OpenDoTT

D3.1 Reflective Report on Policy Implications

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Summary

1. Introduction

OpenDoTT (Open Design of Trusted Things) is a doctoral training programme from Northumbria University and Mozilla, funded by the European Union's Marie Skłodowska-Curie Actions. Since 2019, five PhD research fellows have been exploring how openness, design research and digital technologies intersect with contemporary discussion and practice over Internet Health, privacy and trust in different areas: Wearables and the Self; Smart Homes; Communities and Neighbourhoods; Smart Cities; and A Trust Mark for IoT[55]. This document reports on policy implications concerning the topic of my PhD research: Smart Cities.

It must be noted initially that, in the context of OpenDoTT, Smart Cities are not to be understood simply as adding layers of sensors, data and connectivity to public administration at a local level. The project defines the focus of this topic in the following terms:

> "Technology is fundamentally changing how cities work: sensors and other connected technologies collect masses of data that can be used to create, for example, more efficient public services. However, these smart cities are most often determined in a top-down fashion and cede significant control to major technology companies. This creates challenges around ensuring that cities remain transparent and accountable so that citizens understand how their cities work, how decisions are being made, and how they can challenge them.
> With proper consideration, there are opportunities to create cities that are not just smarter, but kinder, fairer and more citizen-centred[1]."

The entirety of my research journey since arriving in Dundee in 2019 up to the moment I type these words in Berlin followed OpenDoTT's explicit intention to go beyond the deployment of technologies and seek a better future for cities and their populations. My choice in that context, as will be detailed in the following pages, is to focus on local systems to promote the reuse of excess materials in contemporary cities and regions. Public support for actions related to the reuse of materials is often associated with the field of waste management. There are, however, some problematic issues with such thematic affiliation.

The first issue is the extent to which public discourse about waste has gradually been reduced to the attempt to increase the volume of recyclable materials collected by municipal services. As discussed in this report, the dominance of recycling as the end goal of waste management leads to distortions that must be addressed. The second, perhaps of a more conceptual nature, is that accepting to define unused things as waste already changes the perception and expectations about such materials. The well-known formulation "waste is matter out of place" should be challenged from a perspective that considers power dynamics and accommodation to a consumerist society [19,30,60].

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[1] A quick note on terminoloty. A former supervisor drew my attention to the fact that the term "citizen" recently became loaded with political meanings in times of immigration crisis and nationalist-inspired intolerance. I chose then to avoid it when possible, using instead alternatives such as city-dwellers, inhabitants, local society or people.

In my research, I adopt an alternative take: addressing excess materials in cities and regions through collaborative reuse practices. In doing that, we can shift the focus - from an increasingly automated collection of materials that should disappear from the public eye as soon as possible to an ongoing attempt to identify and expose the potential value of discarded materials and actualise that value with local agents. Instead of top-down waste management, my work can be better framed as commons-based waste prevention. I adopt a similar perspective regarding digital technologies to aid in that quest within Smart City initiatives. Instead of deploying sensors and data collection tools to improve objective control by entities of centralised power, my research experiments with the opposite: governing data collectively to rebalance power relations [61]. Any application of the Internet of Things (IoT) in that context should be co-designed with knowledgeable stakeholders to ensure that relevance, trust, privacy and long-term dependability are incorporated by default.

That research focus led me to investigate the behaviour of individuals and groups towards excess materials; map flows of second-hand and broken things in cities and regions; create design concepts in response to my findings; and prototype speculative IoT technologies that help assess the potential value of goods and objects and make related data available. I developed all those actions through participatory methods.

Contrary to top-down practices of waste management usually structured around the collection of solid waste to be recycled, incinerated or sent to landfills, I suggest that there is room for innovative approaches. In particular, inviting local agents to create systems for the commons-based governance of materials, tools, equipment, space and other shared resources. I propose the image of *Generous Cities* - simultaneously, a conceptual setting and an alternative narrative. I do not intend to replace Smart Cities but rather to promote a dialogue in which environmental and social issues take centre stage. Instead of getting rid of excess through engineering and logistics, Generous Cities promote practices of care, transforming excess into generosity.

As OpenDoTT reaches a phase of engaging with policy-making, I recognise that adopting a critical perspective on waste management is a crucial first step for my research to reach the public sector, as well as nonprofits and society at large. The global climate emergency requires from all fields of knowledge a deeper reflection on the materiality of contemporary society and its future conditions of sustenance. By setting my research on designing commons-based systems for material reuse, I set the foundation over which trusted smart technologies can be created with increased awareness of the delicate situation we live in - not around largely abstract and arguably obsolete goals of waste collection envisioned decades ago.

In that context, I look back on activities performed during the last semester when OpenDoTT offered training modules on digital inclusion and digital literacy, as well as policy-making, advocacy and campaigning. This document brings my current understanding of participatory policy-making, an overview of policy areas related to my research topic, and finally describes the design concept I am working on at the moment, Reuse Commons - a toolkit to help create commons-based policy for material reuse within Smart City initiatives. Further work on the concept of Generous Cities will be developed in the coming months as I write my PhD thesis.

1.1. Waste, climate emergency and generosity

To describe it as summarised as I can at this point, my PhD research centres on how society in cities - and regions - can cope with excess materials under a conceptual framing of generosity. Starting from the intention to discuss Smart Cities, this specific focus for the investigation is based on two perceptions. First, my hands-on involvement in the past with community initiatives interested in the reuse of materials. I build on experiences with the reuse of discarded electronic equipment stemming from the MetaReciclagem network active in Brazil between 2003 and 2012. The second factor in deciding on this particular research topic is the scarce literature found on the confluence of inclusive urbanism, environmental studies and digital equality. Particularly in the Smart City narrative, there seems to be no awareness of the rich scholarship, for instance, on Lefebvre's idea of a Right to the City[18]. When it comes to waste, there is often a monodimensional understanding that increasing recycling is the only goal to be pursued by the use of technologies in cities.

