




A Bibliometric Analysis of Circular Economy: Policy Implications for Sustainability in Sub-Saharan Africa

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Received: 21/03/2024

Accepted for publication: 09/04/2024

Published: 30/04/2024

Abstract

This study aims to identify and map out circular economy in scientific literature in the global and Africa context. The circular economy has been adopted mostly in industrial production systems in the developed economies, its application in Africa is limited mostly to environment sector. A paucity of scholarly research and scientific publications on CE instigated the need to map out circular economy for sustainable development Africa. This article provides an overview of scientific publications on circular economy built in Africa through the Scopus database. The study used bibliometric analysis based on data obtained from Scopus database highlighting scientific literature. The analysis obtained 414 publications from 2005 to 2024. It provides descriptive and analytical graphs and bibliographic maps generated in R-Studio software. Findings shows main scientific and scholars are in European and Chinese universities with scanty publications in Africa. These findings signal the inadequacy of scientific research to inform policies on circular economy in Africa. It calls for future demand for more research and scientific publication on circular economy linked to sustainability in Africa.

Keywords: Circular, Economy, Social Life Cycle Assessment, Sustainability, Africa, Policy



1. Introduction

The genesis of the circular economy (CE) can be traced in 1976 with the Batelle Institute Geneva scholars who produced a report titled “The Potential for Substituting Manpower for Energy” for the Directorate-General for Labour and Social Affairs of the European Union. The essence of CE as a development framework for long-term sustainability and for supporting of growing economies (Dominko et al., 2023; Schaubroeck et al., 2021; Yu et al., 2022). The CE is widely discussed using three basic elements of an economic system; resource suppliers, waste assimilators and sources of utility that advocate for cyclical use of resources for the creation, supply and use of products generated for companies (Luis & Celma, 2020; Schaubroeck et al., 2021). Built on CE principle of reducing waste, use of waste and recycling materials (Ogunmakinde et al., 2022; Ogutu et al., 2023; Schaubroeck et al., 2021), the CE is gaining keen interest among researchers, government policy makers, and organizations as an alternative to the linear economy for promoting sustainability because it provides solutions to ecological and socio-economic challenges resulting from increasing consumption of non-renewable resources, waste generation, pollution and resource scarcity (Goyal et al., 2021).

The Circular Economy as an emerging production development model is important for developing economic because it promises sustainable jobs and rational use of resources with environmental, and economic benefits. CE focuses on circularity, reusing and replacing the resources (Luthin et al., 2024). The CE is about decoupling economic activities based on the intake of limited resources and scheming waste out from the system (Gedam et al., 2021; Morales & Belmonte-Urena, 2021). The Circular Economy explores new productive and economic systems that allow for the creation of production systems while saving resources. It has attracted scholarly work and businesses because it operationizes the implementation of sustainable development (Kirchherr et al., 2017; Ogunmakinde et al., 2022). However, there is inadequate evidence in scholarly literature of circular economy for sustainability in the Sub-Saharan Africa.

2. Theoretical background

The concept of circular (CE) economy as a strategy for moving towards sustainability in the European Union is well articulated in the European Circular Economy Action Plan as a blueprint policy for boosting green jobs, growth, and investment for promoting the transition to a carbon-neutral, resource efficiency. In the context of Africa, the African Union (AU) agenda 2063 is the Africa’s development framework for transforming the continent encompasses inclusive and sustainable development. The AU launched the African Circular Economy Alliance in 2016 as development strategy (Ogunmakinde et al., 2022). By 2022, CE has expanded to more than 20 African countries because recycling is a solution to the growing environmental pollution caused by plastics, metals and glass to mitigate the environmental effects.

While linear economy production system takes end-of-life products as waste, circular economy perceives end-of-life products as resources (Gedam et al., 2021), CE has elevated important development strategy that considers sustainability. For this need, circular economy inspired by the World Trade Center calling for public and private industries to adopt it with the potential to support green job creation as an approach to economic growth that is in line with sustainable environmental and economic development (Dunmade, 2021). Circular economy promotes efficient use of resource materials and energy while also



decreasing environmental pollution (Andersen et al., 2022; Furness et al., 2021; Yu et al., 2022). Due to its socio-economic and environmental importance CE is gaining high acceptance of novel strategy of sustainable development. Understanding the life cycle of CE is crucial to achieving the SDG 12 that calls on achieving economic growth and sustainable development requires reducing ecological footprint by changing the way we produce and consume goods and resources. LCA has been used for decision making applications in circular economy perspectives as a standardized tool by the International Organization of Standardization with the guidelines 'ISO 14040–44: 2006 Life Cycle Assessment' and 'ISO 14045: 2012 Eco-efficiency', where "Eco-efficiency" considers some economic aspects for calculating impacts of products (Furness et al., 2021). It is a fact that CE has also become an important field of sustainability, policy makers and academic research with increasing number of publications in scientific journals covering environmental and economic aspects (Geissdoerfer et al., 2017), with less emphasis on social benefits of CE.

