Journal of Namibian Studies, 34 S2(2023): 521-535 ISSN: 2197-5523 (online)

A Framework to Facilitate the Transition to A Circular Economy in Smart Cities

Laila ALIGOD[1], Hebatalla KAOUD[2]
[1] Sidi Mohamed Ben Abdellah University, Morocco
laila.aligod@usmba.ac.ma
[2] Nile University, Egypt
hkaoud@nu.edu.eg

Abstract

A global challenge is the shift to a digital and ecological economy. By exchanging knowledge and best practices, the framework created for this study aims to ease this transition, particularly for developing and underdeveloped nations. This study aims to answer the question, "What are the levers to implement the circular economy in smart cities?". An integrative literature search was conducted. Approximately forty articles were identified in the following databases: Scopus and Google Scholar. The relationship between the research's main concepts was illustrated to help visualize what the circular economy looks like in smart and sustainable cities. According to this study, implementing the circular economy in smart cities necessitates four major levers: 1. Technologies allow to set up an Infrastructure with garbage sensors connected to the network linking the stakeholders. The application of the platform made it possible to collect, communicate, share, and visualize the system's information in real-time and to ensure the monitoring and optimization of physical flows in a win-win perspective; 2. Good governance requires a shared vision, an integrated urban policy, stakeholder coordination, cross-sectoral coordination, and a stimulating legislative framework; 3. At the economic level, reverse value chain, circular design, business models based on the sharing economy, digital entrepreneurship, and data collection throughout the product life cycle should be embraced; 4. At the social level, consumer behavior and the incentive mechanisms for manufacturers to extend their social responsibility are determinants that need to be studied in depth.

Keywords: Circular economy, Literature review, Smart City, Smart Waste Management

Introduction

The shift from a "take-make-use-dispose" economy to the new "Circular Economy" paradigm can be advantageous for Smart Cities [1]. The "take-make-use-dispose" paradigm has been around for decades, but the Circular Economy (CE) model has recently come into being as an alternative [2]. The CE model has gained widespread acceptance worldwide because it offers a long-term solution to the disposal issue and reduces the need for virgin material in manufacturing [3].

In order to replace linear economy patterns that typically turn every product into waste at the end of its existence, the circular economy improvement concept is addressed in a large metropolitan area. A circular economy is a way of doing things where every product is planned—from its conception to the end of its useful life—to minimize resource loss and maximize resource recovery. The goal of the circular economy is to maximize the value of every product both during use and at the conclusion of its useful life [1]. This research aims to design a framework that answers the question, "What are the levers for implementing the circular economy in smart cities?". These levers can, in turn, inspire policymakers to create public policies supportive of their region's ecological and technological transition. This work is structured as follows: First, the key concepts have been defined; "smart city," "circular economy," and "smart waste management." Then, a figure is presented to schematize the relationship between these concepts. Secondly, the practices, models, and ideas cited in the literature that work towards implementing the circular economy in smart cities are presented. Last but not least, the framework of the current study is presented.

Key Concepts

Smart City

The concept "smart cities" has been used in a variety of definitions, including "digital city," "information city," "telicity," "wired city," and "intelligent city." The impact of technology and innovation on urban development was highlighted under the term "smart city" (SC) coined in early 1990 [4]. According to the Strategic Implementation Plan of the European Innovation Partnership on Smart Cities and Communities, smart cities should be viewed as systems of people interacting with and using flows of energy, materials, services, and financing to catalyze sustainable economic development, resilience, and high quality of life. By strategically utilizing information and communication infrastructure and services during the process of transparent urban planning and management that is attentive to the social and economic requirements of society, these flows and interactions become intelligent [5]. A "smart city" is an umbrella term for how information and communication technology can enhance a city's operational effectiveness, its residents' quality of life, and the local economy [6]. More specifically, a city is deemed smart if it links up to democratic processes through a participatory government and balances economic, social, and environmental growth [7]. When a community invests in cyberinfrastructure, they are aiming to promote sustainable economic growth, improved quality of life, and effective resource management [8]. A smart city is defined not only by its intelligent infrastructure but also by the degree to which that infrastructure promotes sustainable development goals.

