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Challenges to implementing circular development – lessons from London

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ABSTRACT

Circular development creates more resource efficient, adaptive, and ecologically healthy cities. Circular food and construction systems; the ecological regeneration of contaminated brownfield sites and circular tactical urbanism are just some of the processes and systems adopted by those implementing a circular development pathway. These produce benefits, however, there are many challenges to implementing circular development, demonstrated by two London cases. The research reveals the difficulties low-value, circular activities encounter when competing for space in London. It shows how the imbalance between local supply and demand for circular products prevents scaling-up. It suggests a lack of data monitoring the benefits of adopting circular development, undermines political support. It reveals the conflict between the reliance on civil society to engage with circular actions versus public resistance. It highlights the need for accountability and transparency in the process of implementation and for a regulatory framework to encourage circular development.

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Introduction

Circular development creates more resource efficient, adaptive, and ecologically healthy cities (Williams 2021a). It has been adopted in many European cities (e.g., London, Amsterdam, Paris, Stockholm). It manifests in a variety of ways, for example: circular construction and food systems; the ecological regeneration of brownfield sites; the adaptive reuse of infrastructure and spaces (Williams 2021a). Evidence currently suggests that circular development produces many economic, social, and ecological benefits (Williams 2021b). However, to adopt this approach will require a radical transformation in the way cities are governed, designed, and planned. It will also require significant changes in lifestyles, social practices of urban inhabitants and systems of provision. In this paper we discuss the challenges to this transformation process.

Various authors have written about circular cities (Prendeville et al, 2018; Petit-Boix and Leipold 2018; Bolger and Doyon 2019; Paiho et al.

2020). Their focus has largely been on creating circular economies in cities; circular resource flows; or encouraging expansion of circular business in cities (ibid). They have not explored the process for creating circular urban systems, introduced here as circular development (Williams 2019a, 2020, 2021a, 2022). Nor have they explored the challenges surrounding implementation. This paper seeks to fill this gap.

Circular development (CD) is a novel concept, first introduced by the author (Williams 2020) and later expanded on (Williams, 2021a, Williams 2022), which offers a new normative model for urban development. Unlike circular economy, its focus is on ecological regeneration and restoration rather than economic growth and efficiency. Thus, it is a regenerative model for urban development (Axinte et al. 2019). CD territorialises circular systems of provision and circular processes (resource looping, ecological regeneration and adaptation, Figure 1).

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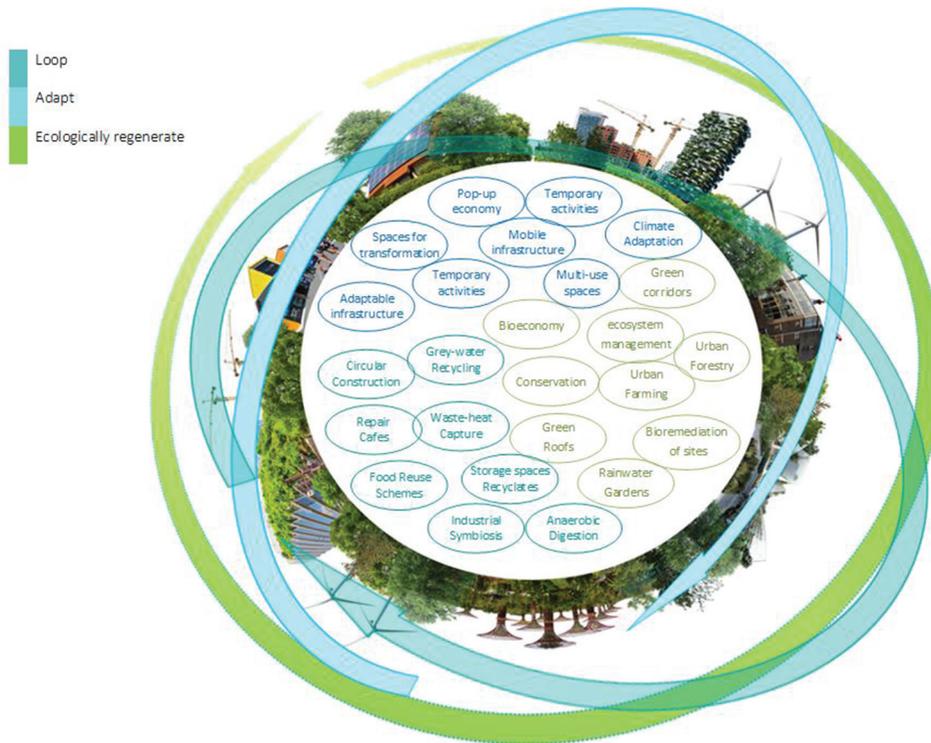


Figure 1. Circular development. Source Author's own

Resource looping (reuse, recycling, and recovery) is enabled through circular infrastructural systems (e.g. grey-water recycling systems, recyclable infrastructure) and the introduction of new circular processes (e.g. water and nutrient cycling, food reuse, waste-to-energy). Urban form may alter to accommodate these new activities, for example through the provision of space to store recyclates. Changes in local systems of provision (e.g. local food banks, composting facilities, repair workshops) also encourage urban inhabitants to reuse and recycle resources. Circular food and construction systems are proving particularly popular in cities.

Circular development produces adaptable cities, allocating space in which to transform (e.g. tactical urbanism) and grow, and infrastructure (e.g. scalable, movable) that evolves with changing needs. It also introduces processes (e.g. co-provision) which support learning within communities and encourage self-organisation. This enables communities to innovate and adapt to changing contexts. The resulting flexibility helps infrastructure and communities transform

to meet the new demands placed on them. Tactical urbanism is one such process which has supported the emergence of circular experiments in cities.

Circular development also restores and enhances urban ecosystem services, which reinforce natural cycles, increases natural resources and improves the health of those living in cities. Ecologically regenerative actions are operationalised through the inclusion of green and blue infrastructure in the urban fabric, the management of urban ecosystems (e.g. water management, conservation, farming) and bioremediation of contaminated sites.