At that confluence, my research promotes an alternative narrative around the idea of excess. That is, a recognition that contemporary cities will inevitably produce a volume of goods and materials beyond the local society's ability to use all of it at a given time. The reasons may vary from city to city, from country to country, from one season to the next. Excess can be a result of overconsumption, changing economic conditions, product obsolescence, and the availability or not of maintenance services, among other factors. In any case, I propose that local stakeholders should be an integral part of developing trusted solutions for excess materials within Smart City initiatives.

Under a global climate emergency, striving to conserve natural resources is paramount. In other words: to understand that raw materials were already extracted from nature and had their environmental footprint increased since they were transformed into goods and objects. In that situation, it is only logical that those goods should stay in use for as long as possible - both delaying the need to extract more raw materials as well as maintaining the value added to them by manufacturing and logistics. In that context, it is vital to challenge the mandate to recycle as much as possible of discarded materials. Premature recycling of objects equates to cutting short the value those objects could still have. Furthermore, recycling is an industrial practice with its own economic and environmental impacts - deriving from logistics, use of energy and the inevitable devaluing resulting from transforming a manufactured good back into raw materials, as pointedly explained by McDonough and Braungart[22].

Within a framing of renovating public services with innovative approaches and new technologies in Smart City initiatives, the practices of reuse I investigate would be identified as related to waste management. As discussed in the introduction, however, that framing is not totally appropriate. Instead of merely trying to update waste management with new technologies and methods, I adopt a perspective of socially-inclusive waste prevention. I am not naive to suppose that we can eliminate the production of waste in the foreseeable future. Nonetheless, framing the discussion into making the most out of materials that have already been extracted from nature and transformed into objects helps see the situation from a different angle and creates new possibilities with positive impacts both in environmental and socio-economic terms. That should be the backdrop to any attempt at developing new technologies.

1.2. Background: original design concepts

After conducting participatory research studies during the first year of OpenDoTT, I created eight design concepts. They were:

1. Universal Registry of Things: an open database with information about how to use, repair and reuse different kinds of objects.
2. Point and Reuse: a mobile app to identify objects and access the Universal Registry of Things.
3. Save This Thing: a map of repair workshops and similar facilities in cities and regions.
4. Make Waste Visible: educational and artistic interventions to raise awareness about the ongoing production of waste in localities.
5. Data on Reuse: an effort to generate data about the reuse of materials and rebalance discussions about reuse in comparison to recycling, incineration and landfilling of waste.
6. Reuse Bin: urban collection points for reusable materials.
7. Transformation Lab / Shop: public facilities allowing city inhabitants to access tools with which they can repair and transform materials for reuse.
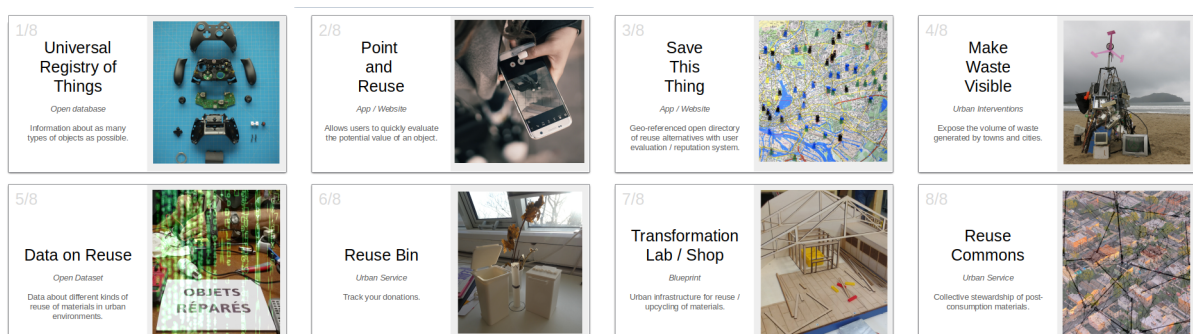8. Reuse Commons: a system for the shared open governance of reusable goods and materials.

Image 1: Original design concepts

In the second year, I worked on some of these concepts under a framing of Internet Health, Open Hardware and Privacy by Default. The Universal Registry of Things (prototyped as a website named ThingWiki) and Point and Reuse (which took the shape of a speculative workbench IoT equipment to identify objects called E-I, or Evaluation Interface). I also created a generic description of Transformation Labs, considering space, equipment and governance.

As we turned to the last and final phase of OpenDoTT in 2022, I was asked to revisit my design concepts from a policy perspective. My work is notably related to systemic proposals to impact policy-making, such as the Circular Economy [9,10,46] and Doughnut Economy [28]. By extension, it also relates to emerging fields such as Zero Waste and similar ones exploring concepts of resource sufficiency. Additionally, points of interaction with the policy agenda manifest in terms such as the Green New Deal or similar formulations, as well as "Net Zero" commitments on an international level. Even if well-intentioned and driven by scientific evidence, however, most of these approaches risk adopting a top-down nature in

richer nations and a colonial position over developing countries [35], a point I will develop further in this report.

