ELLEN MACARTHUR FOUNDATION

CITIES IN THE CIRCULAR ECONOMY: AN INITIAL EXPLORATION

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1. INTRODUCTION

At the heart of creativity, innovation and growth, cities play a central role as motors of the global economy. 54% of the world's population live in urban areas, and cities account for 85% of global GDP generation.[1] Cities are also aggregators of materials and nutrients, accounting for 75% of natural resource consumption, 50% of global waste production, and 60-80% of greenhouse gas emissions.[2]

In the coming decades, cities will be increasingly important as even greater rates of urbanisation are expected, and significant infrastructure investments and developments will be made. Cities could be uniquely positioned to drive a global transition towards a circular economy, with their high concentration of resources, capital, data, and talent over a small geographic territory, and could greatly benefit from the outcomes of such a transition.

As part of the Ellen MacArthur Foundation's ongoing research on the circular economy, this paper expands our understanding of the model in the urban context. This paper outlines some of the challenges cities are facing in today's linear economy, explores the alternative of a 'circular city', and collates our research to date on the benefits of a circular economy for cities. Finally, it outlines outstanding questions on the topic, suggesting possible avenues of research for the future.

1 World Bank, *Urban Development Overview* (March, 2017), http://www.worldbank.org/en/topic/urbandevelopment/overview

2 UNEP, *Resource Efficiency as Key Issue in the New Urban Agenda*, http://www.unep.org/ietc/sites/unep.org.ietc/files/Key%20messages%20RE%20Habitat%20III_en.pdf

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2. CHALLENGES OF THE LINEAR ECONOMY

Cities are operating within a global economic system that is based on the linear 'take-make-dispose' model, and the urban economy mirrors and amplifies the challenges of this model. These challenges are well documented across literature on the 21st century city, and those that are of particular relevance to the circular economy are discussed here.

A growing global population, largely concentrated in cities, and a rising urban middle class, have led to an increase in the demands and pressures on urban infrastructure and government resources, and an increase in the consumption of resources in cities. Combined with the lack of a holistic approach to urban management, this is leading to **economic losses as a result of structure waste** and **negative environmental impacts**.

Structural waste and economic losses: The linear economy is hugely wasteful: most of the value in materials we use is 'lost' to landfills, and the things we make are consistently under-utilised. This is amplified in the urban context where analysis has found significant structural waste in key sectors such as mobility, food, and the built environment. For example, in Europe, the average car is parked 92% of the time, 31% of food is wasted along the value chain, and the average office is used only 35–50% of the time, even during working hours.[3]

In urban mobility systems, congestion and the resulting time lost to traffic have negative impacts on city life and productivity; research shows that congestion related problems cost US drivers nearly USD 300 billion in 2016, with similar burdens felt across other global cities.[4]

The waste generated through these ineffective processes brings about additional costs due to waste management and collection spending which increases pressure on municipal budgets. In developing markets today, solid waste management and collection costs can sometimes reach 50% of municipal annual budgets.[5] This trend is projected to increase, with the annual global cost of solid waste management expected to reach USD 375 billion by 2025.[6]

Negative environmental impacts. The negative externalities of the linear model in cities include air, water, and noise pollution, the release of toxic substances, and greenhouse gas emissions. The following negative impacts have garnered particular concern from urban policymakers in recent years:

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3 Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, *Growth Within: a circular economy vision for a competitive Europe* (2015)

4 INRIX, *Los Angles Tops INRIX Global Gongestion Ranking* (2016), http://inrix.com/press-releases/los-angeles-tops-inrix-global-congestion-ranking/

5 World Bank, *Urban Solid Waste Management* (2016), http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/EXTUSWM/0,,menuPK:463847-pagePK:149018-piPK:149093-theSitePK:463841,00.html

6 World Bank, *Report Shows Alarmig Rise in Amount of Costs of Garbage* (2012), http://www.worldbank.org/en/news/feature/2012/06/06/report-shows-alarming-rise-in-amount-costs-of-garbage

- Greenhouse gas emissions. Urban areas are major contributors to greenhouse gas emissions (60-80% on a global scale)[7] despite the fact that they are often particularly sensitive to the impacts of climate change as 90% of urban areas are coastal.[8]

- Low air quality. Approximately 80% of urban areas have air pollution levels that exceed the World Health Organization's limits.[9] These conditions have adverse effects on cities that go beyond the direct impacts on human health; for example, in China, studies have shown that low air quality is undermining city competitiveness and is leading to a significant brain-drain from China's largest cities.[10]

In order to remain competitive, cities must be able to attract people, businesses, and diverse economic activity – the challenges described above are making it increasingly difficult to do so. These challenges are layered on top of a fragile socio-economic landscape, where cities in Asia are witnessing a welcome and rapid emergence of a middle class with spending power, and cities in the West are experiencing stalling growth and a middle class crisis, rising wealth inequality, and a corporate sector held in suspicion. These are symptoms of a dysfunctional economy and the need for change is increasingly evident, with cities on the frontline.

