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Sustainable urban development and smart sustainable cities

A Guide to Circular Cities

Note by the Secretariat

Summary

The note includes a draft publication “Guide to Circular Cities”, which was prepared within the United for Smart Sustainable Cities (U4SSC) programme.

The Committee is invited to take note of the preparation of the Guide and to approve to publish it as an official publication in English and Russian in digital and print formats.

UNECE

A Guide to Circular Cities



UNITED NATIONS

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Introduction

The industrial evolution has pursued a linear model of production and consumption in which goods are manufactured from raw materials, sold, used (consumed), and then disposed of as waste. Services have also utilized tangible goods (alongside intangible resources) during their provisioning in a similarly linear fashion.

This linear model has been successful in providing affordable goods, services and resources to consumers and material welfare to a large extent. However, the linear model is material and energy intensive; it relies on economies of scale to produce large amounts of goods at minimal costs, and typically builds on more complex and international supply chains. This model of production and management of goods, services and resources encourages short-term consumption and it is leading the planet to a potentially unsustainable future. In this context, the concept of circular economy has recently emerged as an alternative to the linear model of production and consumption for economic activities.

The circularity concept can be extended beyond the sphere of economy. Cities are home to a staggering amount and variety of assets and resources. The efficiency of each item can be improved by applying circular design, bringing positive social, economic and environmental impacts at a much larger scale. Transitioning to a circular economy will also support city leaders to reach the Sustainable Development Goals and other global climate objectives.

Promoting circularity in cities is one of the strategic topics of the [United for Smart Sustainable Cities \(U4SSC\) Initiative](#) which is bringing together 16 UN agencies with the International Telecommunication Union (ITU), United Nations Economic Commission for Europe (UNECE) and UN-Habitat serving as the secretariat. The U4SSC's Key Performance Indicators (KPIs) for Smart Sustainable Cities (SSC) is one of the most effective tools to evaluate circularity in cities. The KPIs are an international standard which supports efforts of governments to evaluate cities' sustainability performance; the KPIs were endorsed by the UNECE intergovernmental Committee on Urban Development, Housing and Land Management (CUDHLM) (ECE/HBP/188 para 41) as well as by the ITU-T Study Group 5 "Environment, Climate Change and Circular Economy", which is global expert group under ITU that develops standards on sustainable and circular cities.

The UNECE is actively supporting national and local governments to improve circularity in cities. It conducts evaluation of performance of cities in the UNECE region using the KPIs for SSC, as well as implementing pilot projects and organising capacity building events to promote circularity in cities. The Smart Sustainable Cities Profiles for Goris, Armenia; and Voznesensk, Ukraine; prepared by the CUDHLM in 2017 and 2019, respectively, address key issues of circularities, such as management of solid wastes, promoting energy efficiency of buildings, reducing food waste, etc.

In April 2019, the UNECE held its sixty-eighth Commission Session with the overall theme "Smart Sustainable Cities: Drivers for Sustainable Development" where challenges of smart sustainable development of cities were discussed. The Session was preceded by the Day of Cities on 8 April 2019 that brought together over 400 registered participants, over 50 Mayors and deputy Mayors from 33 countries of the ECE region. During the two roundtables, Mayors and deputy Mayors shared experiences, challenges and achievements in making their cities smarter and more sustainable. The discussion highlighted that to meet the targets for urban-related SDGs, more opportunities and more direct engagement by local governments is needed at the international level and welcomed the Day of Cities as one such notable initiative.

This Guide to Circular Cities will be very useful for cities in order to be able to implement specific activities to promote circularity and urban sustainability.

About the study

This publication “A Guide to Circular Cities” (hereinafter, Guide) was developed within U4SSC programme under the coordination of the UNECE. The document explains the concept of “circular cities”, demonstrates positive impacts and challenges of the implementation of this concept and includes concrete recommendations for how to make cities “circular”. The Guide aims to increase awareness of policy-makers and experts about policies and issues surrounding circular cities and highlight various potential areas for implementation of the circular city concept in the context of SSCs as defined by the U4SSC programme. The Guide is complemented by 17 case studies which illustrate the application of the circularity concept implemented by cities or by countries at the city level.

Concept of Circular Cities

Challenges facing cities

More than half the world's population now lives in urban areas. In 2016, an estimated 54.5 per cent of human population lived in urban settlements and that figure is expected to rise to 60 per cent by 2030. These urban areas consume 75 percent of natural resources, produce between 60 and 80 per cent of global greenhouse gas emissions, and generate 50 per cent of all waste.

There were 512 cities globally in 2016 with at least 1 million inhabitants and by 2030, their number is projected to reach 662. In the same year, there were 31 “megacities”, that is, cities with more than 10 million inhabitants. The number of megacities is expected to reach 41 by 2030.¹ Hence cities play a crucial role in driving sustainability in production and consumption of goods and services.

Cities are dense and highly congested physical spaces that are prone to a myriad of challenges such as population increase, urban sprawl, climate change, environmental degradation, and fiscal pressures.² More than 80 per cent of cities in 2014 were located in areas that were vulnerable to high risk of mortality or economic losses associated with natural disasters or other environmental challenges. Demographic changes such as ageing populations, volatile economic growth, unemployment, low-wage low-skilled jobs, income inequality, social polarization and segregation are fuelling urban sprawl. Furthermore, the current consumption levels in cities are starting to exceed their economic capacity and biocapacity, ultimately affecting the well-being of all city dwellers.

Realistically, each city has its own unique characteristics and specific social and economic structure along with the associated challenges. Hence, it is important for cities to identify their starting points, or current status, with respect to circularity. The gap between the current state and the intended circular future creates an enormous innovation potential for cities and communities.

Stakeholders, including the public and private sector, NGOs, civil society and the city dwellers themselves can collectively work as partners to close this gap. Creating public-private-people partnerships (PPPP) through the involvement of relevant stakeholders is crucial for circularity. These partnerships enable innovative and alternative financing mechanisms for circular city initiatives. In addition, engaging and working with stakeholders through shared platforms to make the best use of cities' collective capital and to ensure inclusivity are also important factors for success.

Moving from a Circular Economy to a Circular City

This document attempts to identify a list of city assets and products that would broaden the circularity concept beyond economy to include different aspects of cities, hence the term “circular” cities. For example, public spaces in the city (which are not economic products but public assets) may be used for different social activities at different times (i.e., sharing public spaces as a city asset). Similarly, household items may be shared among individuals and households or reused for different purposes. These examples transcend economic activities and enhance city assets' utilization beyond economic ones.

The circularity approach proposed in this study is meant to increase the efficiency and effectiveness of city assets and products by extending either their own or their constituents'/components' utilization and lifetime. This increase is achieved by applying targeted action items (referred to as circular action items in this study) on city assets and products, such as sharing, recycling, refurbishing, reusing, replacing, and digitizing. Action items are a set of specific, discrete,

¹ United Nations Department of Economic & Social Affairs (UNDESA) Population Division (2016). The World's Cities in 2016 – Data Booklet (ST/ESA/SER.A/392)

² UNECE & ITU (2016). Striving for Sustainable Development Goals, United 4 Smart Sustainable Cities

outcome-orientated tasks that can be applied to the city assets and products to improve their utilization and lifetime.³ This document explains the purpose and vision behind a circular economy while providing an implementation framework on how to establish circularity within the context of cities.

Definitions of Circular Economy

The “Guide to Circular cities” does not provide a new definition for circular economy. Instead, it contains a list of existing definitions of circular economy to illustrate the concept.

In general, a circular economy is an economic system where products and services are traded in closed loops or ‘cycles’.

A circular economy is characterized as an economy, which is regenerative by design, with the aim to retain as much value as possible of products, parts, materials and resources.

Table 1 highlights some of the well-known circular economy definitions and interpretations.

Table 1

Definition of circular economy: some examples

Defitnition
<p>A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times while reducing waste streams. A concept that distinguishes between technical and biological cycles, the circular economy is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows, while reducing waste streams.</p> <p><i>Source:</i> Recommendations ITU-T L.1020: Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks</p>
<p>Circular economy refers to the “production and consumption of goods through closed loop material flows that internalize environmental externalities linked to virgin resource extraction and the generation of waste (including pollution)”.</p> <p><i>Source:</i> Sauv�, S., S. Bernard and P. Sloan (2016), “Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research”, <i>Environmental Development</i>, Vol. 17, pp. 48-56.</p>
<p>“Circular economy is an approach that would transform the function of resources in the economy. Waste from factories would become a valuable input to another process – and products could be repaired, reused or upgraded instead of thrown away”.</p> <p><i>Source:</i> Preston, F. (2012), “A Global Redesign? Shaping the Circular Economy”, Briefing Paper, London: Chatham House.</p>
<p>Circular economy “refers mainly to physical and material resource aspects of the economy – it focuses on recycling, limiting and re-using the physical inputs to the economy, and using waste as a resource leading to reduced primary resource consumption”.</p> <p><i>Source:</i> EEA (European Environment Agency) (2014), “Resource-efficient Green Economy and EU policies”, Luxembourg: Publications Office of the European Union.</p>
<p>“A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extracting the maximum value from them whilst in use, then recovering and reusing products and materials.”</p>

³ The action items will be explained more in details in the sections below.

Source: Mitchell, P. (2015), “Employment and the circular economy - Job Creation through resource efficiency in London”. Report produced by WRAP for the London Sustainable Development Commission, the London Waste and Recycling Board and the Greater London Authority.

Circular economy is “an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models”. The overall objective is to “enable effective flows of materials, energy, labour and information so that natural and social capital can be rebuilt”.

Source: Ellen MacArthur Foundation (2013a), “Towards the Circular Economy. Economic and Business Rationale for an Accelerated Transition” (<https://tinyurl.com/hzfrxvb>). - Ellen MacArthur Foundation (2013b), “Towards the Circular Economy, Opportunities for the Consumer Goods Sector” (<https://tinyurl.com/ztnrg24>). - Ellen MacArthur Foundation (2015a), “Towards a Circular Economy: Business Rationale for an Accelerated Transition” (<https://tinyurl.com/zt8fhxw>).

The circular economy is an economy “where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized”.

Source: European Commission (2015a), “Closing the loop - An EU action plan for the Circular Economy”, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM (2015) 614 final.

Circular economy in cities aims to create a sustainable system at city level that allows for the long life, optimal reuse, refurbishment, remanufacturing and recycling of products and materials.

This publication was developed within the programme United for Smart Sustainable Cities (U4SSC). The Guide explains the concept of “circular cities” and develops a methodology for the analysis of circular solutions and implementation of circularity approaches at city level. It also demonstrates positive impacts and challenges of the implementation of circularity concept and includes concrete recommendations for how to make cities circular.

The Guide aims to increase awareness of policy-makers and experts about policies and issues surrounding circular cities and highlight various potential areas for implementation of the circular city concept in the context of SSCs as defined by the U4SSC programme. The Guide is complemented with 17 case studies which illustrate the application of the circularity concept implemented by cities or by countries at city level.

A guide to circular cities

Components of the circular city implementation framework

The four components listed below constitute the key variables in the circular city implementation framework, that is, the necessary components that are needed to implement circularity in cities.

1. **City assets and products**, which encompass various city infrastructures, city resources, city goods and services available for use / consumption in the city.
2. **Circular action items**, a set of specific, outcome-orientated actions that can be applied to city assets and products that include sharing, recycling, refurbishing, reusing, replacing, and digitizing.
3. **Circular city outputs**, i.e. outputs of circular action items applied to city assets and products.
4. **Circular city enablers**, various supplementary and complementary items, which catalyze and support circular city approaches implementations.

1. City Assets and Products

Figure 1 presents various city assets and products classified into three categories, namely: city infrastructure, city resources, and city goods and services (as potential inputs to circular action items described in sub-section 2).

Figure 1

City assets and products categorization

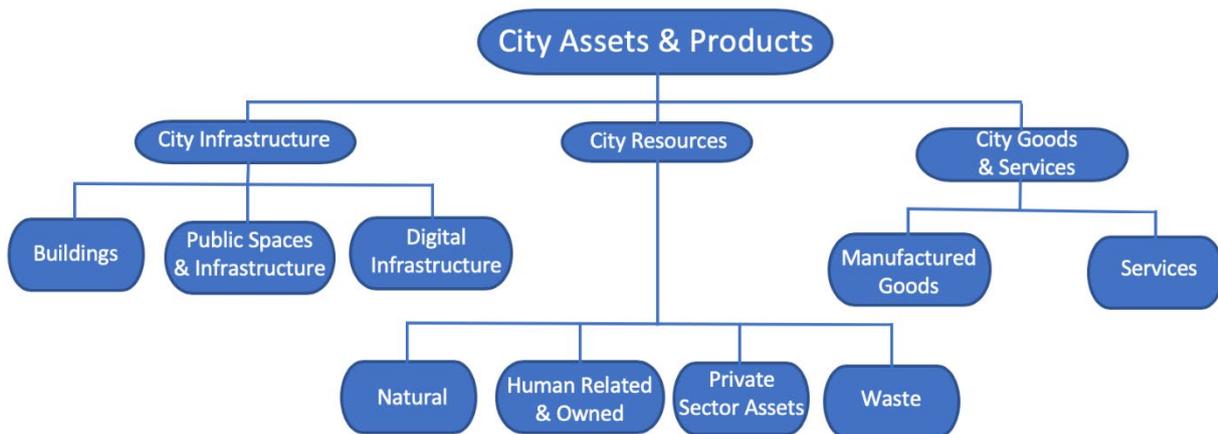
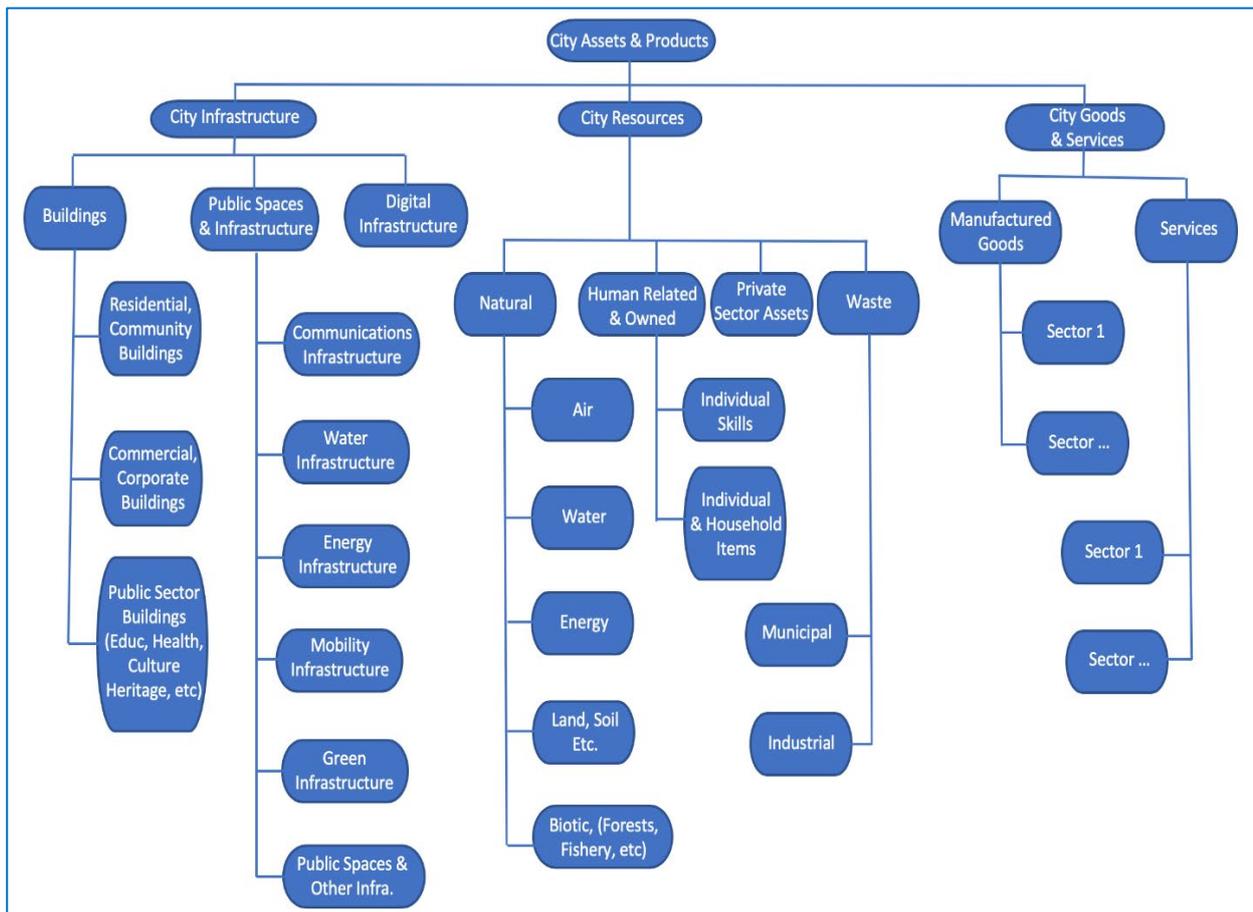


Figure 2 has further broken down the three categories hierarchically.

Figure 2

City assets and products detailed categorization



City Infrastructure: In this Guide, city infrastructure refers to buildings, public spaces and infrastructure, and the digital infrastructure available in a city (see figure 1).

- **Buildings:** Buildings serve various urban needs such as living and working places, storage place for belongings, and as shelter from weather and provide security. The types of different buildings in a city include residential, commercial, and public buildings such as healthcare, educational, religious, heritage, government, military, and civic buildings belonging to the public sector.
- **Public space & infrastructure:** Public space is an urban place that is generally open and accessible to people in a city. Some examples are public squares, sports fields, and beaches. Infrastructures are connective structures that enable people in a city to get the resources they need (e.g., from the environment) and bring them to the city or that enable flows or cycles in city.⁴ Infrastructure types in this deliverable include communications, water, energy, mobility and green infrastructures.
- **Communications infrastructure** includes telecommunications, radio, television, and Internet infrastructures (including analog and digital transmissions through various physical media such as copper, coaxial, fiber, etc.) in a city.
- **Water infrastructure:** includes supply, sanitation, and the management of clean, waste and surface waters including irrigation, drainage and collection in a city.
- **Energy infrastructure:** includes generation, transmission and distribution infrastructures for various available energy types (e.g. power plants, nuclear plants, hydroelectric dams, solar farms, wind farms, bio-energy systems, etc.) in a city.
- **Mobility infrastructure:** includes human and goods transportation and general mobility infrastructures (e.g. roads, airports, railways, ports, promenades, bridges, pavements, footpaths, bicycle paths, etc.) in a city.

⁴ City Anatomy: A Framework to support City Governance, Evaluation and Transformation

- **Green infrastructure:** is composed of natural elements brought into the city in a structured manner (e.g. parks, trees, horticultural areas such as gardens, etc.) in a city.
- **Digital Infrastructure:** Digital infrastructure includes foundational equipment and services needed for delivering digital services (excluding the communications infrastructure) in a city (e.g. data centers, information technology and data processing equipment and systems, cloud computing, etc.).

City Resources: A resource is defined in Oxford dictionary as a stock or supply of assets (money, materials, staff, etc.) that can be drawn on by a person or organization in order to function effectively. Included in city resources deliverable are natural resources, human related and owned resources, private sector assets, and waste in a city.

Natural resources are derived from the environment and are consumed in a city (e.g. air, water, energy, land and soil, and biotic resources such as forests and fisheries).

Human related resources refer to inherent qualities of individuals such as skills and knowledge. Human owned resources are various household items and other materials and goods owned and used by individuals.

Private sector assets are tangible assets owned by private sector organizations that are used to produce products in the form of goods and services. Private sector assets include machinery, warehouse items, company cars and various other tangible assets owned and used by the private sector organizations.

Waste is anything that no longer has a use or purpose and needs to be collected, potentially transported and discarded or disposed of. It includes municipal and industrial waste. Some examples of waste are household trash, wastewater, hazardous waste (e.g. containing hazardous chemicals) and radioactive waste (may require special processing and disposal).

General note on resources⁵: Resources can be broadly classified upon their availability; they are renewable and non-renewable resources. They can also be classified as actual and potential on the basis of their level of development and use, on the basis of their origin they can be classified as biotic and abiotic, and on the basis of their distribution as ubiquitous and localized. An item becomes a resource with time and developing technology.

Resources have three main characteristics: utility, limited availability, and potential for depletion or consumption.

City goods and services: City products include all economic goods and services consumed in a city. They include all economic sectors' and industries' products in the form of goods and services. They can logically be categorized by different sectors or industries (e.g., by SIC – Standard Industrial Classification⁶) within a city economy.

2. Circular Action Items

Circular action items refer to a set of specific, discrete, outcome-orientated tasks that can be applied to the city assets and products as shown in Figure 1 to improve their utilization and lifetimes. Sharing, recycling, refurbishing, reusing, replacing, and digitizing have been identified in this Guide as the potential circular action items.

I. Sharing: Sharing is the joint use of city assets and products. It refers to simultaneous or alternating use of inherently finite city assets and products.

II. Recycling: Recycling is the process of converting city assets and products into new materials and objects. Recycling can prevent the disposal of potentially useful materials (treated as waste) and reduce the consumption of fresh raw materials (that would otherwise be thrown away as trash). It is an alternative to "conventional" waste disposal that can

⁵ Source: Wikipedia

⁶ https://www.osha.gov/pls/imis/sic_manual.html. SIC has been subsequently replaced by NAICS (North American Industry Classification System) in USA.

save materials and help lower greenhouse gas emissions among other environmental impacts. It can reduce energy usage, air pollution (from incineration), and water pollution (from landfilling), etc.

III. Refurbishing: Refurbishing is about restoring an old city asset or product and bringing it up to date for further usage. Refurbishing entails collecting discarded products or materials that can be refinished and sanitized to serve their original functions. Refurbishment is often aesthetic in nature and results in a product that, although in good condition, may not necessarily be comparable with new or remanufactured products. Refurbishing or remanufacturing is a potential circular action that can be applied to extend city assets’ and products’ lifetimes. The process of refurbishing aims for existing city assets and products to be returned to 'like-new' or a better performing condition.

IV. Reusing: Reusing is the action or practice of using something again, whether for its original purpose (conventional reuse) or for a different function (creative reuse or repurposing) to extend the lifespan of city assets or products.

V. Replacing: Replacing refers to filling the place of or providing a substitute for a city asset or product. Replacement of city assets and products or their components may enhance their circularity potential in terms of extending their lifetimes and utilization.

VI. Digitizing: Digitization is the conversion of analogue or physical (tangible) products and materials to digital resources. City assets and products may be potential candidates for digitization to reach more customers, save on cost and reduce environmental impacts. Digitization is a form of dematerialization.

3. Circular City Outputs

When applying circular action items to a city asset, a circular city output is produced. There are many potential circular city outputs given the large number of city assets and products and the number of circular city actions identified in the previous two sub-sections. Hence, each entry in the below table is a potential circular city output.

Table 2

Potential circular city outputs

		Circular action items					
		Sharing	Recycling	Refurbishing	Reusing	Replacing	Digitizing
City assets and products*	Buildings						
	Public spaces and infrastructure						
	Air						
	Water						
	Energy						
						

* See figure 1.

For instance, the circular action item ‘reusing’ when applied to the city asset and product item ‘water’ could produce the potential circular city output ‘obtaining drinking water through desalination of sea water’.

Similarly, the circular action item 'sharing' can be applied to economy services. For example, a day care facility for children could be combined with that of elderly people by placing a day care centre in a nursing home.

Waste such as bottles, metal, footwear and plastic cups could be segregated into compostable and non-compostable then sell the non-compostable items to scrap dealers and compost the remaining items and sell to farmers. This is an example of application of the recycling and reusing circular action items to city resource household items.

The sharing action item can also be applied to public spaces. Public spaces can be used for alternating distinct purposes. For example, a public square can be used as a general place for public gathering and for various art events and festivals at times.

The above examples are given to illustrate the concept of circular city outputs. There are many more combinations of circular action items and city assets and products that can be used to generate circular city outputs.

4. Circular City Enablers

A circular city enabler is any entity that contains various supplementary and complementary functions, which catalyse and assist in circular city implementations. The following is the list of **enablers** that a city can use to assess, implement and boost its circular city outputs.

- a. **Circular KPIs and their baseline and target values**⁷ : Key Performance Indicators (KPIs) are useful for measuring progress and evaluating outcomes toward intended results. Prior initiatives have already been undertaken to define circular economy KPIs. Also, general city related indicators have been formulated some of which can be recast to emphasize circularity. Some examples of earlier formulated circular city related KPIs are indicated below:
 - i. U4SSC KPIs for Smart Sustainable Cities: The "United for Smart Sustainable Cities" (U4SSC) is a UN initiative coordinated by the International Telecommunications Union and the United Nations Economic Commission for Europe and supported by the Convention on Biological Diversity, the United Nations Economic Commission for Latin America and the Caribbean, the Food and Agriculture Organisation, the International Telecommunications Union, the United Nations Development Programme the United Nations Economic Commission for Africa, the United Nations Economic Commission for Europe, United Nations Educational, Scientific and Cultural Organization , UN Environment, United Nations Environment Programme-Finance Initiative, United Nations Framework Convention on Climate Change , UN-Habitat, United Nations Industrial Development Organization, United Nations University – Operating Unit on Policy-Driven Operating Governance, UN-Women and the World Meteorological Organisation to achieve SDG11.⁸ U4SSC serves as the global platform to advocate for public policy and to encourage the use of ICTs to facilitate and ease the transition to smart sustainable cities. The U4SSC developed a set of international KPIs for SSC to establish the criteria to evaluate ICT's contributions in making cities smarter and more sustainable, and to provide cities with the means for self-assessment in order to achieve the sustainable development goals (SDGs).⁹ A subset of these KPIs can be used as circularity indicators.
 - ii. Ellen MacArthur Foundation has undertaken a project called "The Circularity Indicators Project", provides a methodology and tools to assess the performance of a product or company in the context of a circular economy. The project has published a toolkit and methodology for circularity indicators.¹⁰
 - iii. ISO 37120: ISO has developed 37120 under the ISO/TC 268 to help cities measure their performance in improving quality of life and sustainability.¹¹ Some of the KPIs in ISO 37120 can be utilized in the framework of circular cities (e.g., waste management related KPIs).

⁷ This U4SSC deliverable will not develop or identify circular city / economy KPIs. Rather, it will encourage utilizing applicable existing KPIs.