Although this regenerative approach to circular development is gaining some traction, it is still limited in scope. Circular systems of provision and processes, have not yet been integrated into conventional development pathways. Experiments exist, but have not yet disrupted the development regime. The question is why? Drawing upon two case studies this paper seeks to determine the challenges to implementing circular systems of provision (circular food and construction systems) and processes (ecological regeneration and tactical urbanism) in London.

Challenges to implementing circular development

A review of the literature highlights a considerable number of challenges which might be encountered when implementing looping, regenerative and adaptive actions (Figure 2).

However, the literature deals with these actions separately. It also tends to focus on a single aspect of a circular system of provision, for example urban agriculture in a circular food system. In some instances the impact of factors on circular actions can only be extrapolated from the literature (e.g. political, regulatory, socio-cultural challenges). Thus, the literature can only provide an indication of what might be the broad challenges to implementation.

Economic challenges

The economic system presents a major challenge to resource looping, adaptation and ecological regeneration. Resources and ecosystem services are under-

valued by the market (Costanza and Daly 1987; Daly 2007). The current economic model presumes resources are infinite and ecosystem services are a non-excludable asset, so both are under-valued and often over exploited (Gómez-Baggethun et al. 2013; Kremer et al. 2016). It removes the incentive for circular actions.

The costs and risks of shifting towards new circular systems of provision are also high, due to sunk costs, limited suppliers, lack of expertise, lack of robust regulatory frameworks, global markets and political short-termism (Aronson, et al 2017, Bullen and Love 2010; Wilcox et al. 2016; Taheriattar 2020). For example, the future uncertainty created by resource price volatility and changes to global supply chains makes investment in recycling systems risky (Swickard 2008; Velis 2015).

Looping, regenerative and adaptive actions also produce long-term, societal benefits (under-valued by the market) and require long-term investment. These are often difficult to finance because investors and infrastructure providers are looking for short-term

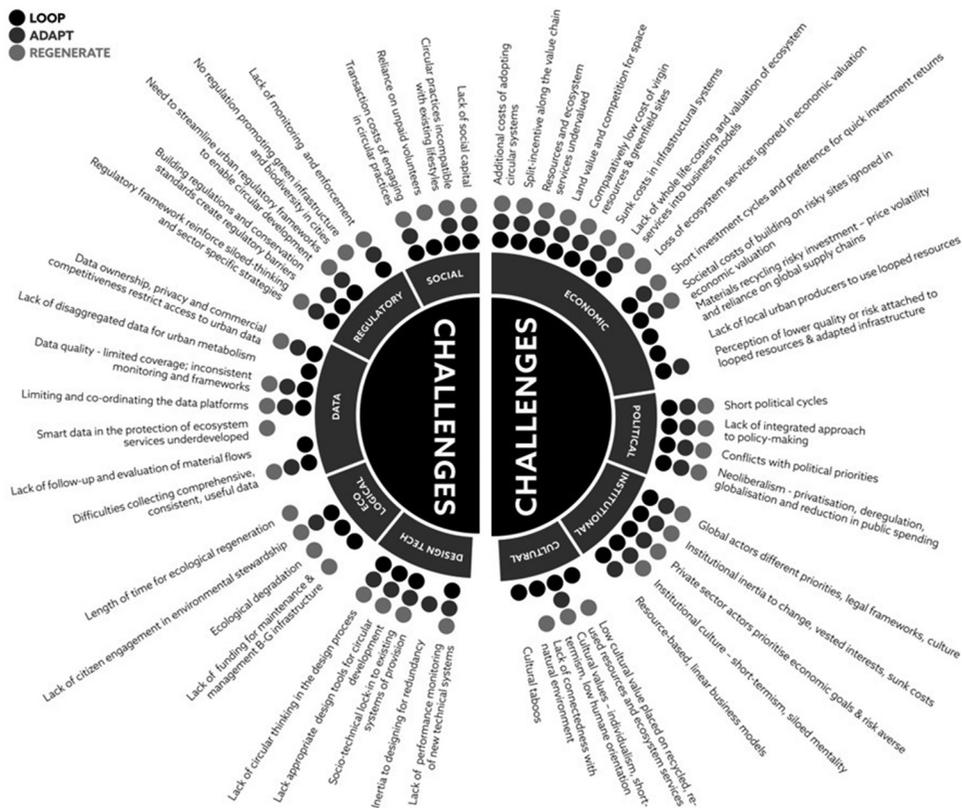


Figure 2. The challenges to implementation framework identified by the literature. Source (Williams 2021a)

returns, driven by short investment cycles (Van Buren et al. 2016; Byström 2018). Integrating whole life-costing and valuation of ecosystem services into business models could help to overcome this. However, the split-incentive along the value chain tends to undermine this approach. Those making the up-front, capital investment do not profit from the long-term societal benefits.

Socio-cultural challenges

The local systems of provision operating in a city affect the lifestyles and social practices of occupants, which influences their ability and willingness to engage in circular practices. Low levels of local social capital undermine the potential for circular actions. Local social capital increases a community's capacity to react to events, collaborate, share resources (expertise, skills, financial, etc.) and learn (Oberndorfer et al. 2007; Alexander and Smaje 2008; Norris et al. 2008; Demuzere et al. 2014). Without it communities adaptive capacity, resilience and ability to create circular systems of provision is undermined.

If the systems of provision incur high transaction costs people are less willing to engage in circular practices. For example, if waste separation or community composting is too time-consuming (incompatible with lifestyle) or physically demanding (lack capability), recycling practices will not change (Bruni et al. 2020). Many circular activities rely on volunteers (Measham and Barnett 2008), yet transactional costs of participation are high, making it hard to sustain. Thus, in the long-term the social and human capital generated by circular projects are often lost. This is exemplified by food-reuse schemes which rely on donations and volunteers (Pollard et al. 2016). Circular practices which offer multiple benefits, can lower thresholds for engagement. For example, urban agriculture (a key component of circular food systems) offers multiple benefits, which encourages greater, long-term engagement (Pearson et al. 2010).

