider ethical concerns, such as sustainability, and the impact of automation on labour and well-being. Rather than evaluating the technical challenges of adopting and integrating a data collaboration framework (as other working groups are doing[22]), our working group focusses specifically on identifying and classifying conceptions and understandings of the ethical issues, and on the long-term implications of creating a framework that relies on the characteristics and efficacy of the technologies employed. In this way, it is intended that these considerations can be incorporated into the technical development process, with a goal of facilitating progress towards ethics by design whereby ethical considerations are raised during the design process and they become design requirements integral to the technology under development, designed in from the start rather than applied retrospectively.

These ethical implications are emergent from the utilisation of these technologies, whether they are used by single or multiple actors, in isolation or in consortia. It is critical that ethical implications must be addressed if such technology is to be implemented in a way that is responsible and socially beneficial.

Responsible (Research and) Innovation (R(R)I)

Examining the ethical implications of emerging technology situates this current work in a wider discourse that has become known as Responsible Innovation with its policy counterpart being known as Responsible Research and Innovation as part of the EU’s horizon 2020 framework programme. This has developed out of predecessors such as Appropriate Technology, Technology Assessment and Science and Technology Studies[28] and the Ethical Legal and Social Aspects of Technology amongst others[29,30]. There are many facets to RRI with its definition and scope subject to multiple perspectives. Having said this, it has been summarised as:

'a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)'[31].

Stilgoe et al[32] expand this to a more general definitions meaning:

'Taking care of the future through collective stewardship of science and innovation in the present.'

Given these definitions, there has been much work on integrating these elements into the operation and governance of Research and Innovation activities. For example, R(R)I considerations have been embedded in the development of specific technologies, for example Smart information Systems (SHERPA)[33], Human genomics, human enhancement and human machine interaction (SIENNA)[34] or approaches to ethical assessment of R and I (SATORI)[35] alongside other approaches technologies such as nanotechnology[36] and geoengineering[32].

These emerging technologies are all subject to uncertainty in their development and impact and what is known as the Collingridge dilemma[37] which states that 'attempting to control a technology is difficult. . . because during its early stages when it can be controlled, not enough can be known about its harmful social consequences to warrant controlling its development; but by the time these consequences are apparent, control has become costly and slow'. This requires steps to be taken to try and anticipate the impact of emerging technology and make changes to its development and implementation before they become more difficult. One potential approach is what is known as the precautionary principle where steps are taken to mitigate potential negative impacts of a technology even when these impacts are subject to considerable uncertainty. This has been seen to be a barrier to technological progress but instead it is intended to act as a safeguard against potential future negative impacts so that they can be addressed before the impact has become embedded and difficult to change. A wide variety of approaches have been developed to address these difficulties in engaging with the ethics of emerging technology. Reijers et al[38] provide a review which classify such approaches into ex ante (for example anticipatory technology ethics and scenario approaches), intra (for example Value Sensitive Design and Ethical Impact Assessment) and ex post (for example checklist approaches or the Ethical Matrix) methods depending on whether they are undertaken before, during or after the technology development process indicating the complexity of the issues at stake and the variety of approaches proposed for addressing them.

The potential impacts and social context of emerging technologies is varied and hard to predict, especially when considered in logically malleable computational technologies such as AI. R(R)I therefore requires scientists and stakeholders in research and innovation themselves to develop skills to reflect on their own practice and engage with stakeholders in an upstream manner[39] to consider and work towards a societally desirable innovation, in all aspects of their work. To this end R(R)I has been generalised into several frameworks, approaches, tools and forms of measurement to enable and ensure responsible innovation. For example, Stilgoe et al formulate R(R)I as a four-stage process to enable the Anticipation, Reflexivity, Inclusion and Responsiveness of Research and Innovation to the concerns of society[32]. This has been adapted and adopted for example by the UK's Engineering and Physical Sciences Research Council (EPSRC) and their AREA framework, which asks researchers to Anticipate, Reflect, Engage and Act in relation to the societal aspects of their research[40], which has been aided by the specification of an accompanying '4P' process asking them to consider the Purpose, Process, People and Product of their research across the AREA framework[41]. In practice, this generalised structure has been considered too vague and non-specific for individual research projects to adopt and 'do' R(R)I for their project. To mitigate this, there have been considerable efforts to provide accessible tools, across subjects and domains to make R(R)I elements accessible, engaging and implementable, as illustrated by the breadth of the information, case studies and tools made available through the RRI tools website[42].

