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Disruptive technologies? Scaling relational geographies of ICT-mediated surplus food redistribution

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Abstract

Information and Communications Technology (ICT) is increasingly mooted as a disruptive and even empowering tool for improving food systems, not least with respect to food waste prevention and the redistribution of food surplus. However, detailed analysis of the practices and impacts of such ICT-mediated redistributive mechanisms is limited. In response, this paper draws on a collaboratively designed database and interviews with key stakeholders in a redistribution ecosystem in order to critically examine how ICT is being used to augment surplus food redistribution, and to interrogate the contention that its role in the process is disruptive and empowering. First, the landscapes of ICT-mediated surplus food redistribution initiatives across 100 cities are mapped, detailing their location, form, function and ICT-mediation, followed by an in-depth analysis of one transnational ICT-mediated surplus food redistribution initiative, FoodCloud, who has matched thousands of retailers and charities and redistributed nearly 10,000 kilograms of surplus food across the UK and Ireland since 2014. Although ICT has been a necessary element in their rapid scaling and radical disruption of the landscape of surplus food redistribution, particularly within Ireland, this research finds that ICT alone is insufficient to build and maintain the required relationalities between donors and recipients, and systemic restructuring of agri-food systems to eliminate food waste and food insecurity is not resolvable by a technical fix. Ultimately, the impact of ICT-mediated surplus food redistribution efforts on state, market and society is still emerging and requires longitudinal analysis and agreed systems of assessment to capture both the affect and effects of ICT-mediated surplus food redistribution.

Keywords: Food waste; Food security; Surplus food redistribution; Food recovery; ICT.

1. Introduction

The UN has predicted that the planet is faced with supporting an additional 2.5 billion people by 2050, when two-thirds of the population are set to live in urban areas (UN, 2014). With over 10% of the global population already suffering from undernourishment (FAO, 2015), this continuing population growth has raised crucial questions as to how sufficient food will be produced and distributed. At the same time, it is estimated that around a third of all food produced is lost from the food supply chain before it can be eaten (FAO, 2011; Lundqvist et al. 2008; Parfitt et al. 2010, Gunders, 2012). Whilst in low income countries food tends to be lost from the food supply chain at the upstream stages due to pests, climate and a lack of infrastructure for storage and transport (Godfray and Charles, 2010), in middle and high-income countries food waste occurs further downstream, through a mix of overstocking, conservative consumption guidelines (e.g. use-by dates) and consumer habits (Buzby and Hyman, 2012). Improving the efficiency of food systems, including a reduction in the volume of food grown but ultimately not eaten, is frequently put forward as a means to address this crisis (Bilska et al, 2016; Miroso et al., 2016; Lindberg et al., 2014) and this has been further cemented by the global agreement on the Sustainable Development Goals (SDGs) to reduce food waste and eradicate hunger. For example, Target 12.3 of the SDGs calls on all nations to halve food waste and reduce food loss by 2030, and although the means to achieve this reduction are not specified, one prospective mechanism is the redistribution of surplus food from those with excess to those who require access.

Surplus food redistribution, alternatively referred to as food rescue (Reynolds et al., 2015) or food recovery (Garrone et al., 2014), generally involves the collection of edible food that would otherwise be discarded and its subsequent relocation to individuals, organisations or communities. Through practices such as gleaning and charitable giving, such systems of redistribution have a long, if territorially diverse, lineage (Edwards and Mercer, 2007). However, the increasing accessibility of ICT - particularly through mobile digital media - has been identified as a means to transform the ways in which the redistribution of surplus food takes place and to

extend its impacts (Lipinski et al. 2013; Ciaghi and Adolfo Villafiorita, 2016; Farr-Wharton et al. 2014; Corbo et al., 2015). Indeed, claims have been made that ICT has the potential to disrupt systemic food waste and empower communities to reduce waste and enhance food security, although previous techno-optimism for ICT-mediated activities in other areas – from education and development to environmental activism – has often failed to meet such lofty aspirations for either system level change or empowerment (Pickerill, 2001; Latzer, 2009; Li et al., 2012; Hafkin and Huyer, 2012; McLennan, 2016.)

In order to test the veracity of claims regarding the disruptive and empowering potential of ICT-mediated surplus food redistribution initiatives, this paper considers the findings of two related investigations of ICT-mediated surplus food redistribution. The first maps and interrogates the landscape of ICT-mediated surplus food redistribution initiatives across 100 cities identifying their location, form, function and ICT-mediation. The second presents the results of a deep-dive analysis of one ICT-mediated initiative which is often credited with the potentiality for disruption and empowerment (Fox, 2016; Gibson, 2015). Before outlining the methodology underpinning these empirical investigations and examining their findings, the following section reviews the state of knowledge at the intersection of food waste, surplus food redistribution and ICT.