Information and data challenges

Information is critical for the transformation of values, practices and institutions needed to support circular activities in cities. It is also essential for policy-makers to determine the best development options and to monitor progress. However, collecting comprehensive,

consistent, useful data in cities is a major challenge. Issues around ownership, privacy and commercial competitiveness restrict access to urban data (Herold and Hertzog 2015). The quality of the data produced is also problematic due to limited coverage, inconsistent monitoring, and frameworks (Allwinkle and Cruickshank 2011; Lacovidou and Purnell 2016). This reduces trust in the information exchanged (Lenhart et al. 2015).

More specifically, there is limited data for monitoring ecosystem services in cities (Anderson et al., 2017; McPhearson et al. 2016). Similar problems exist for monitoring urban metabolism. Data has been collected in only a few cities (e.g. Paris and Amsterdam) and interpretation issues exist due to a lack of common conventions (Browne et al. 2009; Zhang 2013). Most urban metabolism studies use highly aggregated data, which provides only a snapshot of resource or energy use, but no information about location, activities, or people (Pincetl et al. 2012). There is a high data requirement for monitoring resource flows, a lack of follow-up and evaluation of the evolution of a city's urban metabolism and difficulties in identifying cause-and-effect relationships of the metabolic flows (Shahrokni et al. 2014).

Regulatory challenges

There are many layers of regulation affecting resources, ecosystem services and resilience, which coalesce in cities. In Europe, the Pact of Amsterdam 2016, sought to strengthen and coordinate the urban dimension of European policies. Three of its policy priority areas focus on circular economy, sustainable land use and climate adaptation, which map loosely onto the three circular actions. However, the legal framework for supporting urban resource management, green infrastructure provision, biodiversity is lacking.

Legislation largely relates to pollution control (e.g. 98/83/EC, 91/271/EEC, 2008/50/EC, 2010/75/EU and 2020/741/EU) and a reduction in material waste, especially going to landfill (1999/31/EC, 2008/98/EC, 2019/904/EU). There are no directives mandating circular construction processes or food reuse for example. A directive for nature restoration has been introduced, without an urban dimension. There is no regulatory framework to encourage urban adaptation. In fact, regulation may actively impede adaptation. For

example, building regulations and conservation standards create regulatory barriers to adaptive re-use of infrastructure (Bullen and Love 2010).

Political challenges

Neoliberalism has influenced policies, instruments, and funding decisions in European cities (Brenner and Theodore 2002). It has changed the number and diversity of actors involved in service and infrastructure provision; altered power relations between key actors; and shifted the municipalities towards a more facilitative role in urban governance (Williams 2016). It has also resulted in a reduction in public funding for new development (infrastructural projects) and the privatisation of services (waste, water, energy, transport, etc.). Thus, power has shifted away from local government towards the private sector (ibid). The changes can undermine the transformation of systems of provision. Private actors prioritise economic goals and are more risk averse, thus less likely to invest in socio-ecological innovation than their public sector counterparts (Mazzucato 2011). A circular transformation is challenging in this context.

Without a supportive regulatory framework, or economic incentives, there is limited market incentive for private actors to protect resources and ecosystem services (Daly 2007; Kremer et al. 2016). Cities largely rely on enabling tools and public procurement to deliver a transformation (Brand 2007). This approach may produce pockets of innovation, but rarely systemic transformation (Williams 2016). Circular transformations will not be driven by short-term, market-orientated, reactive decision-making. Existing cultural values and short-term political cycles underpin this present-orientated view ((Van Buren et al. 2016; Byström 2018). However, in order to create policies that support futurity and inter-generational equity, resource protection, ecological regeneration and community adaptiveness, the underlying political culture and systems of operation will need to be addressed (Borgström et al. 2016). The challenge here is to create political motivation for prioritising circular development.

Institutional challenges

Many institutions undervalue natural resources and ecosystem services (Guerry et al. 2015). Economic goals are prioritised. Culturally, there is a bias towards

short-termism, individualism, and materialism (Hofstede 2001) all of which potentially cut against the circular development. Sectoral and professional segregation reinforced by the sector-specific legislative frameworks prevents the integrated approach needed to encourage circular systems (Roelich et al. 2015). In combination, these create major challenges to the emergence of institutions which are likely to be supportive of circular development.

Institutional capacity will need to be built to support circular actions in cities. New institutions to produce and enforce standards; to support new ownership models (Bastein et al. 2013); to regenerate ecosystem services; to monitor the impact of circular actions (Allwinkle and Cruickshank 2011; Townsend 2013); and to support learning amongst key stakeholders will be needed (Barragán-Escandón et al., 2017). There will be institutional (cultural and structural) inertia to change because of vested interests in preserving current practices and minimising risk.

Ecological challenges

Ecological degradation can affect urban capacity to ecologically regenerate and for resources to be looped. For example, land contamination reduces the potential for grey-water reuse and soil recycling (Bullen and Love 2010; Wilcox et al. 2016). It also inhibits provisioning and regulating services (Anderson et al., 2017; McPhearson et al. 2016). Lack of vegetation will influence the ecosystems' capacity to absorb carbon-dioxide, air pollutants, regulate temperature and store water (ibid). These problems are exacerbated by local climate, relief, topography, and hydrology.

Bioremediation is a long process, which is problematic to manage in short political cycles (Anderson and Minor 2017). Longer-term political support is required to secure the funds for bioremediation (Frantzeskaki et al. 2017). Bioremediation may also slow the development process, problematic in land scarce environments. However, as long as revenue is maintained in the short-term, the long-term the value of the ecologically regenerated site increases (Cabaneck and Newman 2017).