The following sections explore my understanding of policy, its possibilities and limits; bring stories of my previous involvement with policy-making; and connect to those fields of policy that are directly related to my research. My engagement with policy in OpenDoTT followed an informed decision to pick one of my original design concepts for this particular stage - the Reuse Commons. In the present phase, I transformed it into a participatory toolkit to weave trusted Generous Cities in which care towards materials is systemically rewarded. The Reuse Commons is described in the last section of this document as a participatory toolkit for commons-based policy-making.

2. Policy and Smart Cities

Among the many possible ways to criticise the Smart City narrative, the lack of social participation is a central concern. It may be redundant to argue that any deployment of IoT, sensors and other data-driven devices in the urban environment should be regulated by democratic institutions. That is, however, not always the case. Sidewalk Labs' attempt [1] to force into Toronto the company's understanding of what a Smart City should be is a significant - and by far not the only - example of authoritarian behaviour.

Critical literature about Smart Cities [4,11,14,24] explores some of these aspects vis-a-vis references to a Right to the City [15,18,33]. Smart City initiatives usually offer little to no agency for most local stakeholders. They adopt a top-down approach in which the interests of corporate actors and local authorities align. Typically, expanding profits of the former and control over society by the latter. The collusion of political and economic powers and the resulting unequal dynamics are relatively easy to grasp in topics such as street surveillance with cameras. But it is often unaddressed regarding other target areas of Smart City development. Public services are redesigned under a questionable measure of efficiency[14] based on costs and frictionlessness. The meaning of such efficiency is seldom discussed with local populations, and even less so is the city dwellers' desire to have services redesigned along these lines. Societal trust in solutions is taken for granted.

When expanded internationally, the Smart City rhetoric acquires even more unbalanced characteristics[5,6]. Not only do its leaders allow little room for criticism, but their discourse is charged with coloniality. Typically, the discussion about Smart Cities in developing countries implies that the solution for problems faced by any municipality already exists. It has been created and tested in rich nations and should be imported wholesale, sometimes attached to earmarked development funds. Arguably, even in societies with relatively advanced democratic institutions, participation is lacking in Smart City initiatives [47]. When transposed to nations where such institutions are still emerging and gaining stability, there is a need for even more participation and consensus-making. Not less.

2.1. Participation and policies

Initiatives worldwide are proposing increased democratic participation in policy-making, sometimes with the help of digital technologies - on topics such as online deliberation and voting, collective decision-making, open data and others. Participation is, however, a term

with widely variable meanings. Some bodies see participation only as a matter of transparency, while others seek increased accountability. On the other hand, there are more profound democratic practices to reflect on and incorporate into the discussion, particularly when the intention is to increase multi-stakeholder trust in new developments.

Participatory democracy is not a novelty in the long history of political ideas. To mention only one among uncountable experiences, my birthplace Porto Alegre in southern Brazil was home to experiments with participatory budgeting around the early 1990s. Even though the mechanism was later emptied due to changes in the local political context (a theme I will return to in this report)[62], the initiative of inviting the population to deliberate on how resources were to be applied was influential for a long time[38]. A couple of decades later, also in Brazil, the public sector set up official participatory channels for "transparency and social control", as they were called then. More recently, cities like Barcelona [48] have invested in creating free/open-source software for online deliberation and public decision-making, in addition to the use of computer models to help urban planning[57].

Coming from a different perspective, the growing presence of design-inspired practices in policy-making also carries a vocabulary of participatory methods. The emerging field around civic innovation laboratories[50] helps to articulate collaboration between the public sector, educational institutions, private actors and the organised civil society, often using design research methods. Formal recognition of design as important for public administration can be seen in the creation of roles such as the Scottish Government's Chief Design Officer and of Policy Labs by the European Commission and UK Government. International events like the Creative Bureaucracy Festival[63] engender collaboration spaces for interested parties.

The world clearly needs new policies to address pressing issues. However, creating such policies from an objectively isolated standpoint and expecting societies to adopt them acritically is an illusion. In a time of growing scepticism, sustained and consequential change will only be possible by building trust with stakeholders in a participatory mode along the way. That should be the groundwork for any attempt to plan truly relevant uses for digital technologies in future Smart Cities.

2.2. Policy-making in practice

I come from a background in grassroots activism on themes such as digital rights and ICT for development. My involvement with policy-making happened as some collaborative projects I co-founded started to scale and become influential in Brazilian. It soon became clear to the people involved that ad-hoc activism was not the most effective way to promote sustained change in the real world. If initiatives were to achieve permanence, they had to acquire institutional legitimacy. On a superficial level, that can happen by influencing the political actors involved in making, discussing and approving legislation, as well as deciding on budget allocation.

Policy-making is commonly described as the creation of clear and rational rules over collective - and often diverging - interests. It could then be interpreted as an ongoing effort to shape and adapt institutions to govern society. Policy-making is also related to enforcing and monitoring legislation, regulations and their concrete use. Sadly, there are many examples in

Brazil of well-written laws simply not put into practice. It is important to me then to reflect on the limits of institutional policies.

Particularly concerning technologies, the current pace of change is substantially different from that of institutions. If that condition makes room for radical innovation, on the other hand, it often leads to ill side effects. Technological development is not isolated from issues of power, inequality and externalities. It often exacerbates them, in fact.

Positive and trusted transformation must ensure inclusion, human rights and respect for differences by default. For that to happen, one must be aware of the distinction between policies and *realpolitik*. The former must be as perfectly designed as possible, but the actual game is the latter. There are many limits to policies achieving effective impact in the world: the status quo, power dynamics, prejudices, concentration of capital, actors' self-interest, culture, and short-termism.