2. Background

2.1. A new nexus? Food waste, surplus food redistribution and ICT

The reframing of waste as a resource has been a clarion call of environmental activists for many years (Davies, 2008), but in the last decade it has become a point of discussion in mainstream political, corporate and socio-cultural realms (Evans, 2012; Bringezu and Bleischwitz, 2009), not least with respect to concepts of a circular economy (Gregson et al., 2015; Hobson, 2016). At least rhetorically, waste management policies around the globe are beginning to shift from technical systems of waste disposal towards more holistic approaches which consider both short and long term timeframes along entire supply chains (Papargyropoulou, 2014). Attention to food waste is

an integral part of these developments (Jurgilevich et al., 2016; Borello et al., 2017) and anti-food waste discourses are growing increasingly popular. In the policy sphere, food waste hierarchies derived from general waste management approaches identify prevention, through the minimisation of surplus and avoidable food waste, as the most desirable practice, followed by the distribution of surplus to individuals affected by food insecurity (Papargyropoulou, 2014; Johnston and Green, 2004).

Defined by the FAO (2017 107) as a 'situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy lifestyle' which may be caused by 'the unavailability of food, insufficient purchasing power, inappropriate distribution or inadequate use of food at the household level', food insecurity remains a key issue in many developed countries, particularly following periods of austerity and cuts in social spending (Loopstra et al., 2015). In response to a burgeoning public outcry and an online petition, France enacted the first national law to directly address food waste through surplus food redistribution, significantly pinpointing large retailers as key contributors of food waste and requiring them to sign contracts of food donation to charities under specific circumstances (Chrisafis, 2016; Gore-Langton, 2017). Just four months later Italy also passed legislation with the intention of reducing food waste by encouraging redistribution through tax incentives, allowing food providers to donate food that is passed its sell-by date without risking sanctions for health and safety violations.

Motivated by the scandal of co-existing food waste and food poverty, food surplus redistribution is increasingly being put forward as a logical and viable solution for meeting the needs of food insecure people, heralded by advocates of the practise as a win-win situation and championed by the charitable sector (Tarasuk & Eakin, 2005; Garonne et al 2013; Thang, 2008; Stuart, 2012, Midgley, 2013). Yet the conflation of these issues has faced criticism, and long standing critiques of the charitable food relief sector, including food redistribution (e.g. Poppendieck; Tarasuk et al. 2014; Caraher and Cavicchi, 2014; Fisher, 2017; Midgely, 2013) have identified food donation to

be both a revealing symptom of the growing income inequalities in many societies (Riches, 2011). For example, when commenting on a UK food bank network's potential use of surplus food Lambie (2011:5) highlighted the 'important question of dignity and social justice in relation to such food distribution and whether it is right for clients to be given those items which are only one step removed from the dustbin'. Additionally, Caraher and Furey (2017:17) noted 'it is demeaning to suggest a two-tier approach to a rights-based food issue whereby some citizens are able to choose food in socially acceptable ways while others have that choice made on their behalf'. Further questions have been raised about the motivations of food donors and the overall impacts of surplus food redistribution on food waste reduction at the source (Caraher and Furey, 2017). Accusations have also been made that donations are used as a means to avoid increasing landfill costs or as a marketing strategy (Vlaholias et al., 2015), and it has been suggested that food surplus redistribution ultimately perpetuates unsustainable and inefficient systems within the food chain, allowing for the continuation of overproduction and wasteful practises (Poppendieck, 1999) and distracting from the influences of a capitalistic food system.

2.2. ICT and food waste: an emerging trend

As more people make a connection between food waste and food poverty, one distinct feature emerging as a solution to one or both of these issues is the use of ICT to connect donors and beneficiaries of surplus food. Websites, social networks and mobile apps have been used to forge connections between peers, businesses, social entrepreneurs and charities, with the ability to cross social and geographical boundaries marking a step-change in redistribution activities. Indeed, Ciaghi and Villafiorta (2016) argue that while current food recovery practises are unable to reach the majority of food that is wasted, ICT could play a role in scaling up operations and generating real impacts. Furthermore, Corbo and Fraticelli (2015), found that a range of ICT solutions for food waste prevention are already on the market, from platforms offering full functionalities for users to donate surplus food to peers, to sales oriented platforms allowing surplus and short dated produce to be advertised at a discount.

