International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series L

Supplement 50

(07/2022)

SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Case studies on implementation of cities' circular actions

ITU-T L-series Recommendations – Supplement 50

ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

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Supplement 50 to ITU-T L-series Recommendations

Case studies on implementation of cities' circular actions

Summary

Recommendation ITU-T L.1620, *Guide to circular cities*, contains circular city implementation framework that is designed to improve circularity in cities and support stakeholders in implementing circular actions. The framework consists of a four-step methodology that provides a consistent method for assessing, prioritising and catalysing different circular actions. The Recommendation is developed in response to the growing sustainability challenges that cities are facing and the emergence of the circular economy concept and its applicability and extension in the city setting. Supplement 50 to ITU-T L-series Recommendations aims to further support the circular city implementation framework by providing 17 case studies on cities implementing circularity in urban operations.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L Suppl. 50	2022-07-01	5	11.1002/1000/15087

Keywords

Circular city, circular economy, Internet of Things, smart sustainable city.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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Case studies on implementation of cities' circular actions

1 Scope

This Supplement contains a series of case studies on cities implementing circular actions. The case studies cover a wide range of areas including energy efficiency in buildings, solid waste management, urban mobility, reducing food waste, promoting local businesses and more. Each case study begins by highlighting the background and challenges that the case study is responding to. It then details the vision and content behind each activity including the implementation process. Finally, each case study describes the results of the activity. A list of references and further reading for each case study is also provided.

NOTE – The case studies contained in this Supplement are adopted from the U4SSC deliverable with the same name.

2 References

[ITU-T L.1620] Recommendation ITU-T L.1620 (2022), *Guide to circular cities*.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

None.

3.2 Terms defined in this Supplement

This Supplement defines the following term:

3.2.1 circular economy: An economy closing the loop between different life cycles through design and corporate actions/practices that enable recycling and reuse in order to use raw materials, goods and waste in a more efficient way.

NOTE – The circular economy concept distinguishes between technical and biological cycles and is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimizes system risks by managing finite stocks and renewable flows, while reducing waste streams.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

CFC Chlorofluorocarbon

DE District Energy

DHR District Heat Recovery

DLWC Deep Lake Water Cooling

GHG Greenhouse Gas

GIS Geographic Information System

IoT Internet of Things

RFID Radio Frequency Identification

5 Conventions

None.

6 Case studies on implementation of cities' circular actions

6.1 Case study 1 – Toronto: Deep lake water cooling

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. This rapid growth comes with 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 per cent by 2030 and by 80 per cent by 2050 compared with 1990 levels (Scioli, 16). Since the 60 per cent of GHG emissions in Toronto is 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 1980s, 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, which are 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 1990s, 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 address the water quality issue caused by zebra mussels and provide a source of water that remains at 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 (DE) 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 for the natural environment.

Promoting circularity

Vision and content

DLWC was initially set out to transform the way in which buildings are cooled, in order to reduce the 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 1 391 kg of CFCs, 61 MW of peak electricity demand, 75 per cent 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 per cent of its energy consumption will have to be derived from renewable or low-carbon sources and 30 per cent 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 for cooling.

How deep lake water cooling works

Three DLWC intake pipes extend along the base of Lake Ontario to a depth of over 80 m below the surface, where the water remains at a temperature of about 4°C throughout the year. Once the water has been drawn from the lake and treated to make it potable, it is pumped through heat exchangers to cool it 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 1 shows the DLWC process.

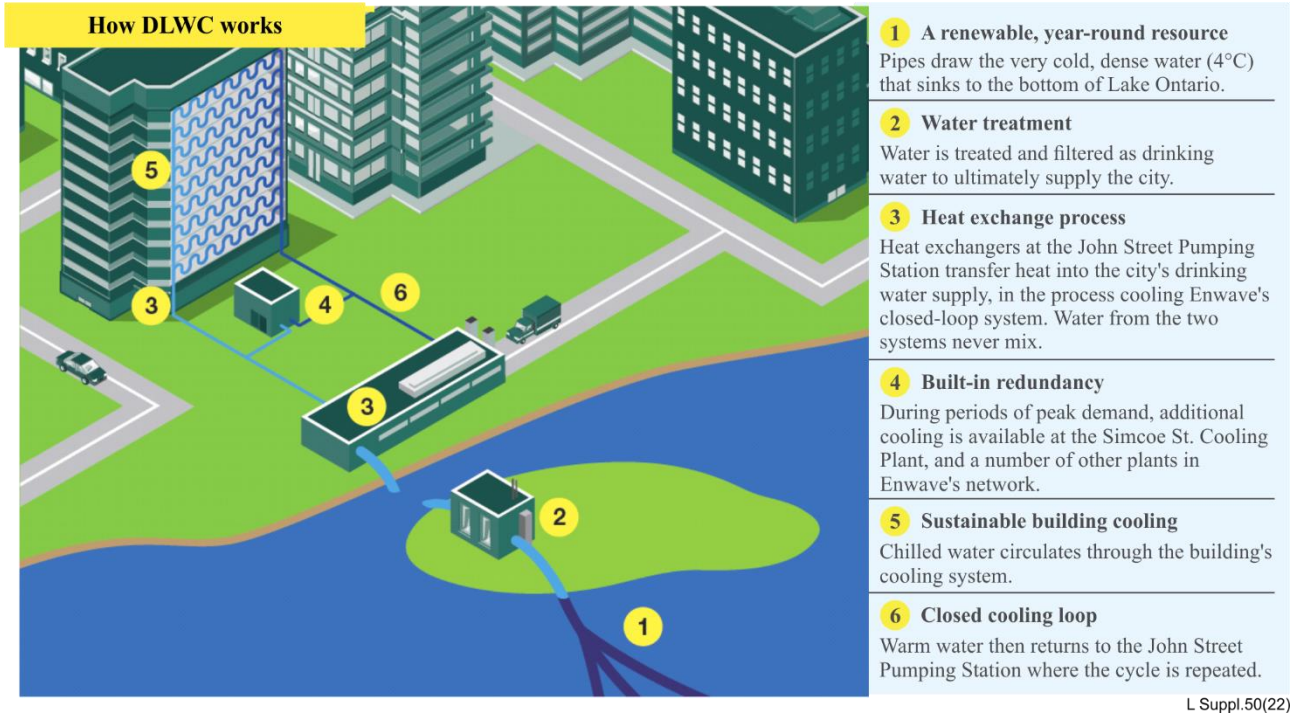

Figure 1 – DLWC process (Source: Toronto Hydro)

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 (DHR) 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 the city infrastructure such as control upgrades at the city's water filtration plant. To make this project a reality, a strong leadership commitment, a close working relationship 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 the existing, abandoned pipe infrastructure and the necessary rights of way 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 greener and cheaper, 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 centres, 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, in order to remain competitive in the market. Table 1 describes Toronto's strategic approach to district energy, while Table 2 describes policy impacts to DLWC, DHR and DE in Toronto.

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 together 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 optimising 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.

Table 1 – Toronto's strategic approach to district energy

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 (DE)	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 modelling 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 modelled as more efficient than the reference building, but buildings using 400% efficient geothermal heating from a district system are modelled 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 the 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 gain a better understanding in building energy efficiency and to improve it. 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 per cent compared with 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, more than 116 million Canadian dollars 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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Toronto Hydro, *Savings Through Technology, Enwave's Deep Lake Water Cooling*, SaveONenergy, http://www.torontohydro.com/sites/electricsystem/electricityconservation/residentialconservation/Documents/THE%201497_Deep%20Water%20Cooling%20Sell%20Sheet_web_dh08.pdf

List of discussion partners/interviews

- Dennis Fotinos, past chairman of Toronto District Heating Corporation and past chief operating officer of Enwave
- Joyce Lee, vice president system operations and asset management at Enwave
- Alex Sotirov, vice president of engineering at Enwave

6.2 Case study 2 – Spain: Smart waste – Promoting recycling of municipal waste

Introduction

Background

Cities are responsible for 50 per cent of the global waste generated and are causing between 60 and 80 per cent 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.[1]

[1] "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

Source: www.esmartcity.es

Figure 2 – Recycling containers

Recycling is one of the fundamental pillars of the circular economy; its objective is to use the waste originating in industrial processes as raw material for another process through exchange, reconditioning, repair and re-use in a closed circuit. In this context, what was previously considered 'waste' can become a valuable resource. Figure 2 shows a typical grouping of municipal recycling containers.

According to the latest Eurostat figures, across the EU on average more than 45 per cent of municipal waste (which does not include industrial or hazardous waste) is being recycled. The new Directive (EU) 2018/851 amending Directive 2008/98/EC on waste, maintains a 50 per cent 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 per cent of municipal waste by 2025, going up to 65 per cent by the year 2035. However, in Spain this figure remains stuck at 29 per cent and the worst part is that the figure has remained practically the same since 2010.[2]

In 2017, Ecoembes, the organization responsible for the recycling of packaging in Spain, created TheCircularLab,[3] the first innovation centre in Europe on circular economy, whose main target is to analyse, design, promote, test and apply in a real environment the best practices in all phases of recycling. Working closely with its technological partner, Minsait[4] (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 EU targets requires facing the following challenges:

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

3 TheCircularLab at https://www.thecircularlab.com/

4 Minsait at https://www.minsait.com/en/home

- 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 no measurement of the quantity of correct disposal of waste generated at home, so promotion policies like individual or community payments for waste cannot be properly enforced.
- 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, do not know the needs, type and location of the containers, or the frequency of filling and their efficiency of materials in order to control the compliance of service level agreements.
- Some areas still maintain a low quality of collected material, with a large number of improper elements that make it difficult to re-use, 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, optimises municipal resources dedicated to the collection of urban waste, and increases the efficiency in re-using the material.

In line with this, Minsait has developed the SmartWaste project for collecting and analysing data from all types of sensors located throughout the recycling process, which allows relevant data to be obtained, in order to make predictive models of behaviour that help in decision making. Currently, the SmartWaste project is in the deployment phase as a pilot project in four 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 stakeholders: citizens, as the main participants; local authorities; and the contractors that provide and operate municipal services.[5]

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.

Citizens should, first of all, be well informed. They should know the details of how to recycle correctly, 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

[5] Sanz, F. 'SmartWaste: a step forward the society of the future'. FuturEnviro. October 2017 at https://futurenviro.es/smartwaste-un-paso-hacia-la-sociedad-del-futuro/

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 the determination of those neighbourhoods that are more efficient and those that are not. This information is aimed at improving the quality and recycling rate.

Implementation

The project 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 3 describes the management units of the SmartWaste pilot project.