⁸ <https://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx>

⁹ <https://www.itu.int/en/publications/Documents/tsb/2017-U4SSC-Collection-Methodology/index.html>

¹⁰ <https://www.ellenmacarthurfoundation.org/programmes/insight/circularity-indicators>

¹¹ ISO 37120 briefing note: the first ISO International Standard on city indicators

- iv. ITU through its ITU-T Study Group 5 has developed a series of international standards to help cities assess their sustainability including Recommendation ITU-T [L.1440: Methodology for environmental impact assessment of information and communication technologies at city level](#).
- v. The circularity concept can be extended beyond mere economy to cities in a much broader context. Cities are home to a staggering amount and variety of assets and resources. In this context, circularity poses an enormous potential for enhancing their efficient and effective usage with significant positive social, economic and environmental impacts.

There are several other circularity indicators developed by different organizations addressing various aspects of circularity¹². Cities can explore existing circularity indicators to determine which ones would be applicable to them in their own context. In addition, the implementation framework depicted in this document is flexible enough to incorporate other specific KPIs which can be formulated by cities themselves for their circularity implementations. Additional KPIs can be considered to be included during implementation by a city.

- b. **Awareness of circular city initiatives/action items:** The success of circular city initiatives depends largely on the awareness of their stakeholders. The uptake of circular city initiatives/action items is highly dependent on city-wide awareness and adoption by their potential users. Promoting and explaining their benefits may help change cultural and behaviour towards them.
- c. **Training and circularity skills enhancement programs:** Targeted skills enhancement programs may help in institutionalizing circularity in cities. Academic programs (e.g., university degrees and courses, related curricula changes) will help to enhance circularity skills through formal education. Vocational and professional training programs could also help in this aspect. Moreover, sharing and disseminating circularity related publications, reports, research, etc. may also help in further developing circularity related skills. These programs and initiatives help in creating highly skilled human capital for implementing circularity actions at the city level as well as bridging skills and expertise gaps that have been a major obstacle towards circular economy.
- d. **Instilling trust, safety, and security for sharing implementations in cities:** Circularity includes sharing action item applied to various city assets and products. The sharing action item may be applied both to commercial items or products (e.g., AirBnB for shared accommodation or Uber for ride sharing) and non-commercial ones (e.g., sharing of household items on a complementary basis in a city among its inhabitants). In sharing, it is important to instill trust among city users. Hence, in sharing services, service providers should ensure that they address the concerns of their customers, protect their rights, and provide them reliable and high-quality services to gain their trust. Additionally, it is important for these service providers to ensure the safety and security of shared city assets and products. Addressing issues consistently and reliably build trust over time for service providers. Additionally, it is important for the service providers to ensure the safety and security of shared city assets and products. Addressing such issues consistently and reliably build trust over time for service providers.
- e. **Urban industrial symbiosis:** Urban industrial symbiosis is a subfield of industrial ecology that engages separate industries in a collective approach to gain competitive advantage involving physical exchange of materials, energy and services among them.¹³ In particular, waste resulting from a generic production process can be used as primary inputs (materials or energy) for other production processes. This allows creation of closed loops within and across industries which in turn enhances circularity for cities.
- f. **Circularity related strategic planning and policy making:** A holistic circularity strategies and policies led by the city administration can align city stakeholders to a common target and mobilize them for successful implementation. In the absence of city administration led strategies and policies, the private

¹² Circular Metrics Landscape Analysis - World Business Council for Sustainable Development May 2018

¹³ Industrial symbiosis for a sustainable city: technical, economical and organizational issues Vito Albino, Luca Fraccascia*, Tommaso Savino - International Conference on Sustainable Design, Engineering and Construction 2015

sector can assume a leading role in implementing circularity in the context of city economy. Impact investment and corporate social responsibility initiatives undertaken by private sector can also catalyse circularity in a city.

- g. **Utilizing procurement as a lever for circularity:** Procurement is a strong lever to emphasize and enforce circularity for both the public and private sectors. It can be used as a tool to avail the supply of circular city assets and products during their procurement (e.g., raw materials, components, etc.). Procurement could act as an incentive to ensure circularity in the city.
- h. **Existence of financial incentives for boosting circularity:** City administrations and public sector organizations may utilize financial incentives to boost circularity in a city. Monetary (financial) benefits can be offered to consumers and suppliers of circular city outputs which could encourage their participation in circularity. Financial incentives include, but are not limited to, tax breaks, tax reductions, tax exemptions, tax holidays, lower loan rates, impact investment alternatives, excise taxes, VAT, etc. An alternative could be to provide financial disincentives for non-circular products (e.g. higher taxes for non-circular products and their suppliers), which in turn would act as indirect financial incentives for circular products and their suppliers.
- i. **Public Private Partnerships for circularity:** City administrations (public sector organizations) and private sector organizations may collaborate and form alliances and partnerships to implement circularity in the city. This approach would allow partners to align and unify their goals and share risks and rewards for circularity implementations. They can also complement each other's skills and resources.
- j. **R&D programmes for circularity:** Circularity provides an enormous innovation potential for cities in addressing some of their sustainability challenges. In some cases, further research and development would be required to turn circularity ideas into reality. Well-designed R&D programmes targeting actual city challenges conducted through academia, private and public sector organizations may help overcome various obstacles for circularity implementations.
- k. **Circularity regulations:** City administrations can issue various regulations and standards to boost circularity in the city. They may take the form of circularity related technical standards, product regulations, compliance standards, trade regulations, waste and safety regulations, etc. Regulations are in general ancillary or subordinate to laws. However, they are enforceable and therefore constitute a strong lever for circularity.
- l. **National laws and directives:** Law is a system of rules created and enforced through governmental institutions to regulate behaviour. Laws can take the form of legislation, directives, acts of parliament, etc. and they are influenced by the constitution. Laws can potentially be used as an alternative tool to change the behaviour of a society towards circularity (in general, laws are made at the national level rather than city level).
- m. **Certifications for circularity:** Cities can leverage on existing certifications or create new ones to encourage and incentivize circularity. Certifications rely on well-defined standards which are verifiable. Certifications are voluntary, rather than required or mandated; however, they can provide a competitive advantage for certified organizations. They are an indicator of compliance to well-defined standards or criteria and are usually issued by a credible third party after an independent auditing process.
- n. **Engagement and participation of stakeholders:** It is important for cities to engage and ensure the participation and inclusivity of their stakeholders during the formulation and implementation of circularity initiatives/action items. It would be highly beneficial for cities to maximize the collective city capital through close collaboration with the public and private sectors, academia, individuals (public), NGOs and civil society in general for circularity. Collaboration platforms can be used by cities to ensure broad engagement.
- o. **Circularity related city innovation ecosystem:** Fostering a robust and productive ecosystem will help boost circularity in cities. Entrepreneurs can be encouraged and incentivized to establish start-ups for addressing circularity challenges in cities. Accelerators and incubators can be utilized to flourish and support circularity related SMEs. City circularity challenges can be posed as business opportunities to

be addressed by the members of city innovation ecosystem. City circularity challenges would constitute concrete demand to be met by entrepreneurs and SMEs in the city innovation ecosystem.

These four framework components are the key variables for formulating circular city strategies. The next section details the methodology and the necessary steps for achieving circularity in cities.

Implementation Framework for Circular Cities

This section describes the four-step circular city implementation methodology according to the four components described above. This methodology uses an action-oriented, pragmatic approach which emphasizes on implementation.

The methodology includes four steps:

1. Assessing current circularity (baselining);
2. Prioritizing and determining future circularity;
3. Catalyzing circularity;
4. Assessing projected circularity impact.

Each of the four steps is explained below.

Step 1: Assessing current circularity (establishing a baseline)

This step entails conducting a swift baseline audit which determines the status of a city with respect to its circularity. More specifically, it evaluates a city's baseline with respect to the following three components:

- a. Key performance indicators (KPIs) related to circularity of cities;
- b. City-level circular initiatives and relevant action items;
- c. Various circular city enablers to assist in implementation.

Each of the above components is explained briefly below.

a. Baselining based on existing circular city KPIs

This component includes actual KPIs formulated and being acted upon by a city towards achieving its various circularity targets.¹⁴ Evaluation of cities' performance using the KPIs may guide the implementation of the circularity approach; not only to measure performance of circular city initiatives but also to monitor their progress. Some examples of circularity related KPIs include percentage of wastewater receiving treatment, percentage of solid waste recycled, percentage of renewable energy consumed in the city, etc. Cities can further define other circularity KPIs at the sector / industry level such as percentage of refurbished, remanufactured, reused, recycled, shared materials and products, etc. Potentially, all circular city outputs defined in this document can be associated with circularity KPIs.

The following table indicates a simple approach that a city can use to collect data according to the KPIs and evaluate progress on the circularity.

City circularity key performance indicator (KPI)	Baseline value (if known)	Target value and timeframe (if known)	Measurement frequency	KPI owner	Comments
KPI 1					

¹⁴ <https://www.itu.int/en/publications/Documents/tsb/2017-U4SSC-Collection-Methodology/index.html>

KPI 2					
.....					
KPI N					

b. Ongoing circular city list of initiatives / action items

This component includes actual initiatives/action items formulated and implemented by a city towards achieving its circularity targets. For some cities, these initiatives/action items may have been formulated to achieve circularity KPIs used by the city or they may have been undertaken as part of the city’s overall approach to implementing circularity (e.g., pilots, trials, strategic projects, etc.) and may reflect its own particular urban needs. In some cases, they may be national level initiatives being implemented at the city level (or local level).

It is common that multiple initiatives / action items be implemented at the same time to achieve circularity targets.

The following table indicates a simple approach that a city can use to collect a list of circularity initiatives / action items.

City circularity initiative / action item name	City circularity KPIs (if any)	Brief explanation	Milestones	Owner	Comments
Initiative/Action item 1					
Initiative/Action item 2					
.....					
Initiative/Action item N					

c. Enablers

Circular city enablers were defined earlier in section 5. The utilization of these enablers is projected to elevate the likelihood of success for a city in implementing its circular initiatives / action items.

A simple table incorporating the above-mentioned enablers is shown below. It can be used by a city to assess its current status or baseline with respect to its circularity implementations. The questions in the table may require further clarification and description by the city to determine its current status.

Assessment Element	Currently exists	Brief description	Comments
Are there awareness programmes for circularity related initiatives in the city?	<input type="checkbox"/>		

Are there skills boosting programmes to enhance and enrich circularity knowledge in the city?	<input type="checkbox"/>		
Are there existing certification programmes in the city for circularity related implementations?	<input type="checkbox"/>		
Is there a vibrant and rich innovation ecosystem in the city to address and implement circularity related implementations?	<input type="checkbox"/>		
Are there regulations and laws (e.g. laws, directives, legislations, standards) supporting or impeding circularity related implementation projects in the city?	<input type="checkbox"/>		
Are there established trusted intermediaries (or plans in place) for sharing initiatives in the city?	<input type="checkbox"/>		
Are there circularity related existing strategies and policies in the city public and private sectors?	<input type="checkbox"/>		
Is procurement utilized as a lever for circularity related implementation projects?	<input type="checkbox"/>		
Are there mechanisms in place to ensure the security and safety of shared city assets and products?	<input type="checkbox"/>		
Are there existing collaborations and partnerships in place among city industrial organizations for circularity implementations?	<input type="checkbox"/>		
Are there existing skills in place within public and private sectors to implement circularity?	<input type="checkbox"/>		
Are there existing PPP style partnerships in the city for circularity related implementation projects?	<input type="checkbox"/>		
Are there existing R&D programs and other targeted academic programs for	<input type="checkbox"/>		

circularity related implementation projects?			
Are the city stakeholders currently aware of circularity initiatives / action items in the city?	<input type="checkbox"/>		
Are broad stakeholders defined for city circularity initiatives / action items?	<input type="checkbox"/>		
Are the stakeholders in the city engaged broadly for circularity related implementations?	<input type="checkbox"/>		
Is there an established financial framework that is able to promote city circularity implementation?	<input type="checkbox"/>		
Are there existing financial incentives in the city for circularity related implementation projects?	<input type="checkbox"/>		

Step 2: Prioritization and determination of the future circularity

Having assessed its status in Step 1, the city can then formulate its own circularity initiatives / action items. The city can engage a broad range of stakeholders to not only define the city's own circularity priorities and needs but also determine a long list of circularity ideas for implementation.

The potential list of circular city outputs (i.e., different combinations of circular city action items applied to city assets and products) can assist in identifying a list of potential circularity innovations in the city. Specific city needs and priorities may help emphasize certain circular city outputs among the potential ones or conversely deemphasize / eliminate others. Each city may have to go through this exercise based on its own context, aspirations and goals. This Guide defines an output as an individual result of an action taken within the implementation framework in regard to furthering city circularity.

Another important input to this step is to compare to the benchmarking of other cities' successful circularity initiatives/action items. The city needs to be careful in assessing the applicability of international benchmarks as the context of cities and their particular aspects may vary significantly.

In this step, a long list of circularity initiatives/action items can be formulated for implementation. It is recommended that a city utilizes its collective capital extensively to come up with various ideas contributing to circularity in its own urban context.

Circularity prioritization approach

The city might not be equipped or may lack the requisite resources to implement the list of circularity ideas in its entirety. In such cases, a prioritization mechanism will be highly beneficial. A pragmatic prioritization approach used in this implementation framework has two main criteria. The first criterion is the value which identifies the projected value of the circularity idea. The second criterion identifies the projected ease of implementation of the

circularity idea in the city's own context. Each criterion is composed of several sub-criteria which are briefly explained below.

i. Value

- The degree of alignment with the city circularity vision and strategy: This sub-criterion refers to circularity idea's overall fit to a city's existing circularity vision and strategy, (if it exists).
- City circularity KPI(s) impact: This sub-criterion indicates the extent of circularity idea's contribution to existing circularity KPI(s) in the city (if any).
- Social impact: This sub-criterion assesses the impact of the circularity idea on people and communities in the city. It would include issues such as people's lifestyle, culture, participation and engagement, health and well-being, personal freedom and privacy, concerns and aspirations. It is also important to assess whether it impacts the entire city or a subset of the city inhabitants.
- Economic impact: This sub-criterion assesses the impact of the circularity idea in the city's economy. Economic impact can include issues such as a city's Gross Domestic Product (GDP), employment, wealth, disposable income, labour force skills, among others.
- Environmental impact: This sub-criterion assesses the impact of the circularity idea in the city's overall environment. Environmental impact captures effects of the circularity idea on urban natural environment and resources (e.g., city water, energy, emissions, air, land, waste).

ii. Ease of Implementation

- The cost of implementation: This sub-criterion measures the total cost and requisite financial resources for implementing the circularity idea.
- The timeframe of implementation: This sub-criterion refers to the total implementation time of the circularity idea.
- Implementation risk: This sub-criterion encapsulates various risks which may potentially arise during the implementation of the circularity idea. The following factors may help in assessing various risks.
 - "PESTEL" barriers: This factor captures the political, economic, social, technological, environmental and legal (PESTEL) barriers which exist in the city and may hinder circularity.
 - Complexity: This factor reflects the complexity of implementing circularity in terms of number of stakeholders involved, various uncertainties involved in implementation, dependencies and connections to other initiatives/action items in the city, among others.
 - Availability of competence and knowledge for the implementation: This factor includes the extent to which the circularity can be implemented by harnessing existing knowledge and skills in the city.
 - Health and safety concerns: This factor entails various concerns and ramifications related to health and safety aspects within the city regarding circularity.
 - Ethical issues: This factor captures various ethical concerns which may potentially arise during and after the implementation of the circularity idea.

The city can use a simple scoring system for various criteria and sub-criteria. For example, a simple three level (low, medium, high) or a five-level scoring system can be adopted by the city to determine priorities. The scores can be determined either quantitatively or qualitatively based on available data and conducted analyses. Having a well-defined prioritization approach helps cities facilitate their relative scoring among the circularity ideas.

The city can apply the prioritization approach described above and can evaluate all formulated ideas.

Figure 2
Evaluation of circular city action items

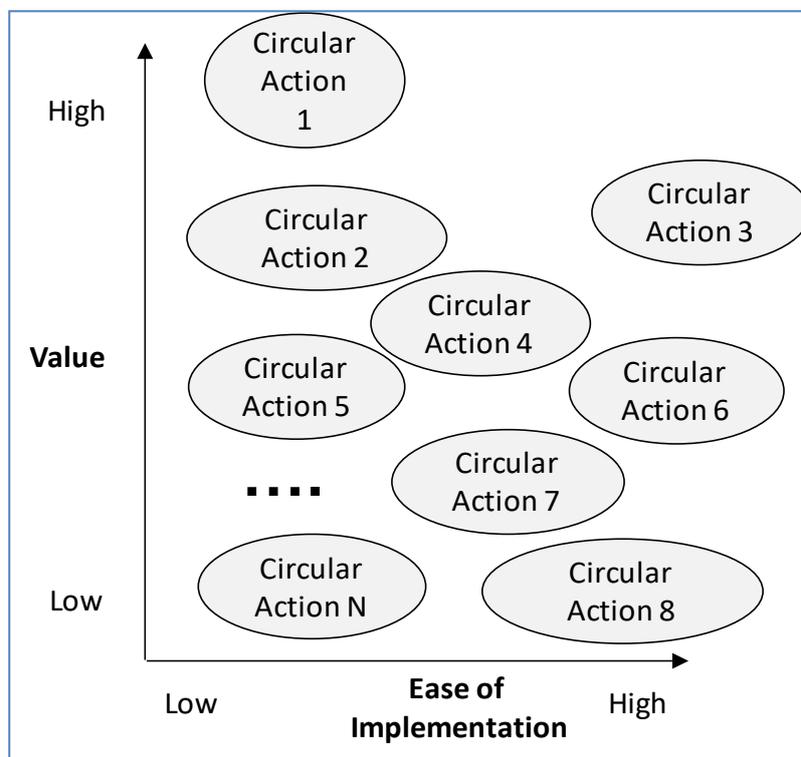


Figure 2 shows how the prioritization approach can be used to facilitate the selection of a subset of circularity ideas by applying the two criteria value and ease of implementation). The city administrators can subsequently short list circularity ideas that are high value and easy to implement. Similarly, low value and relatively highly difficult circularity ideas may be either eliminated or given low priority during the implementation process.

Hence, at the end of Step 2, the city will have a concrete list of circularity initiatives/action items for implementation. The city can then elaborate an implementation plan by deciding which circularity initiatives/action items to kick-off and when certain constraints such as resource availability may determine actual implementation timing. The circularity initiatives/action items can be phased out based on dependencies, constraints and their mitigation timeframes. In some cases, cities may choose to minimize implementation risks before commencing implementation.

Step 3: Catalyzing circularity

Some of the earlier discussed enablers can be utilized during this step to potentially enhance the effectiveness of selected circularity initiatives/action items for implementation. Annex II in this document provides a list of enablers that can potentially boost circularity in a city. The city can utilize an appropriate mix of enablers to implement its own circular initiatives. In other words, combinations of enablers can be used during the implementation. Some examples of potential enablers are given below to illustrate the concept.

Various tools that can be used to promote circularity by overcoming awareness gaps such as education and training programs, university programs, vocational programs to enhance skills and competencies; existing published materials in

this area such as publications which can be distributed and disseminated to the public as well as various related entities. Circular action items in different industries require specialized knowledge and expertise (e.g., e-waste management, refurbishing manufactured items, etc.). Expertise, knowledge, and even awareness of different circularity topics may not necessarily be readily available in cities. Hence, training and awareness programs could be beneficial to close such skills gaps.

Lack of skills and expertise in both the public as well as in policy makers can be a potential barrier. Hence, capacity building, peer learning and twinning among cities can be used as potential action items (policy levers). Formal professional programs in the form of skill building trainings may help build capacity for circularity. However, other mechanisms can also be used for this purpose. Experts and individuals knowledgeable about circularity may train potential and promising individuals in a city. Additionally, cities experienced in circular implementations may assist other cities who are keen to implement circular initiatives.

A trusted intermediary might be essential for various shared social and economic circularities and ensuring security and safety of shared resources would be of importance. Hence, organizations that provide sharing services need to provide reliable and responsible services. They should gain the trust of their customers by respecting their privacy and meeting their needs and expectations. They play a critical role as major players in matching supply and demand of sharing services in cities.

Cultural and behavioural (e.g., in recycling) aspects may pose barriers and it might be beneficial to inform and explain the benefits of circular actions to related stakeholders. In such cases, behavioural changes will be required from city inhabitants and circular service providers. Nudging techniques, targeted communication and various incentives may be utilized to induce behavioural changes in a city.

Urban industrial symbiosis initiatives may be utilized for exchanging resources at an industry, cross-industry or city level. Such resource flows between organizations, considered as by-products or waste, create significant benefits and opportunities. The by-products or waste of an industry could act as raw materials for another industry. This enables loop creation among industries by using each other's by-products or waste, consequently reducing industrial waste in a city and thereby contributing to circularity.

It might be beneficial to adopt a holistic high-level approach with circularity related strategic planning and policy making in public and private sectors. Cities as well as nations have developed circular strategies within their jurisdictions. Amsterdam is an example of a city that has formulated a vision and action agenda for the city and metropolitan area, recognizing circular economy as an important pillar in its sustainability agenda¹⁵. Similarly, Denmark and Scotland are examples of nations that have formulated circular economy strategies^{16 17}.

Procurement can be used as a lever for circularity (e.g., procuring circular materials). City governments have significant purchasing power in city economies. City procurement contracts may be prepared with a circular lens in mind. The case study "Development of a Circular Procurement Framework - City of Toronto – Canada" provides an example of using procurement as a lever for circularity. Procurement policies and particular procurement contracts can specify purchased goods and services to comply with various circular targets in a city. Aforementioned circular action items can provide guidance in formulating specifications for procured goods and services. Reuse, recycling, remanufacturing, etc. of materials, components and their packaging may be indicated during procurement. Procurement can play an important role in not only changing behaviour but in overcoming lack of circular economy markets as well.

Financial incentives can be used for boosting circularity (e.g., tax breaks, reductions, exemptions, holidays, lower loan rates, impact investment, etc.). Suppliers of circular goods and services can be made eligible to utilize these financial

¹⁵ <https://www.circle-economy.com/wp-content/uploads/2016/04/Circular-Amsterdam-EN-small-210316.pdf>

¹⁶ <https://groenomstilling.erhvervsstyrelsen.dk/task-force-oeget-ressourceeffektivitet>

¹⁷ <https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2016/02/making-things-last-circular-economy-strategy-scotland/documents/00494471-pdf/00494471-pdf/govscot%3Adocument/00494471.pdf>

incentives by obtaining tax breaks and exemptions. Favourable loan rates and green bonds can be used to assist suppliers of circular goods and services.

Public Private Partnerships and other appropriate financial mechanisms may be used to boost circularity. Circular action items have significant benefits and positive impacts; hence, both the public and the private sector have a favourable stake in achieving them. This allows forming public and private sector partnerships (PPPs)¹⁸ whereby costs and benefits of circularity are shared among them.¹⁹ The public sector can opt to utilize PPP as a procurement alternative for implementing circular city initiatives. PPPs require upfront systematic thinking about various circular implementation costs, benefits and their timing.²⁰ However, sufficient benefits and positive impacts exist in most cases to justify a PPP approach whereby incentives are aligned among the partners.²¹

R&D programmes may be formulated and implemented in collaboration with academia and the private sector to boost circularity.²² R&D programmes may be undertaken at city or national levels as well as at the regional level.²³ Circularity contains new areas of research, which require further exploration and development. R&D programmes may play a key role in enhancing innovation in circular cities and boosting intellectual property, which can then be put into practical use and potentially commercialized.

Regulations may be used as policy levers and tools to catalyze circularity implementation. (e.g., technical standards, product regulations, compliance standards, trade regulations, waste and safety regulations, etc.). Existing circular related regulations such as waste management regulations, industry (vertical) regulations (e.g. chemical regulations²⁴, CLP²⁵) need to be taken into account during implementation. Furthermore, new regulations, national laws and directives (legislation) may provide an enabling framework to encourage and boost circularity. At the city or national level, a supportive regulatory framework can direct the circularity processes and enable stakeholders to coordinate efforts and operate in an appropriate manner.

Certification programmes may be formulated to incentivize and encourage both the public and the private sectors for circularity implementations. Successful implementations would be recognized under certification programs and would encourage similar or novel implementations in a city.

Engaging a broad range of stakeholders may increase the likelihood of success for circularity implementations (e.g. public sector, private sector, academia, individuals, NGOs and civil society in general).

Nurturing a rich innovation ecosystem and involving and incentivizing entrepreneurs and SMEs to address circularity challenges would help boost circularity in a city. Incubators, accelerators, hackathons, etc. might be leveraged for enriching the city innovation ecosystem around circularity. Since circularity is predominantly a novel area which requires

¹⁸ Public- Private Partnerships Reference Guide Version 3, International Bank for Reconstruction and Development / The World Bank (2017)

¹⁹ Hongo, T. (2016), 'Circular Economy Potential and Public-Private Partnership Models in Japan', in Anbumozhi, V. and J. Kim (eds.), Towards a Circular Economy: Corporate Management and Policy Pathways. ERIA Research Project Report 2014-44, Jakarta: ERIA, pp.17-29.

²⁰ <https://pppknowledgelab.org/>

²¹ Ramanathan, K (2016), 'Public Private Partnerships and Implications for the Circular Economy: Corporate Management and Policy Pathways', Towards a Circular Economy: Corporate Management and Policy Pathways. ERIA Research Project Report 2014-44, Jakarta: ERIA, pp.201-222.

²² CIRCULAR ECONOMY RESEARCH AND INNOVATION - Connecting economic & environmental gains European Commission (2017)

²³ <http://www.interreg-danube.eu/approved-projects/moveco>

²⁴ Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

²⁵ Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

significant innovation, start-up and SME support would be highly important to increase the likelihood of its success in the long run.

Above examples illustrate a long list of potential enablers that can catalyse circularity implementations. Each city based on its own particular characteristics can formulate a set of enablers for its circularity implementations. The appropriate set of enablers can be selected based on their applicability, expected impact, cost and various other requirements.

Step 4: Assessing Projected Circularity Impact

This step involves either interim or final assessment of the results of implementing circularity initiatives/action items in a city. Cities are strongly recommended to retrospectively and objectively conduct assessments comparing actual outcomes with respect to intended ones.

If the city had adopted circularity KPIs with target values and target implementation timeframes for circularity initiatives/action items, it would be highly beneficial for the city to evaluate whether the targets have been met.

Similarly, the city can evaluate various enablers for their effectiveness during implementation. Gaps in them can be identified to address and correct in due course. Lessons learnt can be derived to understand positive and adverse consequences of circularity initiatives/strategic action items. Positive aspects of successful circularity initiatives may be potentially cross-utilized among other circularity initiatives/action items; for example, a successful policy in one initiative may trigger the use of a similar policy approach in another one. Such examples can be extended to other enablers as well. On the other hand, identification of ineffective enablers would result in their potential relinquishment in due course.