Smart waste Management

Systems for waste management still need to be updated and traditional, particularly in emerging and underdeveloped nations. Open dumping, transferring, collecting, and landfilling are the most popular disposal techniques in some metropolitan areas. Overflow refuse is then burned in an open, unregulated manner or spilled into waterways when landfills overflow. Both techniques put residents at greater risk of illness, pollution, and hazardous emissions. Furthermore, the dangers of landfills are increased by the presence of scavengers, trash collectors, and unofficial employees. Both the formal and informal sectors continue to perform the majority of waste collection tasks by hand. Due to the fact that most residents cannot properly separate garbage, the majority of collected waste is still mixed and unsorted. The current waste management system is unable to identify specific qualities, types, and quantities of municipal waste collected in the final collection center. Additionally, the system is unable to provide enough information that can be used to apply the proper treatment technologies to manage the waste in an efficient, effective, and timely manner [9]. Waste management includes trash collection, transportation, processing, disposal, monitoring, and control of these activities [10]. Smart waste management presents an automatic, integrated, and connected system and provides excellent economic opportunities for municipalities, waste industries, and the community in the fields of collection (e.g., route optimization), segregation (e.g., waste identification), and treatments (e.g., recycling, remanufacturing, reconditioning)[11]. [12]provides an overview of the principles and strategies of the leading smart enabling technologies used in waste management; a. IoT performs sensing, data collection, storage, and processing by connecting physical or virtual devices to the Internet. IoT-based waste management systems can provide real-time data on the status of intelligent trash cans and residents' information. This helps optimize garbage collection and vehicle path planning; b. Data stored in the cloud are accessible to all the involved stakeholders to aid decision-making. Analysis and planning can start as soon as the waste is generated for recycling and value recovery activities; c. Big data analytics can be used to reduce waste generation and improve its management. Combined with geographic and socioeconomic data, big data analytics can help understand the spatial distribution of waste; d. Public decision-makers can be assisted by a cyber-based decision support system in the design and planning of waste management systems and in optimizing and monitoring their carbon impact; and e. To assist wise decision-making, artificial intelligence can be used to recognize patterns in waste and the actions of those who produce waste. Artificial intelligence will keep workers close to waste by substituting remote supervision for their tedious duties.

Circular Economy

Natural resource renewal is not capable of making significant advancements. Because of this, it cannot ensure that there will be enough resources for future generations under the ideals of intergenerational justice.

Alternatively, a circular economy addresses the problems above by basing its operations on these principles [7]. The circular economy is widely understood to combine three primary concepts: reducing resource consumption, reusing waste, and recycling activities [13]. Waste can be managed to produce new resources and even resources that are considerably more valuable than their original form [14]. A circular economy means more than recycling waste; it is a complex way of organizing, which involves changes in both production and consumption, such as reducing resource consumption and minimizing waste [13]. A fourth R is appended to the third R: Reduce (Reduce the consumption of resources and the production of wastes in the processes of production, circulation, and consumption), Reuse (use the wastes as products directly, using wastes after repair, renewal, or reproduction or use part or all waste as components of other products), Recycle (use the wastes as raw materials after simple treatment such as collection, separation and suitable modification, during which core physical and chemical properties should remain), Recover (use the wastes as products, or raw materials after technical treatment during which the core physical or chemical properties change in relation to the feeding condition)[15].

When all of the recycled materials and energy can be used in this process or other processes without being discharged into the environment, the system is considered closed. This means that there is "zero" discharge and no environmental pollution. The ideal close-loop devices are rare in practice. But it appears that this is the way to go if you want the economic system to grow sustainably. [16] analyzed the specifics of "10R" CE tactics (Recycle, reduce, reuse, repair, refurbish, remanufacture, repurpose, recover, rethink, and refuse). Consumers' and producers' perspectives on refuse are addressed. Consumers can choose to purchase less or use less, which aims to reduce waste generation; producers can choose to refuse, which allows product designers to forgo certain hazardous materials, prevent waste, and consume less virgin material during the design and production phases [17]. The benefits of transition towards a circular economy are the reduction of pressure on the environment, energy saving, reduction of CO2 emissions, reduced waste management costs, improvement of supply with raw materials, stimulating innovation, and creating new jobs. Due to the preservation of many materials or the recycling of waste, the demand for raw materials declines. This entails reducing reliance on imports and industries' susceptibility to price volatility or supply uncertainty brought on by resource depletion, scarcity, or other complex geopolitical factors [18].

Sustainability, smart city, circular economy: what relationship?

The circular economy, as defined by the European Union, is one in which waste production is kept to a minimum and the value of goods, materials, and resources is preserved for as long as feasible. This serves as the foundation for the creation of "smart cities," which also entails the use of information and communication tools to improve resource efficiency and reduce emissions [19]. As a result, circularity is central to the idea of a smart city, and a circular economy is a requirement for sustainability [20]. Smart cities strive for sustainable growth. Accordingly, a smart city and sustainability are interconnected because a non-sustainable city is, by definition, far from being "smart" [7]. Smartness positively correlates with sustainability and can promote environmental sustainability [21]. However, [22] reported a contrasting result upon identifying a nonlinear relationship between technological development and environmental sustainability. ICT and sustainability can be seen as the two supporting pillars that make a smart city [23]. However, the reverse is debatable. Consider an environmentally friendly community that doesn't have a sizable ICT infrastructure. Some authors suggest using the term "smart sustainable city" to address the problem and shift attention to significant issues in the literature [24].

