



# Integrating Circular Economy Principles in Urban Development for Sustainable Cities in Nigeria: Lessons from Global and Local Case Studies

Ejims, Grace <sup>a\*</sup>, Ibrahim, Adib <sup>b++</sup> and Ijasan, Olere <sup>c#</sup>

<sup>a</sup> Environmental Systems and Assurance, STRABAG, UK LTD, England.

<sup>b</sup> STRABAG, UK LTD, England.

<sup>c</sup> Sustainable Energy Development, University of Calgary, School of Policy, Alberta, Canada.

## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## Article Information

DOI: <https://doi.org/10.9734/ajee/2024/v23i9594>

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/121883>

Original Research Article

Received: 19/06/2024

Accepted: 21/08/2024

Published: 26/08/2024

## ABSTRACT

Nigeria, Africa's most populous country, faces significant urbanization challenges including waste management, resource scarcity, and environmental degradation. This paper explores the integration of Circular Economy (CE) principles in urban development to foster sustainable cities in Nigeria. By examining case studies and best practices from global and local perspectives, including insights from Lebanon's experiences amid its economic crisis, the paper provides strategic recommendations for policymakers, urban planners, and stakeholders to implement CE principles

<sup>++</sup>Environmental Specialist;

<sup>#</sup>MSc;

<sup>\*</sup>Corresponding author: E-mail: [ejims.grace@gmail.com](mailto:ejims.grace@gmail.com);

**Cite as:** Grace, Ejims, Ibrahim, Adib, and Ijasan, Olere. 2024. "Integrating Circular Economy Principles in Urban Development for Sustainable Cities in Nigeria: Lessons from Global and Local Case Studies". *Asian Journal of Environment & Ecology* 23 (9):24-32. <https://doi.org/10.9734/ajee/2024/v23i9594>.

effectively in Nigerian urban contexts. Lebanon's strategic adaptation of CE principles, particularly in response to its severe economic and energy crises, demonstrates the potential for CE to enhance economic resilience and sustainability under challenging conditions. This experience offers critical lessons for Nigeria, as it also faces similar urbanization and sustainability challenges.

*Keywords: Urbanization; economy principles; economic crisis.*

## 1. INTRODUCTION

Nigeria's rapid urbanization has resulted in increased pressure on resources, infrastructure, and the environment. The linear economy model prevalent in Nigerian cities exacerbates these challenges by promoting a "take, make, dispose" approach. The circular economy, with its focus on resource efficiency, waste reduction, and continuous material use, offers a viable solution. This paper aims to explore how CE principles can be integrated into urban development in Nigeria to create sustainable, resilient, and liveable cities.

Lebanon serves as a significant case study for Nigeria, demonstrating how the application of principles can mitigate the impacts of severe economic challenges, such as hyperinflation, currency devaluation, and widespread energy shortages. The adoption of these principles in Lebanon, especially the widespread use of solar energy as a response to electricity shortages, provides valuable insights into how Nigeria could address its own economic and environmental crises [1]. The adoption of CE practices, such as the widespread use of solar energy in response to electricity shortages, provides practical insights that can be adapted to the Nigerian context. Lebanon's experiences underscore the transformative potential of CE principles in fostering economic resilience, resource efficiency, and environmental sustainability, even amid severe economic crises. This case illustrates how strategic CE interventions, such as the transition to renewable energy sources like solar power, can stabilize and rejuvenate urban economies and infrastructures.

## 2. LITERATURE REVIEW

Urbanization poses significant challenges to sustainable development, especially in rapidly growing regions such as Nigeria. The concept of the Circular Economy (CE) has gained attention as a sustainable approach to managing urban resources and reducing environmental impacts. This literature review provides a comprehensive

analysis of key concepts, theoretical frameworks, and previous studies on CE and urban development, with a focus on sustainable urban planning, resource management, waste reduction strategies, and economic implications in the context of Nigeria and Africa.

### 2.1 Key Concepts and Theoretical Frameworks

The CE is an economic system aimed at eliminating waste and the continual use of resources. It contrasts with a traditional linear economy, which has a 'take, make, dispose' model of production. The CE involves reusing, repairing, refurbishing, and recycling existing materials and products to extend their lifecycle [2]. This approach not only minimizes waste but also conserves natural resources and reduces environmental impacts.