The retail sector is frequently identified as an accessible point of interception for ICT-mediated surplus redistribution compared with the production sector which tends to yield unmanageably large volumes. Meanwhile the service industry poses challenges due to the rapid action required to redistribute cooked food within a safe edible timeframe, and the consumer stage (including uneaten household groceries and cooked meals) largely generates unpredictable and unappealingly small quantities (Ciaghi and Villafiorta, 2016). Farr-Wharton et al. (2014) identified multiple apps that sought to reduce domestic wastage, finding a reluctance to share household surplus food outside of close personal situations (i.e. family and friends) and observing an anxiety surrounding the interactions with strangers required by sharing activities. Interestingly, they found that these concerns could be alleviated if a trusted person facilitated, promoted or became a guarantor or intermediary for the transaction (Hearne et al. 2014), an important role highlighted elsewhere in relation to shifting practises enacting domestic sustainability transitions in relation to food waste (Devaney and Davies, 2016).

Embryonic research attention is now focusing on the role of ICT and food waste, however to date these forays have not yet mapped the landscape of ICT-supported activities on a global scale, nor identified how exactly ICT is being used and to what ends. In response this paper first analyses the landscape view of initiatives to identify why, where and how people are using ICT to redistribute surplus food¹, then exploring more precisely how ICT is shaping food surplus redistribution and the role it can play in scaling operationally and geographically through a case study analysis of one ICT-mediated transnational surplus food redistribution initiative.

3. Methodology: Mapping ICT-mediated surplus food redistribution

¹ Though other forms of advanced technology have been identified as having the potential to reduce food waste along the chain, such as apps which provide business and consumers with the ability to track, monitor and analyse food waste, and smart fridges allowing users to remotely check contents and use-by dates, these do not involve the sharing or redistribution of surplus food and are thus beyond the scope of this study.

As discussed above, studies of individual ICT-mediated food surplus redistribution initiatives are emerging (Lindberg et al., 2014; Rogers, 2014) yet little is known about the broader landscape of such activities. To address this lacuna a pre-existing database of more than 4000 food sharing initiatives operating across 100 cities (AUTHORS, 2017) was mined to create a sub-database of food redistribution initiatives, using key words such as 'food surplus redistribution', 'food rescue', 'food recovery', and 'food waste'. A total of 403 initiatives were documented and analysed according to key characteristics including location, form and function, and additional coding was conducted to delineate the sources of food waste and stated motives for, and impacts of, redistribution.

While providing a useful landscape level picture of the range and diversity amongst redistributive efforts that utilise ICT, the online information used to construct the analysis was often limited in terms of details on the scale or scope of redistribution and the specifics and practicalities of ICT usage. In response, in-depth analysis was conducted to flesh out these dimensions and interrogate more carefully what it means to utilise ICT for surplus redistribution in the case of one initiative. The initiative, FoodCloud, was selected as a primary mover in the field of ICT-mediation for food surplus redistribution and as one that has adopted the use of complex ICT - including a mobile app - to connect retailers and charities. Interaction with this organisation has been ongoing for many years and empirical data has been gleaned from multiple sources over that time, including participant observation of activities and site visits. Nine semi-structured interviews were carried out in 2016 with key stakeholders, including the founders and CEOs of the organisation and its sister initiative - a food bank hub - customer support staff, food donors and charity recipients, as well as food safety and waste policy experts. These interviews were audio recorded, transcribed and entered into the qualitative computer data analysis package NVivo, and data was then coded descriptively and conceptually according to the thematic structure of the interview schedule and also themes that emerged from respondents (Hoggart et al., 2001; Kitchin and Tate, 2000). In the following section, the results of this extensive and

intensive research endeavour are interrogated to explore the form, function and practice of ICT-mediated surplus food redistribution and consider its disruptive and empowering potential.

4. Results and Discussion

4.1. Landscapes of ICT-mediated food surplus redistribution

As noted in the introduction, general awareness of excessive and avoidable food waste has increased in the 21st century (Hoornweg and Bhada-Tata, 2012; WRAP, 2014; Neff et al. 2015) as have grassroots responses, such as surplus food redistribution, seeking to reduce this wastage for environmental, economic and social reasons (FAO, 2013). Indeed, the identification of over 400 initiatives across 100 cities has shown that the use of food sharing to mitigate food waste is not a niche practise but is widespread, international and growing, with actors from charities, businesses and communities operating in a myriad of ways on a range of geographical scales. Activities targeted food waste at various and multiple stages along the food supply chain 'from farm to fork', with different drivers and goals and using several forms of ICT. The majority (75%) were found to have emerged from 2008 onwards, the year when Apple's revolutionary App Store and Androids Marketplace for apps were introduced and which is generally taken to be a turning point for ICT and peer to peer information sharing, with a noticeable increase in post 2012 when smart technologies became more accessible. Initiatives established prior to this date have since integrated ICT into their pre-existing activities.