Sometimes creating policy requires stakeholders to reduce the complexity of issues to seek consensus - a boundary object of sorts [39]. When interests diverge significantly, the result may be that none of the parts involved is satisfied. The most appropriate way to address such a condition would be to involve the affected parties as much as possible in the process from the beginning. Those democratic and collaborative processes bear similarities with practices of design research: listening to people's voices to inform and give feedback on proposals.

What would be similar in policy-making to Antonio Lafuente's idea of common science[17] co-created by communities of affected people? We could take the hint from free/open-source software development communities where the boundaries between users and developers are sometimes blurred. Can we think of citizen policymakers as we do of citizen scientists? If so, what would be the proper ways to influence how policies are made? There is a broad spectrum of possibilities - from campaigning to advocacy to civil disobedience. The affected groups are the ones who should make a choice in every case.

To illustrate and reflect on some aspects of collaborative policy-making, I describe below a series of past experiences I was involved with. The intention is to add complexity to the discussion about the involvement of affected communities in policy-making and problematise trust and participation in that context.

2.2.1. Tales of policy-making

Over the last few decades, I have engaged with policy-making from distinct perspectives. First, as one among dozens of activists for digital rights who were invited to design and implement the digital culture strategy for the Brazilian Ministry of Culture. That became an intense collaborative effort through which I learned various lessons: the effect of visionary leadership, the contradictions of working for the government as a precarious worker, and the importance of personal relationships to affect change.

In another period, I have contributed to ensuring that the Brazilian legislation on solid waste covered discarded electric and electronic equipment. My main takeaway was a realisation over the extent to which economic power can stall progress - either blocking the approval of

legislation or making it hard even for legislation that was discussed and eventually approved to be put into practice.

Other two experiences bring relevant elements to the discussion about policy-making and communities: the elaboration of a federal funding programme for experimental digital culture and the attempt to create a participatory body to govern science and technology policies at a municipal level. Both are stories of disappointment due to the mismatch between the time required to build collaborative policy and the time of political/electoral cycles.

A more detailed account of these incursions into policy-making can be found in my research blog[62]. It is interesting to look back and notice that even though none of those experiences explicitly used a design research vocabulary, they could easily be framed as such - for using iterative, participatory and open methods.

2.3. Policies for Generous Cities

Treating excess materials as mere waste equates to missed opportunities for local green transformation. I stress here a distinction between incremental transition and more radical transformation as proposed by Stirling [40]. The author calls environmental authoritarianism the trend of imposing universal objective goals for sustainability policy. Instead of promoting the democratic confrontation of visions and seeking open accountability, institutions would this way be focusing excessively on nudging ordinary people to change their behaviour. Doing that leaves little room for a systemic critique of neoliberal capitalism.

Stirling sees democracy not as a "procedural end-state" but rather as a constant struggle through which the least powerful can challenge power. He counters transformation - the result of conflict, struggle and negotiation - against transition - the consensual albeit relatively emptied construction of controlled responses. He adds that in the context of climate change, the idea of control would be a fallacy, created not to ensure future prosperity for humanity and the planet but to give the impression that society is achieving progress by some arbitrary measure.

In that sense, the author sees transformation not only resulting from occupying the few democratic spaces made possible by those in power but crucially in culturing change and welcoming unruly political contention against power. Finally, he suggests that transformation can be better understood in terms of mutual care instead of control.

Detailed exploration of care and Generous Cities as a concept - as well as the distinction between abundance and generosity - is out of scope for this report. I will return to it in future research phases. Nonetheless, designing and deploying transformative systems to enable Generous Cities is deeply dependent on policies in different areas.

The well-established formula of the "Rs" of waste was gradually assimilated by the public opinion and influenced policy-making worldwide. The simplest version of the formula says that society should Reduce consumption, Reuse products and materials, and Recycle what can be recycled. There are alternative versions of that formula with additional steps. Still, a fundamental fact is that there is an expected hierarchy in all of these. Recycling should be a last resource, only actioned when reducing and reusing materials is not feasible anymore.

As a growing number of accounts phrase, recycling is not enough [41,64]. Waste prevention practices are considered more effective with a lower cost than their alternatives [12,64]. In my research, I focus chiefly on waste prevention through community-based reuse practices, usually found in initiatives of repair, upcycling and re-circulation.

Some of the policy areas described in the following section offer solid foundations for the reuse of materials in cities and regions, taking care into account. Others are more general in scope but could provide a scenario enabling political buy-in for Generous Cities. All in all, their elements could form the bases for discussing local and regional sovereignty over excess materials and structuring systems of material generosity to address the situation. Further, they provide guidelines to be followed by any deployment of trusted IoT within Smart City initiatives seriously committed to address the climate emergency and other critical issues of contemporary life.

2.3.1. Green Deals

In recent years, concerns about the effects of climate change have made their way into the public sphere. Certainly far behind the required urgency, but still significant. Novelist Kim Stanley Robinson published recently a book called Ministry for the future [31]. Considered a referential piece on cli-fi (climate fiction), the novel tells the story of an international environment agency created after a deadly heatwave hits India. The author weaves the narrative around the possibilities and challenges of building international cooperation to address a situation that risks making life unsustainable for humanity at large. Robinson, an experienced science fiction writer, inserts in this near-future novel topics of contemporary discussion in technology circles. The book features an open-source social network, owned by its users, and the use of technologies to mediate compensation for environmental services. It raises important insights also about the limits of traditional policy based on the same old market-based mechanisms.

All that said, the growing acceptance of climate science (chiefly, the IPCC reports [65]) into mainstream media and politics sometimes creates new opportunities. For instance, discussions about a "green deal" or "green new deal". The world needs to limit the emission of greenhouse gases as much as possible. Such plans promise to invest sizeable resources into heat insulation for households and businesses, expand the capacity to generate renewable energy, and promote the electrification of machinery and transportation, among other topics.