### 2.2 Sustainable Urban Planning and Resource Management

Sustainable urban planning involves designing cities to be liveable, resilient, and resource efficient. It integrates principles of sustainability into the planning and development of urban areas, aiming to balance social, economic, and environmental needs [3]. Key aspects include land use planning, transportation, green spaces, and sustainable infrastructure. On the other hand, resource management in urban settings involves optimizing the use of materials, water, and energy to reduce consumption and waste. Effective resource management can enhance the sustainability of urban areas by reducing the strain on natural resources and minimizing environmental impacts (Mason et al., 2015). Muilu & Akinyemi, 2020, provides additional insight into resource management by noting that Water management is a critical component of sustainable urban development. Implementing CE principles in water management can involve practices such as rainwater harvesting, wastewater recycling, and efficient water use in buildings and industries. In addition to water management, Adewale, [4], notes that wastes

reduction strategies are a critical component of CE. According to him, Effective waste management is crucial for sustainable urban development. Strategies such as waste segregation, recycling, composting, and the use of waste-to-energy technologies can significantly reduce the amount of waste sent to landfills and promote the efficient use of resources [4].

In discussing this further using Nigeria as an example, Ogundele et al, (2018), have shown that various initiatives have been implemented to improve waste management. For instance, the Lagos Waste Management Authority (LAWMA) has introduced programs to promote recycling and reduce waste through public-private partnerships (Ogundele et al., 2018). These initiatives highlight the potential for integrating CE principles into waste management practices.

### 2.3 Economic Implication of CE

The economic benefits of integrating Circular Economy (CE) principles are vast and can significantly enhance sustainable urban development. CE can offer significant economic benefits by creating new business opportunities, reducing costs, and promoting sustainable economic growth. It can drive innovation in product design, manufacturing, and service delivery, leading to increased efficiency and competitiveness [5]. In the area of creating New Business Opportunities, the transition to a CE model opens up numerous opportunities for new and innovative business ventures. Companies can develop new products and services that focus on resource efficiency and waste reduction. For example, the concept of product-as-a-service (PaaS) allows businesses to retain ownership of products and lease them to consumers, ensuring that materials are returned and reused rather than discarded. This model not only generates recurring revenue but also fosters long-term customer relationships [6]. The European Commission estimates that shifting to a CE could generate 700,000 new jobs in the EU by 2030, highlighting the potential for job creation and economic growth [7].

Cost Reduction is a key economic implication of CE. CE principles can lead to significant cost savings for businesses and municipalities by optimizing resource use and reducing waste. Ellen MacArthur Foundation, 2013 has noted that by designing products for durability, reuse, and recyclability, companies can lower material costs and minimize waste disposal expenses.

Implementing CE practices such as closed-loop supply chains can also reduce dependency on raw materials, which are often subject to price volatility. Companies like Philips have adopted circular strategies by offering lighting as a service thus Philips maintain control over their products, ensuring that they can be refurbished, reused, or recycled at the end of their life cycle, thus reducing material costs and waste [8]. It has been reported that CE promotes Sustainable Economic Growth encourages a more resilient economic system that can withstand external shocks, such as resource scarcity and environmental crises [5]. Innovation in product design is achieved by decoupling economic development from resource consumption. Innovations such as modular design, which allows products to be easily disassembled and parts to be replaced or upgraded, can enhance product longevity, and reduce waste. Manufacturing processes can be optimized to use fewer resources and generate less waste, leading to greater efficiency and lower costs [9]. The advantage in enhancing competitiveness of businesses by differentiating their offerings in the market has been noted by Lacy & Rutqvist, [10]. They posited that adopting circular strategies can meet the increasing consumer demand for sustainable products and services, gaining a competitive edge over those that rely on traditional linear models. As consumers become more environmentally conscious, businesses that prioritize sustainability are likely to attract and retain customers.