It is urged in the academic research that CE focuses on technological solutions to economic problems. It is these premises that CE boost economy while protecting the environment. Circular economy is therefore a promising sustainable development strategy to overcome greenhouse gas emissions in African economies where emissions are projected to increase by more than 2.5 times by 2050 driven by large transformations in urbanization, industrialization, mineral extraction and electrification (Racki et al., 2014). Much research has been done and scholarly articles written on CE with potential environmental and economic impact; whereby the environmental benefits include waste diversion and emission reduction, reduced raw material use, reduced carbon and glasshouse gas emissions, and provides product regeneration (Ogunmakinde et al., 2022). The operational benefits include product quality improvements, efficiency. However, the sustainability social dimensions in the CE are marginalized. The social impact dimensions include job creation, social equity, workers' occupational health and safety, workers' rights of association, which are the major pillars of Social Life Cycle Assessment (S-LCA) studies (Luthin et al., 2024). Certainly the omission is due to methodological challenge for studying social assessment and its particularities and adaptations (Reinales et al., 2020).

The application of CE in Africa is relevant for sustainable development of many sectors such as manufacturing industries, construction, agriculture, and extractive. For example, the extractive industry in Africa is one of the major economic resources and production accounting between 4.6 – 86 percent contribution to GDP (Nhabinde & Heshmati, 2021). On the other hand, it accounts for about 50 percent of global GHG emissions a biodiversity loss owing to land use. Promoting circular economy in the extractive industry contribute to environmental protection through recycling of water use in the minerals processing and protection of biodiversity. CE is linked to sustainable development because it focuses on industrial applications with both product-oriented, natural resources and services, practice to better understand the limitations that countries focus on strategic investments of the circular economy with different outcomes such as re-use applications and waste management. The circular economy takes into consideration of trade-offs between economic development and environmental protection, industrialization sustainability and environmental management. It also preserves the environment by reducing the consumption of natural resources and prevent depletion of resources by recycling (Mhlanga et al., 2022; Razmjooei et al., 2023).



European Journal of Social Impact and Circular Economy



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It is argued that circular economy as a new paradigm for economic development offers significant environmental and economic benefits. It replaces the notion of end-of-life in production and consumption practices through reusing and recycling products and materials in production, distribution and consumption value chain (Berg et al., 2018). By so doing, CE complements the attainment of the 17 Sustainable Development Goals (SDGs) and in particular the SDG-12 which aim to “ensure sustainable consumption and production patterns” with indicators on the number of national policy instrument to promote sustainable production systems and consumption patterns. As such, CE implement SDG 12 by promoting recycling of production materials for sustainable environmental protection. This article examines the scientific publications on CE that promote a balanced environment, economic and social dimensions for sustainable development approaches.

Scholars (Andersen et al., 2022; Dominko et al., 2023; Gedam et al., 2021; Valdivia et al., 2021) around the globe look at the CE production systems, economic structures, environment and sustainability. Production systems could have significant impact on environment due to significant amount of energy and natural gas needed in production processes (Gaidajis & Kakanis, 2021). More often production and productivity as well as economic and environmental benefits are given more prominence to the expense of social sustainability.

Countries in the Sub-Saharan Africa face challenges of keeping and managing sustainable economic productivity, be it in the manufacturing, extractive industry or agriculture. The concept of circular economy provides potential solutions for addressing socio-environmental-economic challenge (Buda, 2022). Whereas Life cycle assessment (LCA) analytical tools are used for identification and evaluation of potential environmental impacts related to products, production processes, and environmental impacts that derive from emissions, wastes, resource use, and energy consumption (Finkbeiner et al., 2010); the impacts are categorized in the context of global warming potential (GWP), eutrophication, resource use, and others (Gaidajis & Kakanis, 2021), LCA does not cover the social impact. By so doing, pillars of sustainable development, environment, economic (Sala et al., 2016; Sharma, 2017) which has less focus on the social dimensions. Social Life Cycle Assessment (S-LCA) is a methodology to assess the social impacts of products and services across their life cycle (UNEP, 2009). It has become a useful framework for sustainability assessment of products and services (Kalvani et al., 2021). S-LCA include the social dimension to examine the subcategories related to impact on labor conditions, local community conditions, consumers’ well-being (Manik et al., 2013; UNEP, 2009). Social life cycle assessment therefore guides social impact evaluation on stakeholders throughout the life cycle of production and consumption. S-LCA method contributes to the assessment of social externalities of products (Tsalidis, 2022). It is argued that policymakers need to know where the social externalities of products occur in order to make informed decisions and therefore S-LCA is a necessary method in supporting African policy makers and governments in transforming their economies into circular economy (Tsalidis, 2022). The fundamental methodological boundaries of this study covers the relational processes on Circular Economy articles in scientific journals that considers Social Life Cycle Assessment (S-LCA) in Africa. While CE and S-LCA are well studied globally, there seems to be less published in Africa. However, there is insufficient publications and academic research to substantively provide evidence to inform policy decisions on the social benefits of CE. A bibliometric analysis is one of the credible methods to give a valuable reference focusing scientific publications (Singh et al., 2021).



3. Methodology

The study employs desk-top review as a technique of collecting data from secondary sources. The main objective of this paper is to highlight the intellectual structure of S-LCA in Circular economy (CE) in the context of Sub-Saharan Africa continent following research questions.

RQ1: What is the intellectual structure of S-LCA in Circular Economy in Africa?

RQ2: What research strands are dominant in Circular Economy?

RQ3: What are dominant institutions on Circular Economy and S-LCA in Africa?