4.1.1. Form and function of surplus food redistribution

Within the database cohort of 403 initiatives, the majority (65%) of the initiatives explicitly stated they were working to reduce food waste for environmental reasons, highlighting wasted resources and landfill emissions, with others utilising surplus food as a response to food insecurity (58%) or for the purpose of community building and social integration with a greater emphasis on the act of doing things collaboratively (11%). Fresh fruit and vegetables (36%),

tinned, packaged and prepared food products (32%) and meals (26%) were roughly evenly shared across initiatives, with meat and fish making up only 6% of redistributive activities, primarily due to food safety concerns around the handling of raw products (Neff et al. 2015). Table 1 below collates the different surplus materials being redistributed and the key drivers with illustrative examples of initiatives for each. For example, Imperfect Produce, a US based initiative, uses online subscriptions to sell heavily discounted produce boxes to customers, saving fruits and vegetables initially rejected due to cosmetic imperfections from landfill. Ampleharvest.org encourages and provides online resources and support to home gardeners in the US to donate surplus produce to local food pantries, whereas Open Table, a Melbourne based non-profit, uses surplus food to create healthy feasts and bring people from the community together with the goal of creating greater community cohesion and integration (Edwards and Davies, 2017).

Table 1. Redistributed materials and key drivers.

Rescued goods	Environmental	Food Insecurity	Community Building
Produce (fruit & vegetables)	<i>Imperfect Produce</i> – Discounted sales of visually imperfect produce (US)	<i>Ample Harvest</i> – Donations of surplus garden produce (US)	<i>Essential Edibles Urban Orchard</i> – Sharing of home grown produce (Australia)
Food products (tinned, packaged and processed food)	<i>Foodsharing.de</i> – Surplus from individuals, retailers and producers (Germany, Austria)	<i>Food Runners</i> – Redistribution to neighbourhood food programmes (USA)	<i>Freedge</i> – Community fridges where people can leave and take surplus food (Global)

Meals (combined into a meal, hot or cold, before redistribution)	<i>Too Good To Go</i> – Surplus meals sold at discounts nearing close of restaurants (UK)	<i>Real Junk Food Project</i> – Surplus food sold in cafés on a ‘pay as you feel’ basis (UK)	<i>Open Table</i> - Surplus food feasts open to all members of the community (Australia)
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As previously noted, food loss and waste occurs at each stage of the food supply chain. This research found that nearly two-thirds of initiatives intercept surplus food at the retail stage (60%), followed by produce at the upstream production and supplier stages (22%) and the downstream food service sector (20%). Indeed, there is a strong focus on the redistribution of surplus from food retailers to charities, with one third of all initiatives identified facilitating specifically this flow; a trend being increasingly driven by public campaigns and supported by voluntary commitments made by large supermarket chains (Guardian, 2016; WRAP, 2016). This supports previous findings that indicated the retail sector may provide a more accessible point of interception than the supply and consumer stages (Ciaghi & Villafiorita, 2016).

4.1.2. Location

The sample of initiatives examined in this paper is not representative of all cities globally, rather it reflects the ICT-mediated food surplus redistribution landscape across the 100 cities examined in the database. That said, there are cities from each global region present in the database and it provides a useful overview of where and how ICT-mediated food surplus redistribution is occurring. The ten leading cities – London (28 active initiatives redistributing surplus food), Melbourne (18), Barcelona (14), Milan (13), New York City (12), Adelaide (11), Boston (11), Berlin (10), Brussels (9) and Hong Kong (9) – are all large populous metropolitan areas with high levels of GDP compared to the global average and extensive internet penetration. They perform well in ranked indices relating to economic, environmental and social sustainability, indicating active sharing ecosystems and broadly supportive governing structures for activities which relate

to food and sustainability. The cities where no (9 out of the 100) or few ICT supported food surplus activities take place were predominantly located in South America, Asia, the Middle East, and Africa. This does not mean no food surplus redistribution takes place however, as it may be occurring on a more informal base with no online presence. Alternatively, surplus food may be difficult or risky to redistribute for human consumption in the absence of infrastructure for safe redistribution. The higher numbers of initiatives operating in North America, European and Australian cities is also a reflection of the high levels of post-harvest food waste identified in wealthier industrialised countries (FAO, 2011) along with the growing popular and media attention on avoidable food waste and higher levels of ICT usage. With the exception of Australia and New Zealand, the retail sector was the most targeted source of surplus food across the globe (60% of all initiatives), with regional differences emerging including a particularly strong focus on sharing surplus from home and community gardens in Australia and New Zealand; from consumer households in Europe and Asia; and from the food service sector in North America.