Table 3 – 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:[6]

Fill-level sensors, installed in the waste containers, these facilitate the optimisation of waste collection routes in real time, so avoiding situations in which containers are empty. The result is greater service efficiency, cost reductions and lower emissions 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 are of the appropriate quality (whether the container contains inappropriate material that does not correspond with the waste type in question).

Radio frequency identification (RFID) tags[7] installed on containers enable collection service traceability, provide information related to the time of collection, movement or cleaning of a

[6] El Pago por Generación, el aliado de la economía verde". Corresponsables, December 2017 at http://www.corresponsables.com/actualidad/pago-geneneracion-aliado-economia-verde-ecoembes

[7] 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

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 centralised Internet of things (IoT) open platform provided by Indra and tested in multiple Smart City projects, analyses the collected data in real time from sensors in containers and vehicles for waste collection. Being cloud-based, these centralised 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 device, and integration with other information systems.

The IoT platform also relies on a geographic information system (GIS) and big data techniques to analyse 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, and so on. The information obtained by SmartWaste can be used for the internal management of the processes, but also made public to the citizens, in order to support raising awareness 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:

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 as shown in Figure 3. 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 and location of containers and the types required. Later, it could also be used for the implementation of payment policies for waste

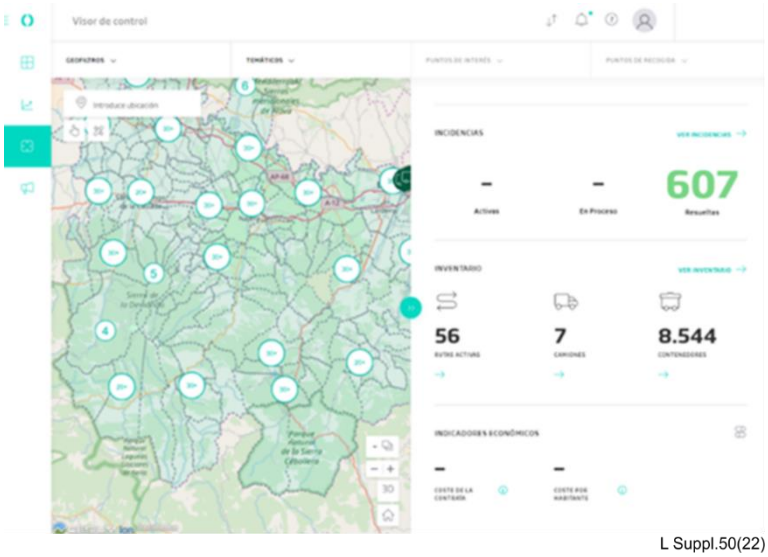

Figure 3 – Section of one city with the location of containers

2) Vision of control and optimization of collecting service: The information provided by the platform, as shown in Figure 4, allows the planning of routes and the frequency of collection in an optimal way, according to the status of the containers, as well as compliance with the collection agreements; the analysis of the incidents detected during the service; the real-time monitoring of vehicles and traffic; and the monitoring of driving patterns.

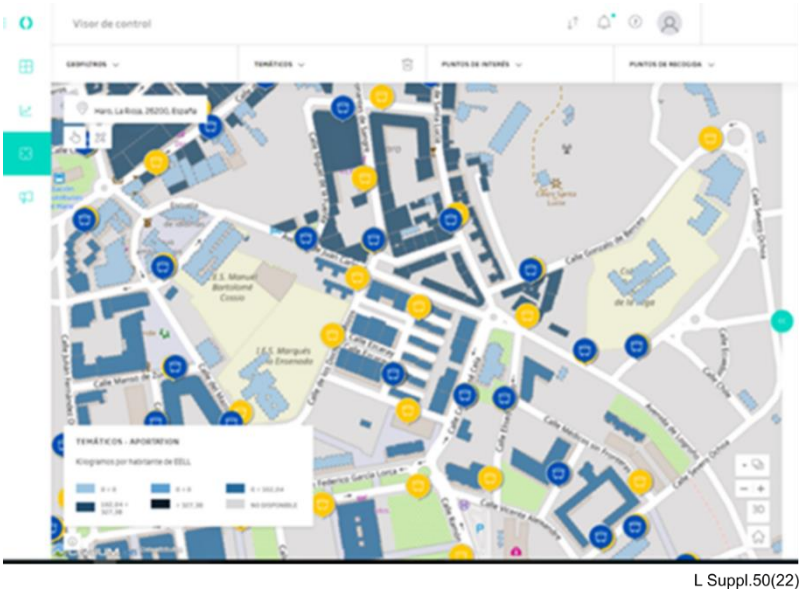

Figure 4 – Control of the collecting services

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

3) Vision for monitoring the performance of the process: The level of detail in the data allows us to know the environmental impact in terms of energy (CO_2 emissions) and water savings, and also the percentage of recycled material that will be useful for re-use at the container level (Figure 5), which will serve to implement promotion campaigns in specific areas that increase the performance of the process.

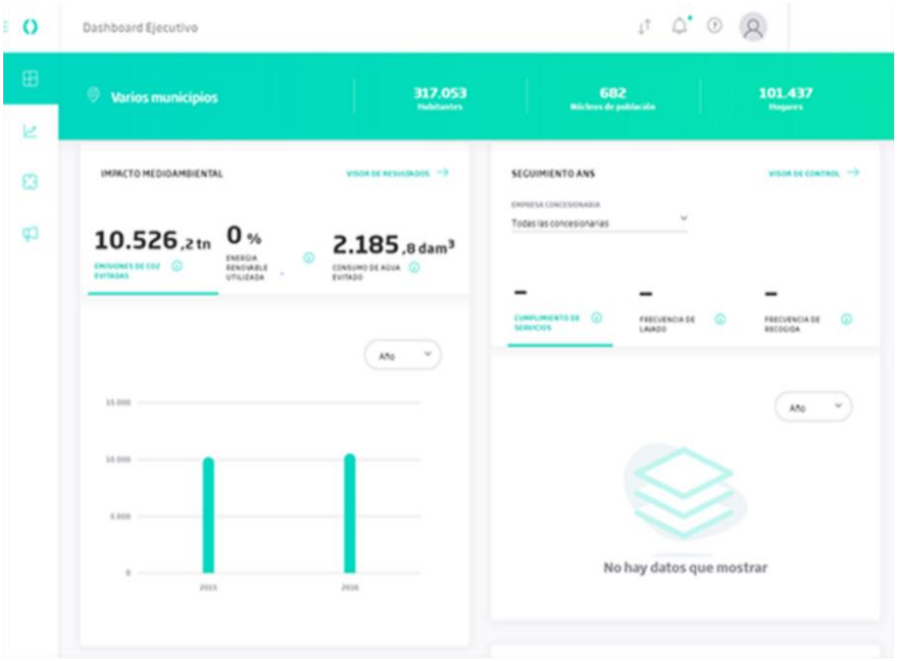

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Figure 5 – Environmental impact: CO_2 emissions and water consumption avoided

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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6.3 Case Study 3 – India: Use of plastic waste in road construction

Introduction

Background

The modern urban lifestyle dictates the generation of plastic waste, which needs to be disposed of or recycled. With developing countries 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, and a significant plastic waste problem, India is a noteworthy case study. In India, almost 70 per cent of the population live in villages. Even though rural inhabitants do not generate quite as much plastic waste as their urban counterparts, 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 re-using plastic waste in India.

Challenge and response

Over the last few decades, plastic materials have become an integral part of the 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 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 in other developing countries, are facing is the enormous amount of plastic waste that is generated due to modern ways of living, and this 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 road construction via a special technology, which makes the road stronger, less susceptible to the vagaries of nature and with less maintenance costs. 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 a common sight 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 that eat plastic bags and similar items. Moreover, plastics found in fields block germination and prevent rainwater absorption. Plastic waste also causes significant water pollution.

Recycling plastic can be done only 3–4 times and melting the plastic for recycling releases highly toxic fumes. In India, plastic waste is recycled inefficiently. About 60 per cent of the plastic waste collected and segregated gets recycled back into materials for further processing into consumer products, while the remaining 40 per cent 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 after proper processing, plastic waste can be used as an additive to toughen roads while also helping to save the environment. Plastic increases the melting point of the bitumen. A city using this technique for road

construction and maintenance is bound to benefit socially, economically and environmentally. Consequently, it should be a part of any long-term city smart vision and strategy.

Implementation

Using recycled plastic to build roads has already been done 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 rainwater penetrates underneath 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, illustrated in Figures 6, 7 and 8, begins with the sorting of plastic waste, the shredding of the waste into tiny pieces, roughly 2-4 mm in length, and by adding the shredded polymer waste to stone aggregate. The stone aggregate, which is comprised of granite and ceramic pieces, is heated to 160-170° 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.

Figure 6 – Aggregate

Figure 7 – Plastic waste

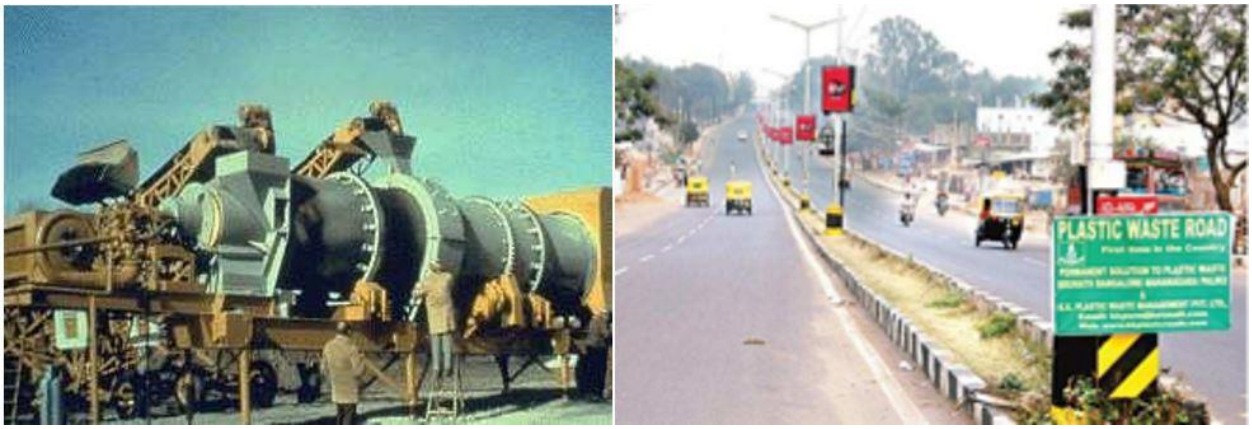

Figure 8 – Mixing of shredded waste plastic, aggregate and bitumen in a central mixing plant

Policy enablers

The state governments in India support this concept. A Government of India order in November 2015 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 to overcome the growing problem of plastic waste disposal in India.