3.1 Bibliometric analysis

A bibliometric analysis is a research method that utilizes quantitative analysis and statistics to describe patterns of publications within a given topic, field, institute, or country in the Social Science Citation Index (SSCI), Science Citation Index (SCI), World of Science or Scopus databases (Chiu, 2005). A bibliometric analysis of CE Social-Life Cycle Assessment (S-LCA) was therefore adopted as a methodology to identify, examine and shape the intellectual structure of circular economy in scientific literature in context of Africa. The bibliometric is an adopted but different methodology from the traditional systematic literature review (De Bakker, 2005). It is a developed method for investigating research from the subject of library and science knowledge. It grants the elaboration of network analysis, giving a clear image of the different links between various scientific studies, countries, authors, and keywords. Additionally, it figures out the co-occurrence of keywords and an overview of the different themes' evolution (Van Eck *et al.*, 2014; Sarkodie *et al.*, 2020). A bibliometric is a set of statistical methods used to measure and analyze the quality and quantity of articles, books, and other publications on a specified area of study from scientific documentations obtained from databases. This method aims to contribute to a better understanding of the scientific research in bibliometric research which synthesizes past and current research findings (Büyükkidik, 2022). This research method makes an objective assessment of the scientific literature using a quantitative approach in systematic and reproducible literature review. This method provides light for future research in the relevant literature as it gives a retrospective view of the published literature that evaluates academic contributions in a focal field (Guleria & Kaur, 2021). Although bibliometric analysis is used in many disciplines, there is little evidence on circular economy and social life cycle assessment

3.2 Database

Bibliometric studies use appropriate databases for retrieving published scientific documents (Ekundayo & Okoh, 2018; Furness *et al.*, 2021). This study adopted bibliometric analysis after searching for data in Scopus database as the appropriate database. This database has more than 23, 000 indexed journals in all scientific fields (Rojas-Sánchez *et al.*, 2023). In addition, Scopus database was preferred because it enables export of data to other programs more friendly as well as allowing search key terms in titles or titles/abstracts or name of the journal or name of the author or affiliation (Furness *et al.*, 2021).

3.3 Searching criteria.

A Boolean search technique was using search query that retrieved relevant published documents. The search query comprised of keywords: "circular" AND "economy" AND social AND life AND cycle AND Africa which brought 8 hits. Whereas the search query of key words “circular” AND “economy” AND “social” AND “life” AND “cycle” AND “assessment” brought on results of 414 hits. The search query inclusion criteria was publications in English language between 2005 -2024.

3.4 Bibliometric data

Data collection for this study was done through Scopus database retrieving information using a bibliometric technique from scientific publications over a specific period from 2015-2024. About 411 data were retrieved from Scopus database from 2015 -2024 which were exported to Microsoft Excel. The exported data included annual growth of publications, types of documents, languages, countries, authors, institutions, journals, citations, and funding agencies. The retrieved were analyzed data for bibliometric indicators using Rstudio v.4.3.3 software (2024-04-07) with bibliometrix R-package. Data were then imported into Rstudio and converted to a bibliographic data frame to create tables, figures and visualization maps as indicated in results and discussion section. The bibliometric method was useful for obtaining data on circular economy and social life cycle analysis or sustainability studies. The underlying theoretical frameworks include authorship, affiliation, country scientific production, citation, and co-citation.

4. Results and Discussion

The performed data analysis show titles of articles and journals, authors and their affiliations, and publications that have a greater relevance on Social Life Cycle Assessment on Circular Economy literature. The results were studied using bibliometric graphics and maps and using Rstudio software. A total of 414 from global datasets compared to 8 datasets obtained from Africa on circular economy and social life cycle assessment. Table 1. displays characteristics of the extracted information on the scientific studies based on the key research words.

Table 1: Main information

Description	Results
MAIN INFORMATION	
Timespan	2005 – 2024
Sources (Journal, Books, etc)	169
Documents	414
Annual Growth rate %	20,76
Document Average Age	2,76
Average citation per doc	28,86
References	29.776

DOCUMENT CONTENTS	
Keywords plus (ID)	2.891
Author's Keywords (DE)	1.197
AUTHORS	
Authors	1.537
Authors of single-authored docs	30
AUTHORS COLLABORATION	
Single-authored docs	30
Co-Authors per doc	4,31
International co-authorships %	37,2
DOCUMENT TYPES	
Article	250
Book	3
Book chapter	28
Conference paper	40
Conference review	2
Editorial	3
Letter	1
Note	1
Review	82
Short survey	4

