# Chapter 12
# Smart Cities in India: Linkages with Circular Economy


**Almas Siddiqui and R. K. Pandit**

**Abstract** The Sustainable Development Agenda 2030 proposed 17 Sustainable Development Goals (SDGs) in which the SDG 11 promotes inclusive, safe, resilient and sustainable cities and human settlements; SDG 7 encourages efforts to ensure access to affordable, reliable, sustainable and modern energy for all and SDG 12 ensures sustainable consumption and production patterns. For achieving these goals, various models have been experimented amongst which Circular Economy (CE) is one of the economic models facilitating key policy objectives for generating economic growth and reducing environmental impacts. In economies, cities are focal points of strengthening the transition of linear to a circular economy by smart practices towards a regenerative system. By consuming the assets at their highest utility, there will be an increase in economic resilience of the city and its citizens. The Smart Cities (SCs) and Smart Cities Mission (SCM) of India, Make in India, Digital India, and the Swachh Bharat Mission has potential to integrate CE principles in a pronounced way to pave the way towards a circular transition. To fulfill the SCs objectives, Indian cities have been integrating smart practices (like waste management, e-governance, and smart mobility) with circularity. For the challenges faced by the cities from the design until the implementation phase, circular economy calls for a refit in resource management. These would require policy-level reforms, institutional capacity building, uplifting infrastructure, and financing mechanisms. In India, there is already an existing repair and refurbish culture with strong local traditions integrating the 6Rs. The paper reviews the role of CE in Indian SCM for achieving SDGs by finding opportunities for circular economy and providing recommendations based on them. A matrix has been developed between the ReSOLVE framework and the opportunities of CE in cities. The SCM has increased the pace of transition, yet the recommendations are given to implement the CE principles efficiently.

**Keywords** Circular economy · Sustainable development · Smart cities

A. Siddiqui (✉) · R. K. Pandit
Madhav Institute of Technology and Science, Gwalior, India
e-mail: siddiquialmas0@gmail.com

R. K. Pandit
e-mail: drpanditrk@gmail.com



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## 12.1 Introduction

In the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012, discussions on the importance of the Sustainable Development Goals (SDGs) recommenced to align our development towards a more sustainable path. It was a follow-up of the Millennium Development Goals (MDGs) which kick-started a global movement. The objective of SDGs are to produce a set of universal goals that meet the urgent environmental, political and economic challenges faced by the world. The achievable targets of SDGs are to reduce carbon emissions, manage the risks of climate change, and to build back better after a crisis, are also aligned with those of the COP21 Paris Climate Conference in 2015 and the Sendai Framework for Disaster Risk Reduction, Japan in March 2015.

SDGs are the best chance to improve life for future generations by involving all of humanity to build a safer and more prosperous environment. Many countries have started preparing their national and local development plans in line with the SDGs, developed indicator frameworks to review their progresses and added the data requirements for the SDG indicators to existing and new schemes. The aim is to identify sources, organize data producers, find out data gaps and instigate necessary capacity development activities.

The pressure on the existing infrastructure in the exploding urban areas due to rapid urbanization has adversely affected the living environment and public health. The urban areas are congested, lack basic services, a shortage of adequate housing, and declining infrastructure. As the population and the demand for cheap energy increase day-by-day, we need to move towards a circular economy which is less reliant on fossil fuels and more on renewable sources. By improving resource use and introducing circular economy into planning, the challenges faced by urban spaces can be overcome. In economies, cities are focal points of strengthening the transition of linear to a circular economy by smart practices towards a regenerative system. By consuming the assets at their highest utility, there will be an increase in economic resilience of the city and its citizens. Investing and improving the energy productivity of solar, wind and thermal power to ensure energy for all is vital to achieve SDG 7 by 2030. Cities have the potential to optimize efficiency by reducing energy consumption and adopting renewable energy sources. For example, in Rizhao (China) 99% of households use solar water heaters, making it a solar-powered city in the central districts.