In order to further explore and explain these regional differences there is certainly more work to be done in relation to identifying economic, social and cultural characteristics and how the territorial governing context supports or hinders the emergence and evolution of redistributive initiatives. While it is not possible within the confines of this paper to detail the divergent regulatory contexts that shape the initiatives in 43 countries and 100 cities, the following section looks at features of the internal governing context and forms of ICT which influence the ways the initiatives operate.

4.1.3. Organisational forms and ICT-mediation

The vast majority of food surplus redistribution initiatives operate outside the mainstream market system, with roughly half registered as non-profit organisations or charities and more than one third operating informally. Only 6% of initiatives function as for-profit enterprises, predominantly those which use more complex forms of ICT such as apps or online platforms to connect suppliers and retailers with charities for a fee, or provide the infrastructure to sell

surplus at discounted prices. Those with apps and interactive web platforms were also more likely to source surplus food at the retail sector (68% of all initiatives using these more advanced forms of ICT), and were associated with redistribution that went beyond individual localities to operate in multiple cities. For example, OLIO, an app which connects people with their neighbours and local shops to facilitate the sharing of surplus food, initially operated solely in London but now has users in over 40 countries.

By considering the landscape level view of redistribution initiatives it is clear there is a growing awareness of food waste and a burgeoning network of initiatives innovating technological solutions for waste at all stages of the food supply chain. Though the database does not offer detailed information on the operational scope and scale of individual initiatives, a distinct trend of social entrepreneurs facilitating flows of surplus between businesses, in particular food retailers, and charities and community groups, is evident, often using online platforms and mobile apps to make connections. In order to explore how this element of food redistribution is being shaped by ICT, the following section presents the findings from research conducted with one case study of a highly-ICT mediated intermediary organisation which has used a suite of ICT to intermediate between large scale food retailers and charities in need of food across Ireland and the UK, and explores ICT enabled food surplus redistribution as disruption of current mainstream and unsustainable food systems.

4.2. Food Cloud: Scale, scope and the emergence of translocal food surplus redistribution

Ireland's waste landscape has been dramatically reconfigured with significant developments in recycling since national waste targets were set in 1998 (Davies, 2008). Although municipal waste recycling levels exceed the 35% target by 2013 (EPA 2017), organic, and particularly food waste, remains a challenge with over one million tonnes of food waste disposed of each year (Stop Food Waste, 2017). Ireland lacks an established national infrastructure for commercial food donations and food banking, with just one Food Bank, Crosscare, in operation solely within the Dublin region

(Faughnan and Byrne, 1998; O'Brien, 2012), potentially limiting outlets for surplus food increasing the quantity of waste going to landfill from food suppliers and retailers. At the same time at least 13% of the population, or one in eight people, are food insecure (DSP, 2015).

It was in response to this paradox that the social enterprise FoodCloud launched in October 2013 in Dublin City Centre, with one Tesco store, a small number of food businesses and six partner charities, since growing to have over 1000 donors and 3600 partner charities across Ireland and the UK. In just four years over 5000 tonnes of food, the equivalent of over 12 million meals² have been donated to agencies such as homeless shelters, community groups and other organisations that service at-risk populations, a rapid increase since 2015 when figures were 567 tonnes and just over 1 million meals. FoodCloud use a range of technology innovations, include a dedicated mobile app and integrated Point of Sales system (including 'donate' options on barcode scanners) to connect retailers with charities and facilitate the donation of surplus food. According to one founder, the technology element, though it has developed substantially over time, was immediately recognised as vital for sustainability and scalability, and allowed for the partnership with Tesco and roll out across 146 stores in Ireland in 2014. They said

'We initially started by matching farmers' markets with charities around the corner but realised that wasn't scalable. So we started looking internationally at how we could scale that retail level solution, and what we found was that we needed some kind of technology.'

In the copious media coverage of FoodCloud it is their use of ICT which generates the most attention, flagged as a disruptive and empowering technology, a contention interrogated in the following section.