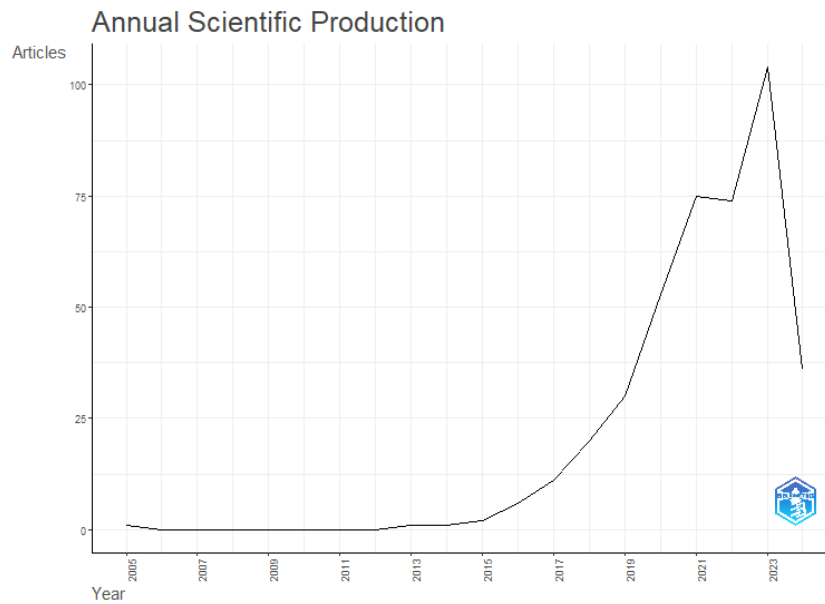
Source: Author's elaboration

Fig. 1 shows annual scientific production of articles on CE began slowly in 2015 and gained momentum from 2016 to 2023. This is probably because there was more emphasis on the global Sustainable Development Goal 8-9 that promote sustainable industrialization and economic growth, thus global and regional economic policies are geared towards sustainability.

Since circular economy is an emerging area, scholarly publications in the global literature started with low pace in 2005 and it reached the highest peak in 2023. The increase in scientific studies between 2015 to 2023 can be associated with the global emphasis on sustainability in production.

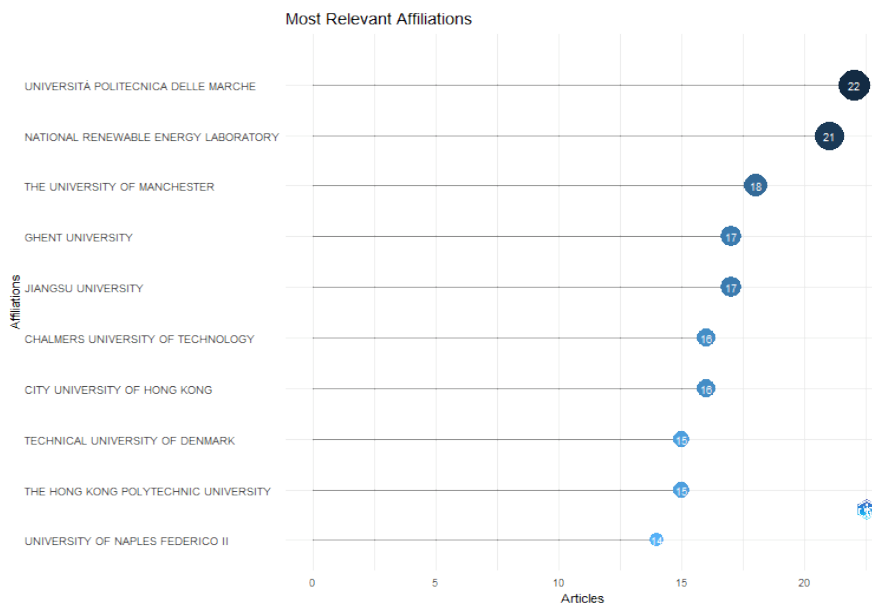
Our analysis shows that for a period between 2015- 2023, most CE and S-LCA publications were affiliated within European universities and China (Fig. 2). This implies there is sufficient capacity for CE knowledge generation in the European and Chinese universities.

Figure 1: Annual Scientific Production



Source: Author's elaboration

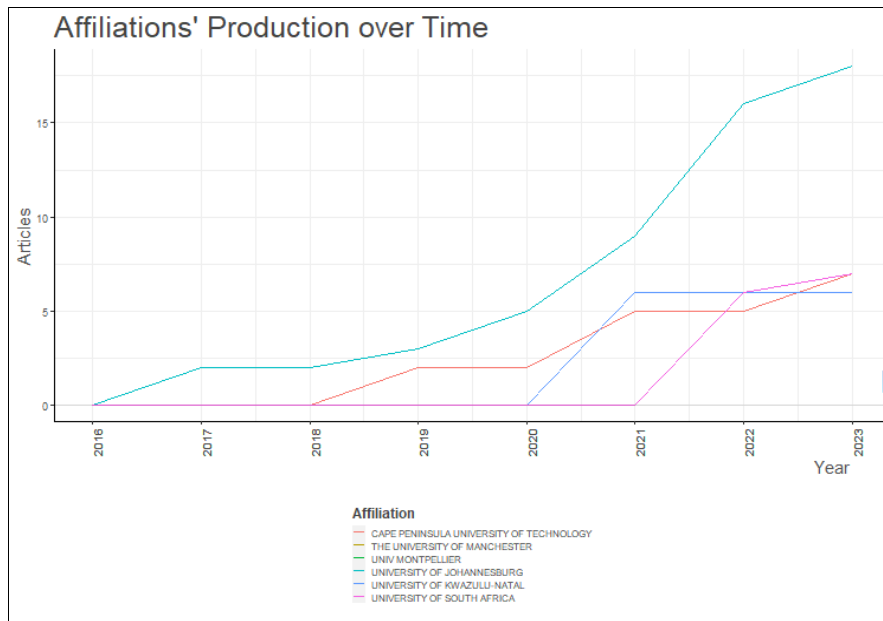
Figure 2: Most Relevant Institution Affiliations



Source: Author's elaboration

However, it was observed other than European and Chinese universities, very few publications are based on African CE and Social life cycle assessment. This is because low research and scientific publications on S-LCA on Circular Economy come from African universities Fig. 3.