To increase the prosperity of India, the dependency on primary materials and energy must be reduced. The proficient use and reuse of national capital by finding value of finished products throughout their life cycles is the motive of a circular economy. It is a restorative approach which doesn't work on today's linear model of production of take–make–use-dispose. Three major principles governing the circular economy are to balance the flow of renewable resources, enhance and preserve natural capital by controlling finite stock; to optimize resource yields by circulating components, products, and materials already in use at the highest possible levels at all times; and by eliminating negative externalities to make the system more effective

(Company 2016). In order to reach higher levels of circularity, substantial economic costs would incur. By 2030, India is expected to be home to six mega-cities with populations above 10 million. The transition of linear to a circular economy can offer an opportunity to India to decrease dependence on resources, increase their productivity, reduce waste, improve competitiveness and unleash innovation, raise employment and augment growth. India has been recycling, remanufacturing, and reusing materials through local vendors especially *kachrawalas* (local term for rag pickers/pickers of unwanted products and materials).

The Government of India's Smart Cities Mission, the Jawaharlal Nehru National Urban Renewal Mission, and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) are working to address the challenge of improving urban spaces (Walter Leal Filho 2016). The Smart Cities Mission (SCM) of India and the Swachh Bharat Mission have integrated few of the CE principles in a pronounced way to pave the way towards a circular transition. To follow and achieve the SDGs 7, 11 and 12 and to fulfill the SCs objectives, Indian cities especially Indore, Coimbatore, and Surat have been integrating smart practices (like waste management, e-governance, smart mobility) with circularity. The paper reviews the role of CE in Indian SCM for achieving SDGs by finding opportunities for the circular economy. Various recommendations are given in governance, ethics, reuse, collaboration, and strong management to pace up the transition of a circular economy. CE has 6 actions, also called as ReSOLVE (regenerate, share, optimize, loop, virtualize, and exchange) framework which must be taken by government and companies. A matrix has been developed between ReSOLVE framework and the opportunities of the CE in cities. The SCM has increased the pace of transition, yet the recommendations are given to implement the CE principles efficiently.

## 12.2 Sustainable Development Goals and Circular Economy

### *12.2.1 Sustainable Development Goals*

Four years of implementation of the UN 2030 Agenda for Sustainable Development, countries are trying to translate the shared vision of providing a global agenda for dignity, prosperity and peace to all, into their national development plans and strategies. In this paper, the circular economy is focused upon by studying the policies, schemes or development initiatives in achieving SDG 7, 11 and 12. To achieve SDG 7- affordable and clean energy, solar empowerment was done across 18 countries through a six-month "solar engineers" study program was possible because of a partnership between the Government of India (GoI) and the Small Grants Programme (SGP) which is supported by the Global Environment Fund (GEF) and UNDP. While ensuring access to energy for all, from 2000 to 2016, only one billion people were living without electricity and the access to electricity increased from 78 to 87%.

SDG 11 aims to intensify infrastructure and upgrade technology for producing clean and more efficient energy which will support growth and improve the environment. National priorities and policy ambitions need to be strengthened to put the world on track to meet the energy targets for 2030. In order to ensure sustainable consumptions and production patterns and achieve SDG 12, one of the most critical challenge is to decouple economic growth from resource use. This requires policies to create a conducive environment which will also improve the social and physical infrastructure and escalate the transformation of business practices in value chains around the globe. About 5 metric tons of per capita "material footprints" were increased during 2000–2017 which is mainly credited due to growth in construction and infrastructure as a result of a rise in the use of non-metallic minerals. Therefore, 108 countries made policies related to sustainable consumption and production by 2018. The SDGs for 2030 encourage nations to reflect on circularity and lead cities with innovative circular ideas and methods as pilot projects in all contexts of social, cultural, economic, technological or regulatory considerations (Schroeder 2018).

The key drivers to accelerate structural transformations approaches for sustainable development are inclusive and accountable governance, leveraging technological advances (like automation, digitalization, etc.), overcoming unsound practices of natural resource management and addressing deficient or obsolete infrastructure and services systematically. To address the challenges, governments require knowledge-sharing, access to high-quality technical advice, effective changes in policy, innovative development, finance solutions to leverage investments and greater capacities to promote innovation (UNDP 2017).

### *12.2.2 Circular Economy*

Since the industrial revolution, a linear model of value creation and the make-use-dispose system has been followed by companies and consumers. As the resource prices have become more volatile and consumer demand increases, people and companies are ever more willing to pay for durable and reusable goods. To extend the lives of the items, they can be tracked and maintained by using digital technologies, novel designs and restrictions on pollution and waste imposed by governments. Redeploying the resources over and over is the organizing principle of circular economies. Research has revealed that by 2030, CE could generate a net economic gain of €1.8 trillion per year (Company 2016).