Circularity initiatives/action items are interventions in an urban context and inevitably lead to various transformations. Therefore, it is important to assess their impact retrospectively. An ex-post impact assessment would be highly beneficial to understand various social, economic and environmental changes that occurred in the city and compare them to the intended ones prior to implementation.

The comparison of ex-ante and ex-post impact assessments will indicate deviations in terms of intended and actual outcomes. Such deviations may aid in planning more accurately in due course or fine-tuning circularity initiatives / action items.

Now that these circularity implementing steps have been established, some case studies from around the globe are presented here to give a good insight into how these guidelines can be applied in the field.

Conclusions

Circularity in the context of cities is a relatively novel concept offering significant opportunities. This document has identified a generic approach by identifying a vast number of potential city assets and products together with a large number of potential circular actions. Their combination illustrates the substantial opportunity inherent in cities across the world. Some of the conclusions from the study are indicated below:

- Circularity concept extends beyond solely economic activities to other social and environmental ones.
- City assets and products can all be considered as potential inputs for circular actions.
- Circular cities optimize their resources consumption by extending their lifetime and by efficiently using them.
- Circular actions reduce waste in cities contributing significantly to the environment.
- Circular economy not only stimulates economic growth but also creates positive social and environmental impact.
- Circularity provides the innovation opportunity for cities and encourages entrepreneurship for new businesses and creation of new industries, as well as social and environmental entrepreneurship.
- Company, industry and cross-industry levels can be considered for circular economy implementations. Successful implementations may require adjustments in supply chains and may create new synergies within and across industries (e.g. industrial symbiosis).
- Circularity is a novel concept that necessitates a new approach in the way cities acquire, manage and consume their vast number of resources and assets.
- Circular cities contribute positively to achieving SDGs within their own context; and in turn contribute to their national implementations.
- The likelihood of success for circular cities is significantly increased by broad stakeholder engagement and participation.
- An appropriate mix of enablers (defined in this document) will be beneficial for accelerating and sustaining circular cities.
- Case studies demonstrate success stories by cities. Disseminating success stories and creating awareness among stakeholders will be critical to reach a certain scale in cities globally. Hence, local, national, regional and international cooperation will expedite the uptake of circularity in cities.
- Circularity can be used as a tool to address some of the global challenges faced by cities such as climate change, economic growth, scarcity of resources, etc.
- Circularity as a novel field requires investment in pertinent knowledge and skills enhancement as well as longer term R&D programmes.
-

Case studies

The case studies presented address the following circularity topics

Energy efficiency in buildings

Toronto: a case study of cooling systems for buildings using Deep Lake Water Cooling

City solid waste management

Spain: promoting recycling of municipal waste

India: recycling of plastic waste through use in road construction

Affordable housing, social inclusion

City of Vienna: House Sharing in Urban Areas as a Tool For Social Inclusion

Kirinda, Sri Lanka: Wild Coast Tented Lodge as best practice of building affordable housing using local construction materials

Urban mobility

Dubai: mobile solutions for ordering taxis and other transportation services, “E-hailing”

Reuse of consumer goods and tools loaning

Toronto: sharing/collaborative city, loaning home and gardening tools

London: Crystal Palace Library of Thing

Delhi: recycling discarded textiles to premium ware

Munich: Halle 2 second-hand store as a hotspot of the local circular economy

Finland: consumer goods and tools loaning

Decreasing food waste

Mumbai: collects surplus food at hotels and distribute to the poor

Oslo: Circular bioresources - treatment of food waste, garden waste and sludge from wastewater

Participatory urban planning

Melbourne: participatory planning of public spaces

Circularity to promote local businesses

Amsterdam: circular economy into the ICT industry effectively

Dubai: circular ICT devices and infrastructure

Toronto: circular procurement framework

Toronto Tool Library & Sharing Depot Case Study

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INTRODUCTION

BACKGROUND

Toronto is Canada's largest and most multicultural city. Beyond its diversity, Toronto is also home to one of the largest library systems with over 100 public library branches. These libraries provide a wide range of services including the loaning of books, magazines, CD's and DVD's in addition to free internet, skill building workshops, public meeting spaces and much more.

CHALLENGE AND RESPONSE

Toronto, like any city in the world, faces the challenge of living within the natural limits of the environment. Economic growth will inevitably collide with the finite natural resources on our planet and infinite consumption growth based on a finite amount of resources is simply unsustainable. In addition to growing carbon footprint, income inequality is also a raising concern in both Toronto and most areas of the world. Ensuring Toronto remains an affordable city is a challenge that needs to be addressed in all areas from housing and food to access to goods and services that ensure the city can sustain its cherished quality of life.

In this regard, a small group of passionate individuals launched a project that addressed both income inequality and environmental concern in 2013. The project was called the *Toronto Tool Library* and was modelled after the successful *Berkeley Tool Library* launched in the 1970s in California. The idea was to make a program that was both affordable and took on the problem of consumption by enabling people's access to a wide range of goods and tools that one only typically uses a few times per year. Through an annual membership, the public could access thousands of items instead of buying and storing these items themselves.

In 2016, the Tool Library expanded to include the *Sharing Depot*, a library for items beyond tools with a focus on children's toys, camping gear, party supplies, sports equipment and board games. Members of the public can purchase membership to either the Tool Library or Sharing Depot or get combined access with an upgraded membership.

The Toronto Tool Library and Sharing Depot integrates its individual and household items under the city assets and products; and applies the action item sharing as defined within the U4SSC "*Guidelines on strategies for circular cities*".

PROMOTING CIRCULARITY

VISION AND CONTENT

The Toronto Tool Library and Sharing Depot started with the assumption that there are already enough available resources to meet the demand of communities not only in Toronto, but also globally. While this statement can broadly apply to food (where we throw away approximately a third of the world's production), energy (where renewable energy sources can easily replace fossil fuel energy if political will allows for it) or virtually all consumer and industrial goods if they were designed and used in an environmentally responsible manner.

The Tool Library's goal was to provide homeowners, renovators, artists, makers, community groups and small businesses with the physical tools required to take on their projects. Rather than buying a full set of tools, which can take up lots of space in one's home and cost thousands of dollars, the Tool Library offers an affordable option for clients/members to borrow the tools they need instead of buying them.

The project was launched in 2013 (see below for further details about implementation) and since then has grown to acquire over 15,000 borrowable items across 3 locations in different neighbourhoods in the city. Over 99 per cent of the available items were donated by the public (virtually no items came from corporate sponsorship) and a small number of tools were purchased with grant funds from government. Later the same year, a makerspace was launched where members can use the tools onsite to complete projects rather than transporting them back and forth to the library. Both programs, the library and makerspace, generate revenue for the organization and the makerspace also hosts workshops to teach woodworking, electronics and other skills.

RESULTS

Overall, the Toronto Tool Library and Sharing Depot is satisfied with the results of the project at this stage. The project has created a great brand and is recognized amongst the city inhabitants for being an innovative programme that is inclusive and reduces waste. Since launching in 2013, over 80,000 items were loaned and generated over USD 750,000 in revenues. Each borrowed item has been donated earlier and therefore did not end up in a landfill. In addition, the item was not purchased by the user, generating less waste down the line. Some of the tools have been borrowed over 100 times each, resulting to several million dollars of saving for communities over the lifetime of the project.

At the same time, the Toronto Tool Library and Sharing Depot has stayed true to its values of maximizing the lifespan of their resources and supplying this abundance to people. The membership prices are less than the cost of even one of the items (memberships start at USD 55/year while the cost of a power drill can easily exceed USD 100) and Pay-What-You-Can memberships are offered to those who cannot afford the modest fees. Each week, a Free Community Night is hosted at the Makerspace where people with all skill levels can learn to use tools under the guidance of expert woodworkers and makers. This program did not exist before the project and the Toronto Tool Library and Sharing Depot is proud to have hosted thousands of people at the Tool Library through this programme alone.

In 2014, the Toronto Tool Library and Sharing Depot has been awarded the Live Green Toronto Award as the "Greenest Group".

An additional unforeseen benefit has been the significant media coverage garnered since launching the programme. Before opening the doors of the first location, the media found out about the project and newspapers and radio shows began spreading the word about the programme. Over the years it had over

100 media spots, promoting the programme and encouraging other groups around the world to launch their own libraries. There are now well over a hundred libraries similar to Toronto Tool Library and Sharing Depot in the world and in 2017 it hosted a Lending Library Symposium to share best practices to other groups and aspiring groups wanting to make a similar impact.

The social impact includes people's satisfaction and happiness about the programme, which contributes to equality and community spirit and brings people together and allows for knowledge exchange and skill-building.

The economic impact includes an increased disposable income for inhabitants due to reduced expenditures for tools; avoiding of unnecessary consumption and production due to infrequently used items; standardizations of tools-related expenditures through a fixed and fair price which is the same for all members who can afford it. It further allows diverting increased disposable income to better uses for the City's inhabitants.

The environmental impact includes reduced consumption and related production and packaging which leads to decreased GHG (Green House Gas) emissions; it also reduces waste in the city through sharing and repairing goods.

A. REFERENCES

- <http://www.fao.org/save-food/resources/keyfindings/en/>
- Main website of the initiative at <https://torontotoollibrary.com>

Sustainable sharing platform and facility for urban consumers

Author:

Heikki Waris

INTRODUCTION

BACKGROUND

Finland is a country of 5.5 million people with a high standard of living and level of consumption, which results in a high per capita carbon and material footprint. The situation is manageable due to low population densities, temperate climate, significant investments into infrastructure and services as well as the still powerful welfare state. The situation is even better in the Helsinki region with 1.5 million inhabitants thanks to its efficient public transport system and a more dynamic economy that can embrace new technologies and business practices faster than other cities. This “good life” makes it difficult for the government to pursue consumer driven solutions to sustainability challenges, and for the growing large cities to implement public sustainability objectives when developing new or city districts. The squeeze on public spending is making it difficult to utilize expensive, conventional solutions that require overhauling existing infrastructure and public services, especially when the consumption patterns change towards online and on-demand.

The traditional Finnish agrarian culture emphasized fair and sustainable sharing within the local village. However, 50 years after people migrated from smaller to larger cities in search of work, they have fully adopted a consumer mindset. The traditionally lively grassroots urban community initiatives, such as recycling, buying local food or local volunteering are struggling to appeal to the newer generations. It is easier to be active and contribute in social media than taking part in an organized activity with schedules and responsibilities. But recently even local communities that self-organizing using social media are facing difficulties as their communications get disrupted by the change of algorithms on the platform.

CHALLENGE AND RESPONSE

In cities, services keep concentrating in malls that are only accessible by car. Consumers would want to move into more sustainable and dense urban residential areas to avoid needing to drive to access social services. In rural and suburban areas, services disappear to nearby cities, and the local economy cannot sustain any new development projects except for areas destined to be suburbs for commuters. At the same time, people would like to tell themselves and others that they live sustainably and are good members of the society and the local “village”, even if they do not want to give up the lifestyle of a modern consumer.

CoReorient provides an online platform and a 24/7 physical facility that supports fair and sustainable local sharing by the local community, while accepting and adapting to the very hard constraints of society, public sector and consumer attitudes. The solution is made easy and convenient enough to appeal not just to sustainability-minded citizens, but also to the broader consumer user segments. By starting from a consumer goods rental and borrowing service (“tool library”) within a walking distance, people can be introduced to the concept and lifestyle changes of sharing and sustainability step-by-step, and critical support can be secured from stakeholders such as real estate companies. By providing multiple local and sharing economy services on the same platform, it is possible to achieve a critical mass of participants even with relatively low population densities and small geographical areas.

THE COREORIENT CIRCULARITY PROJECT

VISION AND CONTENT

The vision of the project is to improve urban sustainability by rebuilding the traditional local sharing communities with scalable tools and methods that match the demands of modern consumers. This exactly merges with the vision of the two co-founders of CoReorient to make sharing easy enough and fair for everyone in the local community, in order to achieve a massive reduction of CO2 and material footprint while also improving people's everyday life and social well-being. The platform effectively catalyzes the transformation of any urban environment and community towards a more sustainable future. This is fully aligned with public sector strategies that emphasize sustainable development and the empowering of local communities. The smart solution mainly provides three services: customized software implementation for companies; smart space and services for sharing tools and accessing local services; and a platform to crowdsource tasks or transport from neighbours or professionals.

The key elements of the solution are:

1. Smart 24/7 physical sharing facility accessible within a walking distance from local users;
2. Tool library service to secure stakeholder support and attract broad consumer segments;
3. Full-spectrum sharing platform and services: delivery pick-up point, peer rental, exchange and recycling of consumer goods, ride sharing and social deliveries, sharing of spaces, sourcing of volunteer or compensated help from neighbours, online store and associated storage for local products and services; and
4. Service delivery which encourages fair and sustainable people's behaviours and community building.

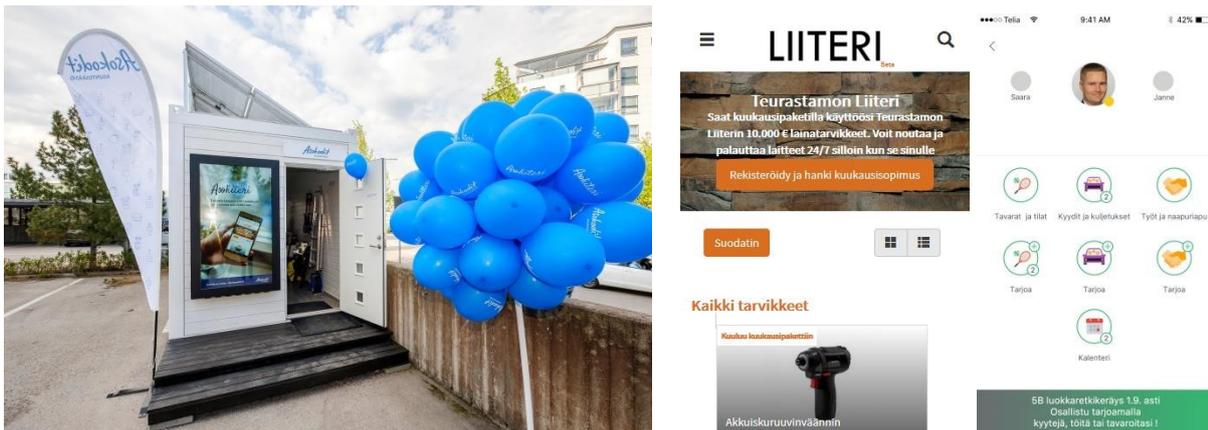


Figure 1: Smart 24/7 sharing facility, tool library service and more comprehensive local sharing platform
The key innovations are:

1. The solution can be accessible in a local community within walking distance
2. The small containers are provided by a facility that can deliver them anywhere globally
3. Integration of multiple peer-to-peer sharing economy services on the platform
4. Local businesses can integrate products and services on the platform; and
5. The solution includes user experience features such as interactive display, proximity access control, user data privacy with blockchain, closed user groups and joint accounts, and authorizations between users.

The whole project was created and evolved thanks to ICT tools (e.g. sharing economy platforms, online store platforms, application frameworks, embedded systems, electronic locks, custom tablets, blockchains).

RESULTS

The positive impacts of a local tool library include a reduced material and carbon footprints due to a decreased consumption and selling of goods and tools; a reduced need to drive outside the area to buy them; a reduced need for storage space; and improved maintenance and increased repairs of buildings and other due to a more affordable access to appropriate tools. The impacts of the other sharing services include a reduced traffic outside the area due to a local availability of services; providing support to people that need assistance when commuting; encouraging community building; and giving access to services for inhabitant of the town which otherwise would have been unaffordable or unavailable especially to vulnerable groups. In addition to the above, the platform includes other social impacts such as: building social cohesion; reducing inequality; and supporting people with less financial or other means to social services that are important to them.

The solution is designed to be sustainable without public support by operating on service revenues. Furthermore, its automation, standardized movable facilities and versatile software platform are designed to make it possible to scale it up even to small local areas. This makes it sustainable and replicable also in larger scale and in different geographies. The solution improves the efficiency and self-sufficiency of the local ecosystem and therefore also increases the resilience of the local area and the surrounding city.

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- Initiative website at <http://liiteri.net/>

London: The Library of Things

Author:

Tony Lee Luen Len

INTRODUCTION

BACKGROUND

London is currently in transition to being one of the world's most resource efficient cities with the Mayor of London's pledge to attain a 65 per cent recycling rate by 2030 and to be a zero-carbon city by 2050 (Ogleby, 2017). With the launch of a route map by the London Waste and Recycling Board (LWARB), more than 100 practical actions on reuse, remanufacture and redistribute materials have been made available to the city's stakeholders in order to help them and the city become more resource resilient. Moreover, this comes with a promise of new job creations in five areas of focus namely textiles, electrical, packaging, the built environment and the food industry (Greater London Authority, 2018).

These measures stem from the city's needs to shift to a circular economy, a more holistic alternative to the current linear economy, mimicking the natural ecosystems in order to help decouple economic growth from harmful environmental impacts (Ellen MacArthur Foundation, 2015).

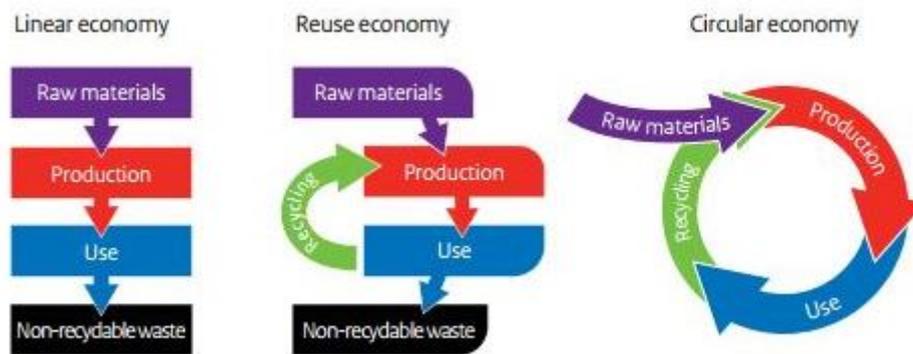


Figure 2: Illustration of different types of economy (Ministry of the Environment, 2016)

London's current waste situation is quite alarming. The local authorities are collecting about 3.7 million tons of waste, which correspond to 1,500 Olympic-size swimming pools filled to full capacity, while the recycling rates have gone back down to 2010 levels (Cole, 2017). With London's population expected to grow to around 10 to 13 million people over the next 30 years, an additional 1 million tons of wastes per year will have to be collected contributing greatly to the major threats posed by climate change and the rapid depletion of the world's resources.

In order to decrease the amount of waste produced and limit the effects of climate change, there should be a change in the consumer's spending habits as around 60 to 80 per cent of the environmental impacts on the planet originate from household consumption. According to a new study published in the Journal of Industrial Ecology, it was found that population's senseless consumerism contributes to 60 per cent of the global greenhouse gas emissions with a total land, material and water use of 50 to 80 per cent (Jacobs, 2016). This can be exemplified by the fact that people prefer to buy new items rather than repairing them.

This habit is fuelled by companies' profit-making strategies whereby products are less sturdy thus having shorter life cycle as testified by their short warranties. Moreover, in many cases, people find the cost of repair to be higher than the cost of buying a new one. For example, as reported by HomeAdvisor, the repair services for major appliances can charge between USD100 to USD250 an hour for labour excluding the price of spare parts and other service fees and taxes. For smaller appliances such as microwaves, the service charge can be around USD70 an hour with the addition of the cost of parts. However, most decent models can be purchased

for prices ranging from USD50 to USD100 (Rox, 2018). Even though it may sound profitable for the consumer and have an illusion of convenience, on the long term, the amount of money spent on a particular item is far higher as the frequency of replacement and/or repair increases.

CHALLENGE AND RESPONSE

The main external city trends that have influenced the Library of Things are:

- **Degradation of the natural environment and economic losses**
The economy as it is, relies mainly upon inexpensive and readily available natural resources. However, as the economic growth increases, the natural resources decrease drastically while carbon emissions and costs of productions get on the high side.
- **Regulatory trends**
More and more policymakers around the world are charging the cost of externalities through environmental taxes. As for example, the number of laws on climate change has increased by 66 per cent since 2009, going from 300 to 500 laws (LWARB, 2015).
- **The change in consumer behaviour**
As people's mindsets change, companies are forced to follow in order to remain competitive. For example, signs of a circular economy can already be seen in London with people consuming goods in alternative ways such as carpooling, reading e-books rather than hard copies, leasing instead of owning, cloud computing or shopping from flea markets and second hand stores (Greater London Authority, 2018).
- **The growing movement of the collaborative economy**
The collaborative economy is growing rapidly. Gross revenue in the EU from collaborative platforms and providers was estimated to be EUR28 billion in 2015. Growth in recent years has been spectacular with revenues almost doubling from 2014 to 2015. In 2016, a Eurobarometer poll showed that more than half of all EU citizens know about the collaborative economy, with one person in six already a user. Almost one third of people who have been on collaborative platforms have already provided a service at least once. That's more than 5 per cent of the EU population already providing products and services through such platforms. The collaborative economy is sowing the seeds of growth (European Commission, 2016).

The collaborative economy, also known as the sharing economy, includes a new and improved concept of flea markets and second-hand stores, where borrowing is encouraged over buying.

Originated in the United States, the Library of Things concept has been adopted in other countries such as the Sharing Depot in Toronto, Canada or Leila in Berlin, Germany. These have consequently inspired the cash-strapped university friends, Rebecca Trevalyan, James Tattersfield and Emma Shaw who were anxious to establish a sharing economy in their local community, to open up a Library of Things at the Upper Norwood Library Hub in Crystal Palace, South London (Library of Things, 2015).
- **Awareness campaigns**
Initiatives, such as the Transition Network, a community-led movement joining together to re-imagine and re-create the world in a more sustainable way, create, deliver and help implement sustainable programmes while connecting the local community. For example, the Crystal Palace Transition Town is helping the local community to reclaim the economy, to spark entrepreneurship and to re-skill themselves by weaving webs of connection and support (Transition Network, 2016).

In response to the trends listed above, the proposed solutions through the Library of Things project are the following:

- **Introducing the borrowing mindset**

The Library of Things has an extensive catalogue of carefully selected items in perfect condition that the members can borrow for a small fee mostly ranging from GBP 1 per day for hand tools and £5 per day for a bread machine to GBP 20 per day for a carpet cleaner with discounts available for regular borrowers and people who are less able to pay (Purdy, 2018).

- **Competitive prices and quick service**

When people need to borrow, for instance, a carpet for an event, they may have several choices: to buy a carpet cleaning machine (around GBP 130 upwards), to pay for a professional cleaning company (about GBP 40), or rent a machine from a private hire firm (around GBP 29 for two days) or to borrow from the Library one for GBP 9 (Balch, 2016). The Library of Things makes a variety of products accessible to everyone.

- **Reducing waste**

In order to avoid people dumping almost new items which have the possibility to be refurbished, the Library of Things set at the disposal of the community a space where the locals can bring their broken items which are then given a second life through the “repair café”. Furthermore, the repair café offers skill sharing classes where volunteers share their mending and repair knowledge to enable people to know how to repair future broken things in their household.

- **Training**

The Library of Things also provides technical training when an item is borrowed. As illustrated by the co-founder Rebecca Trevalyan, “If you haven’t used tools before then it can boost your confidence in having someone to ask questions from and demonstrate how you use it. You don’t get that with Amazon!” By doing so, the library is also performing a social function by saving people money they would otherwise spend on a handyman. The sense of achievement people feel once they’ve learned how to do something themselves is palpable, Trevalyan said, describing a lady who had never used a drill before as “beaming” when she returned it, having put her curtain rail up by herself (Early, 2017).

- **Reinforced sense of community for a greater impact**

As said by Emma Shaw, “the Library of Things “isn’t just about things – the ultimate goal is connecting people to each other”. Besides borrowing items of need, people can attend practical events such as DIY classes or mending meet-ups where skills are shared and acquired, and the communal spirit is strengthened (Lambeth Life, 2018).

PROMOTING CIRCULARITY

VISION AND CONTENT

The vision of the Crystal Palace Library of Things is to reduce consumerism by changing people’s mindset and behavior on waste reduction and prevention whilst reinforcing the sense of community through circular economy. The latter offers a sustainable alternative to the current linear economy which is considered to be incredibly wasteful as it relies on the use of virgin resources and the disposal thereof. On the other hand, a circular economy is one where resources are kept in use for as long as possible in order to extract the highest value from them by designing for re-use, re-manufacturing and recycling. This sharing economy is one of the most direct ways to cut down consumption and move towards a zero-waste economy thus sparing the planet the impacts of yet another fondue set which will inevitably end up in a landfill after years of gathering dust at the back of a cupboard (Vasil, 2016). This project is in alignment with the Circular London programme endorsed by the mayor of London which envisioned that by 2050, sharing, leasing, remanufacturing and reusing of products will be the norm in London. Consequently, it is predicted that London could make a benefit of at least £7bn per year by 2036 and according to the WRAP’s analysis, the city has the potential to create over 12,000 job opportunities in the circular economy sectors by 2030 (London Waste and Recycling Board, 2015).

Furthermore, the Library of Things of Crystal Palace was backed by the Transition Town movement to set up camp at the Upper Norwood Library Hub as this project integrates the Transition Town movement’s vision to

reduce the community’s carbon footprint in a sustainable manner while creating a strong sense of community.

The key features that make up the Library of Things are mainly the items available to the borrowers. These items, as opposed to other existing models of sharing platforms, are sourced primarily from companies’ sponsorships enabling the Library of Things to provide higher quality products than organizations proposing donated second-hand items. The items acquired through this system are catalogued on a wish list created according to the local community’s requirements and preferences which includes but is not restricted to tools, home appliances, board games or sport equipment.

One of their other main characteristics was the will of enabling the clients to have an “Apple Store-like” experience at the Library of Things while being as practical as Argos (a British catalogue retailer). The place was designed in this light as well as a lot of thought was put in finding the ideal location to integrate the Library of Things in the local community. The Upper Norwood Library, having worked in partnership with the Crystal Palace Transition Town, has welcomed the Library of Things to be part of its vibrant library hub. Therefore, one can now borrow books as well as a wide variety of practical items during their trip to the local library.

The membership programme to integrate the Library of Things is very straightforward:

i. Join

All that is required to join the Library of Things is an email and a bank card. It then takes 30 seconds to create an online account and to confirm your email.