Figure 3: Affiliations' Production Over Time

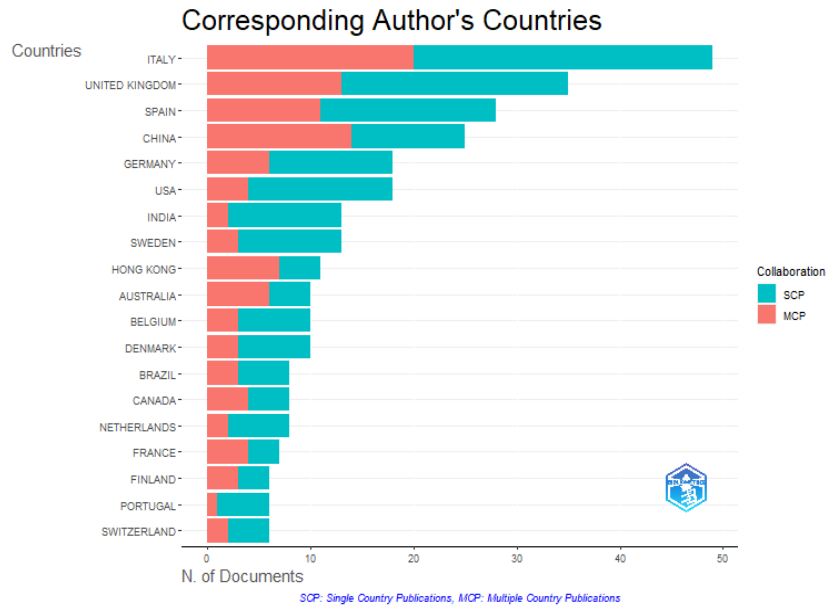


Source: Author's elaboration

This implies that as more African countries adopts CE, more research funding and capacity will be required in the African universities for scientific publication on CE and life cycle assessment. It is important only a few of African countries have made publications on CE and social life cycle assessment area. The most affiliated African universities with scientific knowledge production over time on CE and S-LCA in order of ranking are South Africa, Ghana, Nigeria Kenya, Rwanda, Tunisia, Malawi, Morocco, Senegal, Tanzania, Algeria, Zimbabwe and Mali which have not network with scholars in the North

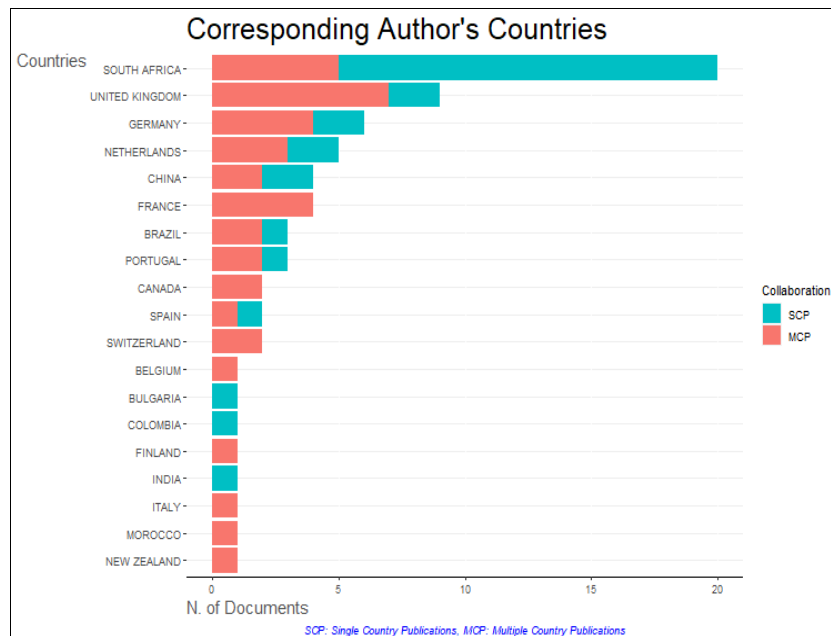
Figure 4 displays global corresponding author's countries on CE and life cycle assessment (LCA) with Italy, the United Kingdom, Spain, China, Germany and the US having more publications in scientific evidence on S-LCA in Circular Economy. It is also important to note that, Africa does not feature well in the CE global bibliometric analysis. However, South Africa (Fig.5) was observed with more multiple country publications on circular economy knowledge due to its importance for sustainability.