It is not by chance that they borrow the image of the "new deal" in the USA, which brought forth heavy public investment to overcome the great depression of the early 1930s. At this point, it seems already clear that the world will not reach a net-zero economy (one in which all the carbon emitted is balanced by carbon-capturing methods or technologies) based on private investment only. Quite the contrary.

These discussions are crucial context to advance ideas such as Mazzucato's Entrepreneurial State[21] and make even more explicit that the role of funding basic research for long-term scientific innovation lies chiefly in the public sector. However, green deal mechanisms are typically off the mark from the perspective of reuse and Generous Cities. They tend to focus on upgrading infrastructure - transportation, home insulation,

electrification. And fail to discuss its concrete impacts following the higher demand for raw materials - minerals required to manufacture batteries being a significant point of contention -, the need to increase energy production in a short timeframe, and what to do with the discarded materials eventually replaced. Granted, green deals often tout the demand for industrial players to adopt circular economy principles. But even that is usually depicted as a utopian view of the future - more innovation than maintenance, to echo Vinsel and Russell [32] - and little is said about handling the immense volume of materials being discarded today.

As a response to the urgent challenges of climate change, pollution and destruction of natural environments, the European Commission created in 2019 the European Green Deal[2]. It is composed of recommendations for a series of policies to be developed or reformed, in different areas. Even though policies adopting the form of a green deal are more frequently formulated and implemented on a national or regional level, they are also influential on the local scale. As climate emergency concerns make their way into the public debate, Smart City initiatives are urged to respond. Herein lies an opportunity to transform current waste management practices into waste prevention strategies. It may be possible to engage with formulators of a green deal type of policy, pointing out the negative economic and environmental impacts of premature recycling. Any plans of using IoT and other data-driven solutions must commit to information-healthy and ethical practices, aligning with privacy and security regulations.

The traction provided by adopting such policies by major institutional players - governments of globally powerful nations, for instance - can help channel investments for technological development and draw public attention to ideas around Generous Cities. Even if deserving criticism and increased scrutiny for their frequent top-down nature. To that point, establishing participatory channels in Green Deal policies can also earn trust from societies that will be impacted by such policies.

Specifically on the focus of Generous Cities, the European Green Deal makes explicit the directive to prioritise the reduction and reuse of materials over recycling. It remains on a higher level, however, and does not offer much detailing on how to get there besides pointing to the EU's Circular Economy Action Plan that will be mentioned in the following section.

Participatory policy-making for Generous Cities that incorporates multiple local stakeholders in the whole process and adopts mechanisms for generating open data and its collective stewardship through digitally-enabled distributed decision-making by default can increase collective trust in green deals. Design concepts of my research, such as Make Waste Visible, could help trigger this kind of discussion with the general public.

2.3.2. Circles and doughnuts

The concept of a circular economy has been around for decades. Still, its adoption by the Ellen Macarthur Foundation [9,10,46] over the last decade made the term well-known in a

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[2] "The European Green Deal",
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN (accessed 14.07.2022)

relatively coherent form. The Foundation bases its argument on its Butterfly Diagram [66], depicting distinct compositions of the "biologic cycle" and the "technical cycle".

Whilst relevant criticism of that flavour of a circular economy points to it being chiefly centred on urban contexts and rich nations [35], it still has the advantage of being relatively easy to grasp by ordinary citizens, civil servants and corporations. It is perhaps another boundary object, useful as a narrative device if not a concrete plan. Based on the dissemination of a circular economy narrative, committees are created in the public sector, knowledge exchange between cities is promoted, and actors who were usually invisible to the industrial sector, such as informal waste pickers, start to be factored in. To this point, one of the principles of the European Green Deal is its Circular Economy Action Plan[3]. Important interaction between urban and environmental issues is also happening around the idea of Circular Cities [10], as well as the embedded circular recommendations in the Fab City commitment [67].

The vision of industrial production and consumption as an integrated system helps to notice gaps and act to overcome them. A group of Finnish organisations recently hosted a conference called Data4Circularity [53] to discuss how data collection and analysis could help promote circularity. As well as green deals and the doughnut, the circular economy seems palatable and understandable enough for authorities both at local and national levels to engage with. The attempt to promote the concept of Generous Cities by promoting commons-based management of used goods and materials could adhere to circular and doughnut strategies. There is the risk of excessively reducing the complexity of issues and treating incremental circularity as the end goal, thus losing sight of the urgency to act on materials already being discarded.

As mentioned above, the green deal perspective is often about setting the guidelines to invest - massively in scale whilst incrementally in form - into reducing carbon emissions. Little attention is put into how the agents of such change are structured at an economic level. The same applies to their production, ownership and income distribution methods. An alternative recently made its rounds - the Doughnut Economy, created by Kate Raworth[28]. According to that vision, society should aim not only to limit carbon and other toxic emissions but also to provide minimal conditions for everyone to have a decent living. By doing that, Raworth targets not only externalities of the global economy in terms of raw materials and emissions but also social concerns in the very structure of global production streams. The Doughnut Economy is a practical tool also to make explicit the links of such streams with the particular conditions of each city and respond with adequate policy and measures. Notoriously, Amsterdam is leading the way on that direction [29].

