NIGERIAN JOURNAL OF PUBLIC SECTOR MANAGEMENT (NJPSM)

Circular Economy, Household Livelihood and Sustainable Development Goals in North-Western Geopolitical Zone: Evidence from Kaduna State, Nigeria

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Abstract

The study examines the relation among circular economy, household livelihood and selected Sustainable Development Goals (SDGS) in Northern Nigeria using Kaduna State as case study. The main instrument employed for data collection was structured questionnaire. Both descriptive and inferential statistics were used for analysis. The logistic regression model was employed to estimate the model. The findings of the study show that circular economy significantly influence household livelihood and SDGS positively and statistically significantly in influencing household livelihood and selected SDGs like poverty eradication, clean water and sanitation, life below water, life above land, and reasonable production. However, it is not significant in influencing affordable clean energy. Based on the findings the following suggestions are proffered: Providing sound regulatory and an effective enforcement mechanism of legislation can drive circular economy as a strategic tool for the progressive realization of sustainable development goals. The need for capacity building and skill acquisition to ensure appropriate skills are acquired to take advantage of circular economy activities through technical education drive is essential for sustainability. Government should come up with an action plan with a clear blue print on environmental awareness and circular economy business model with a view to promote sustainable household livelihood.

Keywords: circular economy, household, livelihood, SDGS
JEL Codes: P28, H31, R13, Q01

Introduction

Household livelihood depends so much on the environment. The human activities (economic and social) in their quest to satisfy various needs are exerting enormous pressure on the environment and sometimes against the nature. For instance, food and raw materials are extracted from the natural environment and throw back at nature the waste generated in the process especially the linear economy (LE) system. Though circular economy (CE) approach provides enormous opportunities to create jobs, and contribute to growth and development of the economy, certain outcomes according to Morseletto (2023) have implications for various forms of disasters, diseases and deaths (3Ds) especially in developing economies..

The United Nation concerns about sustainable development and environmental impact of linear approach to production and consumption, emphasized the need for renewed economic

approach that tackles poverty, does not deplete natural resources and protects the planet for future generations (Schroeder, Anggraeni and Weber, 2022). One of the approaches considered most appropriate to achieve this is to transform from LE system of development that is considered wasteful, to CE system that is not only economically viable but also minimizes waste and environment impact. The transformation requires take-make-dispose economic approach to a fundamental shift toward appropriate technologies, green marketplace, sustainable user-practices, and institutional arrangements that impact on production and consumption pattern, energy, cleaner jobs, or gender-friendly. Thereby addressing many Sustainable Development Goals (SDGs) (Shamsuyeva, and Endres, 2021).

Nigeria with a population of over 200 million people generates huge quantities of solid waste as a result of the take-use-dispose approach, which has been estimated to be more than 32 million tonnes yearly. Solid waste generated in Nigeria is composed of 43.43% food waste, 15.27% plastic, 7.76% paper, 1.39%textile, 3.36% wood, 0.081% rubber and leather, 2.02% metal, 2.39% glass and 24.18% others. However, less than 20% of the waste generated is collected through the formal system while less than 10% is recycled (NBS,2023). The rest of the waste ends up in open and unlined dump sites, water bodies, drainages, farmland, open spaces, etc. Burning of such wastes openly is also a common practice particularly at the dump sites where hazardous and non-hazardous wastes are co-disposed without any form of separation or segregation.

The North West is one of the geopolitical zones in Nigeria where Kaduna and Kano States serves as the industrial hubs. In the States, circular practices demonstrating waste reusing, repairs, redistributing, re-purposing, and recycling among households have long existed. Activities among family members such as waste conversion into something used for another purpose and waste bequeathing in which used materials like clothes, are passed down to other generations for reuse culturally takes place. However, aside waste pickers at homes, there are also ventures providing waste recycling and repairs services in communities across the states. These small enterprises are said to incentivize a network of households to collect, sort or repair used recyclable wastes as basic source of livelihood.

Therefore, this study seeks to examine the relation among circular economy, household livelihood and sustainable development goals in north-west geopolitical zone, drawing evidence from Kaduna State, Nigeria. To achieve this, the study is organized into 5 sections. Apart from section 1 which this part concludes, section 2 is literature review. Section 3 is methodology. Section 4 provides empirical analysis and discussion. Section 5 is conclusion and recommendations.

Literature Review

Conceptual Clarification

Circular economy is a new economic development approach that emerge within the context of sustainable development. It is geared aims toward increasing resource utilization, environmental efficiency and reducing the dependence of economic growth and development on natural resources (Anderson, 2007). It aims at protecting the environment and prevent pollution thereby, facilitating sustainable economic development (Mauss, Bühner, and Fottner, 2023). According to Ellen MacArthur Foundation (2015b) CE is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.

Hartley, van Santen, and Kirchherr (2020), conceived CE as a production and consumption system with minimal losses of materials and energy through extensive reuse, recycling, and recovery. It has been developed to balance the environmental burden of industrialized countries. Kircherr, Reike and Hekkert (2017) described circular economy as the realization of a closed loop material flow in the whole economic system. Added that CE is one that is restorative by design, and which aims to keep products, components and materials at their highest utility and value, at all times.