Figure 4: Corresponding Global Author's Countries



Source: Author's elaboration

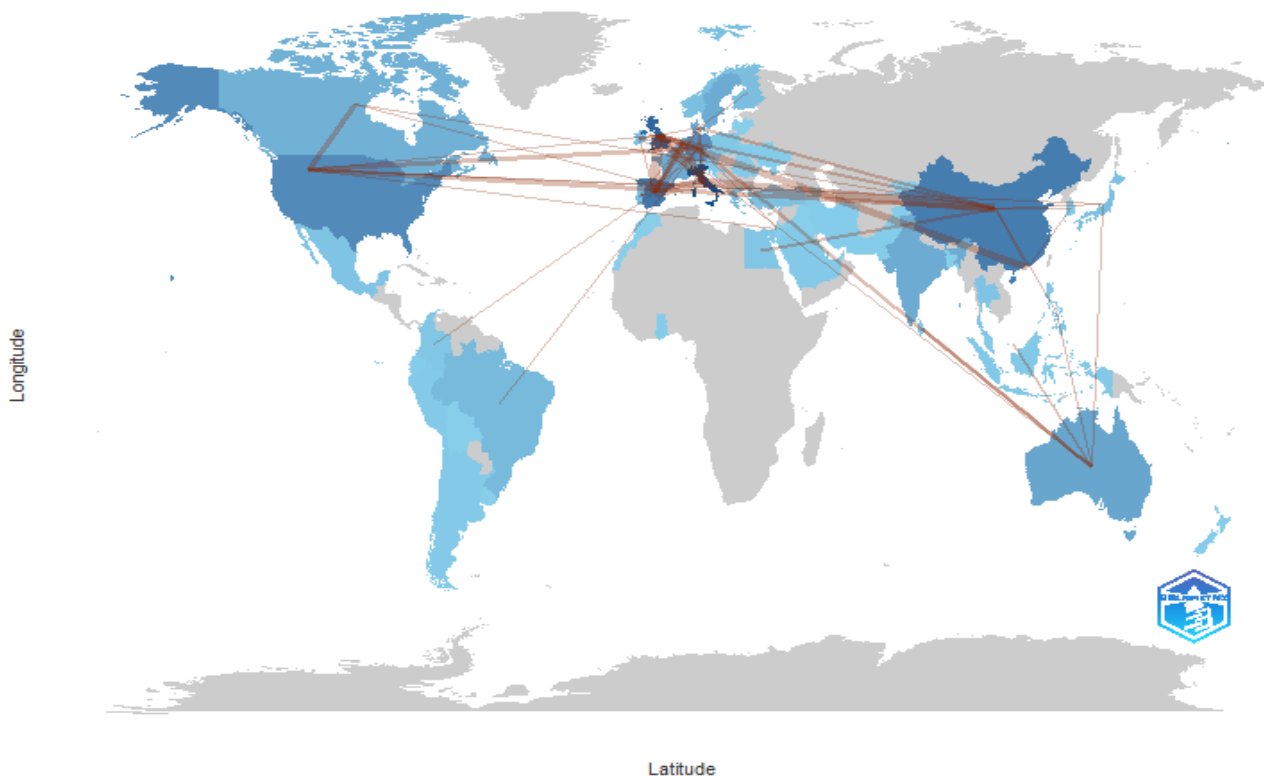
Figure 5: Corresponding African Author's Countries



Source: Author's elaboration

This paper shows an absence of North-South co-knowledge creation between African countries and the North (Fig.6). This throws a challenge and a wakening call for African scholars to take interest and initiatives to network with the North publishers on this area for the African universities in particular to increase number of publications.

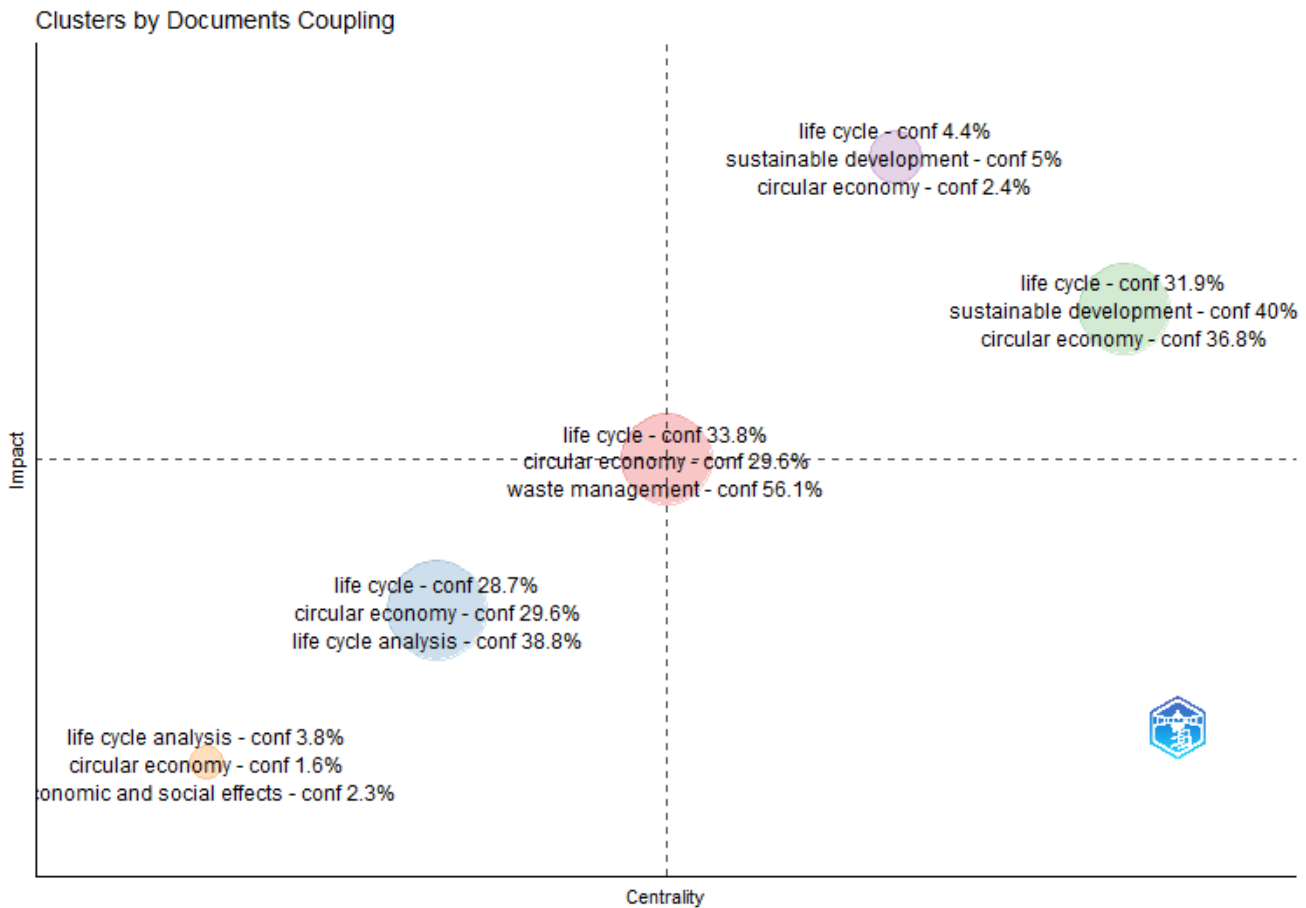
Figure 6: North-North vs North-south Co-Creation