Breaking out the old models and discarding the traditional approaches are naturally challenging but it is outweighed by the efforts and the risk of gaining from the transition to the circular economy. The technical cycles use innovation to close the loop for materials and products and the biological cycles is the cycle of organic material and nutrients. CE is a model in which both the cycles are recognized from a systems perspective by emphasizing human society. Preference is always given to cycles which close on a local scale. Different enabling aspects of CE models are shown by the following nine principles:

1. **Waste is a resource**—Recycling and up-cycling to obtain the highest value of materials are required;
2. **Design is intentional**—Materials should be designed for easy recycling, up-cycling, and longevity making the systems with a service-based attitude;
3. **Social sustainability**—Sharing and collaboration can enhance social sustainability and stimulate economic development;
4. **Innovative business models**—By enabling tools, various innovative business models can become successful;
5. **Inspiration from ecology and living systems**—Inspiration should be taken from nature where both materials and nutrients exists in a cycle to restore and regenerate the ecological system on its own, making it economically viable;
6. **Recognition of both financial and natural capital**—Recycling and restoration of materials can generate new value making it financially viable;
7. **Reduction in energy usage**—Energy demands can be met by using renewable sources which cut off the usage of energy produced by conventional sources;
8. **Designing the system to be both resilient and adaptive**—The system can made adaptive and resilient through flexible design, mitigating risk and diversification; and
9. **Preservation of ecological system**—Ecological system can be preserved by supporting biodiversity and eliminating toxic materials (Lindner 2017)

### *12.2.3 ReSOLVE Framework*

The authorities must undertake the following six actions of the ReSOLVE framework for easy transition from the linear to a circular economy.

- **Regenerate**—Regeneration of health of ecosystems to return the recovered resources to the biosphere can be done by shifting to renewable energy and renewable material.
- **Share**—Sharing of products (privately-owned or public sharing), reusing them to achieve the ends of technical lifespans and prolong them by durable designs, maintenance and repair can maximize the utilization of products reuse them throughout their technical life spans.
- **Optimize**—Eradicating waste from the supply chains or products and leverage technological advancements can improve their performance and efficiency.
- **Loop**—Keeping the components and materials in closed loops and prioritizing the inner ones can reduce waste generation at a big level.
- **Virtualize**—To reduce wastage of resources and manpower, production has to be minimized by delivering utilities virtually like e-books, autonomous vehicles, online shopping, remote sensing, etc.
- **Exchange**—The exchange of used old materials with the advanced renewable ones by attracting buyers and producers with the help of new technologies (like 3-D printing, electric engines) can improve overall economic development.

This framework increases the utilization of physical assets by shifting towards renewable resources, accelerate product performance, increase their cost competitiveness and lengthen their life spans. *CE is bringing sustainability to our urban environment* (Modak 2018).

Figure 12.1 depicts the profit potential (high, medium and low profit) of economic activities as per the ReSOLVE framework. 20 major sectors have been prioritized based on their economic impact of the six actions of ReSOLVE framework. Economic activities like manufacture of wood and paper products; water supply, waste and remediation; manufacture of food products; electricity, gas and air-conditioning supply