### 2.4 Challenges and Opportunities

The integration of CE principles in Nigeria and other African countries faces several challenges, including limited infrastructure, regulatory frameworks, and public awareness. However, there are significant opportunities for leveraging CE to address urbanization challenges and promote sustainable development [11]. Lebanon's experiences in adapting CE principles during economic and energy crises provide valuable insights for Nigeria [12]. Lebanon's decentralized waste management and renewable energy initiatives provide a critical examination of how CE principles can be applied to enhance resource efficiency and sustainability, even in the face of significant economic and infrastructural challenges [13]. These initiatives are particularly relevant for Nigeria as it seeks to develop resilient and sustainable urban environments [14].

### 3. METHODOLOGY

#### 3.1 Research Design

This research employs a mixed-methods approach, combining qualitative and quantitative data collection and analysis to explore the integration of Circular Economy (CE) principles in urban development for sustainable cities in Nigeria. The research will involve a comparative analysis of global and local case studies to identify best practises, challenges, and opportunities for implementing CE in the Nigerian context. Case studies of cities that have successfully implemented CE principles globally and in Africa will be analysed to identify best practices and lessons learned. Additionally, surveys and interviews with urban planners, policymakers, and industry stakeholders in Nigeria will provide insights into the challenges and opportunities associated with CE integration in Nigeria.

#### 3.2 Research Objectives

- To assess the current state of urban development and sustainability in Nigeria.
- To analyze the application of Circular Economy principles in urban development globally and locally.
- To identify key challenges and opportunities in integrating CE principles into Nigerian urban development.
- To develop recommendations for policymakers, urban planners, and stakeholders in Nigeria.

#### 3.3 Case Study Selection

##### 3.3.1 Case studies

**Global Case Studies:** Amsterdam (Netherlands), Cape Town (South Africa), and Beirut (Lebanon)

**Local Case Study:** Lagos (Nigeria)

##### 3.3.2 Selection criteria

**Global Cases:** Cities that have successfully implemented Circular Economy principles in their urban development projects and have documented outcomes.

**Local Case:** Lagos was selected due to its ongoing or completed urban development projects that reflect aspects of CE, as well as

facing significant urbanization challenges where CE principles could be beneficial.

#### 1. Lagos, Nigeria

**Eko Atlantic Project:** Analysis of urban redevelopment focusing on sustainable infrastructure and resource management.

**Lagos Waste Management Authority (LAWMA):** Initiatives in recycling and waste management.

#### 2. Amsterdam, Netherlands

**Amsterdam Circular City Program:** Insights into circular construction, urban mining, and sustainable consumption practices.

#### 3. Cape Town, South Africa

**Waste-to-Value Initiative:** Focus on converting waste to resources and sustainable urban farming practices.

#### 4. Beirut, Lebanon

**2Circular Project:** Private Sector Transition to Green and Circular Economy, focusing on resource efficiency in industrial sectors, such as food and beverage, by implementing cleaner production techniques and promoting sustainability.

**Solar Energy Adoption:** Amidst a crippling electricity crisis, Lebanon has seen a significant shift towards solar energy adoption. This transition, driven by the need for reliable and sustainable energy, offers a pragmatic model for Nigeria to follow as it seeks to overcome similar energy challenges. The Lebanese experience highlights the feasibility and benefits of integrating renewable energy solutions within the framework of a circular economy, providing a blueprint for Nigeria's energy strategy.

#### 3.4 Data Collection Methods

##### Literature Review:

- **Purpose:** To provide a theoretical framework and context for Circular Economy principles and their application in urban development.
- **Sources:** Academic journals, books, reports from international organizations (e.g., UN, World Bank), and relevant government publications.

- **Focus:** Global best practices, CE models, urban sustainability strategies, and specific applications in developing countries.

#### Document Analysis:

- **Purpose:** To analyze existing policies, urban plans, and CE initiatives in the selected case study cities.
- **Sources:** Policy documents, urban development plans, CE project reports, government publications, and NGO reports.
- **Focus:** Identifying the presence and impact of CE principles in urban planning and development.

#### Interviews:

- **Purpose:** To gather insights from key stakeholders involved in urban development and Circular Economy initiatives.
- **Participants:** Urban planners, policymakers, CE experts, city officials, and representatives from NGOs and private sector organizations involved in urban projects.
- **Method:** Semi-structured interviews conducted either in person or via video conferencing.
- **Focus:** Understanding the practical challenges, successes, and lessons learned from CE implementation in urban development.