Fig. 1. The circular economy in smart and sustainable cities ((Based on the work of (Jun et al., 2007) and (Aceleanu et al. 2019)) developed by the authors.

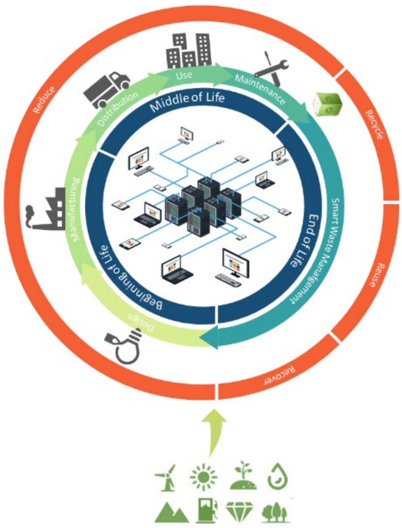


Fig.1 above shows how the main concepts in this study relate to one another and aid in imagining how the circular economy might appear in smart, sustainable cities. Consumption of resources found in a limited supply in the natural environment is necessary to produce products and services to meet community needs and generate profits. The current economic dynamics and growth risk depriving future generations of meeting their needs if using natural resources is inefficient. Biological regeneration phenomena inspire the circular economy and address this problem to ensure sustainable development through four key actions; reducing resources consumed in the design, production, and distribution of the product, recycling of waste, reuse, and recovery of product components to retain value for as long as possible and extend the product lifecycle to the maximum. The product lifecycle can be broken into three main stages [25] : (1) Beginning of Life (BOL), including Design and Manufacturing, (2) Middle of Life (MOL) including Distribution, Use, and Service/Maintenance and (3) End of Life (EOL) including Collection, Remanufacturing, Reuse, Recycling, and Disposal of residual waste. Technology (ICT, Big Data, Cloud, IoT, AI, Geographic Information Systems) is the cornerstone of smart cities. The collection, storage, and sharing of real-time information on the state of the product, its components, and its geographical location throughout its life cycle allow the coordination between the stakeholders of the city system so that the output of one will constitute the input of the other. In this way, circularity and sustainability are ensured.

Best Practices on Waste Management And Implementation Of Circular Economy In Smart Cities

"Intelligent Bins" are suggested for application in the Operational Implementation Plan (OIP) of the European Innovation Partnership on Smart Cities and Communities. Smart bins are garbage cans that have ultrasonic sensors to gauge their interior area. The WLAN protocol is used by a sensor gateway, and the cloud platform is used for junk data gathering, analysis, and visualization [9]. Information on the intelligent bin (position, type of waste, weight, filling level) is communicated to the data center. Installing sensors on bins can enable cities to communicate within the waste collection system to optimize truck routing, minimize energy consumption and congestion, and satisfy customers [26].

Technology (ICT, Cyber-Physical Systems, IoT, Big Data, AI, Wlan protocol, FRID) use provides a new generation strategy to enhance the global waste management system in developed countries effectively and efficiently. Local sensing, data integration, thing analytics, and cognitive action are all part of the ICT-IoT combination used in waste management. To allow efficient and effective waste management and convert large and complex waste characteristics into valuable resources, materials, and energy, waste activity could be tracked and monitored in real-time [27]. IoT has recently been viewed as a critical enabler for a smart environment and improved urban planning [28]. RFID tags may be used during the waste generation, separation, and treatment stages, according to research by[29]. Moreover, RFID tags on recyclable parts of municipal solid trash aid to boost recovery value [30]. A multi-layer design for automatic garbage identification employing RFID and sensors was described by [31]. By automating and speeding up the procedure, load sensors and RFID technology reduce the cost of waste management by making it simpler to recognize trash and calculate its weight. The concept of "smart waste management" should go beyond the straightforward mounting of sensors on trash cans and include an integrated planning approach designed for resource recovery and efficiency within a circular economy framework [1].