Next a membership plan is chosen even if it is a pay-as-you-go plan. The following are the three plans offered:

Pay-As-You-Go Plan for just £1	Simple Membership at £15 for a 3-month plan	Concession Plan for those with low income or unwaged																														
<p>Pay-As-You-Go</p> <p>The lowdown</p> <table border="1"> <tr> <td>£1</td> <td>None</td> <td>Unlimited</td> </tr> <tr> <td>One-off fee</td> <td>Discounts on borrowing</td> <td>Membership duration</td> </tr> </table> <p>Thing prices (per day)</p> <table border="1"> <tr> <td>Hammer £1</td> <td>Waffle maker £3</td> <td>Drill £7</td> <td>Carpet cleaner £20</td> </tr> </table>	£1	None	Unlimited	One-off fee	Discounts on borrowing	Membership duration	Hammer £1	Waffle maker £3	Drill £7	Carpet cleaner £20	<p>Simple membership</p> <p>The lowdown</p> <table border="1"> <tr> <td>£15</td> <td>25%</td> <td>3 months</td> </tr> <tr> <td>Fee</td> <td>Discount on borrowing</td> <td>Membership duration</td> </tr> </table> <p>Thing prices (per day)</p> <table border="1"> <tr> <td>Hammer 75p</td> <td>Waffle maker £2.25</td> <td>Drill £5.25</td> <td>Carpet cleaner £15</td> </tr> </table>	£15	25%	3 months	Fee	Discount on borrowing	Membership duration	Hammer 75p	Waffle maker £2.25	Drill £5.25	Carpet cleaner £15	<p>Concession</p> <p>The lowdown</p> <table border="1"> <tr> <td>£1</td> <td>25%</td> <td>1 year</td> </tr> <tr> <td>Fee</td> <td>Discount on borrowing</td> <td>Membership duration</td> </tr> </table> <p>Thing prices (per day)</p> <table border="1"> <tr> <td>Hammer 75p</td> <td>Waffle maker £2.25</td> <td>Drill £5.25</td> <td>Carpet cleaner £15</td> </tr> </table>	£1	25%	1 year	Fee	Discount on borrowing	Membership duration	Hammer 75p	Waffle maker £2.25	Drill £5.25	Carpet cleaner £15
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ii. Reserve

The item needed is chosen and the required date and time of use is selected. A payment by debit or credit card needs to be made to confirm the reservation.

iii. Unlock

Present yourself at the local Library of Things at the time of reservation. Enter your details at the borrowing kiosk and the Thing requested will be automatically unlocked. A friendly volunteer host will be available to help.

iv. Borrow

The item is taken and used by the borrower along with the handy how-to guides and videos. At the end of the allocated time, the item is brought back on time to the Library of Things clean and with all its parts ready for the next borrower.

v. Participate

Members can join the practical events based on sewing, making, planting, up cycling and repairing or become a volunteer host, a thing fixer, a skill sharer or an ambassador for the Library of Things (The Library of Things, 2018).

Additionally, a 'smart lock' system has been developed to enable borrowers to pick up and drop off products when the staff is not around (The Library of Things, 2018). Along with their ambition of having a network of libraries throughout the country, this technology enables items to be available 24/7 and easily accessible on phones. "(Early, 2017).

ICT has had numerous roles in developing and running this project and these are:

1. Crowdfunding

For the crowdfunding campaigns, communication through web copy, social media, email and above all videos proved to be vital as people generally decide in a matter of seconds whether to leave or learn more (Johnson, 2015). The websites used for the crowdfunding campaigns of this project are Indiegogo and Kickstarter.

2. Website

As the world becomes more digitalized, having an active website is considered as one of the most important tools for any business. This has allowed the library of things to be known and to remain competitive within the industry. According to a study carried out by Nielsen, 85% of consumers will use the internet search engines to find a local business. Without an online presence, the project might not have been as successful (Black, 2018).

3. Membership

ICT was used in creating a membership program with online payment. The interested parties can easily sign up from anywhere and pay for their opted membership package instantly. This user-friendly feature renders signing up easier thus is considered highly encouraging for new members.

4. Online Catalogue

Members can access around-the-clock the Library of Things' online catalogue where they can browse through the available items at their ease and in the comfort of their homes. Once decided, they can book the items required online and pick it up on site at the said time.

5. Electronic receipts and reminders

Electronic receipts are highly recommended along with the printed receipt as the latter is more ephemeral than the former. Moreover, sending electronic reminders is a great tool to have, especially for lending services, in order to remind members when the items borrowed are due back and thus, not having to chase them down. For ease of convenience, the system can be set by default to send out reminders a day before an item's due date to the email listed on the corresponding borrower's file (Share Starter, 2012).

6. Inventory management tools

Even though a Library of Things can be started without this platform, exceeding a couple of dozens of registered members or items in the inventory can quickly become highly troublesome as for example, keeping track of everything on paper or by manually emailing one by one when items are overdue will be a hassle at best—and impossible at worst. One of the solutions is to join online platforms such as myTurn to help manage the library efficiently (Share Starter, 2012).

7. Social Media

Marketing through social media is becoming one of the most preferred marketing tools for business to reach their target audience. In fact, according to Statista, it is projected that by 2018, the number of people using social media across the world would be about 2.5 billion with a great majority of them checking these websites several times a day. Therefore, a presence of social media will significantly help the organization's exposure to the public as well as attracting more traffic to the

official website thus increasing the chance of people signing up for membership (Smith, 2018). The Library of Things of Upper Norwood currently has 3K followers on Facebook.

IMPLEMENTATION

The project has been implemented in different phases which are briefly described below.

Prototype

Inspired by similar projects such as Leila in Berlin or the Sharing Depot of Toronto, in 2014 the project founders launched a pilot with used and salvaged items in an unused community room at the West Norwood Library with the help of local volunteers. The venture was considered a success as they welcomed around 1000 people during the ten-week-trial period having only one open day per week. In total, over 100 persons donated something of their belonging and 1 in 3 returned to borrow an item (Library of Things, 2015).

2014...

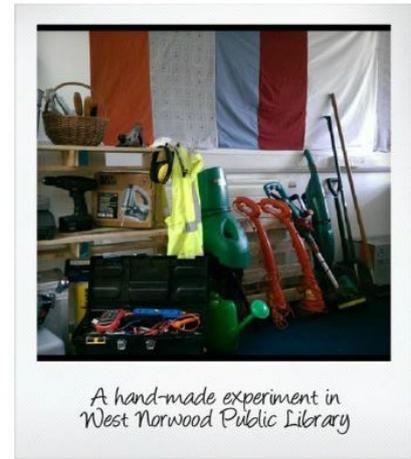


Figure 3: The initial experiment of the Library of Things

2016...



- Demonstrator

From there, after crowdfunding £15k from 250 backers on Kickstarter, the founders progressed to a South London carpark where they placed two retrofitted shipping containers meant to be the new venue of the Library of Things for the next 18 months. 350 items were sourced from companies like Bosch, Karcher, Berghaus, Patagonia and their local B&Q. These items were priced, catalogued, tagged and photographed before being put at the disposal of the public. Again, the project got a great response with about 850 people who came to borrow different items of their needs.

Figure 4: The Demonstrator Phase of the Library of Things

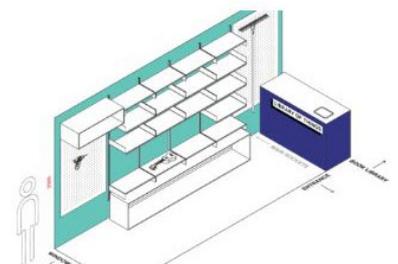
- Operation

Finally, with the guidance of Joe Duggan, co-chair of Crystal Palace Transition Town which is a grassroots network with a track record of building local sustainable projects, the team of the Crystal Palace Library of Things crowdfunded £9,375 from 291 people and organizations to get started in the community library, Upper Norwood Library Hub.

- Scaling Up

The Library of Things team is now looking to expand the new smart borrowing kiosk to nine other earmarked locations around the capital over the next three years and also to create a social franchise to assist other communities to open up their own Library of Things thus making the sharing economy a reality for everyone (The Library of Things, 2018).

2018...



A smart 'borrowing kiosk' displaying all 100 Things available to borrow, installed into existing community spaces like libraries and housing blocks.

For the successful operation of a Library of Things, a couple of several stakeholders need to be in symbiosis involved as per showed by the figure below.:

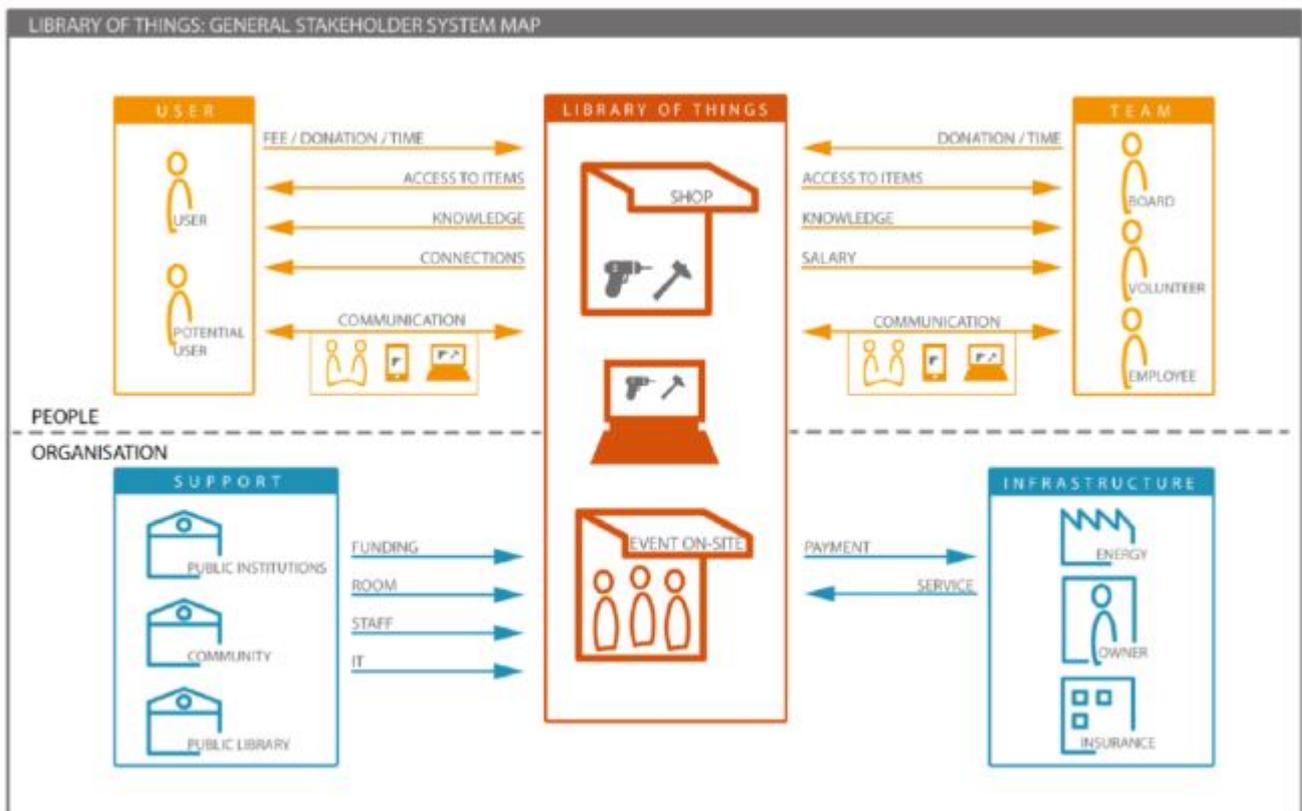


Figure 6: The Library of Things General Stakeholder System Map (Ameli, 2017)

RESULTS

The Library of Things has closed the gap between people’s willingness to share and the actual practice of sharing. Based on several surveys, it is found that existing sharing platforms are either inconvenient for users or require too much effort from the users during the lending process. Moreover, the users were found reluctant to share their belongings to strangers as it requires another level of trust especially through online platforms.

However, within the Library of Things, the sharing process is no longer dependent on users’ willingness to donate their personal belongings as items are sourced from other means such as from companies, enabling the Library of Things to provide high quality items to the users.

The user-friendliness of this system has already attracted over 850 members who already borrowed over 2,500 items throughout the course of the Library of Things’ short lifespan. With more people using the same things, the latter are being used more efficiently and lesser items are needlessly purchased. This will enable a significant decrease in the ecological impact as products consume a great amount of energy and resources over their lifespan i.e. during production, distribution, use and disposal. The Library of Things’ business model helps to significantly decrease the impact on the environment especially for products with high energy demand during the production phase. Besides the positive environmental impacts, this project also has a strong social impact as it acts as a social hub to the community by bringing people together through practical events such as skill sharing workshops or mending and repair classes.

Moreover, volunteering at the Library of Things or popping by to borrow something is also a great way of meeting one’s neighbours or to expand one’s contact network.

This sharing economy system also saves considerable amount of money to people of all social classes by enabling them to get access to high quality items which they would perhaps either not been able to afford buying or spend a ridiculous amount on money to own it and use it for once or a couple of times only. (Perchard, 2017).

Even though the Library of Things seems to be a working business model, Rebecca Trevalyan warned that the infrastructure in place to make things easier and to lower the operating cost is not sufficiently developed. There are still numerous challenges to tackle such as creating a feasible revenue model or a good organizational structure among others. However, the founders of the Library of Things remain confident in their project and are working on a franchise model to create a network of libraries and partners to replicate the Library of Things across the UK.

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Amsterdam: the circular district of Buiksloterham

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Nikolaos Kontinakis

INTRODUCTION

Nowadays, cities around the world are facing several challenges. Amsterdam, the capital of the Netherlands, is not an exception: rapid urbanisation is adding pressure to create more liveable cities, to manage natural resources more efficiently whilst protecting the environment, and to meet the challenges of climate change. Increasingly, cities are recognizing the importance of circular economy as a means of addressing these issues and making cities healthy and enjoyable places to live.

Since 2015, Amsterdam has been discovering the opportunities for circular economy in the city and metropolitan area alike. The municipality of Amsterdam has implemented two programmes geared towards the circular economy, and thus far, over 70 circular projects have been completed. These efforts have been recognized and evaluated in 2018, with the findings presented in *“Amsterdam Circular: Evaluation and Action Perspectives”*. Two important advantages of the circular economy are its affordability and its profitability. Still, the key stakeholders (government and businesses) are in the process of taking the initial steps towards the transition to circular economy. As a forerunner of this transition, Amsterdam now has the task of taking this transition to the next stage, by scaling circularity and standardizing it. To do so, there is a need to structurally share the knowledge and experience from the first years of experimenting and installing a culture of cooperation. That way, we could learn from the lessons and recommendations founded in the evaluation of the first three years of Amsterdam Circular, summarized in action points that could serve as a guide to other cities contemplating a transition to circular economy.

There are five existing key municipal policy instruments: knowledge instruments, public procurement, legislation, spatial planning and business support – these constitute the most prominent forms of public intervention to support the circular economy.

It is important to emphasise that the transition to a circular economy is by no means an easy task, and will require, above all, municipalities harnessing available governance instruments, the power and technologies of urban innovation and an engaged business community.

PROMOTING CIRCULARITY

Bringing circular economy into the ICT industry effectively targets two major fields: products and equipment (waste and consumption) and internal operations and networks (energy and data). Successful implementation of European Commission initiatives starts by engaging with suppliers, a reality that has been once more confirmed by the project Buiksloterham.

The district of Buiksloterham, on the northern bank of the IJ waterway, once the site of Amsterdam’s most polluting industries, is being transformed into a sustainable area to live and work.

Over the coming years, Buiksloterham will develop into a sustainable district, based on the principles of circular economy. It will be up to the project partners in Buiksloterham to determine the particular issues that need to be solved.

The City of Amsterdam is one of the signatories of a manifest which has been drafted to emphasize the circular ambitions of the project. Over the next 10 years, Buiksloterham will be transformed into a circular neighbourhood where products and raw materials are reused as much as possible.

CONCLUSIONS

The past three years of circular economy action in Amsterdam have showcased the importance of local policy to support circular economy activities. Indeed, policy can be the support that circular projects need to transform ideas into practice or scale up from anecdote to standard.

Key lessons learned along five municipal policy instruments: knowledge instruments, public procurement, legislation, spatial planning and business support are as follows:

1. **Knowledge instruments** are developed to disseminate insights about the circular economy through research to the business community and residents of the city. By means of knowledge instruments, the municipality can increase insights in and awareness of the circular economy among its population
2. **Circular public procurement** is the process of acquiring products or services with a view to optimally (re-)use products, parts and materials during and at the end of their lifetime. By means of circular procurement, the municipality can use its purchasing power to influence the market and so to stimulate the production of circular products and the delivery of circular services.
3. **Legislative instruments** are obligations that the municipality can formally impose on itself, the market and consumers in the form of, for example, standards or bans. By means of legislation, the municipality can use its legal authority to require or prohibit more or less circular practices.
4. **Spatial planning instruments** influence the physical environment by determining the amount and function of space, what materials are used as well as its physical character. By means of spatial planning, the municipality can divide and classify the physical environment in a way that promotes circular resource management.
5. **Business support** instruments assist companies with financial and non-financial resources such as grants, guarantees and technical advice. By means of business support, the municipality can assist (small- and medium-sized) businesses that have limited internal capacity and resources to launch circular products or services or those that need high-risk investment.

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- Partners: Circle Economy, Copper8, Amsterdam Economic Board, Amsterdam Smart City and others

Deep Lake Water Cooling:

Its Origins and the Next Evolution

Author:

Catherine Thorn

INTRODUCTION

BACKGROUND

Toronto is Canada's largest city and continues to grow at a staggering rate (City Planning Division, 1). In January 2018, the city earned the unique title of having the highest crane count in Rider Levett Bucknall's crane index (RBL, 3), an indicator of high-rise construction activity in North American cities. With this rapid growth comes with both opportunities and challenges. Economic growth exerts more pressure on Toronto's already constrained electricity grid (Central Toronto Area Integrated Regional Resource Plan, 1) and makes it harder to reduce total greenhouse gas (GHG) emissions; however, it also provides Toronto with the scale and resources to invest in transformative strategies.

The Economist has highlighted Toronto as one of the ten most liveable cities in the world (The Economist Intelligence Unit, 10). To maintain its competitiveness, the City has embraced city building policies that will position Toronto at the forefront of macro energy trends: decarbonization, decentralization, and digitization. Addressing climate change is a key priority for the City, and its climate change action plan, titled "TransformTO", envisions "a city that has achieved a low-carbon future while enhancing [its] local economy, reducing inequalities, and improving public health" (Scioli, 11).

Through TransformTO, the City has committed to reduce greenhouse gas (GHG) emissions by 65% by 2030 and 80% by 2050 compared to 1990 levels (Scioli, 16). Since the 60% of GHG emissions in Toronto are generated by buildings (The Atmospheric Fund, 7), the City has identified thermal energy networks as a critical strategy to meet its goals (Scioli, 32).

CHALLENGE AND RESPONSE

Beginning in the 1980's, concerns about depleting the atmosphere's ozone layer became a key issue for governments around the world, including the City of Toronto. At that time, the primary means of cooling buildings were chiller systems that used chlorofluorocarbon (CFC) refrigerants: chemicals that are particularly harmful to the ozone layer. Although CFC's have been phased out by regulations and replaced by less harmful substances, managing the environmental impacts of common refrigerants remains a challenge (Environment and Climate Change Canada, 1). While seeking solutions to reduce CFC's, a creative mechanical engineer, along with a group of environmentalists and politicians, developed the original concept for Deep Lake Water Cooling (DLWC): a system that would use cold water from the depths of Lake Ontario to supply cooling to buildings in the downtown core instead of refrigerant-driven chillers.

Meanwhile, in the 1990's, the City of Toronto experienced a water quality issue. Zebra mussels infested the City's potable water intake pipes from Lake Ontario, fouling the water and causing undesirable odours. To address the problem, the City considered installing carbon filters, which would have necessitated a large capital investment. Instead, the City decided to evaluate DLWC. Installing very deep raw water intake pipes could both

address the water quality issue caused by zebra mussels and provide a source of water that remains a consistent, cold temperature year-round to support DLWC. Once the design and business case for DLWC was developed, the City established Enwave, the district energy company that developed and operates DLWC.

DLWC is an example of a circular city strategy that has provided and continues to create value for the City of Toronto, and its citizens, and the natural environment.

PROMOTING CIRCULARITY

VISION AND CONTENT

DLWC initially was set out to transform the way buildings are cooled to reduce environmental impact while providing value to the City and fostering economic development. Originally commissioned in 2004, DLWC has accomplished this objective. DLWC now serves over 70 buildings in downtown Toronto, displacing 1391 kg of CFC's, 61 MW of peak electricity demand, 75% of total cooling-related electricity consumption, and related GHG emissions. Looking forward, plans for DLWC continue to support the City's long-term goals. Through TransformTO, the City has identified that to achieve its GHG reduction targets, by 2050, 75% of its energy consumption will be derived from renewable or low-carbon sources and 30% of all floor space will be connected to low-carbon thermal energy networks (Scioli, 2). The next evolution for DLWC will be the backbone for low-carbon heating as well as cooling.

How Deep Lake Water Cooling Works

Three DLWC intake pipes extend along the base of Lake Ontario to a depth of over 80m below the surface, where the water remains at a temperature of about 4°C throughout the year. Once the water is drawn from the lake and treated to make it potable, it is pumped through heat exchangers to cool the water in Enwave's district system that supplies cooling to buildings throughout downtown. The potable water continues through the City's network to individual buildings where it is used; flushed down the drain; and eventually makes its way back to the lake through the City's wastewater treatment systems.

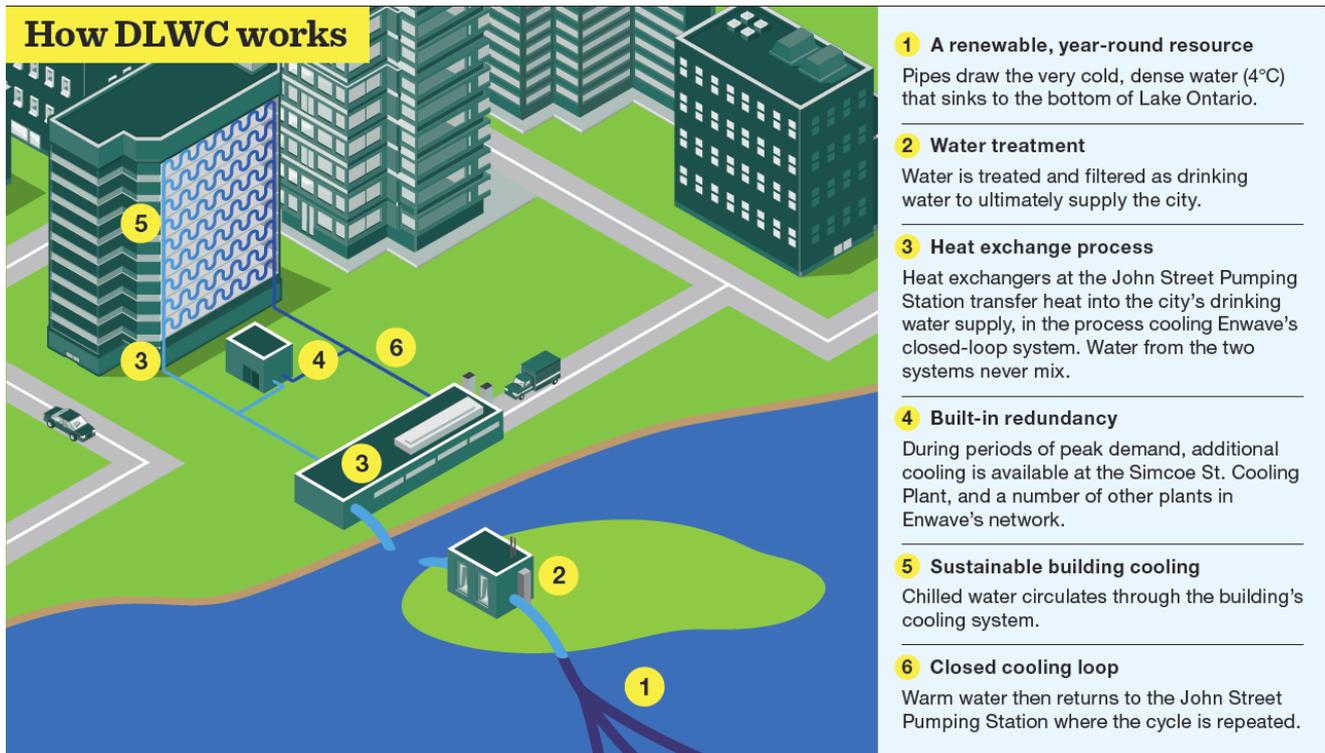


Figure 7: DLWC Process (Source: Toronto Hydro)

The Next Evolution for DLWC

Three major initiatives are being planned that have the potential to expand the benefits of DLWC and capture additional value for Toronto:

- To install a fourth intake to expand renewable cooling capacity for DLWC;
- To add large-scale thermal storage tanks to increase renewable cooling utilization;
- To develop a district heat recovery system that uses rejected heat from buildings connected to DLWC to heat other buildings.

Fourth Intake

Installing a fourth intake into Lake Ontario has the potential to increase the capacity of DLWC significantly while providing improvements to City infrastructure, such as control upgrades at the City's water filtration plant. To make this project a reality, strong leadership commitment; close collaboration between Enwave and Toronto Water; and a fiscally-responsible approach will be required. The City and Enwave will need to revise existing agreements to govern the use and upgrade of existing, abandoned pipe infrastructure and necessary rights-of-ways required to complete the project. Enough growth in demand must be secured to support investing in this new infrastructure.

Storage Tanks

Enwave Toronto recently signed an agreement with "The Well", a mixed-use development in Toronto, where thermal storage tanks will be installed below the 7th level of underground parking, leveraging existing cooling infrastructure to take advantage of off-peak cooling capacity. These thermal storage tanks will be filled with chilled water from DLWC during the night, when cooling demand is lower and electricity is both greener and lower cost, to support peak capacity during the day. Enwave's automated dispatch system will be used to determine optimal timing to fill and dispatch the thermal storage tanks given cost inputs, environmental metrics, and load projections.

District Heat Recovery (DHR)

Many buildings connected to DLWC, such as data centers, require cooling year-round. These buildings reject a substantial amount of heat into the DLWC system, which can be recovered in the winter and upcycled through heat pumps to supply low-carbon heating to other buildings throughout downtown Toronto. Heat pumps use the same technology as refrigerators; they move heat from a low-temperature source (DLWC return pipe) to a high-temperature sink (the building to be heated). Heat pumps are powered by electricity and typically offer efficiencies approximately four to five times that of high efficiency natural-gas fired boilers. Since electricity is currently substantially more expensive on a blended rate basis than natural gas, heat pumps will need to be strategically deployed to minimize electricity demand charges to remain competitive in the market.