#### Surveys:

- **Purpose:** To collect quantitative data on the perceptions and attitudes of urban residents and stakeholders towards CE principles and urban sustainability.
- **Participants:** Residents, business owners, and professionals in the selected Nigerian cities.
- **Distribution:** Online surveys using platforms such as Google Forms or SurveyMonkey, and possibly paper-based surveys in less connected areas.
- **Focus:** Public awareness, acceptance, and perceived benefits/challenges of integrating CE in urban development.

#### Field Observations:

- **Purpose:** To observe the implementation of Circular Economy initiatives and urban development projects in practice.

- **Locations:** Key project sites in the selected cities (both global and local case studies).
- **Focus:** Physical infrastructure, waste management systems, recycling programs, green spaces, and any visible impact on the urban environment and quality of life.

### 3.5 Data Analysis

#### Qualitative Analysis:

- **Thematic Analysis:** Identify key themes and patterns from the literature review, document analysis, and interviews. Use qualitative data analysis software (e.g., NVivo) to code and categorize data.
- **Comparative Analysis:** Compare findings from global and local case studies to identify similarities, differences, and transferable lessons.

#### Quantitative Analysis:

- **Descriptive Statistics:** Use survey data to calculate frequencies, percentages, and means, providing a statistical overview of public perceptions and attitudes.
- **Correlation Analysis:** Explore relationships between variables such as public awareness of CE principles and support for urban sustainability initiatives.

### 3.6 Validation and Triangulation

- **Triangulation:** Cross-validate findings by comparing data from different sources (e.g., literature, interviews, surveys, and field observations) to ensure reliability and accuracy.
- **Peer Review:** Seek feedback from experts in Circular Economy and urban development to validate the research methodology and findings.

### 3.7 Expected Outcomes

- **Identification of Best Practices:** A comprehensive understanding of successful CE integration in urban development from both global and local perspectives.
- **Policy Recommendations:** Practical recommendations for Nigerian policymakers and urban planners on how to implement CE principles effectively.

- **Framework for Action:** A strategic framework to guide the integration of Circular Economy principles in urban development projects across Nigeria.

### 3.8 Limitations

- **Data Availability:** Potential challenges in accessing detailed data and documentation for some local and global case studies.
- **Response Rate:** Variability in survey response rates, particularly in less connected areas of Nigeria.
- **Cultural Differences:** Differences in cultural and socio-economic contexts between global and local case studies that may affect the applicability of certain CE strategies.

### 3.9 Discussion

The discussion will analyse the findings from the case studies and empirical data, highlighting the effectiveness of different CE strategies in urban development. Key themes will include:

**Resource Efficiency:** Strategies for reducing material use and promoting recycling and reuse in Nigerian cities.

**Economic Resilience:** Creating new business opportunities and reducing dependency on finite resources through CE.

**Social Well-being:** Enhancing quality of life through sustainable urban environments and community involvement in Nigeria.

### 3.10 Key Insights for Nigeria

**Resource Efficiency:** Nigeria can enhance resource efficiency by adopting comprehensive waste management practices like those of LAWMA and by learning from Amsterdam's circular construction and Cape Town's waste-to-value initiatives. Lebanon's transition to solar energy amidst severe electricity shortages presents a compelling model for Nigeria [15]. This shift illustrates how adopting renewable energy within a circular economy framework not only alleviates energy crises but also promotes long-term economic resilience and environmental sustainability [1].

**Economic Resilience:** Leveraging CE principles can create new business opportunities and attract investments, as seen in Amsterdam

and Beirut. Nigeria can promote economic resilience by encouraging investments in renewable energy and sustainable infrastructure projects [12,13].

**Social Well-being:** Enhancing social well-being through community involvement in waste management and recycling, as demonstrated by LAWMA and Cape Town's urban farming, can significantly improve living conditions in Nigerian cities. Lebanon's successful adoption of solar energy underscores the vital role of renewable energy in enhancing the quality of life and economic stability within a circular economy framework [16]. This experience highlights actionable strategies that Nigeria could implement to achieve similar outcomes in its urban development initiatives.