Stakeholders involved

The project was elaborated using the technology developed at the 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 rainfall.

Results

This project has succeeded in leading the cities to solve two major challenges in cities in India:

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

In addition to contributing towards good road construction, namely roads that have a longer life and require 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. Potholes in a city cause a slowing down of the traffic, which, in turn, increases air pollution and also results in the wasting of precious fuel, which needs to be imported. Apart from this, potholes on the city roads make them prone to accidents, particularly during the rainy season. Mitigating this challenge is an important step towards improving the quality of life in a city. It has 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 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. Polymerised 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 in the short term, as well as over the long term. There are also significant savings in the use of fuel resulting from the improved quality of roads.

Environmental impact: Plastic waste is a big challenge, particularly for the environment. Many types of plastic are not recyclable but when used along with the bitumen prevent the environmental degradation due to plastic waste.

Case study references and further reading

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- J. Kwabena Appiah, V. Nana Berko-Boateng, T. Ama Tagbor, *Use of waste plastic materials for road construction in Ghana*, Dept. of Chemistry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana and Council for Scientific and Industrial Research-Building and Road Research Institute, CSIR-BRRI, Kumasi, Ghana available at www.elsevier.com/locate/cscm

6.4 Case study 4 – Vienna: House sharing in urban areas as a tool for social inclusion

Introduction

Background

Residential property prices in Austria rose by 4.7 per cent year on year in the fourth quarter of 2017. Price growth for the year as a whole was 3.8 per cent. Property prices in Austria have risen by an average of 39 per cent since 2010, according to the ImmoDEX real estate report.[8] New homes are the most expensive in the capital of Austria, Vienna, where a 123 m^2 apartment or house costs around EUR 471 000 – an increase of 22 per cent since 2010. Rental prices for new properties have risen steeply, by 21 per cent, with average costs now EUR 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, that is people who have registered their interest in renting a council flat.[9] The fact that property prices are increasing should be cause for alarm. According to a recent study, the total population of Vienna will increase by 289 000 (+15.5%) during the period 2018–2048. The corresponding number of residents with a primary residence in the city will amount to 2 178 000 on 1 January 2018.[10]

Since 2007, the number of residents of Vienna has grown by twelve per cent, from 1 661 246 to 1 867 582 in 2016. The population is expected to increase by over 2 million 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.[11]

Challenge and response

The city is about to face a housing shortage that will impact young people and students in particular. 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 existing housing to provide affordable housing options for 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 or renting out, and takes care that everyone involved is satisfied.

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8 ImmoDEX report available at: https://www.immobilienscout24.at/unternehmen/presse/presseaussendungen/2017/27-02-2017-immodex.html

9 Wiener Wohnen at https://www.wienerwohnen.at/

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

11 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

Promoting circularity

Vision and content

The project was launched to respond to three challenges facing 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 the people looking for housing. WGE! *(Gemeinsam Wohnen – Living Together)* is establishing a model of shared multigenerational living in Vienna. WGE! changes the way we use our homes based upon a mutuality of needs of different generations: young people are moving into elderly people's houses or into an empty room in a retirement home. Elderly people can reduce their housing costs, get someone to keep them company and give them a helping hand in managing the household. Young people are benefitting from low rents and the life experience of an elderly person. Table 4 provides some demographic data for Vienna.

Table 4 – Data for Vienna

Data for Vienna	
People over age 60 feel at risk of exclusion	30%[12]
Average money students live with	EUR 850[13]
Number of students living in Vienna	200 000[14]
Average rental cost	EUR 15.50 per m^2 [15]

Affordable housing is one of the key factors at play when measuring a city's competitiveness. Vienna considers itself to be a social city, and the requirement to take care of the needs of young and elderly people alike 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 of WGE! is that its projects stretch out through the generations. Especially in highly technological and developed cities, social isolation is a huge problem. WGE! addresses this problem directly. Not only do the flatmates live together, they also share their lives.

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[12] Silver Living Study: https://www.silver-living.com/silver-living/news/silver-living-studie-angst-vor-einsamkeit-im-alter-ist-weit-verbreitet/

[13] Austrian Federal Ministry for Science, Research and Economy; Report on the Social Conditions for Students: https://www.ihs.ac.at/fileadmin/public/2016_Files/Documents/2016_BMWFW_Materialien_zur_sozialen_Lage_der_Studierenden.pdf

[14] Vienna in Figures 2018 (City of Vienna): https://www.wien.gv.at/statistik/pdf/viennainfigures-2018.pdf

[15] https://www.immopreise.at/Wien/Wohnung/Miete

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

Results

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

- Young people get affordable housing and a family home.
- Elderly people can afford steadily more expensive apartments through having 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 lives.
- 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 more than 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 the flat shares that WGE! helped to create over the last two and a half years are still happily running.

Case study references and further reading

- WGE! Website available at http://www.wge-wien.org/
- *WGE! In the Social Challenge Platform* at https://www.socialchallenges.eu/en-US/city/10/Organisations/199

List of partners/interviews

- Mr Lukas Hecke, Co-Founder of WGE! (http://www.wge-wien.org/, German only).

6.5 Case study 5 – Sri Lanka: Wild coast tented lodge

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 multidisciplinary 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 including 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 cooperation with the local community, see Figure 9.

Background

Kirinda is a small village in the south-east 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 and they 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 recent decades, fish stocks have been in decline and, as a result, many of the young men from the village have left to seek their fortune in the capital, Colombo.

In many ways, this rural village is an isolated enclave in one of the remotest corners of the country, which has been forgotten as the Rajapaksa Government has 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 among the city assets and products, and encompasses recycling and re-using as the action items as defined within the U4SSC '*Guidelines on strategies for circular cities*'.

Challenges

Running 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 second-largest national park in Sri Lanka, and the most visited. 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. It also has the highest density of Sri Lankan leopards in the country, as well as an abundance of aquatic birds.

Figure 9 – 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 – as water, electricity and sewage treatment facilities were all absent. The site was a 14 km 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 for the project were presented to a group of 26 local, unskilled workers who were asked to lend their assistance.

Large, experienced contractors had already proved reticent to build a series of contemporary, organically shaped buildings in such a remote location, which were in complete aesthetic contrast to their traditional work. However, the local community embraced the project and immediately recognized its value and agreed to become 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 the macro scale, and termite mounds, at the 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, see Figure 10.

Figure 10 – 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, see Figures 11 and 12.

Figure 11 – Masterplan

Figure 12 – Beach cocoon

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 gridshell 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 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 70 mm 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 in 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, which 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 155 kw 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 were inspected and approved by Sascha and the site office manager Razim. When targets were met, generous bonuses were distributed among 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.

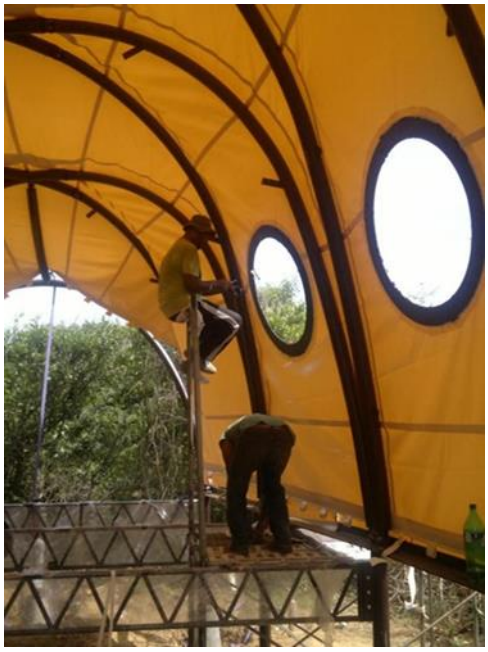

Figure 13 – Membrane installation

During Ramadan, the competition intensified, and the Muslim teams asked if they could work at night. Teams worked from 4 pm until 6 am, and then a second team of Buddhists would work the day shift from 6 am through to 4 pm 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, two German master carpenters and a French architect were brought in to supervise a new, 36-man team of local fishermen for the construction of the bamboo buildings.

Figure 14 – 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 there were regular inspections of the safety equipment.

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 2018 UNESCO Prix Versailles for commercial architecture and were finalists in several other international awards.
- The effects on the local community were tangible – workers bought new tuk tuks (local motorized vehicles), their homes were improved, an additional storey was added to the village mosque, and many new skills were gained.
- The construction company received a UNIDO grant to set up a bamboo treatment facility in the village, so that 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 a wildlife habitat.

6.6 Case study 6 – Dubai: E-hailing initiative

Introduction

Background

The Emirate of Dubai is the second largest of 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 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 a 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 the 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; to adapt technologies and innovative approaches; and to implement world-class practices and standards

Challenge and response

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

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

The RTA engaged with the private sector to collectively create a tangible 'smart' solution to fill 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 upon 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 per cent (11-12 minutes).
- The RTA implemented a mandatory regulatory monitoring system for e-hailing companies and for-hire vehicles in Dubai known as the 'Connected Mobility System' the first-of-its-type system provides real-time monitoring of trips, alerts, violations and driver behaviour analytics.
- 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, namely 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: 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 ranging from flying taxis, self-driving pods and integrated transportation systems, to mobility as a service, are all aligned with the overall vision of serving key stakeholders and creating 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 involves 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 market reviews and identified three potential risks that an 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 so generating concerns about 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.
- An increasing demand on taxis with high waiting time.

Results

The project has contributed towards Dubai's vision of becoming 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, multimodal transactional and journey planner.

The key positive impacts obtained by the project can be summarized as follows:

1) The utilization of limousine vehicles in Dubai increased from four trips per day to 12 trips per day on 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 nine 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 into an international company worth over USD 1 billion.

5) The limousine sector has seen a growth of 36 per cent since the partnership was introduced, which is highest in the history of the sector in Dubai.

6) It has encouraged the taxi sector to think more innovatively and to increase the taxi utilization rate.

7) The RTA's service quality effectiveness reached 78 per cent (2017) from 66 per cent (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 with 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.

Case study references and further reading

- RTA Statistics, 2018
- RTA Dispatch Center Bookings data, 2017 and 2018
- Arthur D Little *Future of Mobility Report* (2017)
- Urban Mobility Innovation Index (2017)

6.7 Case study 7 – Toronto tool library and sharing depot

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, CDs and DVDs, 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 a growing carbon footprint, income inequality is also a rising concern in Toronto as in most areas of the world. Ensuring that 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, which ensures that the city can sustain its cherished quality of life.