A "system of systems" that forms a closed circle and is defined by functions is referred to as a smart city. Additionally to this interpretation, each system generates its own information and utilizes the output information from the others in a clear municipal planning framework [32] within a win-win perspective. In this sense, a company can reuse or recycle its waste to manufacture new products or by-products (internal loop). It can also introduce the waste from other systems to recycle, recover and produce new products or by-products (external loop). ICT applications, through the management of data on all levels by all stakeholders (Manufacturers, suppliers, Retailers, customers, municipalities), can smartly enhance the visualization of intelligent waste management systems [1]. Through the involvement of all stakeholders in the urban context, including local and regional authorities, industry, decision-makers, and citizens, coordinated initiatives can effectively promote widespread knowledge of reuse and recycling [1]. [33] proposed a conceptual framework for a centralized waste management system where three interconnected elements are highlighted: (1) collection of product lifecycle data, (2) new business models based on connected and involved citizens for sharing products and service information to avoid waste generation, and (3) an intelligent sensor-based infrastructure for on-time collection and separation of waste to assure effective waste recovery operations. The complete product value chain's stakeholders must work closely together to implement the proposed framework. To reduce the commercial, legal, and political obstacles to this integrated process, significant work is required. Joining forces with the municipality, public sector, businesses, people, local communities, organizations, and government is strongly advised for improved waste management [13]. Strategies for enhancing waste management efforts include better legislation, raising public awareness, novel treatment technologies, experienced personnel, waste pickers management, designing waste collection practices based on citizens' demographic factors, taking social outcomes of waste management into consideration, centralized planning, and commercialization of the MSW industry [33]. [34]sustain that in order to achieve sustainable development in cities successfully, it is necessary to apply the 3P model based on: (1) coordination between public and private entities, (2) coordination across policies to make sectors complementary through interactions that are appropriately planned during the design and implementation of urban policies, (3) coordination across places because different territorial contexts (urban, rural) should not be considered as isolated systems but rather as global areas in which materials, resources, and products are exchanged. [35]analyzed three smart Spanish cities based on their sustainability strategies and concluded that governance, environmental management, citizen participation, and entrepreneurship are among the success factors in SCs [35].

Developed nations like US, UK, Australia, and Japan have applied advanced methods of waste collection such as underground waste collection systems, Geographic information system (GIS) technology, and solid waste bin monitoring system using GSM technology [36]. Using underground collection points to gather recyclables, organic refuse, and oils, the underground collection system substitutes older waste storage methods like bins. The technology is more aesthetically pleasing, less maintenance-intensive, and appropriate for scorching climates. Geographic Information System Technology (GIS Technology) is an integrated application designed for individual or association municipalities to manage waste production, recycling, treatment, and disposal processes as efficiently and automatically as possible. (landfill). GSM-based device for solid waste bin monitoring; measures the ideal amount of waste inside the bin using sensors installed in public garbage bins. The sensor will signal the controller when the garbage level reaches the threshold level. It will also signal the collection truck driver to begin collecting waste immediately via SMS using GSM. [37] created a framework to make it easier for developing nations to adopt smart waste management in the context of the circular economy. Key Facilitators include; supportive government policies, environmental management system, wide application of digitalization for collecting, sharing, and receiving a waste transfer of waste for reutilization through an industrial symbiosis network, incentivizing the procurement of smart waste technologies, educating and spreading awareness campaigns on circular economy and smart waste management practices, enhanced citizen participation and green behavior through reward-based systems, public–private partnership programs for smart waste technologies adoption, smooth and uninterrupted internet facility and a robust cybersecurity system, foreign aid and NGO's involvement.

Method

The central open-ended research question that guided this research is "What are the levers to implement the circular economy in smart cities?". To answer this research question, an integrative literature search was conducted. This type of analysis requires more creative data collection, as the goal is to create initial or preliminary conceptualizations and theoretical models rather than reviewing old models[38]. An efficient and well-conducted review provides a solid framework for knowledge expansion and the facilitation of theory growth[39]. The two main types of subjects that integrative literature reviews typically address are mature topics and new, emerging topics. A literature review can address research issues with a power that no single study has by integrating the conclusions and points of view from numerous empirical findings.

In this research, the literature review is based on the most relevant scientific contributions. Approximately forty articles were identified in the following databases: Scopus and Google Scholar. These articles were published between 1992 and 2022. The references of the articles found were reviewed to determine other relevant research papers. The articles found were also forward searched to determine related articles. The search terms "smart city," "circular economy," and "waste management" produced a bibliography of articles. The selection is made according to the number of citations, the impact factor of the journal, and the coherence of the abstract and content with the research question. A framework to facilitate the transition to a circular economy is suggested based on this integrative literature search.

Results and Discussion

To facilitate the implementation of the circular economy within smart cities, a set of parameters in the suggested framework must be considered (fig.2)

- For each type of waste, each participant in the value chain of the product, and for the duration of the product's life cycle, a suitable legal framework must be established. The legislation in Switzerland mandates that consumers return their electronic waste to a designated location [40]. However, In China, informal recyclers provide door-to-door collection services, and consumers can receive an additional fee for selling their e-waste [41].