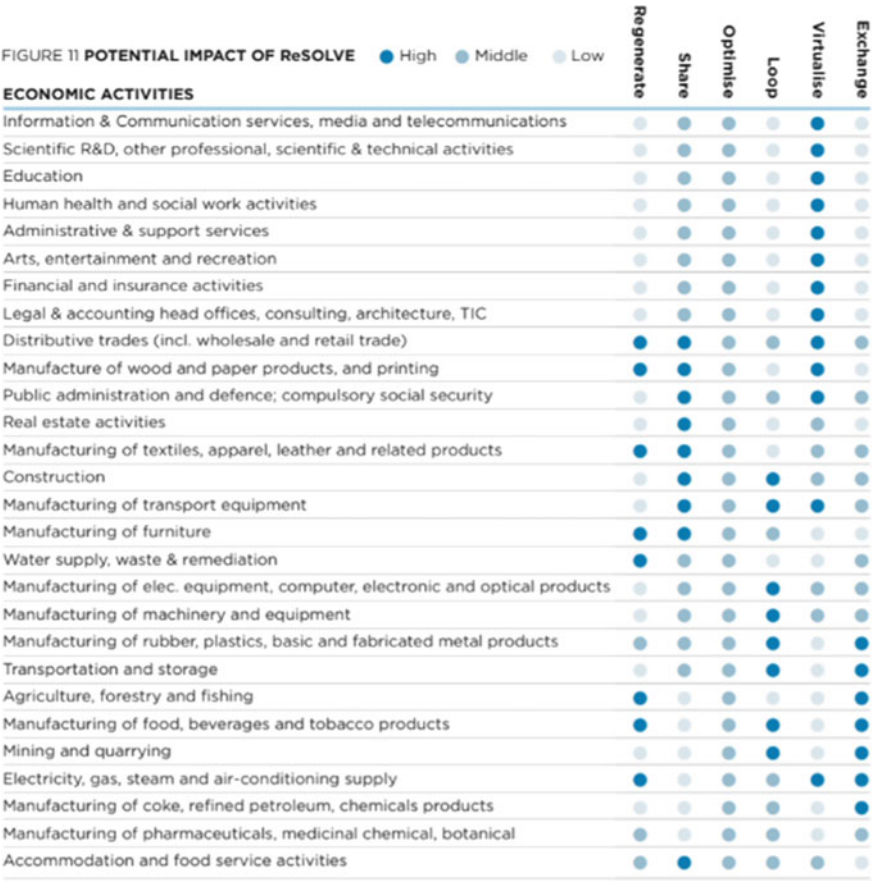


**Fig. 12.1** Potential economic and resource impacts on Resolve Framework. *Source* Ellen MacArthur Foundation (2015) (The authors have used the figure for better understanding of the paper which has been unofficially translated and explained. This do not imply that the content has been endorsed or approved by the Ellen MacArthur Foundation. General website content: Copyright ©Ellen MacArthur Foundation (2015), www.ellenmacarthurfoundation.org. Publications: Copyright © Ellen MacArthur Foundation, *Growth Within: A Circular Economy Vision for a Competitive Europe*, page 27, (2015))

have immense high profit potential in regeneration of resources. Likewise, real estate activities, construction and food-service activities have high profit potential in sharing the products and services. All of the economic activities mentioned have medium-profit potential in optimization. Looping of construction activities; manufacture of transport equipment, electrical equipment and optical products; manufacture of rubber, plastics and machinery; manufacture of food; and transportation and storage can prove to be highly profitable. Virtualization of telecommunications, scientific and technical activities, R&D, education, human health records, social works, administrative services, entertainment, insurance activities, e-currency, wholesale trading, defense and social security can save lots of resources in terms of materials, time, money and man power. Similarly, exchange of used rubber, plastics, basic and fabricated metal products, agriculture waste, storage, etc. can be fruitful in long run (Foundation 2019).

Drivers of cities for their circular solutions include urbanization, supply and price risks, ecosystem degradation, environmental accountability, consumer behavior and advances in technology. Cities are the ideal testing grounds for CE models as they generate more than 80% of global GDP. It is easier to implement changes in policy due to the physical proximity in cities. The circular models and concepts can easily weigh down at a state and a national level due to their bureaucratic structures and legislative timelines. Therefore, cities can be more adaptive and responsive for implementing pilot projects to stimulate faster changes. Through the embedment of CE principles in urban services and infrastructure (energy, mobility, healthcare, etc.), efficiency and environment can be improved (Forum 2018). There is a need for a circular economy in cities as more than two-thirds of the world's energy is consumed in cities, accounting for over 70% of global $CO_2$ emissions. It is also predicted that by 2050, the material consumption of the cities will grow to about 90 billion tones. Also, the resource extraction is expected to be doubled by 2050 which had already increased 12-fold between 1900 and 2015 (Forum 2018). Figure 12.2 depicts the possibilities of practicing the circular economic aspects and principles in the departments of resources, geographies and value chain. This identification of pilot sectors is one of the four efforts suggested for a rapid transition to circular economy in Europe (Ellen MacArthur Foundation 2015). Cities have a huge potential to implement the aspects of circularity in smart water management, land management, and urban mobility.