In this regard, in 2013 a small group of passionate individuals launched a project that addressed income inequality and environmental concern. 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 programme that was affordable and took on the problem of consumption by

giving people access to a wide range of goods and tools that are typically used only a few times a year. Through an annual membership scheme, 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 the sharing depot, or get combined access with an upgraded membership.

Promoting circularity

Vision and content

The Toronto tool library and sharing depot started with the assumption that there are already enough resources available to meet the demand of communities, not only in Toronto but also globally. This statement can broadly apply to food (approximately a third of the world's food production is thrown away), energy and 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, artisans, 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 a lot of space in a 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 more than 15 000 borrowable items across three 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 government grant funds. 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 programmes, 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, more than 80 000 items have been loaned and this has generated over USD 750 000 in revenues. Each borrowed item had been donated earlier and did not, therefore, end up in a landfill. In addition, the item was not purchased by the user, so generating less waste down the line. Some of the tools have been borrowed over 100 times each, resulting in 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 maximising 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 artisans. This programme 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 was awarded the Live Green Toronto ward 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 with other groups and groups aspiring to make a similar impact.

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

The economic impact includes an increased disposable income for inhabitants due to reduced expenditures for tools. Other benefits are the avoidance of unnecessary consumption and production due to infrequently used items, and the standardization of tool-related expenditures through a fixed and fair price that is the same for all members who can afford it. It also enables increased disposable income to be diverted to uses that are better for the city's inhabitants.

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

Case study references and further reading

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

6.8 Case study 8 – London: The Library of Things

Introduction

Background

London is currently transitioning into 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 the re-using, remanufacture and redistribution of 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 need 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 15 shows different types of economy.

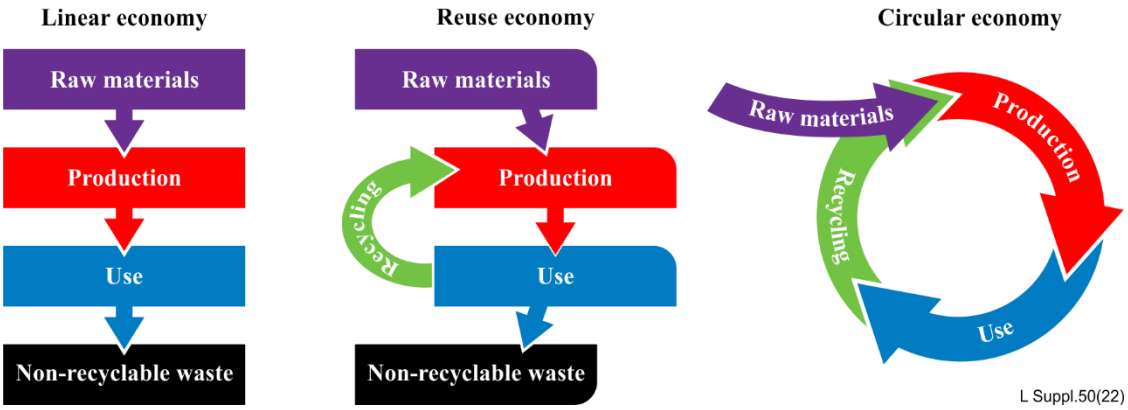

Figure 15 – Illustration of different types of economy (Ministry of the Environment, 2016)

London's current waste situation is quite alarming. The local authorities are collecting about 3.7 million tons of waste annually, which corresponds 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 waste per year will have to be collected so 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 consumer spending habits given that around 60-80 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 60 per cent of global greenhouse gas emissions, with a total land, material and water use of 50-80 per cent (Jacobs, 2016). This can be exemplified by the fact that people prefer to buy new items rather than repairing old ones.

This habit is fuelled by companies' profit-making strategies whereby products are made less sturdy in order to having shorter life cycles, 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 USD 100 to USD 250 an hour for labour, excluding the price of spare parts and other service fees and taxes. For smaller appliances such as microwave ovens, the service charge can be around USD 70 an hour, with the addition of the cost of parts. However, most decent models can be purchased for prices ranging from USD 50 to USD 100 (Rox, 2018). Even though it may sound profitable for the consumer, and give an illusion of convenience, over 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 relies mainly upon inexpensive and readily available natural resources. However, as economic growth increases, natural resources decrease drastically while carbon emissions and the costs of production tend to be on the high side.

– Regulatory trends

  More and more policymakers around the world are charging the cost of externalities through environmental taxes. For example, the number of laws on climate change has increased by 66 per cent since 2009, rising from 300 to 500 laws (LWARB, 2015).

– The change in consumer behaviour

As people's mind-sets 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 EUR 28 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 five 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.

Originating in the United States, the Library of Things concept has been adopted in other countries: examples include the Sharing Depot in Toronto, Canada and Leila in Berlin, Germany. These have consequently inspired 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 mind-set**

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 GBP 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**

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

– **Reducing waste**

To avoid people dumping almost-new items that have the potential to be refurbished, the Library of Things put 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 repairing knowledge to enable people to learn how to repair 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, 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 mind-set and behaviour on waste reduction and prevention whilst, reinforcing the sense of community through a 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 and disposal of virgin resources. 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, remanufacturing 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 re-using products will be the norm in London. Consequently, it is predicted that London could achieve a benefit of at least GBP 7 billion 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 Crystal Palace Library of Things 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 of the Library of Things include the items available to the borrowers. These items, as opposed to other existing models of sharing platforms, are sourced primarily from companies' sponsorships thus 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 and sports equipment.

One of their other main characteristics was the desire to enable the clients to enjoy an 'Apple Store-like' experience at the Library of Things, whilst making it as practical as Argos (a British catalogue retailer). The place was designed in this light, and in addition a lot of thought was put into finding

the ideal location in which to integrate the Library of Things into the local community. The Upper Norwood Library, having worked in partnership with the Crystal Palace Transition Town, has welcomed the Library of Things as part of its vibrant library hub. Therefore, people 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 three plans, shown in Figure 16, are 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

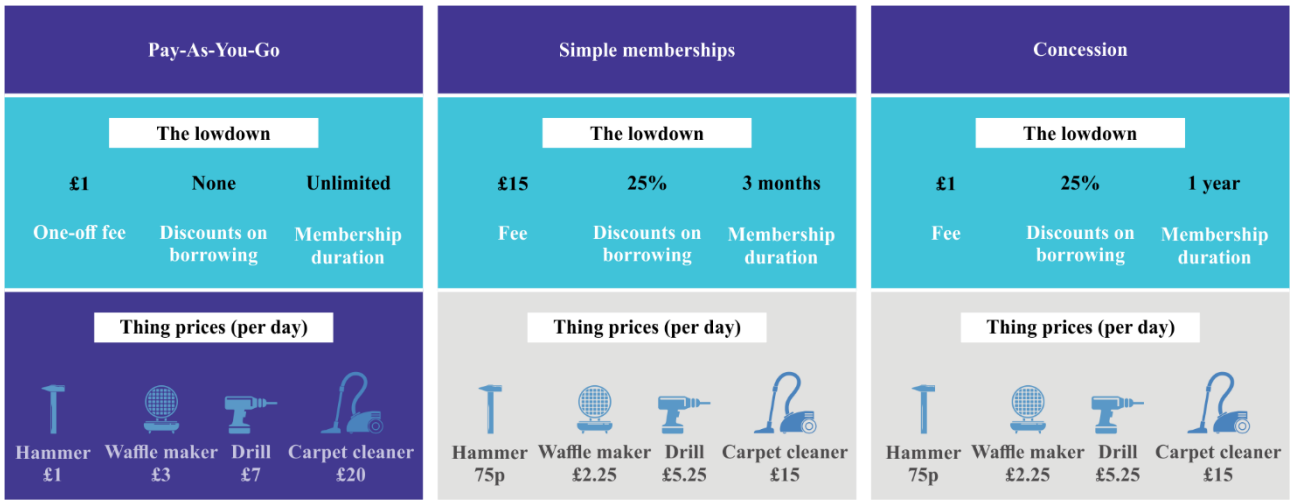

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Figure 16 – Library of Things membership plans

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 unlocked automatically. 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 things, planting, up-cycling and repairing or becoming 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 are not around (The Libary 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 include:

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 to 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 to be one of the most important tools for any business. This has allowed the library of things to become known and to remain competitive within the industry. According to a study carried out by Nielsen, 85 per cent of consumers will use 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 programme with online payment. The interested parties can sign up easily from anywhere and pay for their opted membership package instantly. This user-friendly feature renders signing up easier and is, therefore, considered highly encouraging for new members.

4) Online catalogue

Members can access the Library of Things' online catalogue around-the-clock, browsing through the available items at their ease and in the comfort of their homes. Once they have decided, they can book the item required online and pick it up on site at the pre-arranged 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, especially for lending services, in order to remind members when the borrowed items are due back thus eliminating the need 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 dozen of registered members or items in the inventory can quickly become highly troublesome. 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 businesses to reach their target audiences. 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 Upper Norwood Library of Things currently has 3 000 followers on Facebook.

Implementation

The project has been implemented in different phases, which are described briefly 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 Librarywith the help of local volunteers. The venture, as shown in Figure 17, was considered a success as they welcomed around 1 000 people during the ten-week trial period, having only one open day per week. In total, over 100 people donated some of their belongings, and 1 in 3 returned to borrow an item (Library of Things, 2015)