7 World Bank, *Urban Development Overview*, link: http://www.worldbank.org/en/topic/urbandevelopment/overview

8 C40, *Ending Climate Change Begins in the City*, http://www.c40.org/ending-climate-change-begins-in-the-city

9 World Health Organization, *Air Pollution Raising* (May, 2016), http://www.who.int/mediacentre/news/releases/2016/air-pollution-rising/en/

10 The Beijinger, *Bad Air Causing Beijing Brain Drain* (March, 2014), https://www.thebeijinger.com/blog/2014/03/26/bad-air-causing-beijing-brain-drain

3. THE CIRCULAR ECONOMY AND THE CITY

3.1 A POSITIVE APPROACH – A CIRCULAR ECONOMY

In response to a linear economy ripe for disruption, a circular economy holds the promise of prosperity that is restorative and regenerative by design. It is an approach to economic development designed to benefit businesses, society, and the environment. In contrast to the current linear model, the circular economy aims to decouple growth from finite resource consumption. It relies on three principles:

Design out waste and pollution. Reveal and design out the negative externalities of economic activity that cause damage to human health and natural systems. This includes release of toxic substances, greenhouse gas emissions, air, land and water pollution, traffic congestion.

Keep products, components, and materials at their highest value and in use. This means designing for re-use, remanufacturing, and recycling to keep components and materials circulating in and contributing to the economy. Circular systems favour inner loops to preserve more value, such as embedded energy and labour. Circular systems maximise use of bio-based materials, extracting valuable bio-chemical feedstocks and cascading them into different applications.

Regenerate natural systems. A circular economy enhances natural capital by encouraging flows of nutrients within the system and creating the conditions for regeneration of, for example, soil.

3.2 A VISION FOR A CIRCULAR CITY

A circular city embeds the principles of a circular economy across all its functions, establishing an urban system that is regenerative, accessible and abundant by design. These cities aim to eliminate the concept of waste, keep assets at their highest value at all times, and are enabled by digital technology. A circular city seeks to generate prosperity, increase liveability, and improve resilience for the city and its citizens, while aiming to decouple the creation of value from the consumption of finite resources.

A circular city will likely include the following elements:

A built environment that is designed in a modular and flexible manner, sourcing healthy materials that improve the life quality of the residents, and minimise virgin material use. It will be built using efficient construction techniques, and will be highly utilised thanks to shared, flexible and modular office spaces and housing. Components of buildings will be maintained and renewed when needed, while buildings will be used where possible to generate, rather than consume, power and food by facilitating closed loops of water, nutrients, materials, and energy, to mimick natural cycles.

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Energy systems that are resilient, renewable, localised, distributed and allow effective energy use, reducing costs and having a positive impact on the environment.

An urban mobility system that is accessible, affordable, and effective. A multi-modal mobility structure that will incorporate public transportation, with on-demand cars as a flexible last-mile solution. Transportation will be electric-powered, shared, and automated. Air pollution and congestion will belong in the past, and excessive road infrastructure will be converted to serve other needs of citizens. Central to vehicle design will be remanufacturing, durability, efficiency and easy maintenance.

An urban bioeconomy where nutrients will be returned to the soil in an appropriate manner, while generating value and minimising food waste. Nutrients could be captured within the organic fraction of municipal solid waste and wastewater streams, and processed to be returned to the soil in forms such as organic fertiliser – used for both urban and rural agriculture. Through urban farming, the city will be able to supply some of its own food, reusing food waste and sewage in closed and local loops to produce vegetables, fruit, and fish. Such a system could also provide a more resilient, diversified and cost-effective energy system in the city through the generation of electricity from wastewater, biofuels and biorefineries. These will offer additional revenue streams to the city, capitalising on the utilisation of material and nutrients that are already in use.

Production systems that encourage the creation of 'local value loops'. This means more local production, and increased and more diverse exchanges of value in local economies. Maker-labs (to encourage local production, repair, and distributive manufacturing), collective resource banks (to even out the demand and supply of materials) and digital applications (to broker the exchange of goods, materials, and services) would feature in these local, circular production systems.

3.3 HOW COULD THE CIRCULAR ECONOMY SUPPORT URBAN POLICY OBJECTIVES?

Based on previous research conducted by the Ellen MacArthur Foundation, circular economy principles applied to the city could support urban policymakers in achieving their objectives in a number of different ways.