## 12.3 Circular Economy in the Smart Cities Mission of India

Sustainable development can be linked with the circular economy through various dimensions of economy, environment, social responsibility of corporate, and business's entryway. The SDGs for 2030 encourage nations to act on principles of circularity in cities by experimenting with innovative circular ideas. The GoI launched the SCM with the aim to improve the governance and infrastructural deficiencies of Indian cities. It is an urban regeneration program in which the GoI utilized a competitive structure and selected 98 cities. The number of cities competing in the

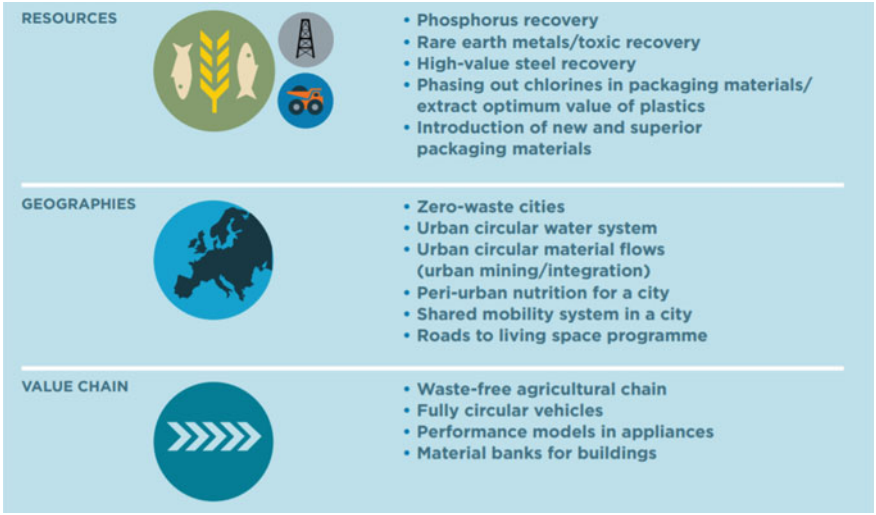


**Fig. 12.2** Possible circular economy pilot sectors. *Source* Ellen MacArthur Foundation (2015) (The authors have used the figure for better understanding of the paper which has been unofficially translated and explained. This do not imply that the content has been endorsed or approved by the Ellen MacArthur Foundation. General website content: Copyright ©Ellen MacArthur Foundation (2015), www.ellenmacarthurfoundation.org. Publications: Copyright © Ellen MacArthur Foundation, *Growth Within: A Circular Economy Vision for a Competitive Europe*, page 40, (2015))

Mission increased from 98 to 110 between 2015 and 2017 and 99 cities were chosen over 5 rounds (including fast track round) of selection. It took place in two stages: stage one was short listing of cities by states based on the conditions precedent (13 criteria) and the scoring was laid out, stage two includes the 'City Challenge' in which proposals were made based on some of the criteria like credibility of implementation, city vision and strategy, impact of proposal, innovation and scalability and its cost-effectiveness. Indian businesses are flourishing in the transition for new economic and innovative models to achieve SDGs. CE have paved ways to incorporate SDGs in the SCM of India. The technological innovation, research, and changes in policies for a plastic economy can provide practical solutions to the challenges being faced in the transition. Some of the opportunities for CE in cities are discussed below.

## 12.4 Opportunities for CE in Cities

The opportunities of circularity lie in key sectors like reuse of wastewater, organic waste and plastic; rain water harvesting; reduced energy usage; unused electronic waste; urban healthcare; unused demolished/broken building materials to build new building sites; and circular procurement. Awareness about CE and cooperation

between role players like businessmen, policy makers, stakeholders and NGOs are the need of the hour in order to make the circular future a reality in cities. Table 12.1 depicts the generated matrix of opportunities for CE in cities and ReSOLVE framework. Channelizing used building materials for new construction can be shared and optimized through material passports, kept in closed loops and can be delivered virtually through online marketplaces and databases. For water harvesting and reuse, shifting to renewable energy for treatment of water can regenerate the ecosystem, and automation of collection of harvested rainwater in each building can optimize