Table 1: Toronto’s Strategic Approach to District Energy

Strategy	Partnership Approach
Description	The operations teams for DLWC and the City’s potable water system work collaboratively in a close partnership to continually optimize operations.
Reason for Development	DLWC operations are highly integrated with the City’s water operations. For example, City water flow rates affect the amount of cooling that can be produced at any given time; therefore, the DLWC operations team communicates projected water volumes needed to meet cooling demand to the City daily so that use of the City’s water reservoir can be optimized to match water flows with DLWC demand.
Impact on District Energy	Using a partnership approach rather than operating in silos based on contract parameters has been critical to optimizing holistic benefits to the City. For example, the DLWC system includes backup power that also supplies the City’s potable water distribution pumps and gives those pumps priority that adds resiliency to the potable water system as well as the DLWC system.
Strategy	Toronto Hydro Incentive
Description	Toronto Hydro, the local electricity utility in Toronto, developed a tailored incentive, paid in \$ per kW of reduced electricity demand, for buildings to connect to DLWC.
Reason for Development	Toronto Hydro recognized that connecting buildings to DLWC reduces its electricity demand and related costs Toronto Hydro incurs for upgrading electricity infrastructure to support the ever-growing demand in downtown Toronto.
Impact on District Energy	The incentive provides buildings with a one-time payment when they connect to DLWC that can help support the business case for connection costs.

Table 2: Policy Impacts to DLWC, DHR and DE in Toronto

Policy	City of Toronto Energy Strategy
Description	The City of Toronto requires that developers applying for an Official Plan Amendment, Zoning By-Law Amendment, or Plan of Subdivision for a development with a total gross floor area of 20,000 m ² or more submit an “Energy Strategy” that evaluates opportunities to use sustainable energy, including low-carbon thermal energy networks.
Reason for Development	Requiring developers to prepare an Energy Strategy ensures developers consider low-carbon energy solutions that may not be part of their business-as-usual approach early in the planning process. This approach facilitates integrating renewable energy, energy sharing, enhanced resiliency, and more innovative solutions into community design from the start.
Impact on District Energy	The Energy Strategy has generated more interest from developers in holistic, innovative, low-carbon solutions, including DLWC, DHR, district-scale geothermal energy, and microgrids.
Policy	Ontario Building Code
Description	The Ontario Building Code establishes the design requirements for constructing a building in the province of Ontario.

Reason for Development	Its primary purpose is to ensure that buildings are safe, but it also includes minimum energy efficiency requirements.
Impact on District Energy	The Ontario Building Code references a modeling approach to evaluate energy efficiency that does not consider the impact of any energy supplied from a district system. A flaw in this approach is that a building with its own 90% efficient condensing boilers can be modeled as more efficient than the reference building, but buildings using 400% efficient geothermal heating from a district system are modeled the same as the reference building.
Policy	Toronto Green Standard
Description	The Toronto Green Standard sets minimum energy, carbon, and environmental requirements for buildings being developed in Toronto. It also establishes more ambitious voluntary targets which, if met, qualify developers for a substantial rebate on their development charges.
Reason for Development	The latest version of the Toronto Green Standard maps out a path to meet the TransformTO goal of achieving net zero carbon development by 2030. As part of this goal, it encourages using low-carbon thermal energy networks.
Impact on District Energy	While the building code establishes minimum requirements that many developers exceed anyway, the latest version of the Toronto Green Standard is much more ambitious and has pushed the market to a new level of energy performance. It also includes a carbon metric for the first time, which is creating additional interest in low-carbon solutions such as DHR.

Digitization has been key in advancing the benefits of DLWC. In 2017, Enwave executed the first phase of a fully automated dispatch strategy that uses real-time data on weather, utility pricing, equipment availability and efficiency to optimize use of its cooling and storage assets. Enwave also recently upgraded energy metering within connected buildings to improve remote troubleshooting, provide Wi-Fi connectivity, and enable data trending. These advancements enable energy managers to better understand and improve building energy efficiency. The DLWC system also has 11 MW of backup generators that make it highly resilient to power outages and provide backup power to the City’s potable water pumps.

RESULTS

While the initial drivers for this project still hold true today, DLWC has generated significant additional benefits since its implementation. Realized and projected benefits from DLWC include the following:

- As part of the initial construction of DLWC, Enwave upgraded City infrastructure and provided backup power to the City’s potable water distribution pumps.
- DLWC has displaced an estimated 1391 kg of CFCs.
- DLWC has displaced an estimated 61 MW of electricity demand. With future expansions planned, this avoided demand is expected to increase to a total of 74 MW. Displacing electricity demand eases the strain on the electricity grid in downtown Toronto, which is heavily burdened and projected to exceed capacity within the next few years due to Toronto’s rapid growth.
- DLWC reduces cooling tower use, saving potable water consumption and related energy used in the treatment process.
- DLWC reduces buildings’ electricity consumption for cooling by an average of 75% compared to conventional chillers.
- DLWC has contributed to economic development in the City by retaining money spent on energy within the local economy and establishing a centre for innovation in district energy in Toronto. Over the past 10 years, over \$116 million of capital has been invested in expansions of the DLWC distribution network.
- DHR has the potential to reduce GHG emissions by a projected 37,000 tCO_{2e} per year relative to that produced by conventional natural-gas fired boilers, provide a new model for low-carbon heating in Canada, and foster further economic development for the City.

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E-hailing initiative in Dubai

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INTRODUCTION

BACKGROUND

The Emirate of Dubai is second largest among the seven Emirates in the United Arab Emirates. The City has a resident population of 2.9 million (2017) along with an annual number of touristic visits of around 15.8 million (2017).

Emerging technological advances and upcoming electro-mobility modes are affecting cities around the world. New disruptive technologies have transformed transportation and have challenged its conventional modes. The significant role of e-hailing (ride-hailing) platforms through smart apps has impacted most of the leading cities around the world as well as Dubai. Being a leading smart city, Dubai is influenced by global urban mobility indices and the Dubai's Roads and Transport Authority (RTA) needs to accommodate innovation in the city 's mobility system.

Due to the rapid expansion of Dubai's spatial landscape and population growth, there is always constant demand for complex expansion and improvements in Dubai's transportation network and infrastructure. The RTA is responsible for providing overall legislation, regulation, planning, and governance of the mobility system in the city, along with operations and maintenance of certain public transport modes.

The RTA's mission is to develop integrated and sustainable transportation systems and provide first-class services to all stakeholders to support Dubai's comprehensive growth plans through preparing policies and legislations; adapting technologies and innovative approaches; and implementing world-class practices and standards

CHALLENGE AND RESPONSE

The advent of e-hailing services in cities has seen significant security and safety challenges, along with negative impact on the traditional taxi industry and drivers. The e-hailing companies tend to work outside the existing legislative frameworks and have less collaborative approach with cities' regulatory authorities.

The E-hailing project in Dubai provided a win-win solution for the city authorities, e-hailing companies, taxi industry, limousine sector, and end user by adopting a customized partnership framework.

The RTA engaged with the private sector to collectively create a tangible "smart" solution to fill in the market gap while mitigating the concerns and challenges posed by the e-hailing services. The RTA supported the creation of Law No. 6 of 2016, a first-of-its-kind in the MENA region, which enables e-hailing services to operate in the city in a regulated manner as part of the RTA's network. This regulation put in place a high-quality standard for transportation services:

- The vehicles should be sourced from RTA-approved limousine companies with specially trained and licensed drivers;
- E-hailing transactional data should be shared with RTA, which can be leveraged on for further enhanced transportation services;
- Greater service efficiency is induced across other transportation modes by a quicker mode of on-demand, e-hailing transport with waiting time of 4-6 minutes; e.g. waiting time for taxis reduced by 31% (11-12 mins);
- The RTA implemented a mandatory regulatory monitoring system for e-hailing companies and for-hire vehicles in Dubai known as 'Connected Mobility System' the system first-of-its-type provides real-time monitoring of trips, alerts, violations and driver behaviour analytics; and
- The E-hailing project in Dubai is pertaining to the city mobility infrastructure (as part of city public spaces and infrastructure) and also manufactured goods in the automotive industry in the circular city framework of these Guidelines; it is also related to the sharing action item within the same framework.

PROMOTING CIRCULARITY

VISION AND CONTENT

The project falls under the revolutionary new vision for a smart city: to be the happiest city on earth. The project also contributes towards the vision of the RTA, which is to deliver safe and smooth transport for all along with addressing four key strategic goals of the RTA namely: Smart Dubai, Integrated Dubai, People Happiness, and Smooth Transport for All.

The Smart Dubai initiative uses the “happiness” vision as the driving force that integrates stakeholders' well-being aligned with the Emirate's strategic objectives. This alignment has formed the basis for the development of this smart mobility concept in the context of Dubai. Consequently, smart solutions range from flying taxi, self-driving pods, integrated transportation systems, Mobility as a Service are all aligned with the overall vision to serve key stakeholders and to create positive mobility experiences.

The concept of e-hailing (also known as ride-hailing) is one of the major emerging mobility modes globally and has disrupted the traditional taxi and public transportation systems in cities across the globe. The concept is basically ordering a car, taxi, limousine or any other mode of transportation through a mobile application. Cities around the world have leveraged the services but face challenges due to the unregulated governance of e-hailing companies.

The RTA studied key constraints facing other countries and assessed how to best respond to this emerging trend in mobility modes. They conducted international markets reviews and identified three potential risks that unregulated transport sector can have on Dubai's public transportation system:

- Vehicle Safety
- Driver Behaviour
- Pricing Control

Before this agreement, e-hailing companies operated in an unregulated manner generating concerns regarding their safety and security. Given Dubai's image as a safe and secure destination for residents and visitors, this was negatively impacting the city's image, along with the following challenges:

- Lack of oversight and governance of e-hailing companies' transactions and activities due to regulatory absence. The transactional records were not shared with RTA;
- Lack of stringent checks on e-hailing drivers as individual car owners permitted them to become drivers;
- Lack of quality control of vehicles being used by individuals to offer transport services;
- A market gap for smart, on-demand transport services offering premium vehicles catering to customer needs; and
- An increasing demand on taxis with high waiting time.

RESULTS

- The project has contributed towards Dubai's vision to become the world's smartest city and given the young population demographics of Dubai, there is great demand for digital and smart services. This agreement has supported the development of the RTA's integrated mobility platform, which will incorporate all modes of transport in Dubai including e-hailers into a smart, multi-modal transactional and journey planner.
- The key positive impacts obtained by the project can be summarised as follows:
 1. The utilization of limousine vehicles in Dubai increased from 4 trips per day to 12 trips per day on the average;
 2. Regulated e-hailing service is being included in the RTA's integrated mobility platform (referred to as s'hail), along with other public transport modes in Dubai; allowing for seamless integration between all modes of transportation;
 3. This pioneering regulation serves as a standard to allow additional e-hailing service providers to operate in Dubai. Currently, around 9 start-ups have obtained the RTA approvals to start operations;
 4. The rapid growth and performance of e-hailing services has encouraged existing service providers to continue their operations and additional e-hailers to set up operations in Dubai, resulting in long-term partnerships with the RTA. For example, Careem, a start-up from Dubai, grew to an international company worth over a USD 1 billion;
 5. The limousine sector has seen a growth of 36% since the partnership, which is highest in the history of the sector in Dubai;
 6. It has encouraged the taxi sector to think more innovatively and increasing taxi utilization rate;
 7. The RTA's service quality effectiveness reached 78% (2017) from 66% (in 2016);
 8. The average waiting time for a customer in Dubai to get a for-hire vehicle has been reduced to 4 minutes compared to 12 minutes before this partnership;
 9. E-hailing company rides have eliminated searching for parking, contributing to their overall satisfaction and also to reduced carbon dioxide emissions;
 10. The E-hailing sector has created a new service industry in Dubai with additional revenues shared among its participants in a win-win manner;
 11. Dubai has taken a pioneering leadership position in terms of regulating and operating high performance, commercially viable and safe e-hailing services.

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- Interview with Careem representatives, 2018
- Interview with Uber representatives, 2018

Mumbai, India: Roti Bank (Food Bank)

Author:

Vimal Wakhlu

INTRODUCTION

BACKGROUND

Globally, one in nine people in the world today (815 million) are undernourished. A vast majority of the world's hungry people live in developing countries, where 12.9 per cent of the population is undernourished. Southern Asia faces the greatest hunger burden, with about 281 million undernourished people. In sub-Saharan Africa, projections for the 2014-2016 period indicate a rate of undernourishment of almost 23 per cent. Poor nutrition causes nearly half (45 per cent) of deaths in children under five – 3.1 million children each year. One in four of the world's children suffer stunted growth. In developing countries, the proportion can rise to one in three. 66 million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone.

The Effects of Chronic Hunger: Chronic hunger—or food insecurity—is as devastating to families, communities and countries as is famine. Chronic hunger claims more victims than famine each year—by far. Effects of chronic hunger include:

- high infant mortality rates;
- vulnerability to common illnesses;
- increased risk of infection;
- acute vulnerability in times of disaster;
- impediments to development; and
- impediments to economic growth.

The former United Nations Secretary-General, Ban Ki-moon, launched the Zero Hunger Challenge²⁶ in 2012 during the Rio+20 World Conference on Sustainable Development²⁷. The Zero Hunger Challenge was launched to inspire a global movement towards a world free from hunger within a generation. It calls for:

- zero stunted children under the age of two;
- 100% access to adequate food all year round;
- all food systems are sustainable;
- 100% increase in smallholder productivity and income; and
- zero loss or waste of food.

The year 2015 marked the end of the monitoring period for the two internationally agreed targets for hunger reduction. The first was the World Food Summit (WFS)²⁸ goal. At the WFS, held in Rome in 1996,

²⁶ <http://www.un.org/en/zerohunger/>

²⁷ <https://sustainabledevelopment.un.org/rio20>

²⁸ http://www.fao.org/wfs/index_en.htm

representatives of 182 governments pledged “... TO ERADICATE HUNGER IN ALL COUNTRIES, WITH AN IMMEDIATE VIEW TO REDUCING THE NUMBER OF UNDERNOURISHED PEOPLE TO HALF THEIR PRESENT LEVEL NO LATER THAN 2015”. The second was the formulation of the [First Millennium Development Goal \(MDG 1\)](#), which includes among its targets “cutting by half the proportion of people who suffer from hunger by 2015”.

This has been followed up by the UN Sustainable Development Goal 2 (SDG2), which includes among its targets “ending hunger in all its forms by 2030”.

Food is an important resource for sustenance of any society or city. It is against this backdrop that the initiative of Roti Bank or Food Bank undertaken by **Dabbawalla Association of Mumbai**, in India assumes importance. The purpose of this case study is to highlight how this initiative helps to meet the objective of overcoming hunger, and also how a resource like food, which would otherwise become waste and a challenge to address, can be used in a circular economy perspective in a city to meet a major SDG.

CHALLENGE AND RESPONSE

Mumbai is the second largest city in India after Delhi with a population of 22 million. The space in the city is limited and the population has been steadily growing. A lot of economic activity happens, and consequently, a lot of people from the hinterland get sucked into this city. With limited scope for housing and other such amenities, 41% of people are forced to live in slums. A lot of people find it difficult even to have a square meal.

The influx of people who get sucked into the Mumbai city because of the lure of employment and a good future is quite large, and this makes limited resources within the city insufficient to cater to the requirement of this new addition to the population every day.

Intense economic activity also results in a lot of people eating out and a lot of food getting surplus at the end of the day in restaurants and eateries, which has to be sent to piggeries or gets wasted. In fact, disposing off this surplus food also becomes a challenge at times.

The solution to the problem has been found by **Dabbawala Association of Mumbai**. They have a Six Sigma quality certificate and a global business fan club that includes Prince Charles and the owner of Virgin Group, Richard Branson. About 5,000-odd Dabbawalas have been in action for over 125 years and deliver nearly 200,000 lunches every day. Their unique operational method is a subject of management study in global business schools. **Roti Bank** is an NGO supporting them in their latest not for profit initiative.

This organization collects surplus food at the end of the day from hotels and individual households and delivers it to the needy people in different parts of Mumbai, including some hospitals where the relatives of poor patients have come from remote corners of the country, and cannot afford eating in regular restaurants. As mentioned, apart from meeting the needs of the citizens, it also ensures that the waste created due to surplus food which otherwise has to be disposed, is taken care of.



Figure 8: Staff of the Roti Bank

This meets the U4SSC deliverable on Circular economy- effective use of resources. Here food is being as a resource for this purpose, and also partly meets the SDG 2 and SDG 11.

PROMOTING CIRCULARITY

VISION AND CONTENT

On the one hand you have a lot of people going to bed hungry. On the other hand, disposing surplus food has become an urban challenge. This is where organizations have come together and come up with this initiative called **Roti Bank**, which literally means **Bread Bank** or **Food Bank**.

The project **Roti Bank** (Food Bank) is a replicable model directed at mitigating the challenge of hunger.

Any city would be sustainable only if the people living in there are satisfied with their lives and living in harmony with all the groups. Crime rate in a city is another determinant. With hungry people around, it would not be possible to have low crime rate. Hence this basic human need of food should be ensured for every citizen. Also, a city having healthy people can contribute to the progress of the city in a big way.

IMPLEMENTATION

Key features and Design: The project is being implemented with a collaboration between the well-established network of the **Dabbawalla Association of Mumbai** and an NGO called **Roti Bank**.

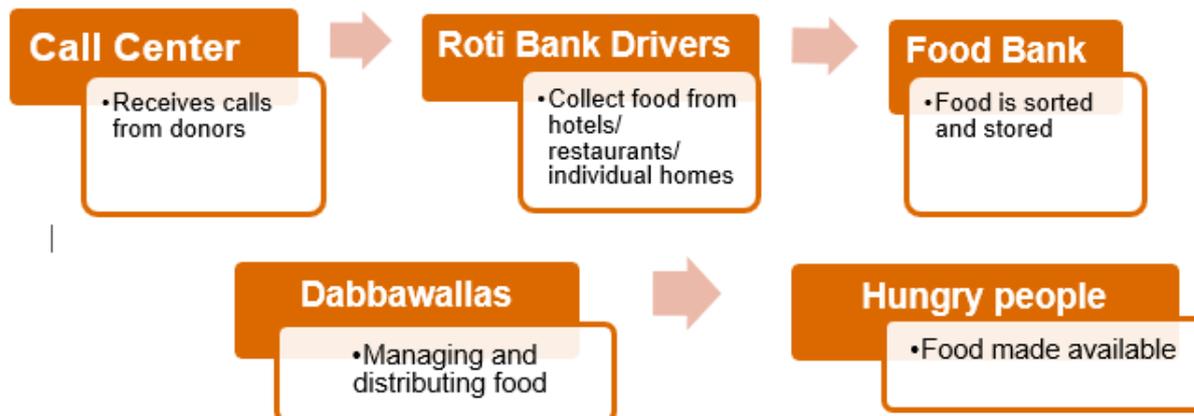
The additional resources that they are using are:

- vehicles for transportation;
- volunteers for supporting the food distribution activity; and
- food preservation mechanisms.

The process of the implementation is described below on Figure 7.

Figure 9

The process of the Roti Bank



Enablers in the process have been the vision of the NGO Roti Bank, particularly under the leadership of Mr. D. Shivanandhan, Former Commissioner of Police of Mumbai, the volunteering spirit of the people, and a proven and effective delivery network of the famous Dabbawallas.

The innovation and smartness of this project is in its uniqueness wherein an otherwise waste in a city is converted into one of the most important resource for human existence.

The role of ICT in the project is connecting the demand to the supply nodes effectively starting with the call centre, where any entity with surplus food on a particular day can call the implementing organization. Besides this, a database of routine donors and recipients gets maintained for an effective utilization of surplus food in the city.

RESULTS

The project is expected to mitigate the challenges of hunger in a city where 41% people are forced to live in slums. The results are sustainable because this model has gained acceptability and other cities in the country are getting motivated to replicate it.

The project has the following impacts:

Social Impact: The challenge of hunger in the society has been addressed. This would lead to more responsible citizens, reduced crime rate and less spending on mitigating health-related challenges. It also enhances community cohesion and to a certain extent equality among its members.

Economic Impact: It is a given that healthy citizens can contribute better to the economic development of a city and country. With issues like malnutrition taken care of, and also with reduced expenditures in health-related issues, the city is bound to see economic improvement in the years to come. It reduces the aggregate food expenditure in the city and also reduces food waste disposal costs which would otherwise incur.

Environmental Impact: The food that would have been disposed of as waste poses different environmental challenges. By converting it as an important resource for the city, the impact on the environment would be reduced in terms of Greenhouse Gases (GHG) emissions and also contributes to the city's goal of achieving a clean environment.

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LIST OF DISCUSSION PARTNERS/INTERVIEWS

- Mr. Shivananda, Former Commissioner of Police, Mumbai
- Mr. Subhash Talekar, Spokesperson of the Dabbawalla Association Mumbai
- Founding Trustees of Roti Bank
- Mr. Sushil Jiwrajika, CMD, Artheon Group, Mumbai

Delhi: From Worn-out /Discarded Textiles to Premium ware

Authors:

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INTRODUCTION

BACKGROUND

The population in India, especially in the cities, has been rising at a very fast pace. Cities like Kolkata, Delhi and Mumbai are very densely populated. Some of the cities in India have more population than many countries in other continents. (Population of Delhi being 22 million). This is the result of industries and other job avenues being concentrated in these cities.

In the recent years the affluence too has grown. A common man has much more disposable income than what it was in the past. All this has resulted in people buying more and discarding more useable textiles. Prosperity has brought with it the burden of disposing huge amounts of garbage in the form of discarded textile material.

This case study focuses on how this challenge can be mitigated using revival of some of the traditional art forms wherein domestic textile waste can be converted into usable, durable premium ware.

CHALLENGE AND RESPONSE

Disposing huge amounts of waste is a challenge for any city, and it applies to the cities of India as well. All cities are looking at various means to tackle this. Some try to look at modern technologies to mitigate this challenge, some work on segregation and recycling, and yet some cities are unable to cope with this challenge.

This problem could be reduced in a very smart way by restoring, refurbishing and recycling textiles which form a huge part of the domestic waste. Two traditional Indian crafts, Kantha from West Bengal and Gabba from Kashmir are brilliant examples of restoring and recycling large pieces of domestic textile waste.

The old fabric pieces like curtains, bed linen, turbans, lungyi, tablecloths, blankets and the like are collected by the company. These are then processed as per customer's requirement and delivered as beautiful, durable articles ready for use.

This is in tune with the Circular Economy and Cities initiative of the U4SSC where the objective is to look at reuse of various resources within the city. In this case we are looking at reusing large pieces of useable/ discarded fabrics from households.

Figure 10
Examples of discarded textiles



PROMOTING CIRCULARITY

VISION AND CONTENT

In the present-day scenario, preservation of the environment is of primary concern across the globe. Recycling, restoring and reusing are the ways to reduce waste creation. New, usable products can be generated with the resources already available, thus minimizing carbon footprints. Restoration, reusing and recycling have been embedded in the Indian culture since the very beginning.

1. Kantha is a traditional art of West Bengal in India. During ancient times, the women of Bengal stacked layers of old, used sarees (traditional Indian female dress), and bound them together with simple hand stitches thus creating beautiful, quilts or other usable articles, depending upon the size. Motifs used were taken from the flora and fauna, everyday life and epics. These discarded sarees were thus converted into heirlooms which were durable and great pieces of art. Kantha is also called 'Needle Painting'.

Figure 11
Examples of Kantha of West Bengal



2. Gabba

In **Kashmir**, old, worn out woollen blanket pieces are dyed in different colours, and attached together and then embroidered with vividly coloured geometric and floral patterns. The embroidery is done with simple tools like hook needles, using woollen yarn. The inspiration for the patterns is from the abundant natural beautiful surroundings in Kashmir. A cotton lining is attached to back the rug thus created. **Gabba** is the name given to this product. These are floor coverings, throws, wall-hangings, of different sizes and shapes. These rugs could be as large as 12 feet by 8 feet or even more depending on the requirements as they can be customised. These products are so durable that they last generations.



Figure 12: Gabbas of Kashmir

Both of these arts are practiced even today in a contemporized manner with new designs and techniques.

The objective of this case study is to highlight these forms of arts from a sustainability perspective.

Encouraging these traditional art forms in modern cities would save the environment by reducing the quantity of waste being generated, and at the same time preserving the traditional art forms and bringing new employment opportunities.

The surplus products, being premium products, can be sold outside o the city, thus giving a boost to the economy of the city.

Also, the products can be marketed online. Some efforts at linking the craftsmen and the potential buyers directly through e-platforms are also being made, to avoid the middlemen.

RESULTS

Employment is generated at all levels, through collection of the fabrics, processing, delivering, etc. It also saves the environment by recycling the enormous amounts of fabric waste and converting it into usable articles which are very durable and aesthetically rich.

Social Impact:

1. Kantha has been a women's craft traditionally, where it was practiced at the domestic level. Therefore, reviving the traditional arts of Kantha and Gabba will offer new employment

opportunities to women. This process of enhanced opportunities for women would lead to meeting SDG 5- Gender Equality.

2. Ancient crafts such as Kantha and Gabba will be preserved and put to use in the present context of Smart Sustainable Cities.

Economic Impact:

1. Craftsmen of traditional arts in developing countries usually live in difficult financial conditions. This type of initiative would provide more work and enhanced income to them, and thus help in the process of reduction of poverty, meeting the SDG 1 and also SDG 8, i.e. Decent Work and Economic Growth.

Environmental Impact:

1. Waste disposal is a big challenge to the environment. Through this project, the amount of textile waste generated is reduced considerably, thus working towards environmental sustainability, thus meeting SDG 11- Sustainable Cities and Communities.

Both these are appropriate examples of circular economy, covering the social, environmental and economical domains.

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Melbourne – Australia Place-Making Case

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INTRODUCTION

The city of Melbourne is the main city of the state of Victoria, in Australia and it's one of the most densely populated cities of the country. The city of Melbourne and Village Well, one of Australia's placemaking consultancy companies, focusing on arranging, transforming and creating public spaces that promote people's health, happiness, and their wellbeing, initiated a cooperation project on sharing public spaces. The purpose of the project was to apply the concept of place-making to engage community members locally; enhance public spaces; and contribute to a healthy sustainable community. Placemaking is defined as the new environmentalism, using processes, tools and practices to create livable and resilient cities, towns, communities and places.