The long-term maintenance of blue-green infrastructure creates another challenge (Mell 2018). Previously this was the responsibility of the local public authority, however, increasingly it has been contracted to private actors. Yet the financial reward is

often insufficient. In some cases, residents maintain the blue-green infrastructure within their neighbourhoods, which reduces public spending, and increases public engagement in the stewardship of their local environment (Connolly et al. 2013). The major challenge is how to get the wider public to engage in stewardship (Shandas and Messer 2008).

Technical and design challenges

Circular design and thinking have not been incorporated into urban systems of provision (Moreno et al. 2016). Systems are linear, segregated, and dependent on grey infrastructure (Unruh 2000; Williams 2016). They are locked-in by the vested interests and sunk cost of those providing them. Citizens also develop lifestyles and social practices which fit with grey infrastructure and linear systems (Frantzeskaki and Loorbach 2010). This creates a socio-technical lock-in, which reinforces linear and separated systems thus impeding the implementation of circular solutions.

Even if there is willingness amongst providers to adopt circular systems of provision, it is practically difficult to alter infrastructural systems due to the capital cost and disruption (Frantzeskaki and Loorbach 2010). There is limited opportunity for the renewal of infrastructural systems in most cities (certainly in Europe), as development rates are low. Training will be required to ensure that professionals have adequate expertise to design circular solutions. There are some design tools which could help assist adoption (Cambier et al. 2020; Earley 2017; van Stijn and Gruis, 2019).

The research contribution

The novelty of this research stems from the fact there has been limited work to determine the actual challenges to implementing circular systems and processes integral to circular development. The literature discusses in broad and tangential terms factors which may create barriers to implementation (presented in this section). My previous work (Williams 2019b) touched upon the actual and potential challenges to looping actions, but did not consider regenerative and adaptive actions. Often circular processes/systems encompass all three. Thus, the research provides a richer understanding of actual challenges to

the implementation of specific circular systems and processes in the urban context, making a valuable contribution to existing literature.

Methodology

The research analysed the key challenges to implementing two circular systems of provision (circular construction and circular food systems) and two circular processes (ecological regeneration of a contaminated site and circular tactical urbanism). These were chosen, because they represented circular systems and processes often implemented in European cities (Williams 2021a). Thus, the findings could have broader significance. They also represent the three circular actions – looping, ecological regeneration and adaptation – integral to circular development.

A case study approach was adopted. London was chosen for the research. The regional authority has overtly adopted a circular approach to development, supported by the London plan (Greater London Authority 2021), public funding, and a number of policies. The two London cases, the Queen Elizabeth Olympic Park (QEOP) and Brixton, were chosen for study. They provided examples of circular food and construction systems and tactical urbanism and ecological regeneration processes. These were implemented at least 5 years ago, which means those involved could identify challenges to implementation and to scaling-up projects.

The Queen Elizabeth Olympic Park (QEOP) is a new eco-district and the largest urban park in Europe. Bioremediation and conservation schemes have ecologically regenerated this previously industrial area. Diverse, natural species have been planted across the park. Waterways have been improved, whilst sustainable urban drainage systems have been integrated into the public realm. A black-water recycling system was introduced to tackle pollution and drought. Contaminated soil and groundwater were cleaned through biological processes. Circular construction practices were also adopted on site. This involved recycling or adaptively reusing existing infrastructure, whilst ensuring new infrastructure was designed to be recycled, adapted, and reused. This approach has significantly reduced material waste produced by the construction process.

Brixton provides an example of circular development in an existing neighbourhood, which adopted circular tactical urbanism and created a circular

food system. Brixton is a transition town with twin aims to tackle climate change and resource consumption. Temporary permissions and leases have enabled local pop-up activities to appear in vacant spaces. Circular, community-led schemes (e.g. food reuse and repair cafes, pop-up businesses) have emerged in these spaces. This form of tactical urbanism is a process which supports the adoption of low-value, circular activities, at least temporarily, in the city. In addition, a local circular food system has been established, via the tactical urbanism process. This combines local food reuse schemes (Brixton Café, People's Fridge, Food Surplus Network), urban farming and food composting to close the resource loop.

Initially the two circular systems and processes operating in each case study were mapped, reconstructed using secondary data (grey literature, largely technical reports). The key stakeholders involved in implementing these processes/systems were also mapped. A group of 19 representative stakeholders were interviewed across the private, public and community sectors (Table 1). They were asked to identify three key challenges to implementation. They were also asked to identify the three key barriers to scaling-up these systems/practices. The challenges framework (Figure 2) was used to structure the questions and act as a prompt. The interviews took place during the period June 2017–June 2019 and lasted between 40–60 minutes. The interviews were recorded and

transcribed. Where possible the responses were triangulated against secondary data provided by grey literature from the same period. The results are below.

Results

Circular construction in the queen Elizabeth olympic park

Construction, excavation, and demolition waste constitute 48% of all waste in London (London Waste and Recycling Board 2017). London's Route map to a Circular Economy (London Waste and Recycling Board 2017) supports the adaptive reuse of infrastructure and recycling of construction materials (ibid). The Greater London Authority (GLA) views the redevelopment of London as a chance to implement circular construction systems. New projects generate demand for recycled materials, while the demolition of existing buildings creates large volumes of construction waste. QEOP was the first project in London to adopt a circular construction system.

The Olympic Development Agency (ODA) set an ambitious target to reuse or recycle 90% of the demolition and construction waste produced by the development. In practice 98.5% was recycled (Epstein et al. 2011). The ODA embedded goals for recycling in design briefs, procurement policies and contractual agreements, supported by design guidance. Pre-demolition audits with

Table 1. Key stakeholders interviewed.