### 3.11 Challenges and Opportunities in Nigeria

**Infrastructure Deficits:** Addressing the lack of adequate infrastructure for effective CE implementation.

**Policy and Regulatory Frameworks:** Developing supportive policies and regulations for CE.

**Public Awareness and Education:** Promoting understanding and acceptance of CE among Nigerian citizens and businesses.

**Economic and Financial Constraints:** Exploring funding opportunities and economic incentives for CE initiatives.

**Cultural and Behavioural Factors:** Adapting CE principles to fit the cultural and social context of Nigerian cities.

### 3.12 Lessons from Lebanon

Lebanon's current economic crisis, characterized by hyperinflation, devaluation of the Lebanese pound, and a crippling electricity shortage, has necessitated innovative solutions and a pivot towards circular economy practices to sustain its urban environments [17,18].

### 3.13 Solar Energy as a Solution

**Economic Context:** Lebanon's economic crisis has drastically affected the availability and reliability of electricity, leading to widespread power outages [15].

**Table 1. Key Themes and Lessons for Nigeria from Case Studies**

<b>Key Themes</b>	<b>Lagos, Nigeria</b>	<b>Amsterdam, Netherlands</b>	<b>Cape Town, South Africa</b>	<b>Beirut, Lebanon</b>
Resource Efficiency	<ul style="list-style-type: none"> <li>- LAWMA's recycling initiatives show the importance of effective waste management.</li> <li>- Eko Atlantic Project demonstrates sustainable infrastructure practices.</li> </ul>	<ul style="list-style-type: none"> <li>- Circular City Program includes urban mining and sustainable consumption practices.</li> <li>- Emphasizes the importance of circular construction.</li> </ul>	<ul style="list-style-type: none"> <li>- Waste-to-Value Initiative transforms waste into resources, demonstrating efficient resource management.</li> </ul>	<ul style="list-style-type: none"> <li>- 2Circular Project promotes resource efficiency in the food and beverage sector.</li> <li>- Adoption of solar energy reduces dependency on traditional power sources.</li> </ul>
Economic Resilience	<ul style="list-style-type: none"> <li>- Creation of new business opportunities through waste management and recycling.</li> <li>- Attracts investment through sustainable urban redevelopment projects like Eko Atlantic.</li> </ul>	<ul style="list-style-type: none"> <li>- Circular economy initiatives create new business models and job opportunities.</li> <li>- Circular City Program shows how to reduce dependency on finite resources.</li> </ul>	<ul style="list-style-type: none"> <li>- Economic benefits from converting waste to resources.</li> <li>- Sustainable urban farming supports local economies.</li> </ul>	<ul style="list-style-type: none"> <li>- Solar energy adoption in response to the electricity crisis promotes economic resilience.</li> <li>- Resource-efficient practices in industrial sectors provide economic stability.</li> </ul>
Social Well-being	<ul style="list-style-type: none"> <li>- Improved waste management and urban redevelopment enhance living conditions.</li> <li>- Community involvement in recycling initiatives by LAWMA.</li> </ul>	<ul style="list-style-type: none"> <li>- Circular City Program promotes sustainable urban environments.</li> <li>- Enhances quality of life through green spaces and sustainable consumption.</li> </ul>	<ul style="list-style-type: none"> <li>- Community-based waste-to-value projects improve social cohesion.</li> <li>- Urban farming initiatives enhance food security.</li> </ul>	<ul style="list-style-type: none"> <li>- Solar energy solutions improve quality of life by providing reliable power.</li> <li>- Recycling and resource-efficient practices foster community engagement.</li> </ul>

**Solar Adoption:** In response, there has been a significant shift towards solar energy solutions. Households and businesses have increasingly adopted solar panels, reducing their dependence on the unstable national grid.

**Impact:** This transition has not only alleviated the electricity shortage but also promoted the use of renewable energy, demonstrating a successful application of CE principles in energy management [3]. Nigeria, facing similar electricity supply challenges, can draw valuable insights from Lebanon's experience to promote solar energy adoption [19].