Source: Author's elaboration

While bibliometric maps shows European countries with most authors who have identified S-LCA in circular economy publications over time from 2005 to 2024. Clusters by document coupling establishes relationship between documents with common work in bibliometric analysis (Martinho & Mourão, 2020). This is an indication of co-existence between CE and S-LCA for sustainability assessment.

Figure 7: CE Clusters by Document Coupling

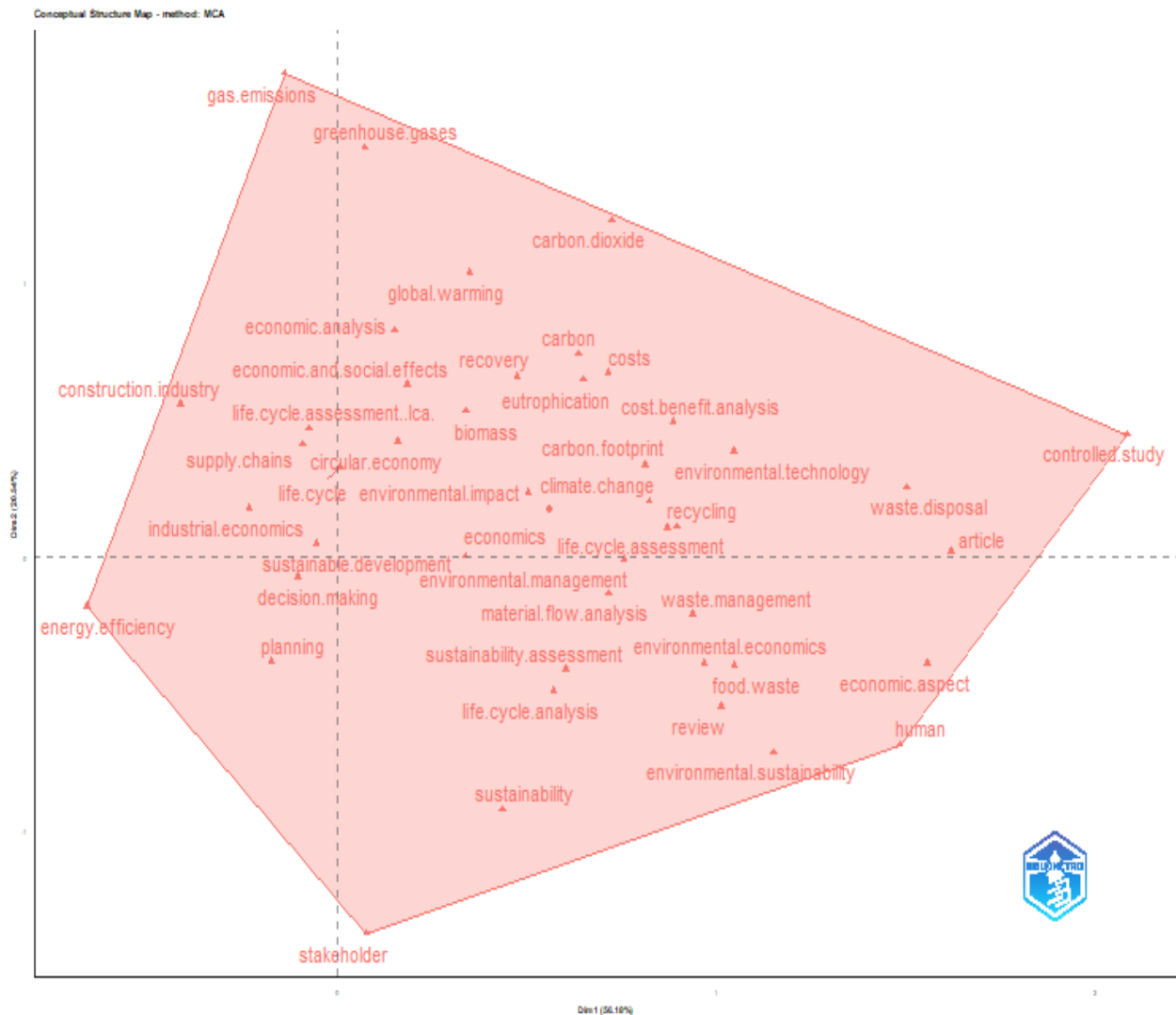


Source: Author's elaboration

Figure 7 indicates waste management (56.1%), life cycle (33.8%) and circular economy (29.6%) intersects with higher centrality. Whereas publications on life cycle (31.9%), sustainable development (40%) and circular economy (36.8%) are given high impact and centrality, thus it is important for the global, regional as well as national policies to develop and implement circular economies that considers the three sustainability pillars at hand.

The paper illustrates the dendrogram research strands including life cycle assessment, global warming, sustainable development, sustainability assessment, energy efficiency which all have positive or negative impact on stakeholders. Fig. 8 displays the dominant research strands for sustainability assessment including environmental, economic and social aspects for sustainability of major sectors such as construction industry, energy, industries, etc.

Figure 8: Dendrogram research strands



Source: Author's elaboration

It is equally important to note that bibliometric analysis is a useful research methodology for studying relational and co-existence of knowledge such as circular economy and social life cycle analysis, which have not taken the attention of African scholars and researchers. This finding has relevance for increasing co-knowledge creation and collaborations between south and north and or south-south scholars. On the other hand, it is worth noting the high concentration of publications in the European Union as Chinese universities. The bibliometric analysis has also shown implication that circular economy and S-LCA are relatively new in African perspectives as they are still emerging areas. Universities and research and development institutions ought to engage to publish on these researchable topics in the established research strands.



Furthermore, the bibliometric analysis in this article shows that circular economy and social life cycle analysis have not taken the attention of African scholars and researchers. This finding has relevance for increasing co-knowledge creation and collaborations between south and north and or south-south scholars. This study implies that circular economy and S-LCA are relatively new in African perspectives as they are still emerging areas. Universities and research and development institutions ought to engage to publish on these researchable topics.

5. Conclusion and Policy Implications

The study results illustrate that CE assures not only the environment and economic sustainability but also social well-fare of actors in the value chain. This study observed paucity of S-LCA literature on Circular Economy in scientific journals. Following the limited publication, this study recommends for increasing articles of S-LCA on Circular Economy in the Sub-Saharan Africa (SSA), where industrialization is taking pace, environmental and economic concerns are of priority of academic and policy makers. Countries in the SSA face challenges of keeping and managing sustainable economic productivity, be it in the manufacturing, extractive industry or agriculture. The concept of circular economy provides potential solutions for addressing the multidimensional socio-environmental-economic challenge. The article contributes to both academic research and policy actions for undertaking the circular economy for the sustainable development in the Sub-Saharan Africa.