These three aspects could be implemented in the city by facilitating the creative patterns of managing, designing and managing of public spaces, paying particular attention to the physical, cultural, and social identities that define the city and supporting its evolution and transformation.

Below is a summary of the "Melbourne Liveability Story", and the opportunities to maintain and improve the city's social and built environment, as well as its identity and culture.

Melbourne has a compelling and modern story of transformation which came from the lessons learned along the way over a number of decades.

The "Melbourne Liveability Story" and its five core strengths are:

- the city's collaborative culture and industry that focuses on people, inclusivity and diversity;
- the city's unique geography that helped the city to address better innovation, responsiveness to local culture, and designing properly for its climate conditions;
- its values and its focus on education, science and research, professional services and creative industries;
- the city's culture, its relationship with the built environment, and the interaction of people with the environment;
- the city's expertise in planning, design and delivery of quality city-making projects.

BACKGROUND

Village Well collaborated with the Government of the state of Victoria including Liveability Victoria International and Trade Victoria to develop an engagement plan that tapped into Victoria's design and built environment sector's expertise, to gain a deeper understanding of the elements that have

contributed to the “Victorian Liveability Story”. As Melbourne is the main city of the state of Victoria, this story and lessons learned facilitated the creation of the “Melbourne Liveability Story”.

CHALLENGE AND RESPONSE

Melbourne was ranked the ‘World’s Most Liveable City’ by the Global Economist Intelligence Unit for seven consecutive years, until 2018. This is the result of work of the city government and its different department who were working together for many years.

Victoria embraces diversity and creativity and boasts numerous acclaimed houses of design. Victorian College of the Arts, Melbourne Theatre Company, Victorian Opera, Australian Centre for Contemporary Art, etc. are a few of the incubators of emerging artists, planners and designers.

The Project and the Challenges

Village Well has refined and developed processes of analysis, engagement, innovation and project management, researching into historical and contemporary narratives to present recommendations to enhance the city’s position and sense of character.

The following challenges can be listed:

- **Infrastructure:** Investing in civic infrastructure and transport networks in suburban areas to improve services on the city fringes and increase social and physical connection (for youth, single parents and the elderly);
- **Housing:** Improving quality-housing stock, in particular apartment design and construction;
- **Affordability:** Improving affordability of property prices especially for families, the elderly, singles and young people.

The Response

The success of place-making is dependent upon collaborations among various civic stakeholders such as governments, private investment entities, companies, not-for-profit organizations, artists and citizens. Melbourne has shared its public spaces and reused its civic stakeholders’ skills through place-making. With the introduction of the place-making concept to Melbourne, the following benefits can be observed:

- **Business Opportunities:** Developing a shared understanding of the sectors that have capacity to grow can enhance different business opportunities. The place-making can help to create new jobs and entrepreneurial opportunities, through supporting local economies and attracting tourism.
- **Policy:** The concept can help improve policy and assessment criteria for all residential development that ensures quality design processes and outcomes.
- **Partnerships:** The concept can improve existing cross-sectoral relationships.
- **Branding:** Place-making can increase self-promotion and offshore promotion of the city, as well as the “Liveability Brand”.
- **Government level benefits:** The concept can increase government and industry understanding of the importance of place-making: for instance, much of Victoria’s liveability case has been the result of building infrastructure and designing spaces for people.
- **Encourage volunteerism in the City:** The concept encourages volunteers to help the city in general.
- **Improve public health and environment and pedestrian safety:** Place-making is an evolving and transformative field of practice that intentionally leverages the power of the arts, culture, sense of

meaning, purpose, engagement and creativity to serve a community's interest while driving a broader agenda for change, growth and transformation. This is done in a way that also leads to people's happiness, builds character and quality of place and the city, through creating cultural districts, artist relocation projects, entertainment, and public art. The purpose of introducing the place-making concept in Melbourne was to promote a shared meaning, and sense of community. Through the use of public space and its sharing, society benefits from the increased interaction of a diversity of people, which in turn, encourages greater social cohesion and promotes a sense of identity.

Promoting circularity

Village Well engaged with leaders within Victoria's design and built environment sector in the past to analyze the projects that also transformed Melbourne to the city it is today. Melbourne became the World's Most Liveable City as a result of long-term, strategic, state and local government planning and policy; community driven, place-led engagement; and its commitment to its guiding principles of authenticity and individuality.

Other contributors to this story include: the advocates and activists who pushed policy reform for a social city founded by good design; leading planners and designers; teachers and leading education institutions; successful public private partnerships; as well as the many significant projects like Postcode 3000, cycling lanes, the women's rights movement, grids and greenery, Federation Square, street-trading policies, laneway culture, improved liquor licensing, design codes, and many more.

VISION AND CONTENT

To create the vision and the content of the "Melbourne pitch", an energetic and fun Victorian Liveability Think Tank event was held at the Treetops of Melbourne Museum.

The group explored ideas to grow and export professional design skills, services and thinking around city making and urban renewal. It also explored the content of Melbourne's design and built environment sector's key strengths, and ways that the Victorian Government and the sector could share a role in pitching those strengths to wider local and international markets.

Ideas for how the government and sector can better collaborate, and the immediate actions seen as critical to building momentum, are detailed in the next section.

RESULTS

The project has produced the following results:

- A Liveability Panel of Experts has been initiated. In fact, building on the success of the Australian Urban Systems cluster, Melbourne has established a panel of experts to lead design advocacy, international networking opportunities, and drive initiatives within this project. Furthermore, the panel guides the development of Melbourne case studies to tell the story, refine the pitch and implement the 'liveability formula'.
- There has been an increased government and industry understanding of the importance of place-making with the collaboration across government, industry and academia. Much of liveability has been the result of building infrastructure and designing spaces for people.

Furthermore, authentic and transformative community engagement is central to the success of Melbourne becoming the world's most liveable city. Processes include:

- Citizen Juries: where a group of randomly chosen Melbourne citizens are paid, educated and informed to give guidance and advice on future planning and development directions and policies.
- Creative on-line engagements where citizens vote for their favorite projects or give advice and direction for council projects.
- Business Inspirations: special evenings where businesses come together to learn the latest successful business / retail practices.
- Kitchen Table Conversations: one to one or small group conversations allowing citizens to be heard and expose their ideas.

The Melbourne central business district is well known globally as one of the events capitals of the world. The innovative busking street and food policy allows a daily creative activation to happen day and night. Great food trucks activate dead spaces while world-class buskers and entertainment attract thousands on weekends supporting the activation of the everyday economy.

Such a strategic and focused plan allows the city to work 24 hours a day. The famous summer and winter night markets at the Queen Victoria Market attract thousands of locals and tourists.

The Melbourne Liveability Strategy has created a city that is both inclusive and some would say a happy and welcoming place full of local shopkeepers and citizens. The renewal of the laneways has created an intimate gathering and shared space for the city's inhabitants, where people meet, connect, eat and play in one of the most creative street art in the world. Distinct neighborhood cultures make popular public squares and meeting places unique with a diversity of places to sit, rest, talk and dine.

The world's largest tram network, which is free in the central business district, allows all citizens to quickly access all parts of the city day and night.

The concept of place-making also generated a new way of designing green buildings that use locally sourced, sustainable and resilient materials. The city has implemented macro-scale master planning to detailed design micro-scale that is high quality, site specific, and people focused.

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- **Professor Rob Adams**, Director of City Design, City of Melbourne
- **Ian McDougall**, Founder and Director, ARM Architecture
- **Chris Razzell**, CEO, Aspect Studios
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Smart Dubai : Circular ICT Services and Infrastructure

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INTRODUCTION

BACKGROUND

Dubai is one of the seven Emirates in United Arab Emirates (UAE) and a highly vibrant city with a population of approximately 3 million people. Dubai has set itself on an ambitious course through a rapid and successful transformation in both economic and social sectors. Over the span of last 40 years, Dubai has witnessed a transformation from a sleepy pearl diving village to one of the most visited global cities and home to the world's busiest airport; the 9th largest port in the world; and the world's tallest building.

Dubai has experienced a significant economic growth over the years and the city acts as the leading economic hub in the region, having undergone successful economic diversification. Sectors such as trade and logistics, tourism, financial services, retail, and real estate have played critical roles in Dubai's economic achievements and are complemented by a highly modernized urban infrastructure. Dubai is currently undergoing its third generation of digital transformation; and can be credited for inspiring public acceptance and confidence in the use of ICTs in all spheres of life.



Figure 13: Digital Transformation Journey of Dubai

In this context, the Smart Dubai initiative was born in 2014 from an idea of His Highness Sheikh Mohammad Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai. The vision of Smart Dubai is to leverage on the city's inhabitants and make Dubai the happiest city on earth. In line with its vision, the Smart Dubai initiative has structured its strategic approach to embrace the latest technology innovation that will make urban experience seamless, safe, personalized and efficient; delivering enhanced quality of life to contribute in making Dubai the happiest city on earth. The

Smart Dubai initiative plays a key role in guiding and enabling the city's ongoing digital transformation across all sectors.

CHALLENGE AND RESPONSE

Dubai strategically relies on digital transformation and the 4th Industrial Revolution (4IR) leading edge emerging technologies in achieving its smart city transformation. Such large-scale transformations require ICT implementations at the city level encompassing public and private sectors and tend to require substantial expenditures, unless planned and managed carefully. In this context, Smart Dubai has strategically centralized and shared targeted ICT services and infrastructure provisioning while decentralizing the innovation related to core business aspects.

Smart Dubai Capturing Cross-entity Synergies: Common digital transformation needs in Dubai public sector entities posed a significant opportunity for achieving operational efficiencies. Ample cross-entity synergies in data management and IoT, blockchain platforms, AI based systems, digital identity and payment, various back-office functions compelled Smart Dubai to embark on a broad government-wide and in some cases even city-wide approach for implementing circular ICT services and infrastructure. This has avoided the need for various entities to separately fund and operate their own similar ICT services and infrastructures.

As a result, Smart Dubai has implemented and delivered more than 60 circular (in the shared sense) ICT services utilized by more than 50 entities in Dubai. This has allowed Smart Dubai to achieve significant cost savings at the public sector as well as city level, due to efficient digital assets utilization.

This smart transformation approach incorporates city digital infrastructure under the city assets and products; and encompasses sharing as the action item as defined within the U4SSC *"Guidelines on strategies for circular cities"*.

PROMOTING CIRCULARITY

VISION AND CONTENT

The main strategic goals of Smart Dubai circular ICT services and infrastructure are to:

- provide customer-focused agile services by capitalizing on ICT-related synergies,
- achieve operational efficiencies and higher returns on ICT investments, and
- significantly reduce the negative environmental impact.

This is very much in line with the overall vision and strategy of Smart Dubai. In fact, Smart Dubai strategy explicitly intends to achieve happiness at the city level as a social impact (hence the customer focused aspects and customer satisfaction), operational efficiencies as an economic impact (hence the sharing and expenditures reduction for ICT) and positive environmental impact (hence the consolidation and reduction in ICT infrastructures). This strategic alignment has been crucial throughout the implementation of Smart Dubai circular ICT services and infrastructure.

Emerging technologies were highly critical and formed the founding blocks of Smart Dubai circular ICT services and infrastructure.

RESULTS

The benefits and the impact of Smart Dubai circular ICT services and infrastructure can be summarized as follows:

- **Focus on core business:** Since Smart Dubai has taken the responsibility of designing, implementing and operating circular ICT services and infrastructure, Dubai government entities were relieved to focus on their core businesses and easily adopt 4IR emerging technologies.
- **Cost savings through operational efficiencies:** A year-long study commissioned by Smart Dubai has quantified the economic impact of its circular ICT services and infrastructure for Dubai Government. A total of 1.2 billion USD savings were achieved in just over a decade. The report found that the Government of Dubai has saved 5.4 dollars for every 1 dollar spent for its circular ICT services and infrastructure. This has allowed Smart Dubai to continue its circular approach in the medium to long term.

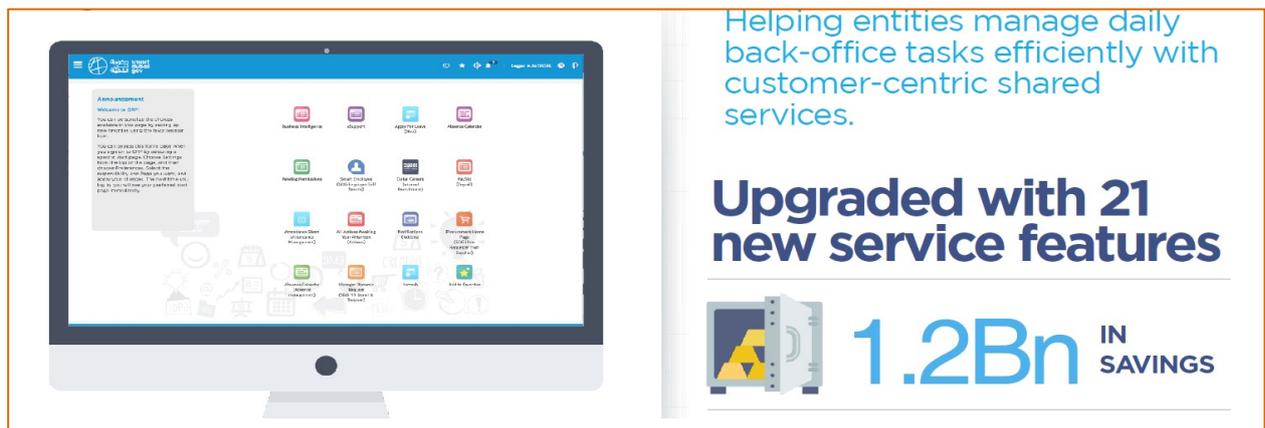


Figure 14: Operational Efficiencies Overview

- **High levels of service delivery:** Smart Dubai constantly enhances its circular ICT services and infrastructure with new features to meet public sector entities' needs and expectations. Smart Dubai provides its circular ICT services through strict Service Level Agreements (SLAs) to public sector entities. 99.95% availability was achieved for its circular ICT services in 2017 and support calls were closed within SLA compliance target times, resulting in more than 80% customer happiness scores.
- **Enhanced Decision Support & 4IR Capabilities:** Government-wide data stored in centralized systems and repositories has enabled advanced analytics and business intelligence for various central government entities responsible for government-level policy making and decision support. It also allowed advanced 4IR capabilities to be utilized such as data science, AI, blockchain, etc. due to their flexible design.
- **Public Sector Policies Implementation:** Circular ICT services also enabled easier implementation of widely applicable public sector policies over the years. In the absence of these services, each and every entity would have to expend significant efforts and resources to their individual systems for policies compliance resulting in significant replication of efforts.
- **Knowledge sharing as a circular activity across the public sector:** Smart Dubai circular ICT services provided a concrete platform for sharing and exchanging ideas across the public sector. Entities shared their business requirements and needs among each other openly. An innovation idea belonging to one entity when implemented became available to all the other entities. Collective knowledge capital was enriched at the public sector level.
- **Scalable and flexible expansion:** Smart Dubai circular ICT services are unified and centralized solutions used by several government entities by their very nature. They are designed to accommodate future expansion in terms of economies of scale (adding new entities) and also in terms of economies of scope (implementing additional new services).
- **Enhanced Resilience:** The centralized nature of public sector circular ICT services and infrastructure enabled disaster recovery and resilience aspects to be implemented in a carefully planned

manner. Smart Dubai circular ICT services and infrastructure are resilient by design incorporating features like redundancies and automatic fail-over mechanisms, etc.

- **Reduced environmental impact due to consolidation:** Circular approach undertaken by Smart Dubai has circumvented the need for public sector entities to replicate ICT infrastructures in their own premises. Consequently, ICT services and infrastructure have significantly been consolidated due to economies of scale and also scope. Furthermore, the total number of ICT equipment (IT assets such as network equipment, server equipment, etc.) has considerably decreased (resulting in cost savings). The impact has also been in CO2 reductions due to considerably reduced and consolidated ICT equipment. Hence, these services have achieved positive environmental impacts and significant benefits in green computing.

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Spain: SmartWaste

Author:

Jorge Díaz García-Herrera

INTRODUCTION

BACKGROUND

Cities are responsible for 50% of the global waste generated and are causing between 60 and 80% of greenhouse gas emissions globally. Against this background, concepts such as circular economy are particularly important, even more so when cities consume three quarters of natural resources.²⁹



Figure 15: Recycling containers. Source: www.esmartcity.es.

Recycling is one of the fundamental pillars of the circular economy, whose objective is to use the waste originating in industrial process as raw material for another process through exchange, reconditioning, repair and reuse in a closed circuit. In this context what was previously considered “waste” can become a valuable resource.

According to the latest Eurostat figures, more than 45% of municipal waste (which does not include industrial or hazardous waste) is getting recycled on average across the EU. The new Directive (EU) 2018/851 amending Directive 2008/98/EC on waste, maintains a 50% target for 2020, and establishes that the new targets for 2025, 2030 and 2035 will require a one-point annual increase. In that scenario, all EU members will have to recycle at least 55% of municipal waste by 2025, going up to 65% by the year 2035, but in Spain that figure remains stuck at 29%, and the worst part is that this figure has remained practically the same since 2010.³⁰

Ecoembes, the organization responsible for the recycling of packaging in Spain, created in 2017 TheCircularLab,³¹ the first innovation center in Europe on circular economy, whose main target is to analyze, design, promote, test and apply in a real environment the best practices in all phases of

²⁹ “La plataforma SmartWaste lleva IoT y Big Data a la gestión de la recogida y al reciclaje de los residuos”. Smartcity.es, June 2018 at <https://www.esmartcity.es/2018/03/16/plataforma-smart-waste-lleva-iot-big-data-gestion-recogida-reciclaje-residuos>

³⁰ Planelles, M. “Why Spain gets a failing grade when it comes to recycling”. El Pais, Marz 2018 at https://elpais.com/elpais/2018/02/28/inenglish/1519836799_117305.html

³¹ TheCircularLab at <https://www.thecircularlab.com/>

recycling. In collaboration with its technological partner, Minsait ³² (from the Indra Group), theCircularLab has developed and deployed the SmartWaste initiative, which applies smart city technologies to monitor and control the entire process of recycling urban waste.

CHALLENGE AND RESPONSE

Increasing the rate of urban waste recycling in Spain to meet the EU targets faces the following challenges:

- The lack of awareness on the part of citizens, due mainly to the lack of information about the importance of recycling and its impact in the environment, and how it must be done at home;
- There is not a measurement of the quantity of correct disposal of waste generated at home, so promotion policies like individual or community payment for waste cannot be properly enforced;
- Garbage collection is a service mainly undertaken by contractors so local authorities do not have real-time information about how the recycling process is taking place on the streets, and therefore they do not know the needs, type and location of the containers, as well as the frequency of filling and their efficiency of materials in order to control the compliance of service level agreements; and
- Some areas are still maintaining a low quality of the material collected, with a large number of improper elements that make it difficult to reuse, due mainly to the lack of education in recycling of all actors involved in the process.

It is important, therefore, to monitor the recycling process using real-time information, which enhances transparency for the citizens, facilitates the implementation of promotional campaigns, optimizes municipal resources dedicated to the collection of urban waste; and increases the efficiency in reusing the material.

In line with this, Minsait has developed the SmartWaste project for collecting and analyzing data from all types of sensors located throughout the recycling process, which allows for obtaining relevant data to make predictive models of behavior that help in decision-making.

Currently, the SmartWaste project is in the deployment phase as a pilot project in 4 management units that bring together 275 Spanish municipalities, and serves a total population of more than 600.000 inhabitants.

PROMOTING CIRCULARITY

VISION AND CONTENT

True commitment to the circular economy requires the cooperation of all the stakeholders: citizens, as the main participants; local authorities; and the contractors that provide and operate municipal services.³³

The main objective of the SmartWaste project is to identify the relevant information for each of the previous actors and provide it in a suitable format for decision making, as well as to enable the implementation of initiatives to promote and facilitate the recycling of waste among citizens.

³² Minsait at <https://www.minsait.com/en/home>

³³ Sanz, F. "SmartWaste: a a step forward the society of the future". FuturEnviro. October 2017 at <https://futurenviro.es/smartwaste-un-paso-hacia-la-sociedad-del-futuro/>

Citizens should, first of all, be well informed. They should know the details on correctly carrying out recycling, how to separate the different types of waste and where to deposit each of them. Citizens should also be aware of the importance and positive aspects of recycling for the environment. Furthermore, they should know the products that can be obtained from their waste as a result of recycling. On the other hand, they should have the necessary means to participate and to be able to report incidents associated with the waste collection service, such as containers that have been overloaded, broken or burnt, or even collected outside the planned schedule.

Municipal councils and other entities, such as consortia and associations of municipal councils should ensure that waste collection and treatment services are carried out correctly and in compliance with the service levels that have been agreed upon, and, when possible, to increase its efficiency. For this purpose, SmartWaste provides local entities and their contractors with the necessary indicators to carry out the management of the service and guarantee an adequate provision of it.

Through SmartWaste, a municipality can determine the optimal position of waste containers, depending on the distance from the citizens, and combines information by integrating data from other systems, for example, the average age of the population in a specific area. The exit indicators shown by SmartWaste will also allow determining the neighborhoods that are more efficient and others that are not. This information aimed at improving the quality and recycling rate.

IMPLEMENTATION

The project has started a pilot phase in June 2018 with four management units: Consorcio de Aguas y Residuos de la Rioja (CARE), municipality of Logroño, Cabildo de la Palma and Medio ambiente, Agua, Residuos y Energia (MARE) of Cantabria.

Table 5
Management units of the pilot project SmartWaste

	Municipalities	Inhabitants	Area (km ²)	Vehicles	Light packaging waste (Tn)	Paper waste (Tn)
CARE	173	164.918	4.964,09	7	2.523,2	3.892
Logroño	1	150.876	80,91	10	2.308,4	3.560,6
La Palma	14	86.528	708,3	15	822	1.604,3
MARE	84	245.926	5.321	41	2.403,4	3.997,5
Total	275	648.248	11.074,3	73	8.057	13.054,4

Source: Minsait

SmartWaste is operated by monitoring technologies such as:³⁴

³⁴ El Pago por Generación, el aliado de la economía verde". Corresponsables, December 2017 at <http://www.corresponsables.com/actualidad/pago-generacion-aliado-economia-verde-ecoembes>

Fill-level sensors, installed in the waste containers and facilitate the optimization of waste collection routes in real time, avoiding situations in which containers are empty. The result is greater service efficiency, cost reductions and lower emissions coming from vehicles;

Container weighing systems are also being installed in garbage trucks to calculate the contribution of a specific area. This information is combined with the fill level measured by the sensor in the container, and thus, the density of the waste can be calculated. By combining with historical data and calculating possible deviations, it would be possible to know if the contents of a container is of the appropriate quality (whether the container contains inappropriate material that does not correspond with the waste type in question);

RFID tags³⁵ installed on containers that enable collection service traceability, providing information related to the time of collection, movement or cleaning of a container. In this way, local councils and/or service operators can compare the service provided with the planned service, detecting possible deviations;

The vehicles are also equipped with devices that facilitate the collection, sending information about the driving and determining patterns to make it more efficient. They are also fitted with cameras, which can record the status of a container before and after collection in order to monitor the process;

A centralized IoT open platform, provided by Indra and tested in multiple Smart City projects, analyzes the collected data in real time from sensors in containers and vehicles for waste collection. Being cloud-based, these centralized services do not require the installation of an infrastructure in the management units and the connectivity to the platform is carried out through APIs and/or web services, facilitating the entry of data from any type of devices and integration with other information systems.

The IoT platform also relies on a Geographic Information System (GIS) and Big Data techniques to analyze the causes of the performance and impact of recycling and waste management in cities and territories.

RESULTS

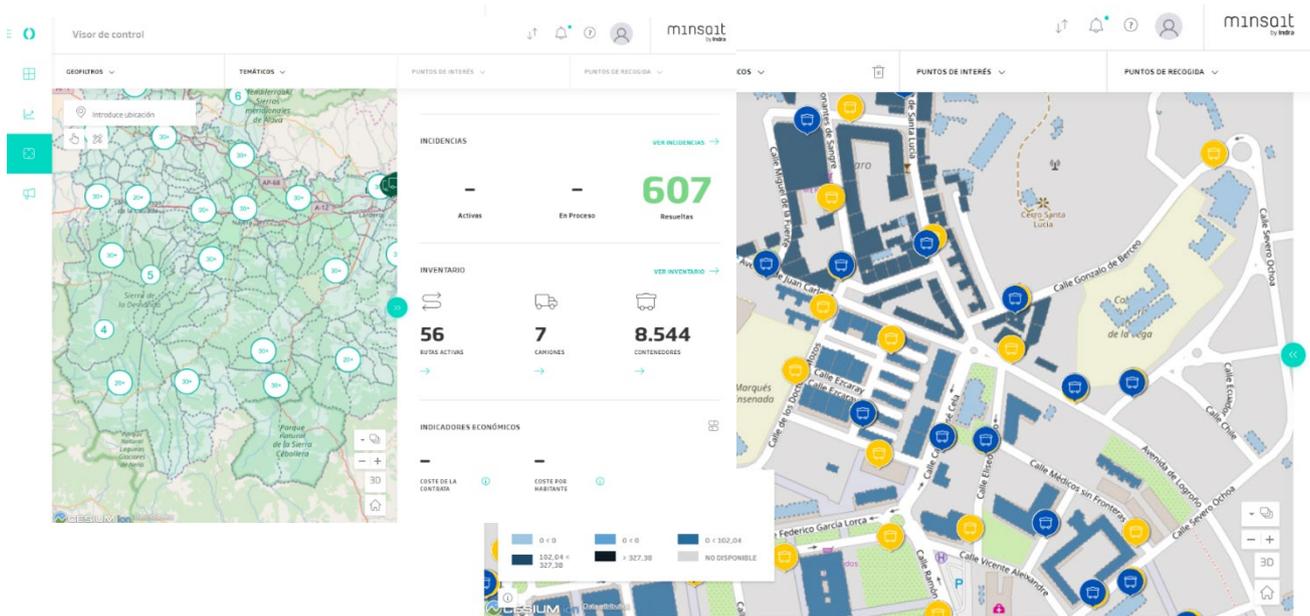
The project pilot deployed in the management units offers data that will serve to improve the collecting process and to take measures that encourage recycling in citizens and municipalities. These data come from the IoT network, but they can also be linked to other information systems like the census, so the platform allows setting correlations between the recycling process and other variables like density of population, building occupation, family members, age, level of education, etc.

The information obtained by SmartWaste can be used for the internal management of the processes, but also made public to the citizens, so to support awareness raising about waste recycling.