### 3.14 Policy Recommendations

Based on the research findings, the paper will propose policy recommendations for Nigerian governments and urban planners to facilitate the adoption of CE principles. Recommendations will focus on:

**Regulatory Frameworks:** Developing and enforcing policies that support CE practices.

**Incentives and Financing:** Providing financial incentives and support for CE initiatives.

**Public Awareness and Education:** Conducting campaigns to raise awareness and educate the public about the benefits of CE.

**Collaborative Governance:** Encouraging multi-stakeholder collaboration and partnerships to implement CE projects.

## 4. CONCLUSION

The integration of circular economy principles in urban development presents a viable pathway towards sustainable cities in Nigeria. By rethinking resource use and waste management, Nigerian cities can enhance environmental sustainability, economic vitality, and social equity [20,21]. This paper underscores the importance of adopting holistic and collaborative approaches to urban planning and highlights the potential of CE to transform urban landscapes for a sustainable future in Nigeria.

### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

## CONSENT

Obtain informed consent from all interview and survey participants, ensuring they understand the purpose of the research and their rights.

## COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

## REFERENCES

1. European Commission. A New circular economy action plan for a cleaner and more competitive Europe. Brussels: European Commission; 2020.
2. Ellen MacArthur Foundation. Towards the circular economy: Economic and business rationale for an accelerated transition. Ellen MacArthur Foundation; 2013.
3. Williams J. Circular cities: Challenges to implementing looping actions. Sustainability. 2019; 11(2):423. DOI:10.3390/su11020423
4. Adewole AT. Waste management towards sustainable development in Nigeria: A case study of Lagos state. International NGO Journal. 2009;4(4):173-179.
5. Geissdoerfer M, Savaget P, Bocken NMP, Hultink EJ. The circular economy – A new sustainability paradigm? Journal of Cleaner Production. 2017;143:757-768. DOI:10.1016/j.jclepro.2016.12.048
6. Stahel WR. The circular economy. Nature. 2016;531(7595):435-438. DOI:10.1038/531435a
7. European Commission. A European strategy for plastics in a circular economy. Retrieved from European Commission; 2018.
8. Accenture. Circular Advantage: Innovative Business models and technologies to create value in a world without limits to growth. Retrieved from Accenture; 2014.
9. Bocken NMP, de Pauw I, Bakker C, van der Grinten B. Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering. 2016;33(5):308-320.



10. Lacy P, Rutqvist J. Waste to wealth: The circular economy advantage. New York: Palgrave Macmillan; 2015.
11. Nzeadibe TC, Anyadike RN. Policies, practices and sustainable development in Nigeria: A study of solid waste management. *Environment and Urbanization*. 2012;24(2):1-16.
12. Kirchherr J, Reike D, Hekkert M. Conceptualizing the Circular Economy: An Analysis of 114 Definitions. *Resources, Conservation and Recycling*. 2017; 127:221-232. DOI:10.1016/j.resconrec.2017.09.005
13. Lieder M, Rashid A. Towards circular economy implementation: A comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*. 2016;115:36-51. DOI:10.1016/j.jclepro.2015.12.042
14. Elia A, Gnoni MG, Tornese F. Assessing the economic and environmental benefits of industrial symbiosis: The case of the Italian paper industry. *Journal of Cleaner Production*. 2021;316: 128362.
15. UNIDO. Private Sector Transition to Green and Circular Economy in Lebanon. UNIDO; 2023.
16. Prendeville S, Cherim E, Bocken N. Circular cities: Mapping six cities in transition. *Environmental Innovation and Societal Transitions*. 2018;26:171-194. DOI:10.1016/j.eist.2017.03.002
17. Berytech. Agri-Food Innovation Hub. Berytech; 2023.
18. Live Love Beirut. Recycling Initiatives. Live Love Beirut; 2023.
19. United Nations. Transforming our world: The 2030 agenda for sustainable development. United Nations General Assembly; 2015.
20. Zink T, Geyer R. Circular economy rebound. *Journal of Industrial Ecology*. 2017;21(3):593-602. DOI:10.1111/jiec.12545

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*

<https://www.sdiarticle5.com/review-history/121883>