- **Relieve pressures on municipal services and budgets.** A circular economy development path in Europe could result in a 32% reduction of primary material consumption by 2030, and 53% by 2050, compared with today.[11]Reduced primary material consumption and material intensity in the economy implies reduced spending on waste management. In addition, public expenditure on products to run public facilities could be decreased by procuring products or services offered through new innovative business models such as performance based business models.

11 Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, *Growth Within: a circular economy vision for a competitive Europe* (2015)

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- **Increase disposable income.** Across three sectors analysed in previous research (mobility, food systems, and the built environment), it was found that a circular economy development path could increase the disposable income of an average European household through the reduced cost of products and services, and a conversion of unproductive to productive time (e.g. reduction in congestion costs). The average disposable income for EU households would increase by EUR 3,000, or 11% higher than the current development path by 2030.[12]

- **Encourage an innovation-rich urban economy.** The aspiration to replace one-way products with goods that are 'circular by design' and create reverse logistics networks and other systems to support the circular economy is a powerful spur to new ideas, and could offer new sources for innovation in cities. Finding new ways for keeping components and materials at their highest value will encourage the development of new business models, and could create vibrant urban communities centred around makerspaces, repair cafes, distributed manufacturing, and sharing and exchange platforms.

- **Reduce carbon emissions.** Research conducted by the Ellen MacArthur Foundation has indicated for Europe, a circular economy development path could halve carbon dioxide emissions by 2030, relative to today's levels, and similar analysis conducted for India indicates that greenhouse gas emissions would be 44% lower in 2050 compared to the current scenario.[13]

- **Increase liveability.** Previous research indicates that circular economy activities can influence some aspects of liveability in cities. This includes reducing the time lost to congestion; in Europe, for example, a circular economy path for mobility systems could reduce time lost in congestion by close to 60% by 2050[14], and in India, a circular development path could lead to a reduction in vehicle kilometres travelled on roads by 38% in 2050.[15] In addition, circular economy activity (particularly in the built environment and mobility systems) could have a positive impact on indoor air quality (through the use of healthy materials in buildings) and could reduce air pollution (through more effective mobility systems). In a circular economy, less unprocessed waste in open-air dumpsites, and improved water and wastewater treatment processes could also increase liveability in cities.[16]

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12 ibid

13 Ellen MacArthur Foundation, *Circular Economy in India: Rethinking growth for long-term prosperity* (2016)

14 Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment,*Growth Within: a circular economy vision for a competitive Europe* (2015)

15 Ellen MacArthur Foundation, *Circular Economy in India: Rethinking growth for long-term prosperity* (2016)

16 Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment,*Growth Within: a circular economy vision for a competitive Europe* (2015), Ellen MacArthur Foundation, *Circular Economy in India: Rethinking growth for long-term prosperity* (2016)

- **Potential for positive impact on employment opportunities in the city.** Although more research and analysis is needed to determine the impact of the circular economy on urban employment, initial indications point towards a connection. For example, an analysis conducted on the city of London assessed that by 2036 a circular economy could provide London with 12,000 net new jobs in the areas of re-use, remanufacturing, and materials innovation.[17] Employment opportunities would not be limited to remanufacturing and growth within large corporations; the employment story in the circular economy could be rich and diverse with jobs created across industrial sectors, by the development of local reverse logistics, within small and medium enterprises, through increased innovation and entrepreneurship, and a new service-based economy.

3.4 ENABLERS OF AN URBAN TRANSITION TO A CIRCULAR ECONOMY

Cities will play a substantial role in a global transition to a circular economy. There are a number of factors that uniquely position cities to drive the global transition towards the circular economy and greatly benefit from the outcomes of such a transition:

Proximity of people and materials in the urban environment. One of the main characteristics of cities is a high concentration of resources, capital, data, and talent over a small geographic territory. This proximity can enable the circular economy in a number of ways. Reverse logistics and material collection cycles could be more efficient due to the geographical proximity of users and producers, creating more opportunities for reuse and collection-based business models. The proximity and concentration of people enables sharing and reuse models (where products or assets are used multiple times by different users, typically within a neighbourhood or smaller geographic unit).

Sufficient scale for effective markets. New circular economy business models are more likely to emerge and succeed in the presence of both a large and varied supply of materials, and a high potential market *demand* for the goods and services derived from them. Both conditions are most likely to be met in cities.