The project discussed in this paper brings together different disciplines and groups at the intersection of Food and Technology research and innovation research communities. The project is focused on aiding the discursive engagement with different stakeholder communities, both through exploring and producing a shared glossary and in using design fiction to creatively anticipate the data trust model and its application in the food sector through the reflective co-creation of the speculative design artefacts. These tools and outcomes will act as an exemplar of how such methods can be used to engage with wider stakeholders. Further engaged reflection using an ethics by design tool will result in the creation of an ethical framework to inform future reflections, engagement and actions in this space from the research, governance, business and civil society organisations and beyond.

Not only will the work represent a grounded reflexive engagement with the ethics of data sharing in the food system, but this will act as an example of a novel, engaged reflexive, co-creation methodology to potentially act as a model for further engagement. Furthermore, this work addresses some of the recommendations and shortcomings identified by Reijers et al[38] with emerging technologies to enable them to be developed towards the goals of Responsible (Research and) Innovation.

Challenges of addressing ethics in the use of AI in digital collaboration in the food sector

In order to begin to address some of these challenges, it is necessary to bring together interdisciplinary teams with a range of expertise and knowledge. It is critical that we consult those with expertise in digital technology, for example, distributed ledger technologies and machine learning. However, we also need contributions from those with in-depth knowledge of the food sector and the current ways in which supply and distribution chains function, as well as legal scholars who can construct new regulatory and governmental frameworks for data sharing. It will also be beneficial to have input from philosophers who can unpick some of the complex ethical challenges that arise from these new technologies, which raise new conceptual and contextual questions such as: How do we frame the nature of responsibility when AI autonomous agents are part of functional and decision-making systems and act on behalf of supply chain actors and ultimately consumers? It is also important to consider expertise from outside the academy, and engage (as responsible innovation advocates) with a wider range of stakeholders including industry, policymakers and the public who have vested interest in the development of these systems. This can be particularly challenging to accomplish.

Such collaborations across disciplines and sectors are necessary and fundamental to tackling these issues. However, working collaboratively with people who have different disciplinary backgrounds can result in its own co-creational challenges. A significant barrier to the development and enacting of effective interdisciplinary collaboration is the lack of a shared common language[43]. This may manifest in subtle ways; for example, the term transparency, utilised already in this paper, is used commonly across many different discussions of this topic but can have very different meanings to those using it (in addition to meanings from everyday language), depending on the discipline from which they come. Transparency might have a range of meanings relating to the ability to have full access to the algorithms and associated training data when considering AI systems[44]. It might also mean that opacity and information asymmetry is reduced and as a result actors have accurate data associated with the traceability and provenance of food items. In the case of certain disciplines such as computer interaction design, it might even mean something entirely contradictory: the ability of devices and sensor-based systems to operate in such a way that they blend into the background and are not consciously considered by those using them[45]. For this reason, we suggest that the first stage in the construction of an ethical framework in this complex area must be a co-created set of definitions of terms in order to develop a common understanding for discussing ethical issues that may arise and their consequences.

A Multidisciplinary Approach

The Ethics of AI in Food Data Trusts Working Group was established to investigate and frame the ethical issues that arise from the creation and use of a data trust, and how the potential negative or unintended consequences of using Industry 4.0 technologies to facilitate a data trust model between many collaborative parties can be mitigated. Table 1 describes our research objectives and aims. Through initial scoping work, we identified sharing data about allergens as a conceptual scenario on which we could base our research. This allergens case study, which included the use of AI for classification and prediction, therefore became the focus of our studies and examples; both to identify why an ethical framework is necessary and how one could be implemented within a specific context.