Sector	Type	Number stakeholders interviewed	Circular Construction QEOP	Ecological regeneration QEOP	Tactical Urbanism Brixton	Circular Food Brixton
Private	Developer	1	X	X		
	Construction manager	1	X	X		
	Engineering/planning consultant	1	X	X		
	Architect	1	X			
	Landscape architect	1		X		
	Water and wastewater engineer	1		X		
	Temporary use consultant	1			X	X
Public	Strategic planner	2	X	X	X	X
	Economic development officer	2	X	X	X	X
	Waste recycling officer	1				X
Community	Social enterprise volunteer	3			X	X
	Social enterprise manager	2			X	X
	Community interest company manager	1			X	
	Food network	2				X

Source Author's own

materials management planning also increased recycling rates (ibid). Operating at scale, with one central construction waste hub, helped to reduce costs (London Legacy Development Corporation 2017). Accurate forecasting improved the management of waste during construction. Award schemes incentivised a further reduction. This approach to delivering circular construction diverted 425,000 tonnes of waste from landfill and saved 20,000 lorry movements (ibid). It is estimated over 20,000 tonnes of new materials were saved by adopting the system, which also produced cost savings for contractors (ibid).

An asset disposal scheme was set-up to help contractors reuse items and materials post-games. For example, modular cabins that formed the high street in the athletes' village were used as a community hub in Hackney Wick (Daothong and Stubbs 2014). However, less than 2% of construction waste was reused. Primarily this was because it required different types of waste management, logistics and networks to be established (Epstein et al. 2011). To drive this type of innovation would require, targets and systems were redefined in contracts.

Contaminated soil was treated on site, in 2 soil hospitals and 5 soil-washing plants. The majority of the soil (80%) was cleaned and reused for enabling works (Atkins Global 2012). Beyond the Olympic Park, the soil hospital linked up with projects such as the M25 widening scheme and Westfield retail development in Stratford, to maximise the local reuse of surplus soil (ibid).

The sustainability programme imposed on the Olympic development had political support from national, regional, and local government (Epstein et al, 2011). There was significant public funding, for infrastructure and bioremediation of the site. Thus, challenges were limited. QEOP offered a profitable opportunity, enabling developers to adhere to the more stringent targets set by the Sustainability Strategy (ODA (Olympic Delivery Authority) 2007).

The sustainability goals for the site and KPI's were agreed at planning stage which further reduced the investment risk (Epstein et al, 2012):

The Olympic Park was an iconic project, so there was no real investment risk, even with the additional costs of capacity building. Clear guidance further reduced the risk.' Developer, QEOP.

However, those interviewed did identify several challenges to the wider implementation of circular construction practices. Firstly, the lack of regulation and public funding available to support circular construction:

Circular construction was supported by politicians and public funding in the Olympic Park. This made the adoption of new construction processes easier. Public funding offset some of the additional costs on site. The KPI's were clear. However, a lack of regulation and public funding, will make it harder to replicate these practices elsewhere.' Construction Manager, QEOP.

Secondly, a lack of consistent local demand for and supply of recyclates in areas with fewer and smaller construction projects:

The creation of stable, local supply chains and local markets for recyclates is possible at scale, but less feasible for smaller projects.' Construction Manager, QEOP.

This challenge is underpinned by the lack of national regulation supporting circular construction:

We need a regulatory framework which supports circular construction. This will drive demand and enable supply chains to develop. Long-term this will increase the cost-effectiveness of circular construction processes.' Architect, QEOP.

There is inertia within the industry to transform. This results from path dependencies, lock-in to existing linear processes, supply chains and expertise. Nevertheless, there is a willingness to change if there is incentive to do so.

Of course, it is possible to shift practice. However, an incentive to do so is needed, be it regulatory, financial or both.' Developer, QEOP.

This need for regulatory or financial incentive for construction companies to change practices was also echoed by a recent study (Adams et al. 2017).

A third challenge is the lack of data for monitoring the stocks and flows of construction materials nationally and in city-regions. There are difficulties in creating a materials database, due to the cost of data collection:

A major challenge is knowing the quantity of recyclates being produced across the site and who wants to use it. There needs to be a system for monitoring both, so we can manage logistics better. But it is hard to get the data.' Construction Manager, QEOP.

A fourth challenge is the lack of appropriate design and logistical expertise amongst built environment professionals:

There just isn't the expertise in the industry to design and build recyclable or adaptable infrastructure cost-effectively. I think building knowledge amongst key stakeholders will be essential for circular construction to be more widely adopted.' Engineering Consultant, QEOP

Developing the skills and knowledge required to deliver circular construction has transaction costs:

We have learnt a lot by being involved in QEOP, but it has been at a cost in terms of time, money and effort. It's good to have built that capacity within the company, but there is internal inertia to change.' Construction Manager, QEOP.

These transaction costs might be outweighed by the benefits, if the regulatory framework supports the more widespread implementation of the practice:

A lot was learnt during this project about designing infrastructure to be adaptable. This can be incorporated into design practice more widely. It could enable adaptive reuse on other sites. It should be supported by regulation.' Architect, QEOP.

Ecological regeneration of queen Elizabeth olympic park

The Olympic site was severely ecologically degraded by its previous industrial uses resulting in soil and groundwater contamination (Hou et al. 2015). The waterways were neglected, silted-up and overgrown (ibid). The combined sewer system had insufficient capacity to handle storm-water discharge during peak time. Thus, it discharged untreated effluent into the River Lea (ibid). Drought was also a problem (ibid).

A process of ecological regeneration was initiated to tackle these problems. This was secured through the sustainability strategy, global and site-specific remediation strategies (ibid). It was heavily subsidised by national and international public funding (ibid). Soil remediation; black-water and grey-water recycling; the bioremediation of ground water; the clearance and stabilisation of waterways and the planting regimes across the site were implemented to restore the health of the local ecosystem. This had beneficial effects for water management and soil health (London Legacy Development Corporation 2017). It enabled the integration of green infrastructure across the site (ibid).