Smart Cities willing to incorporate principles of the Circular Economy and Doughnut Economy can benefit significantly from adopting digital technologies to certify the provenance of goods and materials. Tracking product lifetime with IoT sensors, monitoring their performance over time and generating data about repairs and maintenance are examples of concrete actions - particularly regarding electronics - already put into practice by projects in localities such as Catalunya[7,13] and the UK[68]. In the same context, the

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[3] "A new Circular Economy Action Plan For a cleaner and more competitive Europe", https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN (accessed 14.07.2022)

effort to create an Open Repair Dataset[69] helps visualise possibilities. It can supply policy-makers with data to help justify legislation and public investment improvements. My speculative design concepts Data on Reuse, Save This Thing, and the Universal Registry of Things, could contribute significantly to the discussion by making it more understandable and trusted by diverse stakeholders.

2.3.3. Zero Waste

The Zero Waste movement embeds and expands on discussions on shifting from a linear toward a circular economy. Rather than focusing on the incremental increase in the circularity of industrial production and consumption, however, Zero Waste champions prefer to focus on the horizon of eliminating all waste and discuss topics such as degrowth and resource sufficiency [16,49,70]. Whilst arguably utopian, the Zero Waste narrative is perceived as more open to embedding grassroots, hyperlocal, experimental and informal initiatives [71,72,73]. Promoting more open, spiral-shaped and bottom-up approaches to handling excess materials, the Zero Waste discourse may be a critical mediating device due to its clear message, without compromising on the enormous efforts required for change.

There are diverse ways to define Zero Waste. The US-based Environmental Protection Agency has mapped some of these perspectives [44], including those from the Zero Waste International Alliance [49]. Most of them propose a systems-based approach to increase the conservation of materials on ethical grounds. In terms of policy, there are focal points on zero plastic waste, zero waste food, responses to electronic waste and other approaches [74]. Zero Waste shops and community events are gaining traction following public discussions on how to address climate change.

The Zero Waste movement can both inform Smart City initiatives, help them earn trust from local communities, and incorporate the concept of Generous Cities to address the climate emergency. My design concept of Make Waste Visible can easily connect to the Zero Waste movements, as well as - and particularly so - the Transformation Labs. Offering local societies the infrastructure needed to reuse materials - repairing, upcycling, transforming, and re-circulating them - would be a concrete step toward a Zero Waste reality.

As will be described later in this report, I have recently departed from the idea of setting up new infrastructure towards recognising existing infrastructure and creating collective protocols to put it to use. Still, emerging Transformation Labs - if not a new kind of public service - could still be relevant as vehicles for Zero Waste innovation, and become physical locations that generate data and deploy IoT technologies such as the workbench version of the Evaluation Interface (E-I) I have prototyped, inspired by the design concept Point and Reuse.

2.3.4. Right to Repair

A slightly more concrete approach can be found in the movements advocating for a Right to Repair. Grassroots initiatives such as the Restart Project [68], niche media companies like IFIXIT [75], and high-level policy campaigns have been pushing - and succeeding at that - for legislation to be passed in many regions of the world [76,77]. The right to repair engages movements coming from a background in consumer rights, repair cafes, environmental activism and social inclusion [8]. At the same time as requiring manufacturers to ensure the

long-term repairability of products - including access to service manuals, spare parts and tools -the right to repair movement also makes a case for the role of repair economies at a local scale.

The European Commission has introduced a comprehensive Right to Repair concept in strategic documents related to the European Green Deal and its circular economy action plan[4]. Similar legislation is being passed elsewhere, sometimes sector-specific such as the State of New York's digital fair repair act [58], product repairability indexes [23] or in the form of direct incentives to repair like tax exemption [25,27] or bonuses [56,79].

One particular aspect of the Right to Repair can benefit significantly from a digital distributed approach: information availability. Even when manufacturers provide information on how to repair their products, it is often fragmented. Finding service manuals, product specifications and lists of spare parts typically requires considerable effort.

My speculative design concept for the Universal Registry of Things aims to address that by providing data to help assess the potential reuse of as many different products, goods, objects and materials as possible. The Universal Registry of Things can become the trusted data-powered connective tissue between, on the one hand, hyperlocal initiatives such as professional repair services, community repair events, second-hand shops and others (including my Transformation Labs, equipped with equally speculative IoT devices such as the E-I), and on the other high-level entities such as consumer rights organisations, repair data trusts and national regulatory bodies.

3. Reuse commons: open protocols for Generous Cities

OpenDoTT was planned around a progressive structure. In the first year, I have identified waste prevention as my central subject of investigation within the topic of Smart Cities. I conducted two research studies then and created eight design concepts in response. During the second year, I led an online co-design lab with active participants from seven countries and worked on prototypes based on those concepts. Two such prototypes were speculative ones - ideas for IoT not yet feasible due to technological limitations or constraints to data access - the ThingWiki (a prototype of the Universal Registry of Things) and E-I, or Evaluation Interface (a mashup of Point and Reuse and Save This Thing). They were worth pursuing as a way to trigger "what if" scenario projections. The other prototype turned out to be a blueprint for Transformation Labs.

When I first created the design concepts, Transformation Labs seemed to be the one I would leave temporarily aside and improve only at the last phase of OpenDoTT. The idea of building infrastructure allowing city-dwellers to engage materially with second-hand materials - by repairing, transforming, upcycling or re-circulating them - seemed to align better with policy and inclusion than in earlier stages of the project. However, the conversations with participants of my co-design lab led me to dedicate some attention to it during the prototyping phase and work on ideas about governance, space and equipment for Transformation Labs.