- The use of technologies, such as ICT, IoT, Big Data, AI, Cloud platforms, Cyber-Physical Systems, Geographic information systems, WLAN protocol, and FRID technology, enables the construction of a technological infrastructure that includes sensor-equipped trash cans that are linked to the network that connects the stakeholders. The platform enables the gathering, sharing, and real-time visualization of system information and ensures the tracking and optimization of physical flows from a win-win perspective.

- Include the post-consumer phase of a product's life cycle in the producer's obligation scope. Extended Producer Responsibility (EPR) schemes must encourage producers to consider environmental concerns during the product design process and to omit features of products that are environmentally harmful, in addition to shifting responsibility from municipalities to producers. The primary means by which producers can execute an EPR scheme is through penalty and bonus mechanisms [42]. The authors found that producers are less motivated to increase their recovery rates when the government's reward and punishment systems are less strict [42]. These penalty and bonus systems are a great way to incentivize manufacturers to create eco-friendly goods, create reverse logistics supply networks, and boost resource efficiency [42]. A better understanding of rewards and penalties for various product manufacturer groups would help policymakers persuade more manufacturers to join the EPR scheme [16].

-The smart factory, which links the physical and digital worlds to track the entire manufacturing process of remanufactured/refurbished/repurposed/repaired goods, is a great way to manage waste. In addition, it is a highly digital factory floor that combines cutting-edge technologies (like big data analytics) to gather and exchange data through connected machines, devices, and production systems. It has been noted that "Cleaner Production technologies" are a crucial part of CE models for ecological sustenance to deal with the difficulty of adopting a greener economy and using resources in an environmentally friendly way [43].

- Consumer behavior is a critical tenet in developing sustainable and intelligent communities. The source separation of waste by households, the consumers' minimalist or unconventional lifestyle, their ethics, their level of awareness, and their level of participation are all deciding factors that must be thoroughly researched. According to [44]

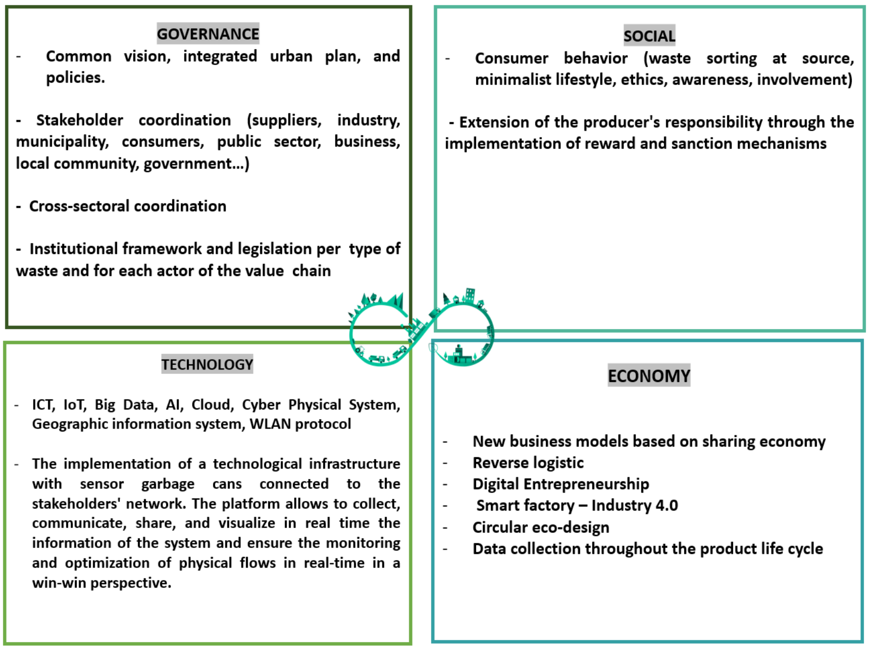
Consumers 'attitudes towards recycled and remanufactured goods are also crucial. The findings suggested that because of growing environmental awareness, consumers may be more inclined to buy recycled or remanufactured goods. However, they consider such goods to be low-quality or unreliable.

- Ecological design is crucial in transitioning from a linear to a CE system [45]. Products that present design and material selection improvements reducing the cost of moving products into ever tighter reverse cycles were marked with the Radical design criterion.

- Effective cross-sectoral collaboration based on an integrated urban plan enables a large-scale circular system to be established.

- Adopting reverse logistics and new business models based on sharing economy.