[Insert Table 1 here]

Our working group comprises researchers from different disciplines who have extensive experience working in interdisciplinary research projects, as well as industry experience within the food sector. Our skillsets include technical expertise in AI, Semantic Web and IoT Technologies, ethics and law, in addition to experience in food safety, food integrity, and food sustainability risk assessment and risk mitigation. The team also includes design researchers who bring new methodological approaches to bear on these challenges, including the use of speculative design and design fiction, which can be used for wider participatory approaches and stakeholder engagement[46].

Speculative design is a design methodology that aims to provoke discussion by using speculation to consider potential, plausible, or possible future outcomes of current directions in societal or technological development. These speculative outcomes are not intended to be predictive or suggest how things should be, but instead provide opportunities for discussion. In their influential work *Speculative Everything*, Dunne and Raby[12] suggest that, "Props used in design speculations are functional and skilfully designed; they facilitate imagining and help us entertain ideas about everyday life that might not be obvious. They help us think about alternative possibilities—they challenge the ideals, values, and beliefs of our society embodied in material culture."

The development of tangible objects that represent and embody technological design speculations is known as design fiction, a method popularised by Julian Bleeker[47]. Design fiction is the process of creating prototypical objects that are physical manifestations of a fictional shift in the world, which may reflect alternate pasts or presents or speculated futures. These design fictions can be used to engage with multiple stakeholders and assist in considering complex issues that might result from the deployment of technology. For example, Jacobs et al[46] created objects representing a fictional deployment of IoT-enabled dustbins and used these objects in participatory work with the local community to consider questions of data access, privacy, and transparency. These objects included informational leaflets and resident access cards distributed by the local council as well as press coverage of public pushback on the privacy implications of the devices.

Because data collaboration frameworks in the food sector are part of complex existing systems, and there are many potential opportunities and solutions to address these challenges, they are a good example of so-called 'wicked problems'[11]. Design fiction is a useful method by which to address such wicked problems, because potential solutions can be evaluated without designing and building expensive fully-working prototype systems, cutting through the Collingridge dilemma described above. If a system is built in its entirety, it may have to be fully redesigned when issues are found. This could prove costly and result in damaging outcomes if such issues are only revealed when the systems are deployed in the real world, and stakeholders interact with them in real-world contexts.

In this project we are therefore combining the design fiction work with another key method, that of ethical reflection, engagement and evaluation using a card-based tool, specifically the Moral-IT cards. The Moral-IT cards have been developed as a tool to prompt reflection on the legal, ethical, technical and social implications of new information technologies[48]. The reflective use of the Moral-IT cards has many flexible applications, one of which is to help technology developers work towards 'ethics by design', as noted above where, ethical considerations are raised during the design process and ethical requirements become integral to the technology under development.

The Moral-IT cards ask open questions across a range of principles, grouped into four loose overlapping categories or suits of Ethics, Security, Privacy and Law (as well as Narrative prompts) (See Fig 1). These questions are all posed in relation to 'your technology', which is the technology under consideration in the exercise. Previous work has shown that the Moral-IT cards work flexibly across a range of IT-based technologies to enable developers to ethically consider their work. The flexibility of their use allows for the expression of a range of perspectives, anchored through the shared resources of the cards to facilitate the ethical assessment of technology[48]. Through the use of combining design fiction and these cards, we can explore speculative ethical challenges.

[Insert Fig 1 here]

To contribute to the development of our ethical framework our approach therefore has three methodological strands that contribute to a novel responsible innovation approach:

Create common glossary: The glossary will be constructed through multidisciplinary literature review and iterative collaborative discussion to reflect the interdisciplinary scope of this activity. It will allow us to map out the key understandings of the different disciplinary definitions of concepts related to ethics within the food industry and supply chain. Through this we can develop a shared understanding and enable discussions across different disciplines and sectors.

Create speculative design for data trust model: This research method will synthesise the expertise of the working group and identify challenges that emerge from the glossary exercise to create design fiction objects; tangible and explorable items which represent a fictional future data trust based on plausible extrapolations of proposed models. These design fictions will be used within the project for evaluation and to demonstrate a methodology which can be used in subsequent work to enable a wide range of stakeholders to engage with the operation of a data trust and explore the ethical issues and potential barriers to its operation. The design fiction objects will revolve around the use-case of monitoring and tracking of food allergens in the food supply chain in a system that includes AI prediction and classification.