4.3. ICT-mediated food surplus redistribution: Disruption or continuum?

² This is a standard metric that converts weight of food into meal equivalents rather than actual meals.

4.3.1. Disruption

The redistribution of food that would otherwise be discarded was not a new concept to Ireland which has seen businesses and charities forming independent relationships with local food businesses, in addition to more traditional models of charitable food giving such as soup kitchens which often utilise surplus food. However, the formation of FoodCloud brought the concept into the public sphere, using innovative technology and growing to an unprecedented operational scale across Ireland and the UK in just five years. Instead of appealing for occasional charitable donations they addressed the issue as a one of logistics, employing business expertise gained in the private sector and building a business model which was able to offer a valuable service to food retailers. Defining themselves as a social enterprise, ('an organization that applies commercial strategies to maximize improvements in human and environmental well-being' (Forfás, 2013)), a term growing in use across Ireland and Europe (Defourney & Nyssons, 2008), they sought to gain credibility from, and access to, large retailers at corporate levels which charities working in very local settings had struggled to get. One community group leader who has since been connected with local supermarket branches by FoodCloud described her previous failed attempts to approach retail outlets and request surplus food donations:

"They say "oh no no no, we don't want somebody coming back with food poisoning". And I said "that is ridiculous". I've gone to [major supermarket retailers]. Some of them did not want to talk to me. They said "Go and talk to the manager over in Kildare".'

By operating at a scale wide enough to merit discussions with the decision makers of substantial retail and supermarket chains, FoodCloud were able to overcome the barrier faced by charities, who were finding that decisions regarding charitable giving and waste management were rarely made at local store level. Their appeal as a trusted intermediary (Guy et al, 2012) to both charities and large multinational retailers was pivotal to their success in scaling activities. While initially envisaging FoodCloud as a city-wide initiative their scalability and potential led to one retailer proposing a nationwide roll-out of activities following a successful pilot in Dublin, with the ICT

enabling a small team of people to efficiently manage a large amount of transactions from a base in Dublin. This initial success further cemented FoodCloud's position as a credible operator for redistributing surplus and led to further expansion. As a manager of one of their first retail stores described:

'A senior guy in the business [...] said they would try it in one or two stores to see if it works. And now it's global. So it's not just Ireland, it's in the UK. And Tesco are trying to bring it to other different countries as well.'

FoodCloud's position as an intermediary not only made donating simpler for retailers, but it was also found to disrupt the pre-existing power balance between the business donor and charity recipient, acting as an external quality control and abating concerns articulated by charities that rejecting poor quality or unrequired food would result in the termination of donations or souring of relations (Tarasuk & Eaken, 2005). One recipient recalled the quality of the food they received from a local supermarket branch prior to their relationship with FoodCloud as *'unfit for human consumption'*, resulting in the need to discard the bulk of the food at the charity's own cost, putting them under undue financial pressure and negating the desired environmental benefits of saving food from landfill. The casual and highly unequal relationship with the retailer was discontinued and the introduction of FoodCloud as an intermediary welcomed. They stated:

'What [the supermarket] were donating, we would have saved them a lot of money, but we ourselves would take on that cost because we would have to waste 80% of what they gave us. A large proportion was baked goods, pastries and things, and the rest were vegetables that seriously looked like someone might have stood on them. And why would they donate that? "Oh the homeless will eat it." What nonsense!'

In contrast, all charities interviewed spoke highly of the quality and variety of food received from FoodCloud, which allowed diets to be improved, as one said, *'the dinners are more fulfilling now'*, and made significant financial savings. Indeed, one suggested that *'we've had over 50% decrease if not more on our food outgoings'*. Unlike other waste materials, the properties of food and its

transition from edible surplus to inedible waste occurs within a relatively short amount of time, a reason why traditional forms of food redistribution primarily involve non-perishable (e.g. dry and tinned) goods. By using ICT FoodCloud are able to speed up the interaction processes between retailers, who can use an app or web based platform to upload or 'post' surplus produce, and charities, who receive an automatically generated text message indicating they must respond within a certain time frame in order to claim the food which can include fresh fruits, vegetables, dairy, meat and fish.

The use of technology also enables full traceability of the donated food as well as tracking those who repeatedly fail to make scheduled donations, offer poor quality food, or claim food but do not collect it. It allows for the provision of reliable data and feedback on impacts and financial gains, which can be an attractive factor to food businesses, both at corporate and store level. As described by one retail store manager:

'[The app] is very simple, and you can go in and track your impact. So that tells you how much you've donated. We have donated 174 crates since we've had it. 3000 kilos, and the number of meals is 7000 meals. And financially it is nearly €10,000. It's really good. When we first got the app we wouldn't have had that information, but it's gotten an awful lot better, and due to get a lot better.'