The first key challenge was the economic viability of ecological regeneration. The additional capital and operational costs of implementing new processes (e.g. black-water recycling, soil remediation) and blue-green infrastructure were challenging (Thames Water, 2019; ibid). Soil remediation cost the government £12.7 million (Hou et al. 2015). This appears expensive when the ecological, leisure and health benefits aren't weighed against it. However, the marginal costs were kept low because of the scale of the project (ibid). The black-water recycling scheme at the Old Ford Recycling Plant (initially subsidised with European funding) was deemed economically unviable. This was due to the low value of water and the risks associated with changing to a new business model:

Black-water recycling was only economically viable with significant public subsidy.' Water and wastewater engineer, QEOP.

Based on Thames Water's existing linear business model and low water prices, black-water recycling wasn't economically viable. The costs avoided by reducing water pollution (from overspills) or increasing water security weren't considered.' Sustainability Consultant, QEOP.

A legislative framework was in place to address soil and water pollution, but it wasn't enforced. Ground water contamination was a significant problem (ibid) but, no punitive action was taken against the water provider (who failed to address pollution issues) or polluting industries. Arguably it was hard to identify polluters, in order to recoup costs. A similar problem arose with soil contamination. These problems were compounded by the risk assessment framework for soil remediation, which overlooked groundwater contamination (ibid). Thus, enforcement was a second challenge.

The third challenge was the length of the development process, which was 3 years (ibid). The decontamination soil and groundwater can take 5–15 years (ibid). This has implications for monitoring and enforcement:

To ensure the decontamination process is complete, monitoring and enforcement need to be in place long after the projects are done.' Sustainability Consultant, QEOP.

Short development timelines also meant only a 'suitable-for-use' remediation standard was achieved on site (ibid). Thus, the remaining contaminants would need to be dealt with post-development to protect ecological and human health. But questions remain around who would finance and manage this process.

Establishing green infrastructure also takes more time. The capital cost for blue-green infrastructure was largely publicly funded. However, maintenance was not publicly subsidised, which created another challenge:

It is difficult securing long-term funding for the maintenance of green infrastructure, particularly during this time of local government austerity.' Landscape Architect, QEOP.

Lack of public funding (post-games) has created issues around who is responsible for the ongoing provision of blue-green infrastructure in QEOP:

The water company has pushed us (developers) to integrate rainwater collection systems, grey-water recycling systems and planting into our projects. So, they have shifted the responsibility of water management to us.' Developer, QEOP.

The restoration of waterways has relied on conservation volunteers. More resources need to be found to provide a more sustainable approach to upgrading the waterways.' Conservationist, QEOP.

Community actors could play a greater role in the stewardship. However, experience from conservation projects in QEOP, which rely on volunteers, demonstrates very high drop-out rates:

It is difficult to retain volunteers long-term. Conservation work is physically demanding and time-consuming. Ecosystems take time to recharge and revive. Some long-term support to pay designated people to work on the project is needed.' Conservationist, QEOP.

Lack of public awareness and appropriate expertise for maintaining and operating new systems of provision can also be a challenge:

Households will be required to maintain rainwater collection and grey-water recycling systems. I am not sure they will have the where-with-all.' Developer, QEOP.

Politician's under-value green space and the ecosystem services they provide. They have other priorities which compete for public finance and space.

There are so many competing priorities in the park. We need affordable housing and local services. These need to be financed by more commercial development. It can be hard to continue to prioritise green space.' Strategic Planner, QEOP.

Monitoring the benefits of ecosystem services is difficult, costly, and time-consuming:

Monitoring the benefits of green space, could help to build local political support, which might also lead to greater public funding for maintenance.' Landscape Architect, QEOP.

Nevertheless, it will be essential if a political case for ecological regeneration is to be made. The ongoing protection of green space is a real challenge:

Competition for space in London is fierce. The improvements in QEOP have increased its value and attractiveness to developers. This produces a challenge for future administrations; whether to protect the park from development or to try to retain it.' Strategic Planner, QEOP.

Circular tactical urbanism in transition town Brixton

The London spatial plan (Greater London Authority 2021) encourages boroughs to support opportunities to use vacant buildings and sites for temporary uses (e.g. for food growing). Adaptable, moveable infrastructure has been placed on sites with temporary permissions (e.g. Place Ladywell project). In Brixton, there is a cluster of circular experiments accommodated on sites with temporary permissions.

'In Lambeth, this approach to delivering circular activities, has proved beneficial to the landowner, developer and community.' Lambeth Economic Development Officer.

In Brixton, tactical urbanism has produced some interesting circular experiments, but most don't scale-up. The main challenge is that circular activities are low value, so can't compete with more commercially viable alternatives:

Temporary leases and planning permissions provide opportunities for urban experimentation. Their short-term nature offers a less risky option to land-owners, which encourages them to make sites available for circular activities. The more commercially viable experiments succeed and those that can't be replaced by more viable market alternatives.' Temporary Use Consultant, working in Brixton.

The under-valuing of societal goods produced by circular experiments, makes it impossible for lower value circular activities to compete long-term with higher value activities, especially in space scarce environments:

Our project offers people the opportunity to socialise, learn new skills and grow fresh food. It also improves the local living environment. But we will be pushed out because we aren't commercial.' Social Enterprise Volunteer, Brixton Urban Farm.

Complete reliance on the market to deliver a (circular) transformation is unrealistic. This approach creates temporary interventions, not long-term changes.' Economic Development Officer, Lambeth.

A further challenge is the reduction in public funds, which means local authorities must maximise return from their assets (including land). So low-value circular projects are replaced by high-value alternatives:

Land is our most valuable asset. There are limited sites available in Lambeth for development. It is difficult, given our limited funds, to pass up an opportunity to maximise returns, as we can use the funds raised to support many of our social programmes locally.' Economic Development Officer, Lambeth.

A third challenge is the lack of a local market (both producers and consumers) for secondary resources. Lambeth tries to support the local circulation of resources using its local currency, but it is not enough:

To be successful, a substantial amount of the currency needs to be circulated and used to pay for goods and services locally. However, there are a limited number of producers (e.g. food, recycled and reused goods) in Lambeth, which restricts capacity to close loops locally.' Community Interest Company Organiser, Brixton.