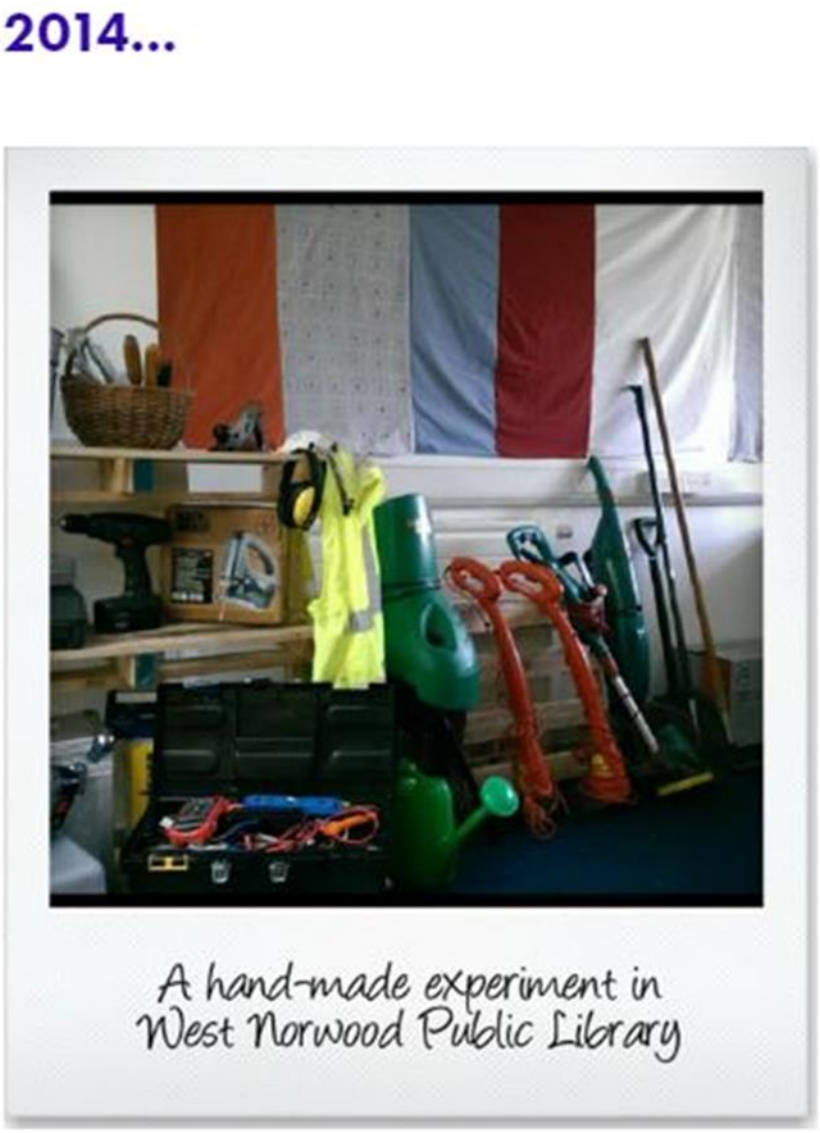

Figure 17 – The initial experiment of the Library of Things

– **Demonstrator**

From there, after crowdfunding GBP 15 000 from 250 backers on Kickstarter, the founders progressed to a South London car park where they placed two retrofitted shipping containers meant to be the new venue of the Library of Things for the next 18 months, see Figure 18. Three-hundred and fifty items were sourced from companies like Bosch, Kärcher, 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 coming to borrow different items to meet their needs.

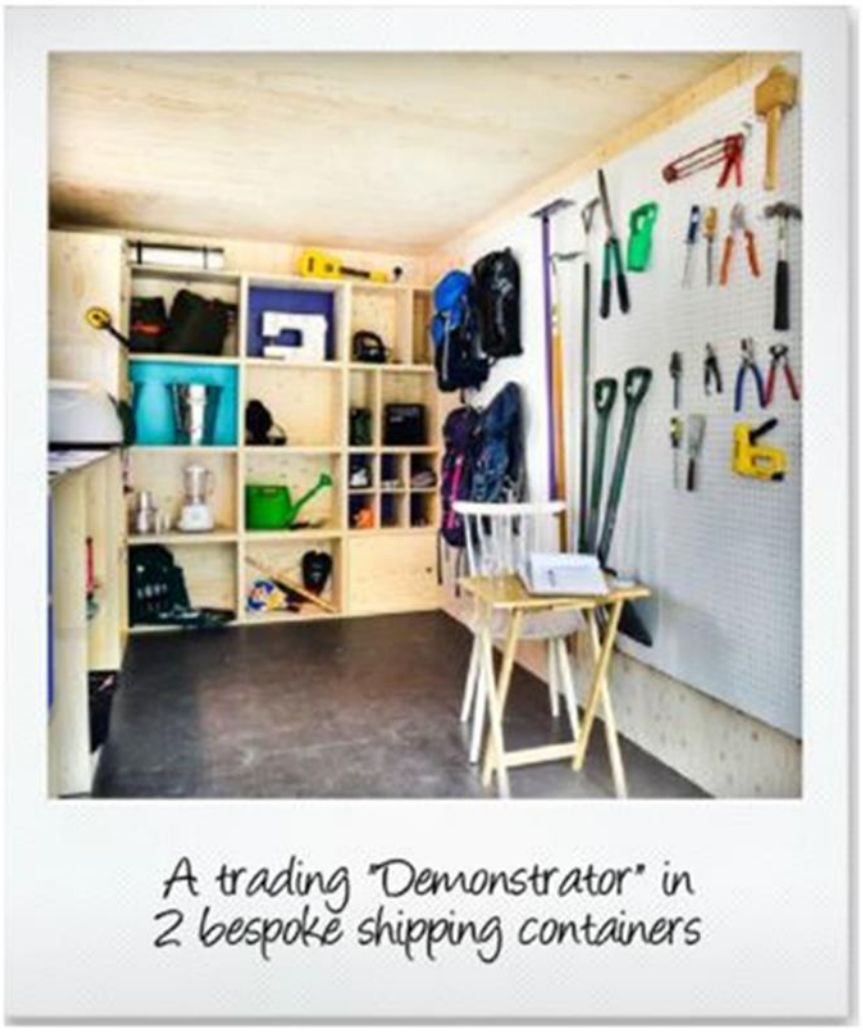

Figure 18 – The demonstrator phase of the Library of Things

– **Operation**

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

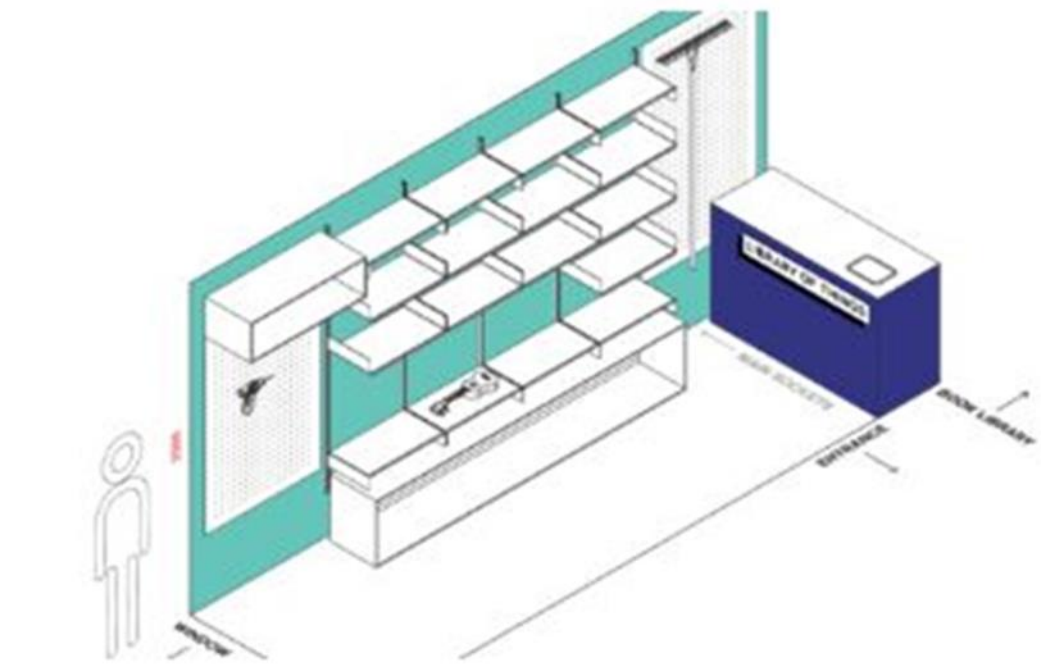

Figure 19 – Smart borrowing kiosk

– **Scaling up**

The Library of Things team is now looking to expand the new smart borrowing kiosk, as shown in Figure 19, 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).

For the successful operation of a Library of Things, several stakeholders need to have a symbiotic involvement, as illustrated by Figure 20.

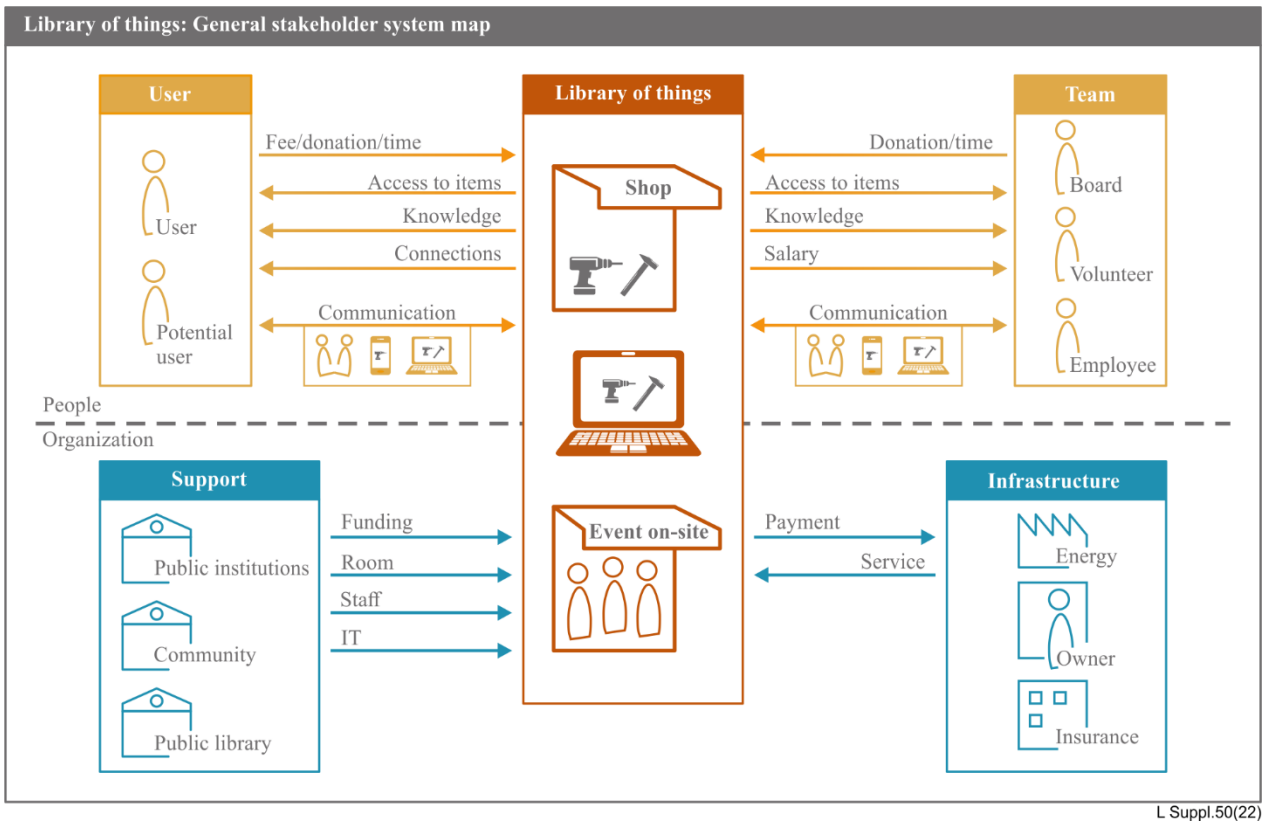

Figure 20 – The Library of Things general stakeholder system map (Ameli, 2017)

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 has been found that existing sharing platforms are either inconvenient for users or require too much effort from the users during the lending process. Moreover, users were found to be reluctant to share their belongings with strangers as this requires another level of trust, especially when operating 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 companies, so enabling the Library of Things to provide the users with high-quality items.