The reading of the innovative technology as a rejuvenation of food redistribution and charitable giving brought global media attention, particularly regarding the ease of using their app, opening the doors for investment and support and winning many accolades and awards for innovation. In addition to their experience of redistribution at the food retail level the technology profile also played a key role in the transnational partnership with the UK based food surplus redistribution charity FareShare, who had previously dealt with large quantities of surplus food sourced from suppliers which often had weeks instead of days, or even hours, before expiry dates and therefore did not necessitate immediate movement. This suggests that ICT does enable organisations to

break through geographical barriers, allowing new practises and scales of redistribution, which in turn is necessary to maintain the technology. According to a FoodCloud founder:

'We needed international expansion to fund the technology, Ireland wouldn't have enough revenue to cover the costs of this technology... FareShare have been running for 20 years, doing food redistribution on a wholesale level but they have never done retail before. So that's where we came in and provided our technology for them.'

4.3.2. Continuity

It is clear that the use of ICT does have many advantages, adding a level of professionalism to food surplus redistribution and providing surety to businesses that brand integrity, liability and waste disposal will be professionally managed. However, although the parallels in ICT growth and the expansion of food redistribution networks may well be interlinked, the focus on the app and technology components potentially overshadows the amount of relationship building and logistical work necessary for enterprises such as FoodCloud to be successful and sustainable. A key discovery from this research is that while ICT is a facilitator, offering significant opportunities and operational enhancements for food surplus redistribution, it is not a technical quick fix or 'silver bullet'. The human and relational elements are key for understanding and responding to individual needs, and to provide the logistical support for coordinated distributions across a variety of agencies. As one founder put it:

'What started off as a very fluid, "Oh, just see if somebody collects it", ended up being really process driven. Everyone says, "Is that not easy? Just give them stuff by the end of the day?" But the practicalities of it were completely different. It's the technology platform that enables it, but the reality is that it needs a lot of process and interpersonal relationships.'

One problem regularly acknowledged with regards to surplus food distribution is the difficulty for charities, often working with minimal budgets and skeleton staff, to respond to and manage random and unpredictable offers of surplus food (Caraher & Furey, 2017). In order to maximise the benefits to charities and impacts on food insecurity it was necessary for FoodCloud to adjust

the initial app-based plan where food was advertised on the app and claimed on a first come, first served basis, to a more process driven system with informed scheduling and allocated days for collections and deliveries. The recipients interviewed identified the schedule as a crucial factor in the relationship, allowing for planning and budgeting around regular and dependable donations. Indeed, much of the donations, particularly from larger retailers, was predictable, with roughly the same amount of surplus and variety generated each day, indicative of the built-in nature of surplus in the retailer's food practices. One manager of a residential homeless accommodation facility that provides food as part of their service stated that:

'[The residents'] lifestyles are chaotic enough. So when FoodCloud came along it was hugely beneficial to our shift planner. You might think 'oh it's just food coming in the door', but it takes a lot of organisation. There might be 40 packets of mince being donated, and as wonderful as that is it has a 24 hour shelf life, and we only have one freezer. So when we get this donation it is all hands on deck.'

Each donor and recipient has different requirements and a one size or 'one app' fits all approach was found by FoodCloud to be unrealistic. In response, they have developed a range of systems and tools to maximise appeal and efficiency for large retailers, with many opting to use solutions other than the app, including a 'donate' button on barcode scanners and simple excel spreadsheets detailing surplus which are sent to FoodCloud on a daily basis. Additionally, it is often not suitable for charities to use ICT and smart technology depending on the nature of the service provision in question. Although the app does enable connections between retailers and charities who arrange their own collections or deliveries, many, particularly inner city charities, do not have capacity to collect the produce. In such cases FoodCloud do more than facilitate the transaction and manage over 200 volunteers to collect and deliver the food to the charities.

4.3.3. Impacts on food waste and food insecurity

In order to produce measureable reductions in food waste and real impacts on levels of food poverty, FoodCloud must balance the needs of the retailers - making it appealing and easy to

donate surplus with minimal staff time and resources required - with those of the charities, by ensuring donations are edible and beneficial to their operations. A major part of this process is the relationship management, engagement and delivery, which takes place through manual intervention despite the use of ICT. As one founder explained:

'Our original idea was, just put it up there and somebody will accept it. Then we identified all these barriers for businesses and charities. So what we realised is we needed to understand the process that the business has, to know the time that they'd have the food and make a decision around 'is that surplus or not'? And then line up charities around that.'