A fourth challenge is knowledge retention. Once circular projects close it is difficult to sustain the social and human capital they have generated. Yet retaining knowledge and creating learning networks locally are important for a successful transformation process:

When these projects close, all the expertise and skills created during their lifetime are lost from the area.' Social Enterprise Manager, Brixton.

Monitoring the benefits and costs avoided by circular projects, could help to build political support at a local level. Currently there is no data collection to enable this:

If we could demonstrate the benefits of the projects, I am sure we would have greater support from local politicians. They need to justify their decisions and spending. We only have anecdotal evidence and don't have the funds, expertise or time to collect it ourselves.' Community Interest Company Organiser, Brixton.

Finally, many circular projects are run as social enterprises, dependent on volunteers and donations. The transaction costs are high leading to burn-out. There is little appetite for scaling-up practices or for monitoring the benefits of schemes amongst volunteers:

These projects rely on us (the volunteers), but we aren't paid. This can be sustained for a while, but eventually we need to earn money. Involvement in local projects is time-consuming and can make it difficult to find paid employment.' Social Enterprise Volunteer, Food Reuse Project Brixton.

Our goal isn't to scale-up or monitor our impact. We don't have the resources to do that. It is about learning to repair things' local recycler-repairer, Brixton.

Brixton's circular food system

Over 8 million tonnes of food are consumed in London per year (Greater London Authority 2015). Approximately 20% ends up as waste. The GLA has set a target to reduce food waste by 50% by 2030 (Greater London Authority 2018). It also advocates local food production as a way of closing resource loops (London Waste & Recycling Board 2015). London has a food strategy and various schemes to reduce food waste (e.g. Social Supermarkets, Food Save, Trifocal) and encourage food growing projects (e.g. Capital Growth, Incredible Edible).

The London Food Strategy (Greater London Authority 2018) advocates the allocation of space by local authorities for urban farming. The London Plan requires the provision of food growing spaces in new developments and as a temporary use on vacant or underutilised sites (Greater London Authority 2021). It encourages local authorities to protect existing food growing spaces and promote urban greening in their local development plans (ibid). Thus, there is a regulatory framework supporting food growing in the capital. However, there is no regulatory framework supporting food reuse, composting or energy recovery from food waste.

A circular food system is emerging in Brixton, which includes a variety of schemes: food growing, food reuse (Brixton Café, People's Fridge, Food Surplus Network), and recycling (composting scheme operated by the local authority). Food is grown throughout the borough, often on temporarily vacant, publicly owned sites. These are run by community groups or social enterprises, sometimes supported with public grants. The food reuse schemes operating in Brixton, are locally based (Brixton Café, People's Fridge) and national schemes (Food Surplus Network). The local authority also collects and composts food waste, which it uses on its parks and gardens.

The key challenges to growing food in Brixton are economic (competition for sites), social (transaction costs) and knowledge-based (lack of skills):

The main challenges for urban farmers are finding space, a lack of farming skills and knowledge, and the cost of plants. Growing your own food can be very rewarding, but it takes time, money and effort.' Urban Farmer, Brixton.

Food growing is a relatively low value activity; thus, it can't compete with high value activities in space scarce environments:

These aren't commercial food growing enterprises, they can't compete with more profitable activities, or provide a neighbourhood with all its food. These schemes are educational. They build communities and provide a healthy living environment.' Community Food Growing Network Member, Lambeth.

Most food growing projects are operated by community volunteers. Engagement incurs transaction costs. Thus, retaining volunteers is a challenge. Developing the knowledge and skills required to be an effective farmer is a challenge. All these factors limit urban farming and the local production of food.

The key challenges for food reuse are economic, informational, and regulatory:

Surplus food is low value. Thus, it is important to localize food loops where possible to reduce transport costs, to make schemes economically viable. However, supply often must be sourced from outside a local area, especially where demand is high. This inevitably increases costs, which makes re-using food waste less economically viable.' Food Surplus Network Representative, Lambeth.

The low value of food-waste against high transportation costs, creates a significant challenge to food reuse. It is important to create a local market where feasible. A limited local supply of food (from urban farming and reuse schemes), in combination with high demand, will prevent loops being closed locally. Data collection to enable monitoring of food flows could support viable supply systems. However, this data is not available.

A regulatory framework to support the reuse of food would help:

Food growing and food reuse schemes are generally run by social enterprises or community groups. The benefits of these schemes are under-valued. Their economic viability without subsidy or regulation is questionable. So, they disappear.' Social Enterprise Manager, Brixton.

Regulation requiring supermarkets, suppliers, and eateries to ensure food waste is reused, would create more robust local supply chains and increase demand. It would increase the number of commercial enterprises involved, and thus the economic sustainability of reuse schemes.

In Brixton, food waste is also composted. The local authority has recently begun to collect household food waste. However, economic, and technical challenges have been encountered:

The collection of food waste is expensive and is logistically difficult for high-rise developments.' Waste Recycling Officer, Lambeth.

Separate collection of food waste increases the cost of waste collection. It is also logistically difficult to collect from high-rise developments. Waste-to-energy (creation of biogas from food waste) may offer a more economical alternative. However, lack of treatment facilities creates a barrier to composting and energy production in London.

There aren't many processing plants in London. This creates barriers to composting and energy generation.' Waste Recycling Officer, Lambeth.

Currently, less than 50% of London's food waste is processed in the capital (Greater London Authority 2015). There are only two WTE plants and 4 large-scale composting facilities within Greater London. The mayor is encouraging the development of treatment facilities; however, financing them is a problem.

Service operators who compost and recover energy from food waste, have faced other challenges including high capital costs, investment risks, difficulties distributing energy and public opposition to facilities:

The economic viability of setting up a waste-to-energy plant is affected by the supply of materials and demand for energy. It is also affected by the ease of distributing energy and public opposition to plants. These potential barriers, mean that WTE plants can be a risky investment. A better regulatory framework could help to address these problems and provide security to those investing in them.' Waste-to Energy Provider, Greater London.