Fig.2: A framework to facilitate the transition to a circular economy in smart cities developed by the authors



The first significant challenge to adopting the circular economy process, both for the public and private sectors, is financial, according to [13]. New expenses for asset investment, R&D, public spending on subsidies, and investments in waste management are all included. The second critical challenge is the lack of an institutional framework properly designed to stimulate and encourage efficient resource reuse and recycling. The third challenge of the transition towards a circular economy is the quality of the human capital, unprepared yet for the new technical skills required by the new concept. The third challenge also entails financial expenses for businesses that must spend money on specialized, targeted training programs for their current workforce or raise wages to entice highly skilled workers. Surpassing all these boundaries asks for implementing a set of actions designed in a distinctive way according to different levels and policy areas.

Conclusion

A worldwide challenge is the shift to a digital and ecological economy. Specifically for developing and underdeveloped countries, the framework created for this study seeks to ease this transition. In most of these nations, private interests take precedence over public welfare, corporate profit-seeking trumps environmental protection, social pressures to consume extravagantly to appease inflated egos, households prioritize domestic cleanliness over environmental protection, and local governments continue to cling to archaic customs. Under these circumstances, transitioning to a smart, sustainable city is significant. The mountains of garbage make us consider the dishonorable job of the informal waste management system collectors, repulsive landscapes, illnesses, economic disadvantages, and the ill health of the populace. The time has come for researchers, businesses, civil society organizations, and government decision-makers to mobilize to lay the groundwork for a sustainable and intelligent city.

The facilitating framework developed proposes four main levers to implement a circular economy in smart cities: 1. The use of technologies (ICT, IoT, Big Data, AI, Cloud platform, Cyber-Physical System, Geographic information system, WLAN protocol, FRID technology) allows to set up a Technological Infrastructure with sensor garbage cans connected to the network linking the stakeholders. The platform allows to collect, communicate, share, and visualize the system's information in real-time and ensures the monitoring and optimization of the physical flows in a win-win perspective; 2. Good governance requires coordination between stakeholders (Suppliers, producers, municipality, consumers, public sector, companies, local community, government), cross-sector coordination, a legislative framework by type of waste, stimulating for the actors of the value chain, a shared vision, plan, and integrated urban policy. 3. At the economic level, the adoption of the reverse value chain, circular design, business models based on the sharing economy, digital entrepreneurship, and data collection along the product life cycle are all good business practices for the implementation of the circular economy; 4. Finally, at the social level, consumer behavior (minimalist lifestyle, involvement, awareness, ethics, sorting at source) and the incentive mechanisms for manufacturers to extend their social responsibility are determinants that need to be studied in depth. This study contributes to four sustainable development goals (SDG's): Good health and well-being (SDG 3); Decent Work and Economic Growth (SDG 8); Responsible Consumption and Production (SDG 12) and Climate Action (SDG 13)..

Bibliography

1. Del Borghi, « Waste management in Smart Cities: the application of circular economy in Genoa (Italy) | », 2014. https://www.academia.edu/66326365/Waste_management_in_Smart_Cities_the_application_of_circular_economy_in_Genoa_Italy_ (consulté le 3 février 2023).
2. D. Ness, « Sustainable urban infrastructure in China: Towards a Factor 10 improvement in resource productivity through integrated infrastructure systems », *The International Journal of Sustainable Development and World Ecology*, vol. 15, janv. 2008.
3. P. Ghisellini, C. Cialani, et S. Ulgiati, « A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems », *Journal of Cleaner Production*, vol. 114, p. 11-32, févr. 2016, doi: 10.1016/j.jclepro.2015.09.007.