However, there was little evidence of the systematic practises which produce the edible surplus in the first instance changing within the multinational organisations involved where logistics and distribution systems are set at an international level from company headquarters rather than through individual stores and managers. For example, all stakeholders interviewed in this study talked of excessive volumes of surplus bread, far beyond the abilities or desires of charities to accept. Yet there was no evidence of attempts or plans to reduce the production despite a widespread awareness of this problem, with one retailer indicating there may even be additional bread available to charities in the future due to plans to adjust pricing patterns.

'We are not going to be reducing bakery for the customer from now on, so we might have a little bit more for FoodCloud. We used to reduce it at 5 o'clock in the evening, but now the direction is that if the customers are coming in to buy bread they will buy it regardless.'

Yet the technology and relationships formed by FoodCloud have the potential to begin a dialogue for source reduction and harnessing the data in order to enable actors in the food supply chain to reduce waste in the first place, and whilst ICT may not enable the operations, it certainly supports efficiency, affordability and scalability. As a FoodCloud customer support staff described:

'In theory a store could ring and say "we have this", and then you ring a charity to collect it. But then it would be a lot slower and a lot less reliable. It's not scalable.'

5. Conclusion

It is evident that food surplus redistribution is a diverse practice that is occurring in many different forms and to different ends around the world. ICT is increasingly being used to facilitate these connections between those with surplus food and those who need or desire it, including suppliers, retailers, and consumers. The international mapping exercise captured in the [AUTHORS] Database demonstrates that the movement of surplus food in urban areas from retailers to charities is a dominant form of food surplus redistribution, driven by voluntary commitments from large retailers, emerging policies facilitating and encouraging redistribution instead of disposal, and grassroots action and public lobbying. Within this body of activity, FoodCloud have been successful in diverting significant quantities of food from landfill to food insecure people, contributing towards the Sustainable Development Goals Target 12.3 with which they have aligned. Their development and use of targeted ICT supports has enabled them to rapidly scale up activities from an initial pilot in Dublin city to become an international enterprise operating across Ireland and the UK, transforming the system of food surplus redistribution and opening doors for investment and support around reducing food waste and utilising surplus food. By offering a professional service to corporate food retailers and the ability to scale-up their operations beyond localities, they have attracted partnerships with key players in the food retail business. For charities, FoodCloud provide not only free food but an element of protection in terms of food safety and quality, as well as a level of distance from donors which frees them from the burden of the gift and allows them to be strategic and selective about the varieties and quantities of food they accept.

However, as detailed in this paper, the management of interactions between large multinationals and diverse local charities is complex and relational and cannot be simply replaced by technological facilitation. In order to maintain lasting and mutually productive relationships and systems of donations FoodCloud has worked hard to understand the needs and routines of

different retail donors and charity recipients, modifying their technology and establishing bespoke schedules to maximise benefits to all stakeholders. ICT is then ultimately a facilitator, not a technical quick-fix, and media attention focused on the technological components of the initiative can obscure the amount of logistical and relationship management that FoodCloud do as key intermediaries (Bush et al., 2017; Hamman and April 2013; Davies and Swilling, 2015) to ensure satisfaction amongst donors and recipients and on-going redistribution of surplus food.

So, is ICT-mediated surplus food redistribution disruptive and empowering and will widespread adoption of similar models radically transform urban food systems onto more sustainable pathways? Although FoodCloud has proven to be disruptive in terms of diverting significant amounts of surplus food from landfill and onto people's plates, FoodCloud, and indeed the many other initiatives in this space are not, as yet, having such disruptive impacts on the wider food systems that generate the surplus in the first place. However, while FoodCloud is currently a provisional activity operating very much 'in the meantime' (Cloke et al., 2016), connecting food surplus with those who need it, they have long term goals to provide data and support to the producers of food waste for upstream waste prevention. At the same time, it remains that hunger is an immediate issue and FoodCloud has increased access to and choice of safe and high quality food, while raising awareness of food insecurity.

Though further research is needed into the long term sustainability of surplus food redistribution initiatives particularly with respect to their replicability internationally, it is probable that a degree of surplus at food retail level will always exist and there will be continue to be room for initiatives like FoodCloud to operate. Although to date activities tend to be acting within systems rather than transforming them, the redistribution of surplus food has shown to be enabled, enhanced and supported by ICT, and will play an important mediating role in operationalising sustainable food futures.

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