The user-friendliness of this system has already attracted over 850 members who have already borrowed more than 2 500 items throughout the course of the Library of Things' short life span. With more people using the same things, these things are being used more efficiently and fewer items are being purchased needlessly. This will enable a significant decrease in the ecological impact as products consume a great amount of energy and resources over their life span, 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 since 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 neighbours and expanding a contact network.

This sharing economy system also saves people of all social classes considerable amounts of money by giving them access to high-quality items that they would perhaps not have been able to afford to buy, or would have had to spend a ridiculous amount on money on, in order to own it and use it only once or twice . (Perchard, 2017).

Even though the Library of Things seems to be a working business model, Rebecca Trevalyan has warned that the infrastructure in place to make things easier and lower the operating costs is not sufficiently developed. There are still numerous challenges to tackle, such as creating a feasible revenue model or a good organizational structure. However, the founders of the Library of Things remain confident about 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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6.9 Case study 9 – Delhi: From worn-out /discarded textiles to premium ware

Introduction

Background

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

In recent years, affluence has grown too. Ordinary people have much more disposable income than was the case 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 of huge amounts of garbage in the form of discarded textile material.

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

Challenge and response

Disposing of huge amounts of waste is a challenge for any city, and this 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, others work on segregation and recycling, and yet other 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 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 their customer's requirements and delivered as beautiful, durable articles ready for use. This is in tune with the Circular Economy and Cities initiative of the U4SSC, the objective of which is to look at the re-use of various resources within the city. In this case we are looking at re-using large pieces of useable/ discarded fabrics from households. Figure 21 shows some examples of discarded textiles.

Figure 21 – Examples of discarded textiles

Promoting circularity

Vision and content

In the present-day scenario, the preservation of the environment is of primary concern across the globe. Recycling, restoring and re-using are the ways to reduce waste creation. New, usable products can be generated with the resources already available, thus minimising carbon footprints. Restoration, re-using 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 also great pieces of art. Kantha is also called 'needle painting'. Figure 22 shows some examples of Kantha of West Bengal.

Figure 22 – Examples of Kantha of West Bengal

2) **Gabba**

In **Kashmir**, old, worn-out woollen blanket pieces are dyed 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 are the abundant, naturally 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 (approx. 3.6 × 2.4 metres) or even more depending on the requirements, as they can be customized. These products are so durable that they last generations. Figure 23 shows Gabbas of Kashmir.

Figure 23 – Gabbas of Kashmir

Both of these arts are practised even today in a contemporized manner with new designs and techniques. The objective of this case study is to highlight these forms of art 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 the city, thus giving a boost to the economy of the city. In addition, the products can be marketed online. Some efforts at linking the craftsmen and potential buyers directly through e-platforms are also being made, in order to avoid the middlemen.

Results

Employment is generated at all levels, through the collection of the fabrics, processing, delivering, and so on. 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 traditionally been a women's craft, where it was practised 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 them with more work and enhanced income, and would 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 and meeting SDG 11- Sustainable cities and communities.

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

Case study references and further reading

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- Indiamart.com
- Kashmir Box – https://www.kashmirbox.com/blog

6.10 Case study 10 – Munich: Halle 2 second-hand store as a hotspot of the local circular economy

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 tonnes per year, of these 326 096 tonnes were collected separately for recycling. The recycling rate was about 51 per cent. 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 been to

forge partnerships for a sustainable lifestyle for all citizens. AWM started with waste-reduction campaigns in the 1990s and implemented a separate waste-collection system in 1994. Besides the collection of 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 centres located in many districts. Here they are asked to separate their recyclables into 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 centres, mobile recycling centres and bulky waste collection on demand, and by direct donation.

Knowing that several waste materials can be re-used, in 2011 AWM started the first second-hand store. AWM installed special collection points on the Recycling Centres for items which are still useful, and which can still be used after repair. When this store was demolished, AWM set up a multidisciplinary 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 are needed to achieve the best outcome for our city and its people. This is why we have Perspective Munich!'[16] Perspective Munich is an urban development concept established by the City Council in 1998. So far, it has been updated four times.

In order to respond to the city's challenges and support the Perspective Munich!, the Halle 2 project was launched by the city in 2016. The project consisted in setting up a second-hand store to recycle and re-use 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 stronger cooperation with companies that support recycling, the number of resold items had risen in recent years.
– Social targets: Halle 2 offers Munich citizens cheap used products. Halle 2 is also used as a 're-use-lab'. AWM provides a knowledge platform for re-use ideas. At the same time, AWM tests new ways of arranging awareness-raising campaigns and public relations by installing repair cafes, by contacting stakeholders of the 'sharing economy', by providing space for upcycling workshops, and by organizing exhibitions, music performances, science conferences, lectures, and so on.
– Job perspectives: Halle 2 offers training and qualifications to social enterprises for special target groups like young or long-term unemployed people.

Promoting circularity

Vision and content

Halle 2 combines a circular economy with the idea of sustainable lifestyles in Munich. In fact, by being a second-hand store that sells goods collected in the 12 Munich Recycling Centres, Halle 2 greatly extends the lifetime of everyday items and is also a good example of embracing active,

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

societal responsibility because it is based on strong partnerships between the city and many non-profit organizations.

Halle 2 is more than just a second-hand store; it is a 're-use lab', which means a testbed in which 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 re-using and recycling. In Halle 2, repair cafes, auctions, information and cultural events, online-marketing activities, and so on are organized routinely. 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 're-use 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 receive an alert if they are collected by AWM.

Results

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

– Re-usable goods: Goods that are suited for re-use without repairs and upcycling are collected at the recycling centres 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 nationwide label Einzigware. Einzigware is a fashion label that successfully distributes upcycled clothes. Old working clothes from AWM and also from Halle 2 staff are given to Nähwerk. Nähwerk also integrates and employs special target groups of people.

Thanks to cooperation with several social companies through Halle 2, the Munich Department of Labour 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 European Social Funds and are designed to facilitate the integration of target and vulnerable groups into the local labour market.

In addition, Halle 2 is used as an information and participation platform since it provides space for exhibitions, music performances, science conferences, lectures, and other events. 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 re-use and recycling ideas, such as:

– Catering: The non-profit organization Regenbogen Arbeit offers beverages and food as a catering service for events in Halle 2. The organization gives work perspectives to the long-term unemployed and to disabled people.

– Repair Cafe: This provides rooms for voluntary activities by Munich citizens. Experts support citizens who, for example, bring their bicycle that is in need of repair and give them advice on how to fix it. This is completely free of charge, but the participants are expected to donate something to one of the Munich social care institutions.

– Upcycling: With its Werkraum, Halle 2 offers a room for upcycling workshops for do-it-yourself amateurs, as well as for artists, and interested and skilled people. Munich vocational training schools cooperate with students of the Social Entrepreneurship Academy.
– Cooperation with educational institutions: Halle 2 offers Munich educational institutions like schools, universities or adult education establishments, various opportunities.
– Schools benefit from Halle 2 as a learning field and test bed for the awareness of re-use. Universities also use Halle 2 as a test bed for research and business cases. Institutions for adult education use Halle 2 as a platform for presentations, lectures, seminars on issues like sustainable lifestyles and problems of over-consumption, as well as for 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 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, and so on.

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

Halle 2 has become a strong brand as a second-hand store that facilitates cooperation with social companies, in order 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 re-used items (almost 15 000 articles sold per month, with an estimated revenue of EUR 50 000 per month).

Halle 2 is a good example of wide-scale 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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The Munich flea market portal (German) at https://www.awm-muenchen.de/privathaushalte/abfallvermeidung/muenchner-flohmarktportal.html

Halle 2 homepage (German) at https://www.awm-muenchen.de/privathaushalte/abfallvermeidung/halle-2.html

AWM-Repair Guide (German) at https://www.awm-muenchen.de/privathaushalte/abfallvermeidung/reparaturfuehrer.html

A summary of AWM's sustainability report (English) at https://www.awm-muenchen.de/fileadmin/PDF-Dokumente/privatkunde/2014_AWM_Nachhaltigkeitsbericht_Kurzinformation_E.pdf

Sustainability Report of the City of Munich (German) at https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Gesundheit-und-Umwelt/Nachhaltige_Entwicklung/Nachhaltigkeitsbericht.html

Application clip Halle 2 at https://www.youtube.com/watch?v=VURfqLLvTCM

6.11 Case study 11 – Finland: Sustainable sharing platform and facility for urban consumers

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, a temperate climate, significant investment in infrastructure and services, as well as the still-powerful welfare state. The situation is even better in the Helsinki region with its 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 the 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 mind-set. 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 to contribute through social media than to take part in an organized activity with schedules and responsibilities. But recently even local communities that are self-organizing using social media are facing difficulties as their communications are disrupted by the change of algorithms on the platform.

Challenge and response

In cities, services keep concentrating in malls that are accessible only by car. Consumers would want to move into more sustainable and dense urban residential areas to avoid the need to drive in order to access social services. In rural and suburban areas, services disappear into 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 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 massive

reductions in CO_2 and in the material footprint, while also improving people's everyday life and social well-being. The platform effectively catalyses 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. Figure 24 shows a smart 24/7 sharing facility, tool library service and more comprehensive local sharing platform.

The key elements of the solution are:

1) Smart 24/7 physical sharing facility accessible within walking distance of 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.
4) Service delivery which encourages fair and sustainable behaviour, and community building.