**Table 12.1** Matrix of opportunities for CE in cities and ReSOLVE framework

| Opportunities for CE in cities | Regenerate | Share | Optimize | Loop | Virtualize | Exchange |
|---|---|---|---|---|---|---|
| Channelizing used building materials for new construction | | ■ | ■ | ■ | ■ | |
| Water harvesting and reuse | ■ | | ■ | | | |
| Circularity through reduced energy use | ■ | ■ | ■ | | | ■ |
| Electronic waste in cities | | ■ | ■ | ■ | ■ | |
| Circular solutions to urban healthcare | | ■ | ■ | ■ | ■ | ■ |
| Organic waste, including food | ■ | ■ | ■ | | | |
| Plastic waste | ■ | ■ | ■ | ■ | ■ | ■ |
| Circular procurement | ■ | ■ | ■ | ■ | | |

*Source* Authors

the wastage of water. Circularity through reduced energy use can be regenerated by compelling the utility companies to use only renewable sources. CE can be optimized by new models of decentralization of energy exchange between sellers and buyers and smart energy grids to improve efficiency. Pool sharing can maximize the utilization of products. Electronic waste in cities can be reduced by increasing the replacement cycles, refurbishing old phones, creating second markets for its optimization, and maximum utilization. Looping can be done by fast and easy collection process through a virtual platform.

Circular solutions to urban healthcare can be optimized on a shared platform virtually between the healthcare center, manufacturers and waste collectors for optimal use of surplus medical equipment. By incentivizing manufacturers, looping can be done by reusing the medical equipment. Organic waste (including food) can be collected and good food can be donated; treated and used for composting, thus regenerating, optimizing and maximizing utilization or organic waste. Plastic waste can be reclaimed before returning it into the ecosystem, reused throughout its life span through repair and maintenance, automation of the waste collected can help in optimizing waste to improve the performance and new technologies can be devised to increase the rates of collection and make the disposal methods efficient. Virtual platforms for buyers and sellers of recycled plastic wastes can boost the process in a circular economy. Based on the literature reviewed and understanding of the concept of circular economy with respect to smart cities in India, a matrix of opportunities for CE in cities and six actions of the ReSOLVE framework have been attempted in Table 12.1.

An approach of circular procurement provides better opportunities by sharing bonds between departments rather than buying new, reused, refurbished items, and providing service of leasing products (McLennan n. d.). For this, designing tenders technically and functionally, collaborating with industrial sector, closure of the loop of materials and energy, and deciding the purchase of goods or services can be done for the circular procurement.

There are four main types of barriers to successful implementation of circularity being financial, institutional, social and technical (Forum 2018). The financial barriers include lofty transition costs, an upfront investment which makes finding the investors difficult, and finding new economic viable solutions for recycling. The institutional barriers include the efforts to change the deep-rooted mindset of business models based on linear economy, the designed policies, rules and regulations for linear processes which hinder the potential of innovative models and partnerships and limited or unclear allocation of responsibilities to urban local bodies. The social barriers include the lack of awareness, sense of urgency to focus more on up-cycling and reuse, and the resistance to change the production processes from linear to circular. The technical barriers comprises of lesser efforts in designing the product-as-a-service models, greater incentives to develop high-end quality, stronger and maintainable products; planning obsolete products which leads to limited availability of spare parts and their disposal; separating technical and biological nutrients; lack of information exchange; and lack of standardized methodologies in cities to evaluate levels of circularity.

## 12.5 Circular Economy's Opportunities in India (Council 2019)

### *12.5.1 Cities and Construction*

India has invested in the SCM in order to incorporate the principles of the CE into the design of the infrastructure and to improve citizens' quality of life. It is the responsibility of urban planners and managers to aim for targets like lower congestion, healthier environment, higher air quality, reduced urban sprawl and densification, preservation of biodiversity and low carbon footprints by planning the city spaces more systematically and smartly. Circularity can be easily incorporated in daily routines by flexible and easy to use urban spaces, buildings and infrastructures with the aids of digital applications (NETWORK 2018). With the help of renewable and recycled materials, collapsible structures, modular construction methods, waste and construction costs can be decreased effectively while constructing houses for urban poor. With the sudden changes in needs and ecosystem, buildings should be adaptable to climate change and affect it in the least way possible during their use phase.