***Evaluation of speculative design project*:** The design fictions will be ethically 'assessed' using the Moral-IT cards, which were developed to support and encourage the 'ethics by design' of technology. This research method will help to identify and prioritise emergent ethical issues and concerns in the design and use of a data trust system for the food system, with particular focus on the management of food allergens.

Preliminary findings

We have found that the process of bringing together an interdisciplinary team has itself yielded promising insights into this topic. Ideas that were initially developed in a two-day research retreat have been developed through collaborative working and a series of workshops[2]. In the first of these workshops, the allergen model that was proposed at the retreat event was developed further via a process of speculative worldbuilding. This process (following Coulton et al (2017))[49] aims to construct not a single speculative object or a narrative scenario, but rather a cohesive 'world' which can be probed and explored, and which can be further explicated through representative design fiction objects which instantiate and concretise its features. In this case, our model included identifying different actors who would interact with the data trust as well as features of the data storage and functions of AI processes that would act within it, such as prediction systems to provide producers with information on likely periods of increased demand in the event of a contamination incident (see Fig 2).

[Insert Fig 2 here]

Based on this work, four design fiction objects were developed through a grounded, iterative process to represent plausible elements of the future implementation of a food data trust and associated socio-technical systems. These include a documentary film, minutes from the meeting of the governance board managing the data trust, the design and use by consumers of a smart phone app, and the use of smart packaging that uses shared data (see Fig 3). We held a participatory workshop whereby external academic participants with a range of domain expertise (including computer science, law and food) assessed these objects using the Moral-IT Cards.

[Insert Fig 3 here]

During this process, the participants were asked to identify: potential ethical benefits and harms of the technology, ways of maximising the benefits and minimising the harms, as well as the pragmatic challenges of implementation of these maximisation and minimisation strategies. The workshop discussions were prompted and anchored by the questions and cards in relation to the design fiction artefacts. By analysing the data from this activity, we aim to reveal emergent themes important to the overall data trust concept. For example, how people view the technology according to how they are situated in relation to it (e.g whether allergen tracking is of concern to them), particular concerns of the use of AI (e.g whether issues of bias and fairness disproportionally affect some stakeholders) and how the ethical challenges of a system may relate to the wider sociotechnical context of which it is part. Using such a flexible and pragmatic tool to ethically assess the design artefacts provides insights generated in response to 'real' scenarios to enable the development of an ethical framework based on the reality of an as yet undeveloped system. This will give the ethical framework a pragmatic grounding that would be lacking from a more abstract approach to the potential implementation of a data trust within the food system and will reveal how

[2] These were held online due to COVID-19 restrictions, which required the development of some novel tools for remote collaboration.

this methodological approach compares to those developed for practising ethics and responsible innovation in relation to technology as noted above [38].

Future work: Creating an ethical framework:

Having conducted the research through these different activities, our working group plans to collate the extensive findings to create an ethical framework. This framework is conceived as a mechanism for parties at all stages of the digital food chain to identify ethical questions, risks, and trade-offs that need to be considered for their systems to contribute to responsible innovation.

Through undertaking this multidisciplinary research, it has become apparent that there is significant value in a combined methodological approach of this nature. Often in work pertaining to such complex systems and theoretical questions, the starting point may be a set of generalised principles such as transparency and trust. By contrast, our approach started from a situated, plausible and tangible (though fictional) instantiation (that is, example) of a data trust in operation, which provided valuable grounded insight. The fact that this data trust is a speculative fiction means that this interrogation could take place without having to wait for technical or practical implementation, which could take many years, potentially mitigating some of the impact of the Collingridge Dilemma as discussed above.

An ethical assessment developed from first principles would also have been impeded by the need to coalesce complex and varied understandings of ethical terms across perspectives, as demonstrated through the creation of a shared glossary and vocabulary which took considerable work. Starting with the technology rather than the ethics helps to mitigate this issue and has allowed for valuable insight into the ethical considerations of a data trust to emerge, an approach which may be valuable and applicable more widely in the context of responsible innovation.