Discussion

The main challenges to implementation raised by the case studies are summarised (Table 2). We can see that the potential challenges framework developed

drawing from the literature (Figure 2) appears to be reasonably accurate, when comparing it to the real-life experiences of the case studies. However, new economic, social, informational, regulatory and institutional challenges were also identified by the case studies (highlighted Table 2).

For the London cases, the cost of land and competition for space had a major impact on both the implementation of circular systems and processes. Low value circular activities were unable to compete for space long-term in the city. This is particularly important in London where there is reliance on the market to deliver the circular processes and systems of provision. The cases also highlighted the imbalance between local supply and demand for circular products (e.g. recycled construction materials, reusable food 'waste'), which prevented operations from scaling-up.

The lack of data which supported a circular transformation, by highlighting the benefits, created another challenge, for policy-makers and investors. Engaging urban stakeholders in the creation of data-banks was suggested as a possible solution, however, the cost of collecting data was prohibitive. The retention of 'circular knowledge', by those engaged in projects, was also considered to be a problem.

Heavy reliance on civil society to deliver circular systems (circular food) and processes (ecological regeneration and tactical urbanism) in London was also identified as being an implementation challenge. This problem was further compounded by the fact there was public opposition to some circular activities (e.g. waste-to-energy and recycling plants). Problems identifying those institutions responsible for delivering the circular transformation (or preventing it) also posed a challenge to ecological regeneration.

Table 2. Challenges to circular development processes & systems.

Challenges		Circular construction	Ecological regeneration of brownfield site	Circular tactical urbanism	Circular food
Economic	Competition for space		✓	✓	✓
	Lack of local markets (supply and demand)	✓		✓	✓
	Low value circular actions, resources & ESS	✓	✓	✓	✓
	Transaction costs	✓	✓		✓
	Split incentive	✓	✓		
	Short timeframe for investment		✓		
	Additional costs	✓	✓		✓
Social	Risks to investors	✓			✓
	Public opposition				✓
	Retention of volunteers		✓	✓	✓
Information & data	Loss of capacity (social/human)			✓	
	Lack of data monitoring resource flows	✓			✓
	Lack of monitoring benefits of circular development		✓	✓	
	Knowledge retention			✓	
	Cost of data	✓	✓		
	Engaging groups in data collection			✓	
	Lack of long-term monitoring		✓		
Regulatory	Lack of regulatory framework	✓	✓		✓
	Difficulties identifying polluter		✓		
	Lack of punitive action/enforcement problems		✓		
Political	Limited public funding		✓	✓	
	Short-termism	✓	✓	✓	
	Competing political priorities		✓	✓	
Institutional	Reliance on community		✓	✓	✓
	Lack of institutional responsibility		✓		
	Institutional inertia to change	✓	✓		
Ecological	Long time frame for ecological regeneration and costs		✓		
Technical	Infrastructural issues				✓
	Lack of skills & expertise (amongst public, infrastructure & service providers)	✓	✓		✓

Source Author's own

Given the emphasis placed on the private sector to drive the circular transformation in London, a supportive regulatory framework is critical. It offers certainty and provides incentive for potential investors. In some cases, the regulation is absent (for circular construction and food reuse) and even where regulation exists, it is not always enforced as was the case for the ecological regeneration example. Regulations should require polluters and those benefiting from uplift in land value, to contribute financially to the site clean-up. These funds could be used for long-term maintenance or the adoption of circular systems beneficial to the local ecosystem (e.g. black-water recycling). Creating stronger regulatory frameworks for circular construction and food waste, could also help to generate markets for recyclates. It will increase the number of producers of food, bioenergy, compost, adaptable/ recyclable buildings.

A city-regional approach to circular construction and food, reinforced by the planning system and public procurement, could also create local markets for construction and food waste. Land-use planning could intervene in land markets, supplying sites long-term for circular activities. It could also place conditions on new development to ensure circular principles are adopted.

The cases also demonstrated that each circular system and process has its own set of unique challenges. For circular construction, the challenge is to overcome the institutional inertia to change in the construction industry. With the right regulatory framework and financial incentives this could be dealt with. For ecological regeneration the length of the process is the key challenge. The need for ongoing enforcement, monitoring and maintenance of projects is essential. However, a lack of public funding makes this difficult. Raising funds via development uplift taxation or requiring the polluter to pay for remediation could help.

The key challenge for circular tactical urbanism is the low value placed on circular activities. In space scarce environments, where public funding is limited, circular experiments fail to compete long-term. Land-use planning can intervene in markets to protect spaces for these activities. The greatest challenge for circular urban food systems is the scale of demand compared to local supply. This is compounded by the low value of food, land scarcity and the economic challenge of supplying communities cost-effectively from local sources. Regulation preventing food waste going to landfill and requiring food is reused, recycled or energy recovered, would help

to generate supply and demand locally. Furthermore, public procurement of the reusable food, recycle or energy produced would also stimulate demand.

Conclusions

The purpose of the paper was to determine the under-explored challenges to implementing circular development and more specifically circular systems (food and construction) and circular processes (tactical urbanism and ecological regeneration) in cities. The research confirms the accuracy of the framework developed using the existing literature. However, it identifies some additional implementation challenges and highlights that challenges will differ given the system/process on which we focus. Thus, the modified framework could provide a useful tool for identifying potential challenges to circular urban transformations. To improve its utility, further analyses of existing circular experiments, across a range of activities and contexts, could enrich our understanding of the barriers to implementation and help us to further develop the framework.

Data availability statement

Restrictions apply to the availability of the interview data. Data was obtained from third parties on the proviso the data was anonymized. Thus, data can only be made available with their consent.

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Institutional review board statement

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Informed consent statement

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