### *12.5.2 Food and Agriculture*

To meet India's growing food demand, a combination of traditional practices and modern technology (like precision farming, and digitally enabled asset and knowledge-sharing systems) can regenerate the agricultural system. In order to do so, a large-scale network of farmers can be formed to share their experiences and local knowledge, to interconnect their practices and to leverage the small-farm structure, decrease requirements of water, pesticides and fertilizers, and increase yield significantly. In order to reduce food waste and transportation requirements, solutions like digitizing food supply chains, urban farming, and optimizing production can bridge the gap between demand and supply effectively.

### *12.5.3 Mobility and Vehicle Manufacturing*

In order to provide effective mobility systems and transportation facilities, the dependency on imported fossil fuels need to be reduced. Innovation in technology can provide faster and safer travel. Vehicles also need to be designed based on CE principles of reuse, remanufacturing and recycling of vehicles. Innovations like zero-emission propulsion, multi-modular, vehicle-sharing, door-to-door convenience, mobility system on demand, etc. need to be regularized.

GoI has undertaken substantial work towards policy interventions and formulation. Some of them are promotion of cleaner production processes; adapting BS-VI

fuel standards by 1st April 2020; taxing polluting vehicles and incentivizing hybrid and electric vehicles. Some of the amendments were done in the waste management regulation; construction and demolition waste management regulation; and implementation of national river conservation plan. The main focus of India's National Manufacturing Policy is to promote and adopt greener technologies and green manufacturing. GoI has embarked upon an initiative of creating 100 smart cities across the country in which waste management and resource conservation are main agendas. GoI is in the process of finalizing national goals prioritised under UN's SDGs. One of them is the concept of Zero Defect Zero Effect which accelerates the process in achieving green economic growth by producing items with zero defects by the process having zero impact on the environment.

## 12.6 Recommendations for a Rapid Transition to a Circular Economy

### *12.6.1 Innovation*

Solid waste management is one of the infrastructure services on which municipalities (especially in developing countries) have spent almost 20–50% of their budgets. This financial pressure can be relieved by introducing private sector into its planning and management, but this doesn't guarantee value recovery which discourages private sectors to invest into. Innovative ideas need to be incorporated in the planning process. The plastic economy is doomed because of its single use-disposal in landfills, costly packaging and huge environmental costs. It can be made as a circular system by finding ways to reduce the need for single use, improve reuse and recycling processes, improve resource productivity through innovations, and define shared goals and standards between various organizations. Innovative ideas like refilling systems, credit-based return systems, taxation on food waste to reduce its quantity on landfills, promote reusable good quality plastic containers can encourage producers and consumers to reduce single-use plastic waste. Technological innovations in collecting, segregating and processing plastic waste can increase the chances of materials being recycled with high quality. Digital innovations, like 3-D printing and nano-printing, in manufacturing and distributing the plastic can alter the needs of companies for plastic packaging. Costly innovations like bio-based plastics can replace the use of fuel-based plastics in packaging but their viability is yet to be proved. The handling and protection of products, simplicity in management, efficient logistics, and coordinated businesses transport goods can be achieved by fitting the plastic containers with radio-frequency-identification (RFID) tags.

### 12.6.2 Strong Management

To extract more value from technological investments, scale and volume should be justified. A strong management is required for integrating infrastructure and supply chains amongst widely dispersed consumer products. Developing countries are aiming for stronger performance-based management, better strategic decisions and an industrial approach in managing waste.

### 12.6.3 Economic Viability

For a thriving resource-recovery system, capacity building of recyclers with a strong balance sheet, reliable agreements, access to feedstock, assurance on consistency are the pre-requisites. Investors should know the commercial and operational processing for long-term efficiency which is being researched based on the socio-economic impact of plastics and their energy recovery.

### 12.6.4 Recycling Plastics by Private-System Operators

This needs to have a robust, cash-flow position and externally audited balance sheet. Private-system operators don't invest in the recycling business due to poor quality of plastics, lack of global standards, generation of lower-value applications, inadequate quality and quantity of packaging, old collection methods, inefficient processing systems, and lack of programs about collection and recycling of local waste.