With respect to the diverse ethical questions and issues surrounding digital collaboration and the use of AI in the food industry we have found that, unsurprisingly, there are no simple “right or wrong” answers. There are complex issues at stake, and trade-offs to be considered. For example, our workshops included discussion of the multiple competing environmental impacts which could require compromise. Creating systems to evaluate the environmental impact of different food solutions with a view to reduce environmental damage must be balanced against the environmental impact that harnessing the required additional computing power would have. Before anyone can start to make ethical decisions, a pragmatically emergent and grounded framework needs to be in place to highlight all of the different elements that need to be considered such that users of the framework can be empowered to make informed decisions.

Recommendations & Conclusions

Working on this project has made it very clear that it is absolutely vital to have an interdisciplinary team. Ethics is a complex interdisciplinary issue and as such needs to be understood across a range of different domains. Preliminary discussions demonstrated that there are disparate meanings and understandings of the core ethical terms (such as transparency and accessibility) across different domains, and as such it is imperative to work to develop a shared understanding of the language used. While our working group did include those with practical industry experience, the majority of the group are academics. The pilot project was limited and scope and reach due to resource constraints, and we therefore suggest that further work should take a similar methodological approach but extend this to include a much wider range of stakeholders and expertise, including from outside academia in line with the focus on engagement at the heart of responsible innovation.

A key aspect that keeps arising is the need to plan and consider ethical issues of digital collaboration *before* embarking on their creation and usage. Using a range of methodologies such as design fiction and the Moral-IT cards enables researchers, managers and designers in both an industry and an academic context to explore potential ethical issues from the start rather than after system development. Most importantly, an iterative approach is key, as ethical considerations need to develop alongside changing digital collaboration developments. Such considerations speak to responsible innovation and its requirement to anticipate and reflect on potential impacts of technology in advance. The creative combination of ‘design fiction’ and ‘ethics by design’ methods developed here to potentially act as a valuable way of engaging with the ethical acceptability of emerging technology, mitigate elements of the Collingridge Dilemma and help them to be aligned to be more societally desirable overall.

Experimental Procedures

Resource Availability

Further information and requests for resources should be directed to and will be fulfilled by the lead contact, Naomi Jacobs (naomi.jacobs@lancaster.ac.uk)

Materials Availability

This study did not generate new unique materials, beyond the use-specific Design Fiction objects which can be viewed via contacting the lead contact.

Data and Code Availability

The qualitative data reported in this study cannot be deposited in a public repository because of ethical considerations and identifiable personal information.

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Author Contributions

N.J initiated the paper and drafted the initial manuscript. This was based on the working group proposal documents that were collaboratively developed by all authors. N.J and J.S led the design fiction process, and P.C led the use of the Moral-IT Cards. All authors took part in the workshops and read and provided input into the manuscript. S.K and S.M helped revise the final manuscript. The working group was led by S.K with support from S.M and S.B.

Declarations of Interest

The Authors declare no competing interests.

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Figure Titles and Legends

Figure 1: The Moral-IT Card Categories or 'Suits'

Figure 2: Speculative World Building Preliminary Model

Figure 3: Design Fiction Object: Smart Packaging

Tables, Table Titles and Legends

RESEARCH QUESTIONS	RESEARCH AIMS
RQ1: How can we translate well-established ethical issues for cutting-edge technologies to the particular context of the food industry, to support wider discussion about ethics in digital collaboration systems?	**RA1:** Identify ethical issues (both obvious/unobvious and intentional/unintentional) of using cutting-edge technologies to create and implement a large-scale data trust model for collaboration and data sharing

RQ2: What tools are needed to support those who are sharing data in ensuring that they provide individuals with the necessary information and tools to make ethical decisions about, for example, allergens data, if they want to? This should be considered on both a small individual scale and large corporation scale in a food network.	**RA2:** Identify potential mitigations / solutions to these ethical issues of sharing data between supply chain actors.
RQ3: Can we develop tools that enable evaluation of whether a data trust model benefits and is accessible to all related parties irrespective of size, resources or access to technology?	**RA3:** Identify a set of strategies to provide individuals at each stage of the food supply chain with the necessary tools and information to identify and make ethical decisions about (allergens related) data, if they want to?
	RA4: Address diversity and inclusivity in all aspects of our work

Table 1: Research Questions and Aims