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[4] "Right to Repair", https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698869 (accessed 14.07.2022)

Transformation Labs were my response to a perceived absence of available infrastructure for city dwellers to access tools, equipment and knowledge to reuse materials through repairs, upcycling, adaptations, and exchange. Even having worked on them in the second year, I still envisioned returning to the Transformation Labs later. My initial expectation for the final year was to work further on the concept. I saw Transformation Labs as similar to Fablabs and Makerspaces, only tilting the discourse and vocabulary from creating new products to reusing redundant materials. Developing new IoT devices, tools and data entry points to feed on other concepts such as the Universal Registry of Things was also part of the plans for the Labs. I assumed there was room to deploy them as public infrastructure in cities and design policy around their social, environmental and economic benefits.

However, my approach to this last round of co-design led me through a slightly different route. That was based on my direct observation of reuse initiatives in different parts of the world, as well as taking part in a series of events on related topics both online and offline and ongoing interaction with peers working in associated fields. Additionally, a recent call to pay attention to issues around coloniality helped me better understand my path.

To this last point, looking back on my previous experience in international cooperation, I can now identify aspects of colonial imposition both culturally and financially. I expect my work to be useful for waste prevention and material urban generosity beyond cities in the global north. In that case, it doesn't make sense to focus on a prescriptive blueprint with a list of equipment, spaces and methodologies. Instead, I prefer to be informed by relevant work to balance scarcity and excess in all parts of the world.

I had, for instance, the chance to learn from initiatives such as #ASKNET[2], which helps organise repair cafes, set up physical workshops and promote knowledge exchange in different parts of Africa. I had yet another layer of understanding when participating in CEHotspot, a conference on Circular Economy in Barcelona. The meeting took participants to visit a series of circular economy initiatives, including reuse centres, social stores, community-based repair workshops and a fablab integrated with a natural park. I made similar visits and observations to reuse initiatives in Berlin, as well as a festival on Zero Waste. I have also attended events on innovative approaches to policy and public administration, and presented my work in a seminar[80] associated with COP-26, the international conference on environmental policy. Finally, conversations with OpenDoTT colleagues and supervisors were also part of my construction.

I eventually decided to move on from the plan of detailing a blueprint for Transformation Labs in the form of a predefined infrastructure such as Fablabs [81]. It is important here to point to scholarship exploring connections between grassroots innovation, makerspaces and social issues [20,36,37,42,43]. In my work, I view any contemporary city as a large-scale situated makerspace. In that setting, materials are already circulating and being transformed by all sorts of facilities. Commercial repair services, community networks material exchange, civic collectives, second-hand shops and many others. From that point of view, equipment and knowledge are already in place.

3.1. Cities as Makerspaces

Cities have workshops where skilled persons transform, repair and adapt goods and objects. To increase the reuse of materials under a vision of Generous Cities, what needs to be better developed are governance tools - open protocols - enabling individual and collective actors to connect and find ways to cooperate. Cooperation can take many forms - sharing tools and equipment, circulating materials, bidding collectively to acquire infrastructure or influencing policy-making at a local and regional scale.

This understanding made me return to another of my design concepts from Year 1. Originally described as an "ecosystem for the collective stewardship of post-consumption materials", the Reuse Commons can be used as a mediating layer connecting initiatives on the ground with one another. It can also become a tool to negotiate Generous City strategies between communities, nonprofit organisations, businesses and the public sector.

The Reuse Commons is - explicitly so - inspired by the literature on commons-based governance systems. Mainly the work of Elinor Ostrom [3,26,34], posing the concept of institutions being collectively recognised systems - either formal or informal - to govern common-pool resources. That perspective on the commons is helpful in situations with diverse stakeholders, simultaneously competing and cooperating sustainably. Looking to develop ways to govern the reuse of materials in cities and regions can draw inspiration from these forms. A Reuse Commons strategy can help reinforce the social and environmental benefits of actors often seen as isolated, such as repair shops, clothing swap events, mobile bike repair workshops and a vast diversity of other initiatives.

Ostrom proposes eight rules for managing the commons, most of which can be immediately applied to the Reuse Commons concept. Risking oversimplification, they are as follows[45]:

- Clear boundaries.
- Locally relevant rules.
- Participatory decision-making.
- Monitoring of the commons.
- Graduated sanctions for abuse.
- Easy conflict resolution.
- Right to organise.
- Nested within larger networks.

Departing from top-down waste management defined exclusively by local authorities in the direction of commons-based governance of excess materials can significantly improve multi-stakeholder trust in environmental strategies for Smart City initiatives. In the following section, I introduce the Reuse Commons toolkit as a concrete means to co-design policies to aid in that.

3.2. A toolkit to weave Generous Cities

The current version of Reuse Commons is a toolkit for local agents to create systems to increase the reuse of goods and materials. It can be used as a guide to facilitate strategic

workshops at the municipal scale or otherwise applied by individual organisations to identify potential tactics to promote systemic change.

The first layer of the Reuse Commons is generative mapping. It can start from a geographic map of the city or region, on top of which participants locate actors in multiple sectors that can potentially integrate the commons: repair professionals, hardware stores, waste sorting centres, recycling facilities, second-hand shops, technical schools, and so on.

In a second moment, similarities and complementarity between agents are discussed. Individual profile cards are used to map offers and requests of each agent to the commons - for instance, tools, equipment, goods and materials. Current and desirable flows of materials and information are plotted back to the map.

Finally, thematic cards trigger conversations between participants and drive them to agree on strategies and future actions. Relevant gaps in data generation and availability can guide the development of novel technologies such as IoT devices, data storage, privacy and access policies, and innovative combinations of digital, manual and power tools.