### 12.6.5 Reuse

Reusing is a better alternative to recycling. This is due to the lesser requirements of material for plastics per-use. It needs to be adapted in the system to make it as a common practice by embracing new behaviors in producers and consumers.

### 12.6.6 Transparency

In order to assess and access track of improvement and important metrics, ease the monitoring of environment and social outcomes by authorities, to adjust the changes in the process of system management, to inform the regulatory authorities about everything legally, transparency needs to be maintained with priority.

### *12.6.7 Ethics*

Manufacturers should take responsibility to dispose the products they sell. Voluntary pledges, legal documentation and policies should be framed to accelerate this process and to encourage recycling or reuse. Also, it should be the responsibility of the producers and consumers not to dump waste in their bins and ultimately on landfills after a certain extent.

### *12.6.8 Governance*

Initiatives taken by government like banning plastic bags and CNG driven vehicles have boosted the transition to sustainable development. Similarly, refilling system of bottles instead of single-use plastics, drinking fountains in publicareas, restriction on manufacturing of polythene bags, public procurement and awareness about circular economy from the school levels should be incorporated into governance models at local, state and national levels. Pilot projects can help in improving the governance structure.

### *12.6.9 Collaboration*

In order to incorporate innovative ideas into practice, much collaboration of government organizations with companies, industries and non-governmental organizations is the need of the hour. New technologies will be developed with improvement in research collaborations between researchers and businessmen.

### *12.6.10 Standardization*

Innovative ideas need to be implemented with standardization of products being manufactured. Recycling can be made economical by setting standards for packaging materials, specifications of quality for easy sorting and collection of waste. This will assure the buyers of recycled materials and satisfy their goals. This will be helpful for uniform batches of production.

## 12.7 Conclusion

The main aims of the circular economy are to relieve pressures on municipal services and budgets, increase disposable income, reduce carbon emissions, increase livability, encourage an innovation-rich urban economy, and create employment opportunities in the city. The circular economy is a new way to extend the lifespan of products by improvement in service and design and creating value, complete the loop of products and waste generated for the reuse and recycling, utilize resources more efficiently and cautiously. The CE also offers employment and entrepreneurship opportunities especially in sectors of health, sanitation, waste management, recycling, and research in developing countries (Foundation 2017). This paper emphasizes the circular economic potential of cities and comes up with recommendations to pursue a sustainable growth trajectory with a focus on Indian SCM. The initiatives underpinning SCM by the Government of India have been analyzed in the paper to recognize the potential of circular economy. It is clear from the review that the capacity building activities and implementation of CE in urban local bodies and private sector will contribute to the sustainable development of the nation. Governance structures need to be strengthened for the purpose of incorporating circularity at all stages of development. Decentralization of the powers and policies can be done through pilot projects at the local levels.

The matrix generated between the opportunities of CE in cities and the ReSOLVE framework clearly mention the possibilities, ideas, and methods to implement the action plan of circular economy in cities. Some of the important conclusions include sharing and optimizing of channelized used building materials for new construction virtually through online marketplaces. For water harvesting and reuse, shifting to renewable energy for treatment of water can regenerate the ecosystem, and automation of collection of harvested rainwater in each building can optimize the wastage of water. Plastic waste can be reclaimed before returning it into the ecosystem, reused till its life span through repair and maintenance, automation of the waste collected can help in optimizing waste to improve the performance and new technologies can be devised to increase the rates of collection and make the disposal methods efficient. Virtual platforms should be created for buyers and sellers of recycled plastic wastes which will pace up the processes in a circular economy. Through decisions on purchasing works, goods or services, closing energy and material loops within supply chains, designing tender specifications using a technical or functional approach, collaboration with industries, etc. can be done for circular procurement. The barriers in the transition towards a circular economy are subsequently discussed. It can be concluded that Indian cities have significant potential for embracing a circular economy, provided that right policies, stakeholder interactions, innovations, and capacity building are put in place. A more holistic approach aimed at country-wide development would have been more equitable in the transition of circular economy nation-wise instead of few cities selected in SCM. Therefore, a more inclusionary approach and a new policy should be devised in order to implement the CE principles all over India. Incentives should be given to companies to

encourage them in investing in a circular economic model of growth. This would also be more in line with the Sustainable Development Agenda 2030 to promote circularity.

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