These indicators are grouped to form rates that are displayed in different visions of a Balanced Scorecard, depending on the stakeholder to whom the information is directed:

³⁵ The RFID tag is an ID system which consists of a chip, some memory and an antenna. It uses small radio frequency identification devices for identification and tracking purposes. More information is available at <https://internetofthingsagenda.techtarget.com/definition/RFID-tagging>

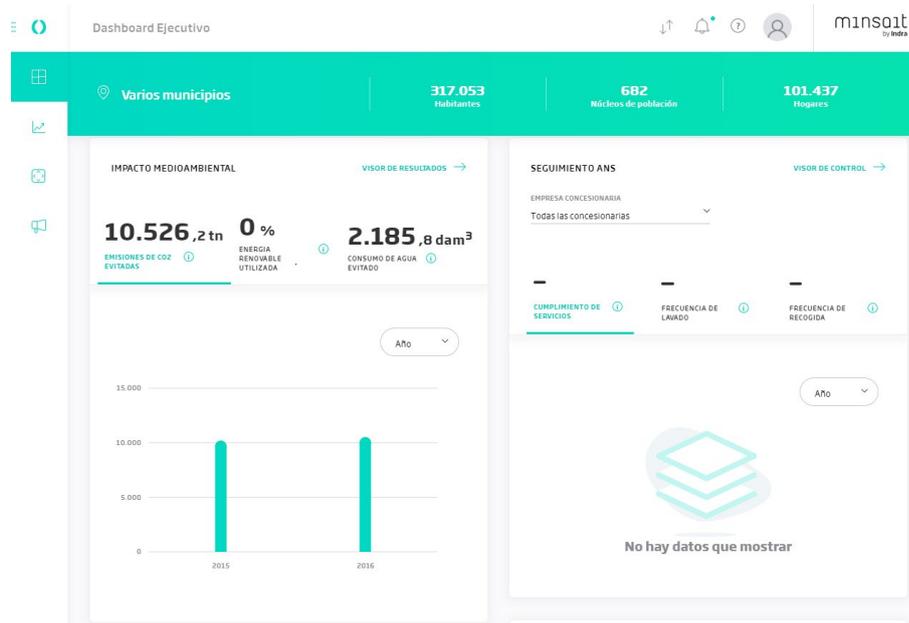
Figure 16
Section of one city with the location of containers



1. Vision of the recycling infrastructure: The SmartWaste platform allows service providers to know the exact location of the containers, their filling status and the needs of the area in which they are located (Figure 20). The data obtained can be grouped according to the needs and reach a high level of granularity, allowing statistical analysis and simulations. The next step would be to use the result of the analysis to optimize the number, location and required types of containers. Later it could also be used for the implementation of payment policies for waste [Figure 17: Control of the collecting services](#)
2. Vision of control and optimization of collecting service: The information provided by the platform allows planning of routes and the frequency of collection in an optimal way, according to the status of the containers, as well as the compliance to the collection agreements; the analysis of the incidents detected during the service; the monitoring in real time of vehicles and traffic; and the monitoring of driving patterns.

This information is of special interest for the contractors that operate the service in order to optimize the use of their resources.

Figure 18
Environmental impact: CO2 emissions and water consumption avoided



3. Vision for monitoring the performance of the process: The level of detail in the data allows to know the environmental impact in terms of energy (CO₂ emissions) and water savings (Figure 21), and also the percentage of recycled material that will be useful for reuse at the container level (Figure 5), which will serve to implement promotion campaigns in specific areas that increase the performance of the process.

The specific indicators provided by the platform are:

- Percentage of selective collection on total waste collection
- Percentage of selective collection on organic waste collection
- Percentage of selective collection on light packaging waste collection
- Percentage of selective collection on paper and paperboard waste collection
- Percentage of selective collection on solid urban waste collection
- Average improper waste
- Selective collection by citizen and year
- Light packages collected by citizen and year
- Paper and paperboard collected by citizen and year
- Solid urban waste collected by citizen and year
- Organic waste collected by citizen and year

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India: Use of plastic waste in Road Construction

Author:

Vimal Wakhlu

INTRODUCTION

BACKGROUND

Modern urban lifestyle dictates plastic waste, which needs to be disposed of/recycled. As developing countries are undertaking considerable road construction activities, some have found a way to repurpose plastic waste for road construction.

As the world's second most populous country with a population of 1.3 billion people and a significant plastic waste problem, India is a noteworthy case study. In India, almost 70% of population lives in villages; and even though rural inhabitants do not generate quite as much plastic waste as their urban counterparts do, this amount is still substantial given their sheer number. Meanwhile, across India, about 174 km of roads are built every day, whilst the amount of plastic waste generated exceeds 5.6 million tonnes per year. Merging these two could potentially represent a solution for reusing plastic waste in India.

CHALLENGE AND RESPONSE

Over the last few decades, plastic materials have become an integral part of modern lifestyle. Plastic bags, packing material, bottles, cups, and various other items have slowly replaced their counterparts that are made of other materials, largely thanks to the advantages of plastic. Plastic is in fact durable, easy to produce, light, odourless, and chemically resistant. However, plastic materials have an important drawback: they decompose at an extremely slow pace which poses serious threat to the environment.

The challenge that most of the cities in India and other developing countries is facing is the enormous amount of plastic waste that is generated due to modern ways of living and it is becoming increasingly difficult to handle. Most people living in cities start their day generating waste such as milk wrappers.

While improper plastic waste disposal poses a serious risk to the ecological system, it also impacts human health directly. Hence, the opportunity of converting plastic waste into a resource for road construction activity is very much needed in countries like India.

The solution involves using plastic waste in the road construction via a special technology, which makes the road stronger, less susceptible to the vagaries of nature and with less maintenance cost. At the same time, we are getting rid of plastic waste generated inside the cities. Thus, it represents a smart solution, which pertains to the Circular Cities deliverable of U4SSC.

PROMOTING CIRCULARITY

VISION AND CONTENT

Plastic garbage is commonly seen around the country and has started to cause numerous problems. For instance, plastic waste clogs drains, causing floods. It also represents a choking hazard for animals who eat plastic bags, etc. Moreover, plastics found in fields blocks germination and prevent rainwater absorption. Also, plastic waste causes significant pollution to water.

Recycling plastic can be done only 3-4 times and melting the plastic for recycling releases highly toxic fumes. Plastic waste is recycled in India inefficiently. About 60% of the plastic-waste collected and segregated gets recycled back into materials for further processing into consumer products, while the remaining 40% is left unutilized. This remaining plastic waste needs to be handled effectively in order to protect the environment.

The plastic waste can be used in road construction. Field tests have proved that plastic wastes after proper processing can be used as additive to toughen roads while helping in saving the environment. Plastic increases the melting point of the bitumen. A city using this technique for road construction and the maintenance is bound to benefit socially, economically and in environmental terms. Thus, it should be a part of any long-term city smart vision and strategy.

IMPLEMENTATION

Using recycled plastic to build roads has already been underway in different parts of India starting from Tamil Nadu. The idea is gaining traction worldwide and is being tried out in countries like Uganda.

In India, which has a heavy rainfall during the Monsoon season, the usual bitumen used in laying roads is lost when rain water penetrates under the layer and strips it from the binding layers below. When plastic is used to coat the bitumen, it prevents water from seeping in. The road layer therefore remains strong even after lashing rain.

Key features and design

The technology for this was developed by the 'Plastic Man' of India, Dr. Rajagopalan Vasudevan, Professor of Chemistry at Thiagarajara College of Engineering, Madurai, India. It promises to make a significant difference to the quality of roads in India.

The **process** begins with sorting plastic waste, shredding the waste into tiny pieces, roughly 2 to 4 mm in length, and adding the shredded polymer waste to stone aggregate. The stone aggregate, which is comprised of granite and ceramic pieces, is heated to 160 to 170 °C. The coated stone aggregate is then added to bitumen at a temperature between 155 and 163 °C, and the mass is mixed thoroughly. This mixture is then loaded onto road layers that put the final coat on the road. It is finally levelled with a roller.

Mixing of Shredded Waste Plastic, Aggregate and Bitumen in Central Mixing Plant



Figure 20: Aggregate



Figure 21: Plastic waste



Policy enablers

The State Governments in India support this concept. A Government of India order in November 2015 has made it mandatory for all road developers in the country to use waste plastic, along with bituminous mixes, for road construction. This was primarily aimed at helping overcome the growing problem of plastic waste disposal in India.

Stakeholders involved

The project was developed with the technology developed at Thiagarajara College of Engineering, Madurai, Tamil Nadu, and then implemented on a commercial scale on small highways by the highway authorities. The same concept is being extended to major highways and also to the city roads, particularly in those areas with excessive rainfalls.

RESULTS

This project has been able to lead the cities to solve two major challenges in a city in India:

- Prevention of potholes during rainy seasons; and
- Disposal of non-biodegradable plastic waste.

In addition to contributing towards helping in the good road construction, which has got longer life and less maintenance, this project helps in the process of handling urban plastic waste. This constitutes a sustainable and smart solution.

There are other indirect tangible benefits as well. Potholes in a city cause slowing down of the traffic, which in turn increases air pollution, besides resulting in wasting precious fuel which needs to be imported. Apart from this, potholes on the city roads, particularly during the rainy season make them prone to accidents. Mitigating this challenge is an important step towards improving the quality of life in a city.

It had the following impacts:

Social Impact: There are many people involved in collecting waste, including plastic waste. Since there is an opportunity for them to sell this waste to organizations involved in road construction, this constitutes a potential source of income, as the road construction activity in a developing country is a continuous process. Smooth flow of traffic due to prevention of potholes during rainy season also ensures better quality of life.

Economic Impact: The use of plastic materials in road construction ensures the road's greater longevity. Polymerized bitumen makes the road more flexible and can take heavy traffic without showing signs of wear. Thus, less maintenance is required in the process, which is also economically beneficial both in the short and in the long run. There are also significant savings in the use of fuel resulting from improved quality of roads.

Environmental Impact:

Plastic waste is a big challenge, particularly for the environment. Many types of plastics are not recyclable. But when used along with the bitumen prevents the environmental degradation due to plastic waste.

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City of Vienna: House Sharing in Urban Areas as a Tool for Social Inclusion

Author:

Eva Schlotter

INTRODUCTION

BACKGROUND

Residential property prices in Austria rose by 4.7% year on year in the fourth quarter of 2017. Price growth for the year as a whole was 3.8%. Property prices in Austria have risen by an average of 39 percent since 2010, according to the ImmoDEX real estate report.³⁶ New homes are the most expensive in the capital of Austria, Vienna, where a 123m² apartment or a house costs around €471,000 - an increase of 22 percent since 2010. Rental prices for new properties have risen steeply, by 21 percent, with average costs now €11,50 per square metre. In Vienna council-owned properties, where rents tend to be cheaper and only rise according to inflation, are in high demand. Wiener Wohnen, the municipal department that manages the public buildings in Vienna, says it currently has 13,100 people on its waiting list, who have registered their interest in renting a council flat.³⁷ The fact that property prices are increasing should be cause of alarm. According to a recent study, the total population of Vienna will increase by 289,000 (+15.5 %) during the period 2018 to 2048. The corresponding number of residents with a primary residence in the city will amount to 2,178,000 on 1 January 2018.³⁸

Since 2007, the number of residents of Vienna has grown by twelve percent from 1,661,246 to 1,867,582 in 2016. The population is expected to increase by over 2 million people by 2029. More than one third of all new migrants, who come to Austria from abroad each year, move to Vienna. Most of them come from other European countries.³⁹

CHALLENGE AND RESPONSE

The city is about to face a housing shortage, especially concerning young people and students. The demand for affordable one- or two-bedroom-apartments is high.

WGE! is a social Start-up that is supported by the City of Vienna. It uses already existing housing to provide affordable housing options to young people. It connects students with elderly people who have a spare room or even a small apartment available in their house. WGE! not only acts as a broker for the two parties, it also accompanies the process of renting/renting out and takes care that everyone involved is satisfied.

PROMOTING CIRCULARITY

³⁶ ImmoDEX report available at:

<https://www.immobilienscout24.at/unternehmen/presse/presseaussendungen/2017/27-02-2017-immodex.html>

³⁷ Wiener Wohnen at <https://www.wienerwohnen.at/>

³⁸ Population Projection Vienna 2018, City of Vienna: <https://www.wien.gv.at/statistik/pdf/pop-proj-2018-sum.pdf>

³⁹ Facts and figures on Migration 2017 - Viennese population (official statistics of the City of Vienna):

<https://www.wien.gv.at/english/social/integration/facts-figures/population-migration.html>

VISION AND CONTENT

The project was launched to respond to three challenges of the city:

- Rising rents (affordable and cosy housing is getting more and more difficult to access);
- Elderly people fear loneliness and isolation;
- In Vienna, like many other cities, vacant housing is increasing.

The problem is that there is not a simple and systematic way to bring together the empty living space and people looking for housing. WGE! changes the way we use our homes based upon a mutuality of needs of different generations: young people are moving into an elderly people's house or into an empty room in a retirement home. Elderly people can reduce their housing costs; get someone to keep them company; and a helping hand for managing the household. Young people are benefitting from low rents and the life experience of an elderly person.

Data for Vienna:	
people over age 60 feel at risk of exclusion	30% ⁴⁰
Average money students live with	EUR 850 ⁴¹
Amount of students living in Vienna	200.000 ⁴²
Average rental cost	EUR 15.50 per m ² ⁴³

Affordable housing is one of the key factors at play when measuring a city's competitiveness. Vienna considers itself as a social city, and the need of taking care of the needs of both young and elderly people will be met by this project.

WGE! connects older people and senior citizen residences with housemates. Mostly, this will be young people who provide time for joint activities and everyday support for a low-cost room.

WGE! does connect people through:

- An elaborate algorithm to find the right partner for a flat share (website);
- A residential agreement to regulate the flat share;
- Supervision and monitoring throughout the project.

The most innovative part about WGE! is that its projects are stretching throughout generations.

Especially in highly technological and developed cities, social isolation is a huge problem. WGE! addresses this problem directly. The flatmates do not only live together, they share a living.

⁴⁰ Silver Living Study: <https://www.silver-living.com/silver-living/news/silver-living-studie-angst-vor-einsamkeit-im-alter-ist-weit-verbreitet/>

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⁴² Vienna in Figures 2018 (City of Vienna): <https://www.wien.gv.at/statistik/pdf/viennainfigures-2018.pdf>

⁴³ <https://www.immopreise.at/Wien/Wohnung/Miete>

In addition, the very real problem of housing shortage is addressed as well. Instead of leaving rooms or lodger flats unoccupied (while still paying for their maintenance/gas/light etc.), WGE! makes sure that such spaces can be used by people in need.

RESULTS

The results of the project are several and can be summarized as follows:

- Young people get affordable housing and a family home;
- Elderly people can afford the steadily more expensive apartments through a roommate;
- Cross-generational exchange of knowledge and experience;
- Understanding and strengthening solidarity between the generations;
- Elderly people get support in everyday life and can thus live more self-determined;
- Elderly people can share their life experience and knowledge with younger generations;
- Separation and isolation are being counteracted.

Since its foundation in early 2016, WGE! has successfully connected over 230 people. At the moment, WGE! is expanding to two other cities in Austria. Three other countries are interested in implementing the concept in their cities. All of the flat shares that WGE! helped creating over the last 2.5 years are still happily running.

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LIST OF PARTNERS/INTERVIEWS

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Kirinda, Sri Lanka: Wild Coast Tented Lodge

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Louis Thomson

Reviewer and editor:

Gamze Hakli Geray

INTRODUCTION

Sustainability, community and heritage were intertwined in the design of the Wild Coast Tented Lodge, located on the edge of Yala National Park in the south of Sri Lanka. A multi-disciplinary design team, consisting of Nomadic Resorts (architecture and landscape design) and Bo Reudler Studio (interior design), created the award-winning, safari camp for Resplendent Ceylon, a subsidiary of Dilmah Tea.

The project was designed using a combination of local materials such as bamboo, shingles for the main area buildings such as the welcome area, bar, and restaurant; and sophisticated, tensioned architectural fabrics for the 36 tented accommodation units.

The project was built in close collaboration with the local community.

BACKGROUND

Kirinda is a small village in the Southeast of Sri Lanka on the edge of Yala National Park (the largest and oldest national park in Sri Lanka). The village was originally founded as a shrine dedicated to Queen Viharamahadevi, who lived in the 2nd century BC. The temple is at the heart of a local legend: when raging waters threatened Ceylon, King Kelanitissa ordered his youngest daughter into a boat as a sacrifice. The waters were calmed, and the princess miraculously survived.

In the 18th Century when the British built salt flats in the area, they imported a community of Malay Muslims into the region who have lived and worked in the village ever since, side by side with the existing Buddhist fishermen and farmers.

The village is extremely poor - essentially the population survives from fishing activities on the Basses reef complex off the coast, working in the saltpans and taking part in some minor tourist activities.

Over the last decades, fish stocks have been in decline, and as a result, many of the young men from the village have left to seek their fortunes in the capital Colombo.

In many ways this rural village is an isolated enclave in one of the remotest corners of the country that has been forgotten as the Rajapaksa government focused its attention on the mega projects planned in the Hambantota.

In the shadow of this behemoth, a smaller more natural project was built. This case incorporates commercial buildings under the city assets and products; and encompasses recycling and reusing as the action items as defined within the U4SSC *"Guidelines on strategies for circular cities"*.

CHALLENGES

In parallel to these mega developments, the local tourism industry had suffered a series of setbacks due to the mismanagement of the area's main tourism attraction. Yala National Park is the most visited and second largest national park in Sri Lanka, The park covers 979 square kilometres and is located about 300 kilometres from Colombo.

The park is best known for its variety of wild animals and is crucially important for the conservation of Sri Lankan elephants, and has the highest density of Sri Lankan leopards in the country as well as an abundance of aquatic birds.

Figure 22

Restaurant and Bar at night



However poaching, gem-mining, logging, encroachment by agriculture, and free-roaming domestic livestock are the main threats to the park. Three wardens have been killed in clashes with poachers.

In addition the noise, air pollution, and incessant traffic on the only safari road have

caused significant trauma to the wildlife. The situation was highlighted in 2012 when a BBC journalist Charles Havilland, wrote a scathing article about his visit to the park, highlighting the speeding, and traffic jams following the death of a 4-month-old female leopard in a hit and run incident.

In 2014 Nomadic Resorts was approached by Resplendent Ceylon, a successful local hotel management company, and asked to design a low impact tented resort that would set a sustainability benchmark in Sri Lanka and rival the high-end safari operators in Southern Africa. The aim of the project was to rehabilitate a 7-hectare site; build a tent camp; and transform the site into a sanctuary for the surrounding wildlife.

There were however a range of complex challenges associated with the project – the site had been leased as part of a tourism development initiative, but water, electricity and sewerage treatment facilities were all absent. The site was a 14km drive from the nearest village and the winding, dirt road access was challenging.

In essence, a resort for 72 guests and a staff village to cater for nearly 120 personnel was created, in an area regularly frequented by elephants, leopards and bears.

These challenges were overcome by developing relations with the local community- using a former school principal as the community manager in the village and a 22-year old British intern from the

University of Plymouth as the construction manager, 3D renders were presented for the project to a group of 26 local, unskilled workers and asked them for their assistance.

Large, experienced contractors had already proved reticent to build a series of contemporary, organically shaped buildings in such a remote location, that were in complete aesthetic contrast to their traditional work; however, the local community embraced the project and immediately recognized its value and agreed to be involved in the project.

VISION AND CONTENT

The vision of the project was to create a camp with organic architecture that integrates seamlessly into the site, and the rugged sandy coastline overlooking the Indian Ocean. The entire lodge is designed to give visitors an intimate experience of Yala, celebrating the flora, fauna and culture of the area with minimal intrusion on the landscape. Local influences form an integral part of the project, from vernacular traditions and materials to community involvement. The architecture references natural formations in Yala's landscape, namely the massive rounded boulders scattered throughout the park, at a macro scale, and termite mounds, at a micro scale. Adopting a human scale in between, the camp's main buildings appear as outcrops of boulder-like pavilions clustered organically together at either end of the site. Larger open volumes intersect with smaller enclosed domes that house more private functions.

Figure 23

Main areas



Connecting the welcome area at the entrance with the waterfront bar, restaurant and library is a meandering natural landscape lined with clusters of cocoon-like tensile membrane structures called Loopers.

Figure 24

Masterplan





Resembling a leopard paw print, each cluster overlooks a watering hole designed to attract wildlife. The spa is set back from the beachfront. From afar, the large pavilions appear solid but on closer inspection, they are revealed as light, open structures crafted from a woven grid shell bamboo structure clad in reclaimed teak shingles. Large, arched openings and

high vaulted ceilings create a strong sense of space. The existing vegetation is retained to ensure an [Figure 25: Beach cocoon](#) authentic experience of the landscape.

The cocoon like guest accommodation was inspired by the caterpillar's process of metamorphosis. The tensile membrane structures have minimal physical impact on the site but maximum resistance to the strong coastal winds and large animals (notably elephants) that roam the site.

A 70mm layer of locally sourced insulation was sandwiched between the recyclable external membrane and internal liner to reduce passive solar gain.

The low-emissivity, double glazed facades on either end of the building ensure that the tents have excellent thermal performance when cooled.

In addition, LED lighting and an inverter AC unit with heat recovery for hot water was put to reduce the electrical load.

Wastewater from the buildings is channelled to the sewage treatment plant where it is purified and then recycled into the five ponds for tertiary treatment and irrigation of the xeriscape.

The restaurant and welcome area seating is made from site sourced clay bricks, that were coated in an elephant dung/clay render.

The pathways throughout the project are made from site sourced laterite gravel from the excavation of the ponds, which was then sieved – the clay was used for render, the gravel for the pathways and the large rocks were using in drainage channels.

In addition, the resort has 155kw solar PV array, 885 litres of solar hot water capacity and a biogas plant.

IMPLEMENTATION

As mentioned previously, the project was built with a core group of 23 workers.

These workers were trained by Sascha Meyer, a German expert with over 15 years' experience of membrane manufacturing and installation. Sascha showed the workers how to erect the steel and install the membranes.

As the project went on the size of the teams was increased and the best performers were made team managers and allocated specific targets which would then be inspected and approved by Sascha and the site office manager Razim. When targets were met, generous bonuses were distributed between all team players equally. As a result, skill levels improved, and teams competed against each other to get larger shares of the bonuses by completing more units.

During Ramadan the competition intensified, and the Muslim teams asked if they could work at night. Teams worked from 4pm in the evening through until 6am in the morning and then a second team of Buddhists would work the day shift from 6am through to 4pm during the day - resulting in remarkable progress.

Following Ramadan, the contractor was asked to build the main area buildings as well (this had not been in the original scope). As a result, 2 German master carpenters, and a French architect was brought in to supervise a new 36-man team of local fishermen for the construction of the bamboo buildings.

Figure 30
Membrane installation

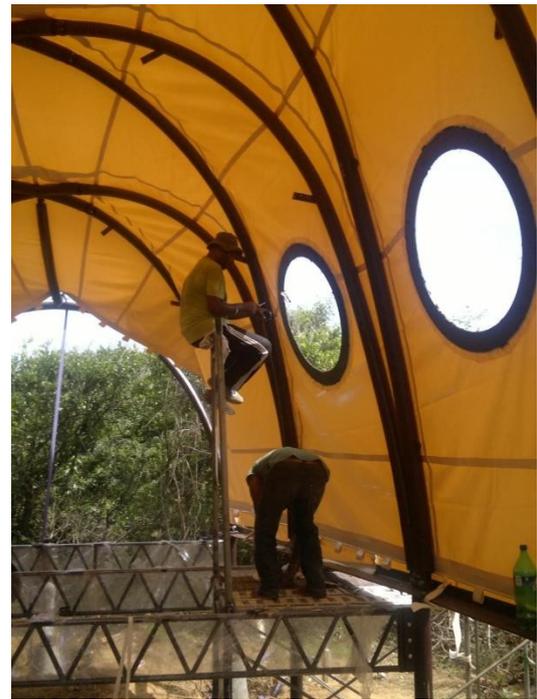


Figure 31
Bamboo building



The construction of the bamboo building was challenging as the materials were less predictable and working on the complex network of scaffolding was demanding. Safety regulations were strictly enforced, and inspections of safety equipment were regular. In retrospect one of the critical strategies was to develop an egalitarian spirit.

RESULTS

The recognition of the project and its success are as follows:

- The resort was featured in the world's leading travel magazines and was a financial success for the client with very high occupancy rates;
- Guest comments and reviews have been outstanding;

- The designers, Nomadic Resorts, won the UNESCO Prix Versailles for commercial architecture 2018 and are finalists in several other international awards;
- The effects on the local community were tangible – workers bought new tuk tuks (local motorized vehicles); improved their homes; added an additional storey to the village mosque; and gained many new skills;
- The construction company received a UNIDO grant to set up a bamboo treatment facility in the village, so it could offer locals long term employment and develop bamboo construction technology in the country;
- Sri Lankan tourism has an iconic property to boost tourism arrivals and improve the brand image of the country;
- The wildlife returned to the site in volume after the project completion thanks to the waterholes dotted around the project and a strategy of planting nesting trees and creating wildlife habitat.

LIST OF DISCUSSION PARTNERS/INTERVIEWS

- Architecture: Olav Architecture: Olav Bruin, Creative Director, Nomadic Resorts (www.nomadicresorts.com)
- Landscape Design: Louis Thompson, CEO Nomadic Resorts (www.nomadicresorts.com)
- Interiors: Bo Reudler (www.boreudler.com)
- Client: Dominique Nordmann, CEO Resplendent Ceylon (www.resplendenceylon.com)
- Contractor: Louis Thompson, Managing Director, Lighthouse Sustainability
- Solutions Bamboo consultant: Vinc math (www.vincmath.com)

Munich: Halle 2 Second-hand store as hotspot of the local circular economy

Author:

Nikolaos Kontinakis

INTRODUCTION

BACKGROUND

Munich is a growing city with a prosperous economy. In 2017 Munich had about 1,5 million citizens. The household waste production was 637,593 t per year, of these 326,096 t was separately collected for recycling. The recycling rate was about 51%. Munich has a long history of waste reduction, starting 126 years ago with the aim of avoiding diseases like cholera. More recently, the aim of Munich's Municipal Waste Management Corporation (AWM) has become forging partnership for sustainable lifestyle for all citizens. AWM started with waste reduction campaigns in the 1990s. and implemented a separate waste collection system in 1994. Besides collection for paper, organic and residual waste at every building and 960 kerbside bottle banks not only for glass but also for metals, plastics and used clothes, Munich citizens also have the opportunity to bring their recyclables to one of the AWM recycling centers located in many districts. Here they are asked to separate their recyclables in 30 different fractions. In 1997 AWM closed a waste incinerator and stopped the landfilling of untreated waste. At the same time, AWM collects used goods via 12 Recycling Centers, mobile Recycling Centers and bulky waste collection on demand and by direct donation.