4. D. V. Gibson, G. Kozmetsky, et R. W. Smilor, *The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks*. Rowman & Littlefield, 1992.
5. EC, « European Innovation Partnership on Smart Cities and Communities - Strategic Implementation Plan ». 2013.
6. M. Gascó, « Building a smart city: Lessons from Barcelona », *Communications of the ACM*, vol. 61, p. 50-57, mars 2018, doi: 10.1145/3117800.
7. V. Formisano, E. Iannucci, M. Fedele, et A. B. Bonab, « City in the loop: assessing the relationship between circular economy and smart sustainable cities », *Sinergie*, vol. 40, nº 2, p. 147-168, 2022, doi: 10.7433/S118.2022.07.
8. A. Caragliu, C. Del Bo, et P. Nijkamp, « Smart Cities in Europe », *Journal of Urban Technology*, vol. 18, nº 2, p. 65-82, avr. 2011, doi: 10.1080/10630732.2011.601117.
9. Y. A. Fatimah, K. Govindan, R. Murniningsih, et A. Setiawan, « Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia », *Journal of Cleaner Production*, vol. 269, 2020, doi: 10.1016/j.jclepro.2020.122263.
10. W. Kepa, A. Luhach, M. Kavi, J. Fisher, et R. Luhach, « GSM Based Remote Distribution Transformer Condition Monitoring System », 2021, p. 59-68. doi: 10.1007/978-981-16-3653-0_5.
11. M. Antikainen, T. Uusitalo, et P. Kivikytö-Reponen, « Digitalisation as an Enabler of Circular Economy », *Procedia CIRP*, vol. 73, p. 45-49, janv. 2018, doi: 10.1016/j.procir.2018.04.027.
12. A. Zhang, V. G. Venkatesh, Y. Liu, M. Wan, T. Qu, et D. Huisingh, « Barriers to smart waste management for a circular economy in China », *Journal of Cleaner Production*, vol. 240, p. 118198, août 2019, doi: 10.1016/j.jclepro.2019.118198.
13. M. I. Aceleanu, A. C. Serban, M.-C. Suciu, et T. I. Bitoiu, « The management of municipal waste through circular economy in the context of smart cities development », *IEEE Access*, vol. 7, p. 133602-133614, 2019, doi: 10.1109/ACCESS.2019.2928999.
14. T. Yigitcanlar, Md. Kamruzzaman, M. Foth, J. Sabatini-Marques, E. da Costa, et G. Ioppolo, « Can cities become smart without being sustainable? A systematic review of the literature », *Sustainable Cities and Society*, vol. 45, p. 348-365, févr. 2019, doi: 10.1016/j.scs.2018.11.033.
15. J. Hu, Z. Xiao, R. Zhou, W. Deng, M. Wang, et S. Ma, « Ecological utilization of leather tannery waste with circular economy model », *Journal of Cleaner Production*, vol. 19, nº 2-3, Art. nº 2-3, 2011, doi: 10.1016/j.jclepro.2010.09.018.
16. X. Pan, C. W. Y. Wong, et C. Li, « Circular economy practices in the waste electrical and electronic equipment (WEEE) industry: A systematic review and future research agendas », *Journal of Cleaner Production*, vol. 365, p. 132671, sept. 2022, doi: 10.1016/j.jclepro.2022.132671.
17. D. Reike, W. J. V. Vermeulen, et S. Witjes, « The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options », *Resources, Conservation and Recycling*, vol. 135, p. 246-264, août 2018, doi: 10.1016/j.resconrec.2017.08.027.
18. H. Wilts, « Key Challenges for Transformations Towards a Circular Economy – The Status Quo in Germany », *International Journal of Waste Resources*, vol. 07, janv. 2017, doi: 10.4172/2252-5211.1000262.
19. COM, « Closing the loop - An EU action plan for the Circular Economy », 2015. https://www.eea.europa.eu/policy-documents/com-2015-0614-final (consulté le 15 février 2023).
20. M. Geissdoerfer, P. Savaget, N. M. P. Bocken, et E. J. Hultink, « The Circular Economy – A new sustainability paradigm? », *Journal of Cleaner Production*, vol. 143, p. 757-768, févr. 2017, doi: 10.1016/j.jclepro.2016.12.048.