The ability of city governments to shape urban planning and policy. Local governments have a large and direct influence on urban planning, the design of mobility systems, urban infrastructure**,** local business development, municipal taxation, and the local job market. Therefore, local governments can play an active role in embedding the principles of the circular economy across all urban functions and policies. Experts estimate that on a global scale, 60% of the buildings that will exist in 2050 are yet to be built, and in emerging economies such as India, this figure reaches

17 London Waste and Recycling Board, *Route Map Charts Course to 2-8 Billion Economic Prize for London* (July, 2017), http://www.lwarb.gov.uk/route-map-charts-course-to-2-8bn-economic-prize-for-london/

70% by 2030.[18] Since these investments will largely need to be made in cities, it presents a massive opportunity for local governments to use their influence to apply circular economy principles from the outset for this infrastructure, which will help to avoid the 'linear lock-in' currently seen in developed markets (where there is a need to transform large parts of existing, entrenched infrastructure systems). Local governments can use demonstration and pilot projects at the local level as showcases in order to engage national and business actors in the process as well. Where there's a lack of leadership on the national or regional level, local governments have been seen to step in. In addition, research suggests that local leadership is more trusted by citizens, indicating a stronger level of possible influence.[19]

Digital revolution. Digital technology has enabled a fundamental shift in the way the economy functions, and has the power to support the transition to a circular economy by radically increasing virtualisation, de-materialisation, transparency on product-use and material flows, and feedback-driven intelligence. Through the collection and analysis of data on materials, people, and external conditions, digital technology has the potential to identify the challenges of material flows in cities, outline the key areas of structural waste, and inform more effective decision-making on how to address these challenges and provide systemic solutions. Technologies like asset tagging, geo-spatial information, big data management, and widespread connectivity have been identified as enablers of circular economy activity in cities.

18 NRDC-ASCI, *Constructing Change* (2012)

19 Gallop, *Trust in Government Trends*, http://www.gallup.com/poll/5392/trust-government.aspx

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4. FURTHER EXPLORATION

In this paper we have outlined some of the challenges cities are facing in today's linear economy, explored the alternative of a 'circular city', and collated the Ellen MacArthur Foundation's research to date on the benefits of a circular economy for cities. However, the exploration of the 'circular city' has just begun. Important questions still need to be addressed, and a structured evidence base needs to be developed in order to enable and encourage urban decision makers to drive the transition forward in the right direction.

These questions include:

- **What kind of economic activity will the circular economy generate in cities, and at what scales?** A key focus area for local policy makers is boosting job creation and encouraging economic development within their constituencies. Initial research suggests that the circular economy could lead to more jobs and entrepreneurial activity within the areas of remanufacturing, repair, logistics and services.[20] However, these are only initial findings, requiring further exploration and quantification. In addition, there has been limited discussion on the *kinds* and *quality* of jobs and economic activity that the circular economy transition could generate. There is also a need to explore the short-term and longer-term impacts on economic activity in cities, and who the 'winners and losers' will be of such a transition.

- **What role does the circular economy have in achieving the low carbon economy goals laid out by cities?** Carbon emissions are currently a major strategic focus area for local governments, and though high level results exist on the impact of circular economy activities on carbon emissions, cities need a greater evidence base and more nuanced narrative on the link between the two topics. This could strengthen the arguments and strategic decisions of local policy makers. As cities commit to moving towards a low carbon economy, a circular economy framework could offer a cohesive model for change.

- **How could a circular economy enable greater liveability in cities?** The 'liveability' of cities (often measured by factors as varied as stability, infrastructure, education, healthcare, and the environment)[21] is of great importance to local policymakers for attracting people and remaining competitive. Initial indications suggest that a circular economy will influence liveability positively, through the reduction of congestion, improved air quality, and the reduction of other forms of pollution. However, a more thorough and holistic analysis on the impact of a circular economy on liveability in cities is required, supported by the creation of a narrative on the citizen experience of a circular city.

20 WRAP, *Employment and the Circular Economy* (2015)

21 The Economist, *The World's Most Livable Cities* (2016), https://www.economist.com/blogs/graphicdetail/2016/08/daily-chart-14

- **How does circular economy activity create economic, social, and environmental resilience in cities?** The resilience of cities, as defined by organisations such as 100 Resilient Cities, is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow, no matter what kinds of chronic stresses and acute shocks they experience.[22] While circular economy activity has been seen to increase the resilience of business' to external shocks, an exploration of how circular economy activity could increase *urban* resilience to both shocks and stresses could offer insights into the role a circular economy plays in influencing the fabric of urban environments.

- **What tools and methodologies are needed in order to enable urban leaders to transition towards circular economy?** In 2015, the Ellen MacArthur Foundation published an actionable report - *Delivering the circular economy: a toolkit for policymakers* - for governments who wish to embark on a circular economy transition. Building on this work, there is an expressed need from local governments to get access to even more specific tools and methodologies that will enable them to begin their city-level transitions.

Over the next year, the Ellen MacArthur Foundation will address some of these key questions through its research on the impact of the circular economy in cities. As with any circular economy challenge, a broad collaboration of actors across the board will be needed in order to develop a comprehensive understanding of the pathway towards the circular economy transition.

22 100 Resilient Cities, *FAQ*, http://www.100resilientcities.org/100RC-FAQ/#/-_/

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