Knowing that several waste materials can be reused, in 2011 AWM started the first second-hand store. AWM installed special collection points on the Recycling Centers for items which are still useful, and which can still be used after repair. When this store was demolished, AWM set up a multi-disciplinary working group of 15 people to create another store and established cooperation agreements with local social enterprises, educational and community organizations to create expertise and activities that would encourage people to be more environmentally aware and active.

CHALLENGE AND RESPONSE

The Mayor of Munich, Dieter Reiter, said in 2013, "A city that grows dynamically faces enormous pressure for change. Mobility, housing space, architecture, nature, social aspects – the city administration is faced with the challenging task of creating conditions that allow the preservation of our city's identity. The cooperation of all city departments and the vigorous participation of citizens is needed to achieve the best outcome for our city and its people. This is why we have

Perspective Munich!"⁴⁴ Perspective Munich is an urban development concept established by the City Council in 1998. So far it has been updated four times.

⁴⁴ Munich Future Perspective, 2013 https://www.muenchen.de/rathaus/dam/jcr:ea585d01-a676-4ee2-889b-5345f480d44b/PM_Magazin_en_web.pdf

In order to respond to the city's challenges and to support the Perspective Munich, the project Halle 2 has been launched by the city in 2016. The project consisted in the set-up of a second-hand store to recycle and reuse waste materials.

The project targets are summarized below:

- Sustainable targets: The reduction of the amount of waste by selling still useful items to Munich citizens. Due to information campaigns and a stronger cooperation with companies that support recycling, the number of resold items had risen in the past years.
- Social targets: Halle 2 offers Munich citizens cheap used products. Halle 2 is also used as a "reuse-lab". AWM provides a knowledge platform for re-use ideas. At the same time, AWM tests new ways of awareness campaigns and public relations, by installing repair cafes; contacting stakeholders of the "sharing economy"; providing space for up-cycling workshops; organizing exhibitions, music performances, science conferences, lectures, etc.
- Job perspectives: Halle 2 offers qualification and training to social enterprises for special target groups like young or long-term unemployed people.

PROMOTING CIRCULARITY

VISION AND CONTENT

Halle 2 combines Circular Economy with the idea of sustainable lifestyles in Munich. In fact, by being a second-hand store which sells goods collected in the 12 Munich Recycling Centers, Halle 2 greatly extends the lifetime of everyday items and is also a good example of embracing active, societal responsibility because it is based on a strong partnership of the city with many non-profit organizations.

Halle 2 is more than just a second-hand store; it is a "reuse-lab", which means a testbed to develop new ways to increase the number of re-used items. Halle 2 is also a communication platform to reach people who are not interested in reuse and recycling. In Halle 2, repair cafes, auctions, information and cultural events, online-marketing activities, etc. are routinely organized. The experiences of this project are shared with other Municipalities and are included in the AWM's sustainability report.

In the future, Halle 2 would be combined with the AWM's online flea market platform, the repair guide and the lending guide. The implementation of a "reuse and repair network" with all other local actors in the waste reduction field could be the next step. In the future, it could be possible to reserve goods, and get an alert if they are collected by AWM.

RESULTS

Halle 2 provides a long list of positive social impact by extending the life span of the following items:

- Reusable goods: Goods that are suited for a reuse without reparation and upcycling are collected at the Recycling Centers and sent directly to Halle 2;
- Electronic devices: The city is cooperating with the social companies "Weißer Rabe", "ConDrops" and "AnderWerk" in order to check the used electronic devices and evaluate, if it is possible to repair them. Secondly, they are responsible for the obligatory security checks and documenting of the results. The devices are sent to the repair shops by AWM. All usable electronic devices will be sold afterwards at Halle 2;
- Bicycles: The social company "Werkstätte für Zweiradmechanik" checks and repairs the bicycles, or takes used spare parts. The company sells the repaired bicycles in its own shop but is obliged to sell a certain number at Halle 2;

- Textiles: The social company "Nähwerk" is responsible for the re-use of clothes. It is a subsidiary of the catholic institution Caritas which has introduced the nation-wide label "Einzigware". Einzigware is a fashion label which successfully distributes upcycled clothes. Old working clothes from AWM and also from Halle 2 staff are given to Nähwerk. "Nähwerk" also integrates and employ special target groups of people.

Thanks to the cooperation with several social companies through Halle 2, the Munich Department of Labor and Economic Development integrated a network of social companies in its employment and qualification programme. These companies are implementing the local employment initiatives, often supported by the European Social Funds and are designed to facilitate the integration of target and vulnerable groups into the local labor market.

Halle 2 is also used as an information and participation platform as it provides space for exhibitions, music performances, science conferences, lectures, etc. AWM also organizes auctions of second hand goods every Saturday as a social event. Furthermore, it hosts a functional room which offers opportunities for seminars and other public events. It is used for campaigns, auctions, repair cafes, upcycling activities and other events to promote reuse and recycling ideas, such as:

- Catering: The non-profit organization "Regenbogen Arbeit" offers beverages and food as a catering for the events in the Halle 2. The organization gives work perspectives to long-term unemployed and disabled people;
- Repair Cafe: it enables rooms for voluntary activities by Munich citizens. Experts support citizens who, for example, bring their bicycle which is in need for repair and give them advices how to fix it. This is completely free of charge, but it is expected that the participants donate something to one of the Munich social care institutions;
- Upcycling: With his "Werkraum", Halle 2 offers a room for upcycling workshops for do-it-yourself amateurs as well as for artists or interested and skilled people. Munich schools for vocational training co-operates with students of the Social Entrepreneurship Academy;
- Co-operation with educational institutions: Halle 2 offers Munich educational institutions like schools, universities or establishments for adult education different possibilities;
- Schools benefit from Halle 2 is a learning field and test bed for the awareness of reuse. Also, Universities used Halle 2 also as a test bed for researches and business cases. Institutions for adult education uses Halle 2 as a platform for presentations, lectures, for seminars on sustainable lifestyles, on problems of over-consumption etc. as well as for doing networking in the themes of circular economy and sustainability;
- Room for arts and culture: Halle 2 offers exhibition possibilities for Munich artists working on the field of re-use of waste. AWM also plans lectures of the second-hand books, poetry slams about waste, "second hand records disco", guided art tours on "second hand art", etc.

Halle 2 has allowed the city of Munich to implement all the pillars of a successful and sustainable circular economy. Indeed, it not only became a vital part of the waste prevention activities of the AWM but also allowed Munich to achieve their strategic targets in reducing the amount of waste; promoting the reuse of goods; improving recycling rates; and strengthening a sustainable lifestyle for its citizens.

Halle 2 has become a strong brand as a second-hand store that facilitates the cooperation with social companies to make their activities more visible.

The success of the project can also be measured by the number of visitors in the shop (3,500 people monthly since the beginning of 2017) and the number of reused items (almost 15,000 articles sold per month with an estimated revenue of € 50,000 per month).

Halle 2 is a good example of wide collaboration between very different stakeholders and interest groups from different branches which makes the concept of circular economy even more successful.

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Oslo, Norway: Circular bioresources - treatment of food waste, garden waste and sludge from wastewater

Author:

Nikolaos Kontinakis

INTRODUCTION

BACKGROUND

Oslo is the capital of Norway and the country's largest city with approximately 670,000 inhabitants. It is a compact capital city surrounded by a nationally protected forest and by the Oslo Fjord. The population is young, highly-educated and diverse – one third of the population is first or second-generation immigrants. The standard of living and thus consumption levels are high. This also generates a lot of waste from the households, and roughly half of the waste is organic.

Oslo is one of the fastest growing cities in Europe – constituting both a great opportunity and a great challenge. The city has to plan and build for growth in terms of infrastructure, schools, care facilities and service production, while implementing an ambitious environmental and climate policy.

CHALLENGE AND RESPONSE

The cycling of nutrients is critical for the growth of all plant and animal life on the planet. Humans set the natural balance of nutrients and the soil carbon cycle under stress by intensive use of land, harvesting plant material for food, feed and other applications. Mostly, the residues of these activities end up as 'bio-waste'.

Cities are major concentrators of bio-waste flows from food waste, garden and park waste, and the urban wastewater sludge. The bio-waste represents a significant opportunity to recover nutrients and return them to the soil. It is also possible to produce biogas and other biobased products from the biowaste. Moreover, the production of biowaste-based products provides a positive climate impact in comparison with landfilling and incineration, and by replacing fossil-based products such as mineral fertilisers, peat and fossil fuels. No biodegradable waste is sent to landfill (this has been prohibited in Norway since 2009).

The city of Oslo wanted to establish a cycle-based waste management where the resources in the bio-waste could be used for the benefits of the citizens and the society. Since the inner city is compact and the spaces for waste bins are limited, Oslo decided to keep the system with collection of waste from two bins at home. Therefore, it was decided to build optical sorting plants to be able to put three waste fractions in one bin.

Oslo has a circular waste management system where the waste is used as raw materials to the industry. Buses and waste trucks run on environmentally friendly biogas produced from food waste and sewerage. Biofertilizers and soil products from food waste, sewerage and garden waste are used, for example, by local farmers, residents and in the urban areas.

THE SMART PROJECT

VISION AND CONTENT

Oslo is aiming to have a circle-based waste management system. By recycling and recovery, the resources in the waste should be introduced back to citizens in the form of raw materials for production, compost and soil qualities for gardens and farmers, and energy in form of biogas for trucks and buses, district heating and electricity.

City-wide vision and strategy

The City Government aims to make Oslo a greener, fairer and more creative city for everyone. The Government also aims to improve local food production and develop a cycle-based resource management. The political program includes a vision for reducing waste through circular and sustainable consumption, including reuse, sharing and recycling. In a circular economy, the resources should be kept in cycles with 100% reuse and recycling of suitable waste. In June 2016, the City Council passed the Climate and Energy Strategy for Oslo. This lays out targets to cut emissions by 36 % by 2020 and by 95 % by 2030.

The circular bioresources are part of circular resource management. The use of renewable biogas on buses and waste collection trucks in the city, contributes to reduce emissions.

Waste management system in Oslo

Oslo has a cycle-based waste management system. Household waste is separated at source and collected according to waste type, with the aim of acquiring clean waste streams for recycling. Food waste and plastic packaging is source-separated by the citizens in green and blue plastic bags. The coloured bags are put in the same waste bin as residual waste. The sorting facilities optically recognize the colours and the green and blue bags are separated from residual waste. The collection system covers all citizens.

Oslo's biogas plant is transforming food waste into biogas, which is used as fuel by buses and waste collection trucks in the city. The biogas plant also produces bio-fertilizer which is used by local farmers to produce food. The plant has the capacity to process 50,000 tonnes of food waste per year. This provides sufficient biogas for 135 buses, and enough biofertilizer for 100 medium-sized farms. The biogas is carbon-neutral and is considered one of the most eco-friendly fuel alternatives available today. Biofertilizer contains many important nutrients and can replace current fossil-based chemical fertilizers.

Garden waste is collected at the recycling stations and is composted. The city produces several soil and compost qualities, and products are used in citizen's gardens, professional gardeners and agencies in the city.

The city also produces biogas and fertilizer from sewerage sludge. The biogas is used as fuel for buses and the fertilizer is used on grain areas.

When the bio-fertilizer and compost are used in gardens, parks and by local farmers, the cycle of the bioresources is closed.

The holistic approach to the use of bio-waste is innovative and smart. Oslo is looking into the whole value chain of food waste, from food waste prevention through using food waste as a resource to new products. It has been important to communicate to the citizens that by source sorting their food waste, they contribute to cleaner air in the city and reduction of CO₂ emissions from the buses and waste

collection trucks. They also contribute to production of new food grown on bio-fertilizer. The city focuses on the quality of the products by further developing the processes.

At the same time, the city recognizes the importance of reducing food waste and are involved in activities to reduce the generation of food waste in public canteens, restaurants, grocery stores and among our citizens.

Oslo also actively works to reduce the inflow of wastewater containing micro-pollutants to the municipal sewage network, through its two treatment plants, which also produce biogas. Biogas from both food waste and sewerage sludge is marketed together.

The City is at the forefront of circular use of available resources, like using bio waste and city sewage for biogas production, fuelling city buses and waste collection trucks. Waste no longer reaches an end point but is a resource to exploit. The city owned biogas plant also produces bio-fertilizer from the food waste, and the fertilizer is used by local farmers to produce food.

Communication is really important to be able to change the sorting habits of the households. Surveys have been done to reveal the citizens attitude to source separation. The city has communicated about source separation and waste through campaigns, stands at malls, knocking on doors etc. The city also educates 4th graders about the waste management system.

RESULTS

Since the city of Oslo started source separating food waste and plastic packaging in 2012, rates of material recovery of the household waste increased significantly. In 2017 38% of the household went to material recycling, only 3% ended in landfills and up to 2% was reused.

Waste analysis done in 2018 shows that the collection rate for food waste was 45% or 41 kg food waste per person. Around 20.000 tons of garden and park waste was collected through the recycling stations in 2017. The city produced around 27 000 tons of compost and soil products.

Nearly all waste collection trucks and more than 150 buses in Oslo now run on biogas produced from food waste and wastewater, which help reduce the city's overall CO₂-emissions. The liquid fertilizers used by local farmers, also reduce the demand for phosphorus-based fertilizers. This is beneficial because producing synthetic fertilisers involve mining limited resources such as phosphate rock.

Compost and soil qualities from composting garden waste are highly demanded from both citizens and professional gardeners, reducing the use of other resources of soil and compost based on peat.

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Development of a Circular Procurement Framework - City of Toronto

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INTRODUCTION

BACKGROUND

Toronto is Canada's largest city, the fourth largest in North America, and home to a diverse population of about 2.8 million people. Toronto has an aspirational goal of being a Circular City with a zero-waste future as outlined in the City's Solid Waste master plan, approved by Toronto City Council in July 2016 titled the *Long-Term Waste Management Strategy* (Waste Strategy).

The Waste Strategy recommended the creation of a new unit within Solid Waste Management Services Division, called the Unit for Research Innovation and a Circular Economy (UFRICE). In 2017/2018 an initial task of the new unit, was to establish a Cross Division Circular Economy Working Group (CDCE) and to develop a city procurement strategy to drive waste diversion through the circular economy in collaboration with the City's Purchasing and Materials Management Division.



CHALLENGE AND RESPONSE

The need for a comprehensive "Waste Strategy" was identified in 2013, when the Solid Waste Management Services (SWMS) Division provided the Council's Public Works and Infrastructure Committee with a status update of the 2004 "Target 70" plan initiatives. The update explained why the goal of 70% diversion from landfill was not achieved, pointing in part to changes to waste composition and measures used in the targets. For example, the light weighting of packaging and a decline in newsprint resulted in fewer tonnes of waste entering the recycling stream, even though the volume of recycling (and costs to recycle) remained high. To establish new optimistic, effective and achievable waste targets, SWMS considered the current state, including the limitations to recycling, such as high processing costs, high contamination rates, and challenges around implementing programs that include the multi-residential and commercial sectors.

The two guiding principles of the "Waste Strategy" are: to consider options that support waste reduction, reuse, recycling and recovery before final disposal; and to develop policies and opportunities for collaboration. The development of the "Waste Strategy" sets a course to grow beyond service delivery

for waste collection, processing and disposal and to take a leadership and advocacy role in working with other municipal, provincial, federal and international stakeholders to support a shift towards a circular economy.

Introducing circular procurement to the City's purchasing processes follows the waste strategy's emphasis on the waste hierarchy (reuse/reduction before recycling) and complements the Purchasing and Material Management Division's (PMMD) Supply Chain Management Transformation Programme. Toronto's circular procurement initiatives have been directed by the City's Government Management Committee (GMC) and in May 2018, staff reported back to the GMC to provide the informational report "*Implementation Plan and Framework for Integrating Circular Economy Approaches into City Procurement Processes to Support Waste Reduction and Diversion (Framework)*." The Framework establishes goals, objectives, measures and a timeline for piloting circular procurements. In November 2019, a mid-project report will be brought to the City Council and a final report that makes recommendations for a Citywide Circular Procurement Policy is expected for June 2021.

PROMOTING CIRCULARITY

VISION AND CONTENT

The above-mentioned Framework will be used to leverage the City of Toronto's significant purchasing power (approximately \$2,055 Million annually in 2017) to drive waste reduction, economic growth, and social prosperity through a circular economy approach. It aims to develop an evidence-based and measurable circular procurement policy.

The Framework, which will be tested through pilots, works to enable the City to achieve the following circular economy goals:

- To increase the amount of goods and services that are regenerative by design, have lower lifecycle greenhouse gas emissions, are less toxic, and rely less on raw material extraction/consumption;
- To increase the number of City contracts that are procured through a process that considers full value, lifecycle impact including greenhouse gases, resource potential, and maximum utility of goods and services;
- To introduce the requirement for the re-examination of City contracts from a circular economy lens prior to issuing solicitations.

The City has a history of social, economic and environmental procurement policies including the City's Environmentally Responsible Procurement Policy (1999), Purchase of Garments and Other Apparel from Responsible Manufacturers (no-sweatshop) Policy (2008), and most recently, Social Procurement Program (2016). The implementation of the Framework supports several City-wide strategies that aim to enhance City social, economic and environmental outcomes, including:

- *TransformTO*: which identifies the City's greenhouse gas emissions reduction targets (i.e. 80 per cent of 1990s levels by 2050) to improve health, economic growth, and improve social equity;
- *City of Toronto Consolidated Green Fleet Plan 2014-2018*, which identifies a number of circular targets and actions, such as 4.1A, "Purchase, lease or otherwise obtain the most fuel-efficient vehicles where appropriate for the City operations, while considering lifecycle cost of the vehicle";
- *Toronto Strong Neighbourhood Strategy 2020*, which identifies Action #70, "Invest in green jobs and a green neighbourhood" under the broader strategic theme "Create a cleaner, healthier environment"; and,

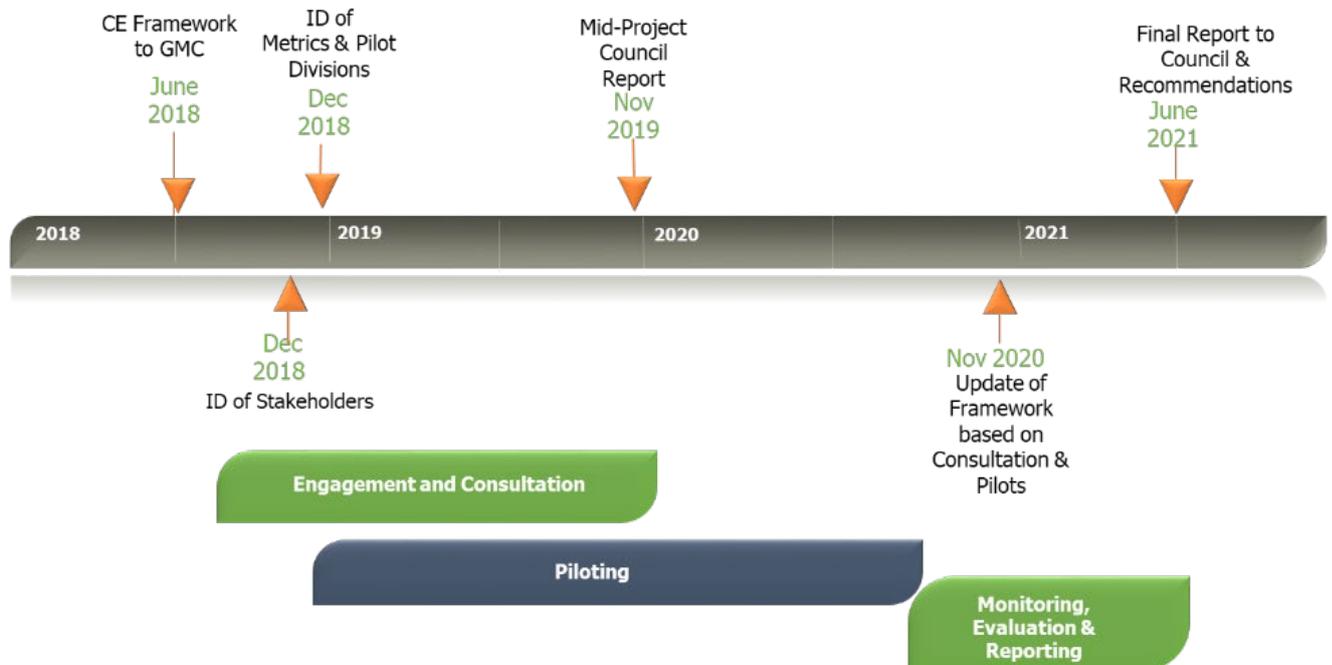
- *City of Toronto Strategic Actions 2012-2018*, which identify "Environmental Sustainability" and "Fiscal Sustainability" as the strategic themes.

Circular procurement will also increase the City's resilience and control its responses to global events, such as the international decline in traditional markets and profitability across the paper products and packaging recycling industry. Circular economy procurement integration can help the City mitigate risks associated with end-of-life management of goods (due to changes in manufacturing and consumer behaviour, technical challenges and decreasing demand for recycled material).

IMPLEMENTATION

The Framework is being implemented through pilot procurements, as described in the May 2018 report to GMC. Both Divisional (SWMS or other City Division-related) and Corporate (Citywide) pilot procurements will determine how changes to solicitations can meet the objectives outlined in the Framework.

Figure 26: Framework Implementation Timeline



Framework implementation and procurement pilots will be supported through the following collaborations:

PMMD AND THE SUPPLY CHAIN MANAGEMENT TRANSFORMATION PROGRAMME:

The Framework will be implemented in conjunction with PMMD's Supply Chain Management Transformation Programme, which includes a process of implementing the Strategy for Category Management and Strategic Sourcing. Circular economy integration into procurement processes can help send harmonized messages up and down the supply chain concerning the value of resources, including incentives for using waste previously requiring disposal as material for new production cycles.

CROSS DIVISIONAL CIRCULAR ECONOMY WORKING GROUP (CDCE):

The CDCE is led by SWMS and includes seven other City divisions: Purchasing and Materials Management; Transportation Services; Toronto Water; Parks, Forestry & Recreation; City Planning; Environment & Energy; Facilities Management; and Economic Development & Culture. An initial step in the formation of the group was to build an understanding of circular economy and explore what could be integrated into the procurement processes at the City. The group discussed solicitations that had previously been issued and contracts already in place to discover examples of existing circularity. For example, the terms and conditions in a contract for the provision, delivery and servicing of garbage and recycling bins include elements of circularity with 10 year extensive warranty requirements, service requirements for the repair of bin lids, wheels and lift bars, bin redeployment as well as re-grinding and recycling non-redeployable bins for use in the manufacturing of new bins (thereby off-setting the quantity of virgin resin required).

FUTURE POTENTIAL COLLABORATORS:

A Vendor Engagement Package is being prepared as the next step in the process of implementing the Framework in order to build capacity among City's current and potential vendors to respond to circular contract solicitation documents. The creation of such a package will be a collaborative undertaking with leaders in the private sector, who could also provide information to the City about the feasibility of circular solicitations. The City is exploring the potential to share this work through pitching the creation and testing of the Package through the Ellen McArthur Foundations CE100 membership. Toronto is the first Canadian city to join the Ellen McArthur Foundation CE100 network.

RESULTS

The City of Toronto's collaborative work has resulted in a Framework that outlines clear principles, goals, and objectives for circular economy procurements and sets up the opportunity to further realize the City's circular economy procurement potential through pilot projects.

The six core principles will guide the procurement pilots:

1. Mitigate climate change and achieve a resilient low-carbon future, considering both operational and lifecycle emissions, and advancing community resilience in alignment with the City's climate strategy: TransformTO.
2. Minimize both the full lifecycle impacts and maximize the full utility of goods and services.
3. Achieve aspirational goals of zero waste, and to treat any remaining waste produced that cannot be reused or recycled as resource that has value.
4. Align with the City's Supply Chain Transformation and be strategic, transparent, and encourage innovation while adhering to all City purchasing legislation and By-laws.
5. Align with City Council approved strategies aimed at improving environmental (i.e. reduction in greenhouse gas emissions), social (i.e. community health, wellbeing, employment) and economic (i.e. fiscal sustainability) outcomes.
6. Collaborate with relevant partners and sectors, including relevant local industry associations, to help drive innovation towards more circular services, products, and mutually beneficial solutions.

A further result of the Framework's development has been capacity building throughout the Great Toronto Area. After holding a city-focused workshop with the CDCE to develop the Framework, the City of Toronto together with a partner organization (the Recycling Council of Ontario) held a second circular economy procurement workshop with neighbouring municipalities and local City agencies. This workshop brought together 45 representatives in order to share knowledge and build capacity for the development circular procurement practices in their organizations. Following the event, the city of Toronto and

Recycling Council of Ontario produced a guidance document called *"Moving Toward a Circular Economy: Considerations for Developing a Circular Procurement Framework for Municipalities"* which consolidates the workshop learnings and recommends actions summarized as follows:

Key Learnings, which identify the importance of:	Recommended Action Summary:
Education, Awareness, and Collaboration	Ensure that municipal staff have a clear understanding of divisional needs, opportunities, and barriers - Circular procurement begins with those who are responsible for planning, budget development, procurement policies and practices, specifically those that draft specifications that guide procurement
Pre-Procurement Planning	Get to Know Your Purchasing Department – Fostering a circular economy involves a high level of pre-procurement planning
Understanding Buying Power	Understand how areas in which funds are spent – This is fundamental to planning and streamlining product and service focus areas, and identify high potential product groups
Setting Objectives and Key Priority Indicators	State your objectives and know how to measure your progress towards them
Identifying Internal and External Stakeholders	Understanding key influencers will support the development and implementation of procurement strategy, including internal (i.e. champions who have sway within organization) and external (e.g. vendor, manufacturers, neighbouring municipalities, etc.)

The City of Toronto has continued to share key learnings on a national platform: on August 21, 2018, the National Zero Waste Council hosted a webinar called "Advancing the Circular Economy through Procurement – Municipal Perspective." Over 85 participants listened and engaged in a question and answer period following presentations by both the City and Recycling Council of Ontario.

REFERENCES

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- Implementation Plan and Framework for Integrating Circular Economy Approaches into City Procurement Processes to Support Waste Reduction and Diversion, (GM25.29 – Report from the General Manager, Solid Waste Management Services and the Treasurer on Implementation Plan and Framework for Integrating Circular Economy Approaches into City Procurement

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