21. S. J. Wu et W. Raghupathi, « The Strategic Association between Information and Communication Technologies and Sustainability: A Country-Level Study », 2018.
22. D. Higón, R. Gholami, et F. Shirazi, « ICT and Environmental Sustainability A Global Perspective », *Telematics and Informatics*, vol. 34, janv. 2017, doi: 10.1016/j.tele.2017.01.001.
23. F. Bifulco, M. Tregua, AMORANI, et D'auria, « ICT and sustainability in smart cities management | Emerald Insight », 2016. https://www.emerald.com/insight/content/doi/10.1108/IJPSM-07-2015-0132/full/html (consulté le 16 février 2023).
24. H. Ahvenniemi, A. Huovila, I. Pinto-Seppä, et M. Airaksinen, « What are the differences between sustainable and smart cities? », *Cities*, vol. 60, p. 234-245, févr. 2017, doi: 10.1016/j.cities.2016.09.009.
25. Y. Zhang, S. Ren, Y. Liu, T. Sakao, et D. Huisingh, « A framework for Big Data driven product lifecycle management », *Journal of Cleaner Production*, vol. 159, p. 229-240, août 2017, doi: 10.1016/j.jclepro.2017.04.172.
26. EC, « European Innovation Partnership on Smart Cities and Communities - Operational Implementation Plan ». 2013.
27. M. Adam, M. Okasha, O. Tawfeeq, M. Margan, et B. Nasreldeen, *Waste Management System Using IoT*. 2018, p. 4. doi: 10.1109/ICCCEEE.2018.8515871.
28. C. Perera, A. Zaslavsky, P. Christen, et D. Georgakopoulos, « Context Aware Computing for The Internet of Things: A Survey », *IEEE Communications Surveys & Tutorials*, mai 2013, doi: 10.1109/SURV.2013.042313.00197.
29. C. Binder, R. Quirici, S. Domnitcheva, et B. Stäubli, « Smart Labels for Waste and Resource Management », *Journal of Industrial Ecology*, vol. 12, p. 207-228, avr. 2008, doi: 10.1111/j.1530-9290.2008.00016.x.
30. S. Abdoli, « RFID Application in Municipal Solid Waste Management System », *International Journal of Environmental Research (ISSN: 1735-6865) Vol 3 Num 3*, vol. 3, juin 2009.
31. B. Chowdhury et M. Chowdhury, *RFID-based real-time smart waste management system*. 2008, p. 180. doi: 10.1109/ATNAC.2007.4665232.
32. M. Naphade, G. Banavar, C. Harrison, J. Paraszczak, et R. Morris, « Smarter Cities and Their Innovation Challenges », *Computer*, vol. 44, nº 6, p. 32-39, juin 2011, doi: 10.1109/MC.2011.187.
33. B. Esmaeilian, B. Wang, K. Lewis, F. Duarte, C. Ratti, et S. Behdad, « The future of waste management in smart and sustainable cities: A review and concept paper », *Waste Management*, vol. 81, p. 177-195, nov. 2018, doi: 10.1016/j.wasman.2018.09.047.
34. O. Romano, T. Matsumoto, M. B. Beck, M. Thompson, B. Fath, et w Liu, « Cities and the Circular Economy », 2020. [En ligne]. Disponible sur: . https://www.oecd-ilibrary.org/ sites/c849691b-en/index.html?itemId=/content/component/c849691b-en
35. S. Escamilla Solano, P. Plaza Casado, et S. Flores Ureba, « Smart Cities and Sustainable Development. A Case Study », Cham, M. Peris-Ortiz, D. R. Bennett, et D. Pérez-Bustamante Yábar, Éd., in Innovation, Technology, and Knowledge Management. Cham: Springer International Publishing, 2017, p. 65-77. doi: 10.1007/978-3-319-40895-8_5.
36. W. Umer et A. Zulfiqar, « Latest technologies of municipal solid waste management in developed and developing countries: A review », oct. 2016.
37. F. Khan et Y. Ali, « A facilitating framework for a developing country to adopt smart waste management in the context of circular economy », *Environmental Science and Pollution Research*, vol. 29, déc. 2021, doi: 10.1007/s11356-021-17573-5.
38. [38]J. Webster et R. T. Watson, « Analyzing the Past to Prepare for the Future: Writing a Literature Review », *MIS Quarterly*, vol. 26, nº 2, p. xiii-xxiii, 2002.

39. H. Snyder, « Literature review as a research methodology: An overview and guidelines », *Journal of Business Research*, vol. 104, p. 333-339, nov. 2019, doi: 10.1016/j.jbusres.2019.07.039.
40. D. Sinha-Khetriwal, P. Kraeuchi, et M. Schwaninger, « A comparison of electronic waste recycling in Switzerland and in India », *Environmental Impact Assessment Review*, vol. 25, nº 5, p. 492-504, juill. 2005, doi: 10.1016/j.eiar.2005.04.006.
41. S. Salhofer, B. Steuer, R. Ramusch, et P. Beigl, « WEEE management in Europe and China – A comparison », *Waste Management*, vol. 57, p. 27-35, nov. 2016, doi: 10.1016/j.wasman.2015.11.014.
42. F. Zhao, O. I. Fashola, T. I. Olarewaju, et I. Onwumere, « Smart city research: A holistic and state-of-the-art literature review », *Cities*, vol. 119, p. 103406, déc. 2021, doi: 10.1016/j.cities.2021.103406.
43. J.-P. Birat, « Life-cycle assessment, resource efficiency and recycling », *Metallurgical Research & Technology*, vol. 112, p. 206, janv. 2015, doi: 10.1051/metal/2015009.
44. A. T. H. Kuah et P. Wang, « Circular economy and consumer acceptance: An exploratory study in East and Southeast Asia », *Journal of Cleaner Production*, vol. 247, p. 119097, févr. 2020, doi: 10.1016/j.jclepro.2019.119097.
45. M. C. den Hollander, C. A. Bakker, et E. J. Hultink, « Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms: Key Concepts and Terms for Circular Product Design », *Journal of Industrial Ecology*, vol. 21, nº 3, p. 517-525, juin 2017, doi: 10.1111/jiec.12610.