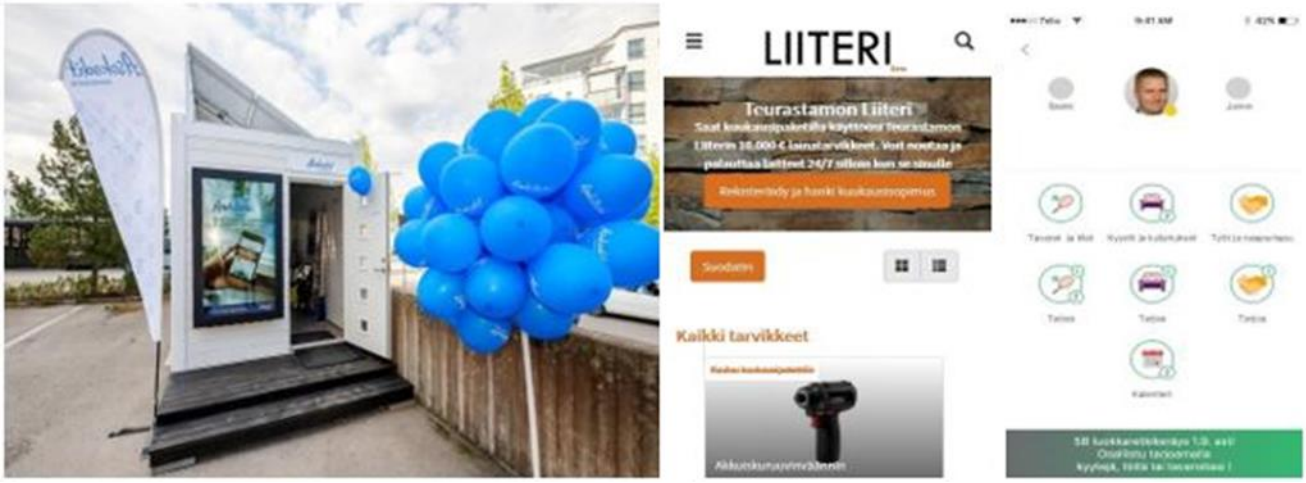

Figure 24 – Smart 24/7 sharing facility, tool library service and more comprehensive local sharing platform

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.
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 authorisations 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 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 others due to a more affordable access to appropriate tools. The impacts of the other sharing services include reduced traffic outside the area due to the local availability of services; providing support to people who need assistance when commuting; encouraging community building; and giving access to services for inhabitants 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 reduced financial, or other, means to obtain access those 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 also makes it sustainable and replicable on a 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.

Case study references and further reading

- Founders website at http://coreorient.com/
- Initiative website at http://liiteri.net/

6.12 Case study 12 – Mumbai, India: Roti Bank (Food bank)

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 an undernourishment rate 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. Sixty-six million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone.

Effects of chronic hunger: Chronic hunger – or food insecurity – is as devastating to families, communities and countries as 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 Challenge[17] in 2012 during the Rio+20 World Conference on Sustainable Development.[18] The Zero

[17] https://www.un.org/zerohunger/

[18] https://sustainabledevelopment.un.org/rio20

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 being 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)[19] goal. At the WFS, held in Rome in 1996, 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 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, see Figure 25, 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 growing steadily. A lot of economic activity happens here and consequently many people from the hinterland get sucked into this city. With limited scope for housing and other such amenities, 41 per cent 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 Mumbai City because of the lure of employment and a good future is quite large, and this makes the limited resources within the city insufficient to cater for the requirements of these new additions to the population every day. Intense economic activity also results in many people eating out and a lot of food becoming surplus to requirements at the end of the day in restaurants and eateries; this has to be sent to piggeries or get wasted. In fact, disposing of 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 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 to eat in regular restaurants. As mentioned, apart from meeting the needs of the citizens, it also ensures that

[19] http://www.fao.org/wfs/index_en.htm

Figure 25 – 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 SDG 2 and SDG 11.

Promoting circularity

Vision and content

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

The **Roti Bank** project 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 are living in harmony with all the groups. The crime rate in a city is another determinant. With hungry people around, it would not be possible to have a low crime rate. Hence this basic human need for food should be met 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 through a close working relationship between the well-established network of the **Dabbawalla Association of Mumbai** and an NGO called **Roti Bank**.

The additional resources 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 in Figure 26.

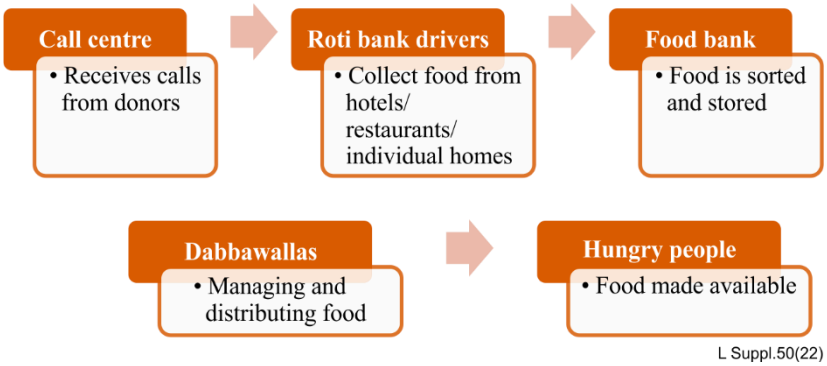

Figure 26 – The process of the Roti Bank

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 lies in its uniqueness, in the fact that what would otherwise be waste in a city is converted into one of the most important resources for sustaining human existence. The role of ICT in the project is to connect the demand with 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 is 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 per cent of people are forced to live in slums. The results are sustainable because this model has gained acceptability and other cities in the country are being motivated to replicate it.

The project has the following impacts:

Social impact: The challenge of hunger in society has been addressed. This would lead to more responsible citizens, a 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 a 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 cuts food waste disposal costs that would otherwise be incurred.

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 this also contributes to the city's goal of achieving a clean environment.

Case study references and further reading

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- Figure 8 at https://solvingworldwidehunger.weebly.com/
- World Population Review at worldpopulationreview.com/world-cities/mumbai-population/
- Zero Hunger Challenge at http://www.un.org/en/zerohunger/
- World Food Summit at http://www.fao.org/wfs/index_en.htm
- The Rio+20 information at https://sustainabledevelopment.un.org/rio20
- First Millennium Development Goal (MDG 1) at http://www.un.org/millenniumgoals/poverty.shtml

- The main website concerning the initiative is www.rotibankindia.org

6.13 Case study 13 – Oslo, Norway: Circular bioresources – Treatment of food waste, garden waste and sludge from wastewater

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 the Oslo Fjord. The population is young, highly educated and diverse – one third of the population are first or second-generation immigrants. The standard of living, and thus consumption levels, is high. This also generates a lot of waste from households, and roughly half of the waste is organic.

Oslo is one of the fastest growing cities in Europe, thus constituting a great opportunity, as well as 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 bio-based products from the bio-waste.

Moreover, the production of bio-waste-based products provides a positive climate impact in comparison with landfilling and incineration, and by replacing fossil-based products such as mineral fertilizers, peat and fossil fuels. No biodegradable waste is sent to landfills (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 retain the system involving the 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 into one bin.

Oslo has a circular waste management system where the waste is used as raw materials in industry. Buses and waste trucks run on environmentally friendly biogas produced from food waste and sewerage. Bio-fertilizers 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 programme includes a vision for reducing waste through circular and

sustainable consumption, including re-use, sharing and recycling. In a circular economy, the resources should be kept in cycles with 100 per cent re-use 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 per cent by 2020 and by 95 per cent by 2030.

The circular bio-resources are part of circular resource management. The use of renewable biogas on buses and waste collection trucks in the city, contributes to the reduction of 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 bio-fertilizer for 100 medium-sized farms. The biogas is carbon-neutral and is considered one of the most eco-friendly fuel alternatives available today. Bio-fertilizer 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, as well as by 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 bio-resources 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 CO_2 emissions from the buses and waste-collection trucks. They also contribute to the 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 is involved in activities to reduce the generation of food waste in public canteens, restaurants, grocery stores and among our citizens. Oslo is also actively working to reduce the inflow of wastewater containing micro-pollutants into the municipal sewage network, through its two treatment plants, which also produce biogas. Biogas from food waste and sewerage sludge is marketed together.

The city is at the forefront of the circular use of available resources, such as 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 its message on source separation and waste through – to name a few examples – campaigns, stands at malls and by knocking on doors. 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 have increased significantly. In 2017, 38 per cent of the household went to material recycling, only 3 per cent ended in landfills, and up to 2 per cent was re-used.

Waste analysis carried out in 2018 shows that the collection rate for food waste was 45 per cent, 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 to reduce the city's overall CO_2 emissions. The liquid fertilizers used by local farmers also reduce the demand for phosphorus-based fertilizers. This is beneficial because producing synthetic fertilizers involves mining limited resources such as phosphate rock.

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

Case study references and further reading

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6.14 Case study 14 – Melbourne, Australia: place-making case

Introduction

The City of Melbourne is the main city of the state of Victoria, in Australia and is one of the most densely populated cities in the country. The City of Melbourne and Village Well, one of Australia's place-making 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; to enhance public spaces; and to contribute to a healthy sustainable community. Place-making is defined as the new environmentalism, using processes, tools and practices to create liveable and resilient cities, towns, communities and places.

These three aspects could be implemented in the city by facilitating the creative patterns of the 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 boasts a compelling and modern story of transformation, which has arisen 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 has 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 worked closely 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 the 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 departments, which were working together for many years.

Victoria embraces diversity and creativity and boasts numerous acclaimed houses of design. The Victorian College of the Arts, the Melbourne Theatre Company, the Victorian Opera and the Australian Centre for Contemporary Art 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 historical and contemporary narratives, in order 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 the youth, single parents and the elderly).
- **Housing**: Improving quality-housing stock, in particular apartment design and construction.
- **Affordability**: Improving the affordability of property prices especially for families, the elderly, singles and young people.

Response

The success of place-making is dependent upon close working relationships 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 re-used 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 to 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 livability 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 a 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 analyse the projects that also transformed Melbourne into 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; its 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 Livability think tank event was held at the Treetops of Melbourne Museum.

The group explored ideas about growing and exporting 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 the sector can work better together, 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 set up. 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 'livability formula'.
- There has been an increased government and industry understanding of the importance of place-making with cooperation across government, industry and academia. Much of the livability 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 favourite 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 event capitals of the world. The innovative busking street and food policy allows daily creative activation to happen day and night. Great food trucks bring dead spaces back to life, while world-class buskers and entertainment attract thousands at the weekend, thus 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 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 scenes in the world. Distinct neighbourhood 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 every citizen to quickly access all parts of the city day and night.

The concept of place-making has 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.

Case study references and further reading

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6.15 Case study 15 – Amsterdam: The circular district of Buiksloterham

Introduction

Nowadays, cities around the world are facing several challenges. Amsterdam, the capital of the Netherlands, is no 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 recognising 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 opportunities for a 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 were 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 (governments and businesses) are in the process of taking the initial steps towards the transition to a 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 standardising it. To do so, there is a need to structurally share the knowledge and experience from the first years of experimenting and install a culture of cooperation. This 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 a 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 emphasize that the transition to a circular economy is by no means an easy task and, above all, will require municipalities to harness 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). The successful implementation of European Commission initiatives starts by engaging with suppliers, a reality that has once more been 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 in which to live and work.