Image 2: Reuse Commons Cards

Ideally, the Reuse Commons would be the environment on top of which other design concepts and prototypes I have worked on can come to life. These can feature as individual cards in the toolkit, to be applied where users see fit. That would be the case with the Universal Registry of Things, the Evaluation Interface, Point and Reuse and Transformation Labs, the Reuse Dataset and others.

Reuse Commons is still a work in progress. In the coming months, I intend to drive my research in that direction, positioning it as a valuable tool for the spiral design of Generous Cities. In the near future, I intend to discuss it with potentially interested agents, including participants of research studies I conducted in the last three years, to improve the toolkit's design and mechanics and discuss where IoT and data are relevant. An online version may be feasible further into the future, but that is beyond the timeframe of my PhD.

3.3. Reuse Commons and Smart Cities

Smart City initiatives are in the privileged position of having a mandate - and often the financial means - to reshape public services based on contemporary concerns. As suggested earlier in this report, it is essential to move beyond a framing only interested in improving objective efficiency - reducing costs, increasing speed or availability. This section advances some ideas on connecting the concept of Generous Cities to Smart City projects.

To achieve that some measures are required. First of all, Smart City projects should involve all stakeholders in discussing first whether they even want change to happen. Instead of being driven by the predefined need to find relevant uses for emerging technologies, they should understand the real needs of each particular locality. Only then should data, IoT devices and other technology - which can certainly help - be brought into the discussion. Here again, instead of predefined one-size-fits-all solutions, digital tools should be co-designed with local participants, and their governance made transparent and inclusive.

With a focus on Generous Cities - regenerative both in social and environmental dimensions - Reuse Commons can promote potentially transformative dialogue for Smart City initiatives. They can shift the focus of waste management from an uncritical effort to speed up the pace of consumption and discard toward one in which care for humans and objects is central. This conjunction may establish a new vocabulary setting Smart Cities as powerhouses of environmental regeneration in the context of a global climate emergency. Involving stakeholders every step of the way can also contribute to strengthening social ties and rebuilding trust in institutions.

Generous cities can certainly benefit from the use of digital technologies. I have identified a shortage of data about the reuse of materials in contemporary cities, making it even harder to challenge the status quo on waste management, already served by significant datasets[82,83,84]. Making an effort to generate privacy-aware data about repairs, re-circulation, transformations and upcycling would arguably increase buy-in for waste prevention strategies. New equipment such as the speculative IoT design of E-I - the machine with sensors to identify objects prototyped in my second year of research - can help collect such data and make it available for stakeholders. Through another design, the Universal Registry of Things, such data can be maintained collectively by commons-based governance arrangements. There is a vital role for digital-literate local authorities in promoting and managing data for those purposes. Municipally supported reuse centres like those in Berlin, Barcelona and Helsinki can become stewards of locally available datasets in addition to their physical facilities and benefit from local Smart City strategies offering data infrastructure.

Groups activated by the Reuse Commons can also partner with Smart City initiatives to conceive and implement policies that reinforce the role of digital technologies in addressing climate change at a local level. Local legislation on the Right to Repair can expand national or international policy [23,54,56,59,85] and improve the conditions for digital initiatives on the ground. Furthermore, IoT technologies can be used to track objects and ensure their longer lifetime, provide information about parts and components, and offer the means to reward individual or organisational behaviour that helps keep materials in use instead of discarding them. A Smart City strategy that explicitly commits to addressing global change by setting the conservation of materials as a goal can foster innovative solutions based on the generation and use of open data.

4. Conclusion: Generous Cities in Smart City projects

This report draws connections between my research on waste prevention in Smart Cities and the overall themes of OpenDoTT - open design, trust and Internet Health. It introduces the concept of Generous Cities as an alternative take for Smart City projects to address the issue of waste in the urban context. Instead of managing waste simply as a logistic operation, I propose to help prevent waste through collective practices of reuse - namely repair, upcycling, and re-circulation.

The main objective of the last phase of research in OpenDoTT was to reflect on how my investigation relates to policy-making, and conversely how policy impacts my research topic. In the previous sections of this document, I made considerations about climate change, explored my past involvement with policy-making, situated areas of policy that may be interesting for waste prevention, and described a design concept called Reuse Commons - a participatory toolkit to enable Smart Cities to transition to Generous Cities.

Drawing on my work exploring waste and the Smart City, I have the following recommendations for policy and smart cities in general:

- The top-down approach of most Smart City initiatives fails to earn trust from stakeholders such as city inhabitants, communities, organisations and businesses. I recommend participatory and transparent policies be created and implemented. Technology should not only be developed for people but also about and with people.
- Frictionless systems (e.g. solutions for waste management focused on making materials disappear from the public eye) hinder transparency and erode trust. People need to see, hear and touch information related to their everyday life in order to get the big picture. That extends to data about the waste generated and circulated in contemporary cities. I recommend adding friction to systems by making data more visible and relatable to the inhabitants of Smart Cities.
- Positive and trusted transformation must ensure inclusion, human rights and respect for differences by default. I recommend policies that ensure inclusion and human rights since their early design phases for any new Smart City developments. Within the concept of Generous Cities, that means incorporating informal agents seldom considered in official waste policy conversations - such as waste pickers, members of community-based zero-waste initiatives and repair professionals.
- There is a mismatch between the time required to build collaborative policy and the time of political/electoral cycles. I recommend stronger cycles of development that

weave city inhabitants into collaborative policy-making activities for the future of the Smart City, ensuring buy-in and resilience against changes in the political scenario.
- Transparency needs to be built in by default. As well as friction, I recommend data stewardship as a strategy for Smart Cities to achieve more transparency and give people more agency over the data that is being collected through IoT devices in the Smart City.

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