The increasing environmental and production ecosystems challenges call for policies that are promoting sustainable economic development, where production systems do not compromise with the current and economic growth of future generations. Scientists find new ways of production systems that make our ecological footprint compatible with global sustainability. The concept of the circular economy has brought relevant contributions to global sustainable development. The African researchers and scholars need to co-create knowledge and publications within the south-north as well as south-south collaborations.

This paper contributes to knowledge in many ways. First, by providing a bibliometric map of the CE publications and research in Africa, where we found none despite of the growing CE compared to European countries, Asia and Latin America. This is a challenge to African scientists and scholars to increase research and publication on CE, sustainability and social life cycle assessment. Our findings suggest that despite the increasing importance of Circular economy in Africa and the theoretical progress in scientific literature of sustainability and Social life cycle assessment, African scholars have not penetrated into the literature. As CE scholars accept the role of sustainability, governments and companies dealing with CE must uphold the pillars of sustainability.

While collaborative publications between south-south scholars and researchers is encouraged for the promoting implementation of CE practices, African scholars ought to take lead to inform policy decision making on CE and sustainability. The role of researchers is to generate scientific evidence to policy makers. This include the social life cycle assessment of CE long-term policies as well as the development of circular economy development framework. Since there is paucity of scientific research

and publication of CE and S-LCA in Africa, it is recommended for having co-knowledge creation between governments and academia whereby, the role of academia is to identify policies linked to a specific CE projects and conduct analysis for understanding and realizing providing informed solutions and recommendations to policy makers and implementation of sustainability policies tackling environmental challenges.

Conflict of Interest

I declare of not having any potential conflict of interest in the process from manuscript to publishing of this article.

Acknowledgements

This paper benefited from Funding provided by the German Federal Ministry of Education and Research to implement a capacity building for technology transfer in at Mzumbe University in Tanzania in partnership with RWTH Aachen University, Germany. We thank Institute of Sustainability in Civil Engineering, RWTH University for the knowledge and technology transfer that has contributed to the advancement of sustainability assessment methodology.

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