Over the coming years, Buiksloterham will develop into a sustainable district, based on the principles of a 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 manifesto that 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 re-used as much as possible.

Conclusions

The past three years of circular economy action in Amsterdam have showcased the importance of local policy in supporting 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 into, 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-)using 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 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 of 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. Through 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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6.16 Case study 16 – Smart Dubai: Circular ICT services and infrastructure

Introduction

Background

Dubai is one of the seven Emirates of the United Arab Emirates (UAE) and is 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 the economic and social sectors. Over the last 40 years, Dubai has witnessed a transformation from a sleepy pearl diving village into 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 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 27 illustrates the digital transformation journey of Dubai.

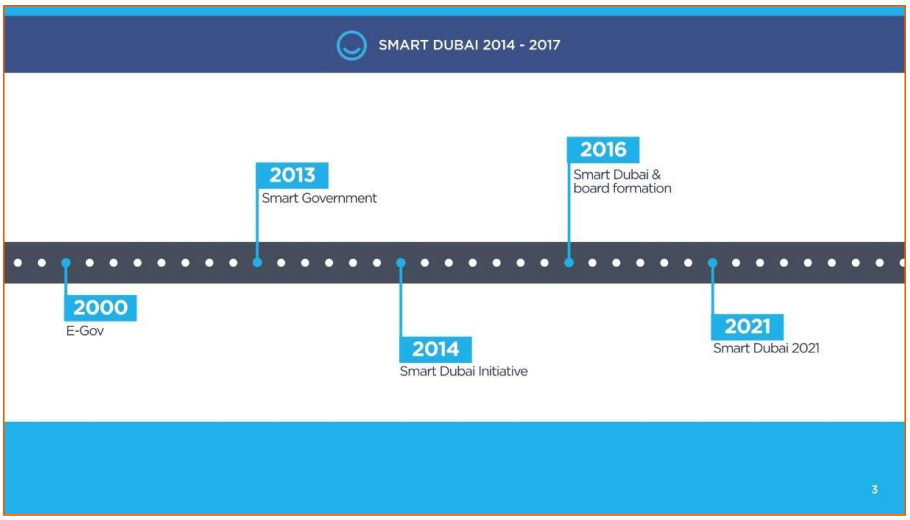

Figure 27 – Digital transformation journey of Dubai

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, and 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 expenditure, unless planned and managed carefully. In this context, Smart Dubai has strategically centralized and shared targeted ICT services and infrastructure provisioning while decentralising the innovation related to core business aspects.

Smart Dubai capturing cross-entity synergies: Common digital transformation needs in Dubai public sector entities provided 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 fund and operate their own similar ICT services and infrastructures separately.

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 at city level, due to the efficient use of digital assets.

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 capitalising 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 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 the Dubai Government. A total of USD1.2 billion in 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 28 shows an overview of operational efficiencies.

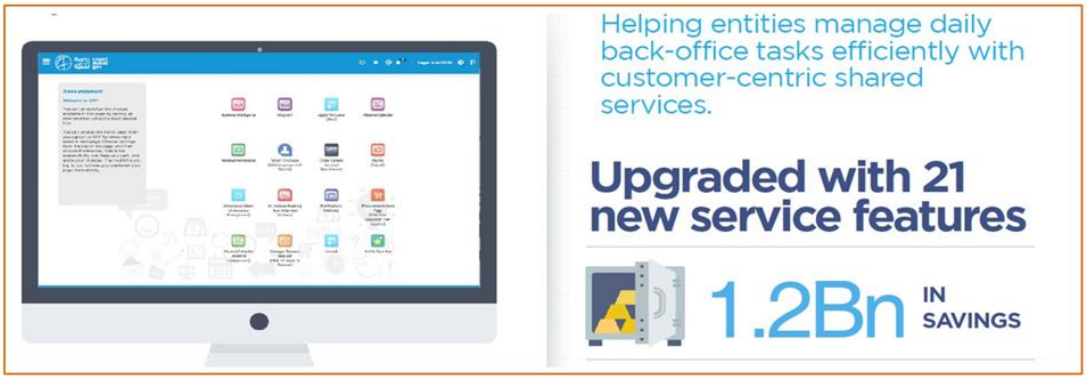

Figure 28 – Operational efficiencies overview

- **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. An availability of 99.95 per cent was achieved for its circular ICT services in 2017 and support calls were closed within SLA compliance target times, resulting in more than 80 per cent 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 the utilisation of advanced 4IR capabilities such as data science, AI and blockchain, due to their flexible design.
- **Public sector policies implementation**: Circular ICT services also enabled the easier implementation of widely applicable public sector policies over the years. In the absence of these services, each entity would have to expend significant efforts and resources to their individual systems for policies compliance, resulting in a 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.
- **Reduced environmental impact due to consolidation**: The 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 been consolidated significantly due to economies of scale and also scope. Furthermore, the total amount of ICT equipment (IT assets such as network equipment, server equipment) has decreased considerably (resulting in cost savings). The impact has also been in CO_2 reductions due to considerably reduced and consolidated ICT equipment. Hence, these services have achieved positive environmental impacts and significant benefits in green computing.

Case study references and further reading

- Smart Dubai Achievement Report 2014-2016
- Smart Dubai Government Lean Administration Support Services Project Reports 2016
- Smart Dubai Blockchain Strategy 2017
- Smart Dubai AI Roadmap 2017
- Smart Dubai Paperless Strategy 2018

6.17 Case study 17 – Toronto: Development of a circular procurement framework

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 the 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 cooperation 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 per cent 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 of recycling) 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 programmes that include the multi-residential and commercial sectors.

The two guiding principles of the Waste Strategy are: to consider options that support waste reduction, re-use, recycling and recovery before final disposal; and to develop policies and opportunities for a close working relationship. 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 (re-use/reduction before recycling) and complements the Purchasing and Material Management Division's (PMMD) supply chain management transformation program. 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 Framework will be used to leverage the City of Toronto's significant purchasing power (approximately 2.055 billion Canadian dollars 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 life cycle 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, life cycle 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 the 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 29 outlines the Framework implementation timeline.

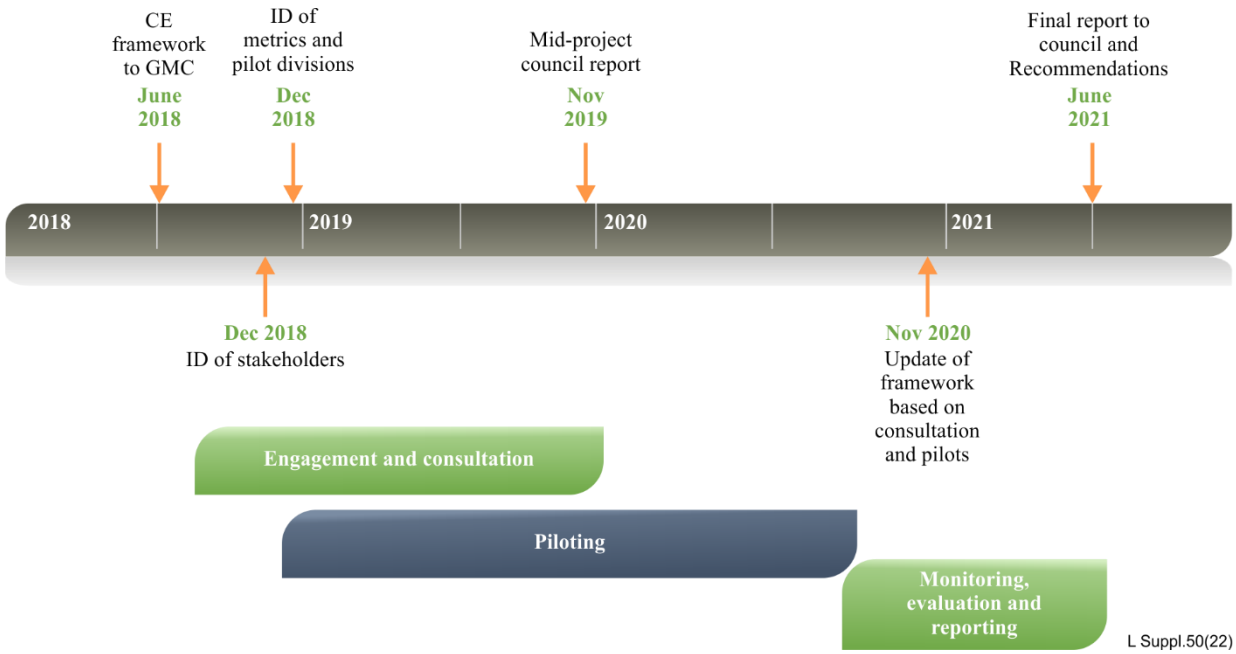

Figure 29 – Framework implementation timeline

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

PMMD and the supply chain management transformation program

The Framework will be implemented in conjunction with PMMD's supply hain management transformation program, 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 the 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 working relationships

A vendor engagement package is being prepared as the next step in the process of implementing the Framework in order to build capacity among the city's current and potential vendors to respond to circular contract solicitation documents. The creation of such a package will be a cooperative 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 cooperative 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.

These six core principles will guide the procurement pilots:

1) Mitigate climate change and achieve a resilient, low-carbon future, considering both operational and life cycle emissions, and advancing community resilience in alignment with the city's climate strategy: TransformTO.
2) Minimize the full life cycle impacts and maximize the full utility of goods and services.
3) Achieve aspirational goals of zero waste, and treat any remaining waste produced that cannot be re-used 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) Work closely 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 of 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 in Table 5.

Table 5 – Learnings and recommended actions

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 identifying 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., vendors, manufacturers, neighbouring municipalities).

The City of Toronto has continued to share key learnings on a national platform: on 21 August 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 session following presentations by the City and by the Recycling Council of Ontario.

Case study references and further reading

- *Advancing the Circular Economy Through Procurement – Municipal Perspective, National Zero Waste Council* (August 21, 2018) http://www.nzwc.ca/videos/webinar/30
- *Approved Final Long Term Waste Management Strategy*, City of Toronto (PW14.2 – Attachment 1, July 15, 2016) https://www.toronto.ca/wp-content/uploads/2017/10/9803-Final-Long-Term-Waste-Management-Strategy.pdf
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- *Long Term Waste Management Strategy*, City of Toronto (Technical Memorandum No. 1 Current System Summary, August 25, 2015) https://www.toronto.ca/wp-content/uploads/2017/10/967e-SW_Technical-Memo-No-1-FINAL-AODA.pdf
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Printed in Switzerland
Geneva, 2022