The definition used in this study is that circular economy is the re-circulation of material resources for new or improved product that entails reduction, reuse, recycling and repair activities. The framework is depicted in Figure 1b.

On the other hand, Sen (1985) defined livelihood in its simplest term as a means of gaining a living. Similarly, Scoonest (Soonest 2015, 1998) defined livelihood as comprising of the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. A living is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (see figure 2).

Therefore, household livelihood as conceptualize in the study connotes capabilities, assets and activities required for a means of living by households (Soonest, 2009) using circular economy that include waste management; material production; products repair, recycle and reuse. .

Theoretical Review and Framework

The theory of cradle-to-cradle was expended by the works of Bouton, Hannon, Rogers, Swartz, Johnson, Gold, and Staples (2016). The theory enlightened on how to conserve the environment in the face of increasing human population and activities that degrade natural

resources and ecosystem. The theory is a philosophy and way of life that focused on responsible production and consumption which keep production material into continuous cycle with the aim of protecting the environment and improving the quality of human life in such a way that generations to come would continue to enjoy incessant pleasurable quality of life.

The theory emphasized circular economy as an alternative to the traditional linear economy (make, use, dispose) in which resources are kept in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (Milena, Vladimir, Milana, and Imre, 2023; Fellner and Lederer). It is a system that makes effective use of resources and addresses mounting resource-related challenges for business and economies with good prospects to generate growth, create jobs, and reduce environmental impacts, including carbon emissions.

The CE consists of the principles of 3Rs (reduction, reusing, and recycling) (Cecchin, Salomone, Deutz, Raggi, and Cutaia, 2021), and the extended model 6Rs (reusing, recycling, redesign, re-manufacturing, reduction, recovering) (Puntillo (2023). The main building blocks of the CE goes beyond just product design. In designing a circular product, the principles to be considered are durability (extended life), ease of maintenance and repair, ease of disassembly or reassembly, potential for up-cycling and re-purposing, material separation and recovery (Garcia-Saravia, Ortiz-de-Montellano, and van der Meer, 2022; Abad, Avila, Vicent and Font, 2019).

The linear economy model is about take, make, and dispose in the process of production, consumption and disposing wastage (Figure 1a). Aside from polluting the environment, linear model results in huge waste and inefficient use of resources. Th CE describes a method to manage resource circularity, efficiency, and optimization that advocates the use of wastes as resources to generate value (Omar and Romdhana, 2023). The model involves production, consumption, dispose of wastage to recycle it for further production (Figure 1b). it is governed mainly by Recycling, Reduce and Reuse (3Rs) concept (Atalay-Onur, 2020). Thus, the circular economy (CE) model is one of the most environmentally friendly and sustainable development ways ((Khajuria, Atienza, Chavanich, Henning, Islam, Kral, and Li, 2022).

a) Linear Economy Model

b) Circular Economy Model

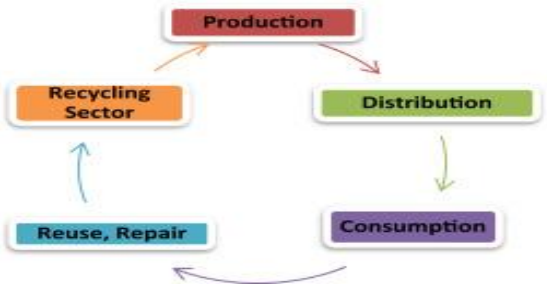

Figure 1(a &b). Linear and circular economy models respectively.

It has been expanded to the 7 value retention stages (VRS) of (i) reduce; (ii) regenerate; (iii) use, reuse and re-sell; (iv) repair, refurbish and re-manufacture; (v) recycle; (vi) recover; (vii) recirculate (Garcia-Saravia Ortiz-de-Montellano and van der Meer, 2022). therefore, CE seek to extend the useful life of the product, but also favors the possibility of repair, refurbishment and reuse of products before their actual end-of-life.

The CE practice can be related to some of the SDG goals including SDG-6 (clean water and sanitation), SDG-7 (affordable clean energy), SDG-12 (reasonable consumption and production), and SDG-15 (life on land) (Haga, 2023). It can result in resource efficiency, improve use and reduce pressure on natural environment. By achieving SDG 12, progress on climate mitigation and environmental goals such as SDG 14 (life below water) and SDG 15 (life on land) including cleaning water and sanitation, clean energy can be achieved too (Neumann, Petranikova, Meeus, Gamarra, Younesi, Winter, and Nowak, 2022).

Furthermore, CE has potential impact for household livelihoods. It promotes resource efficiency by making better use of finite resources like forests, soil, water, air, metals, or minerals (Govind, Anamika, Nirali, and Navnath, 2022). It provides economic opportunities by avoiding waste and creating new employment opportunities. It reduces environmental impact through reuse, recycle and design products for longevity. It has social benefits such as job creation, improved health, and better living conditions.

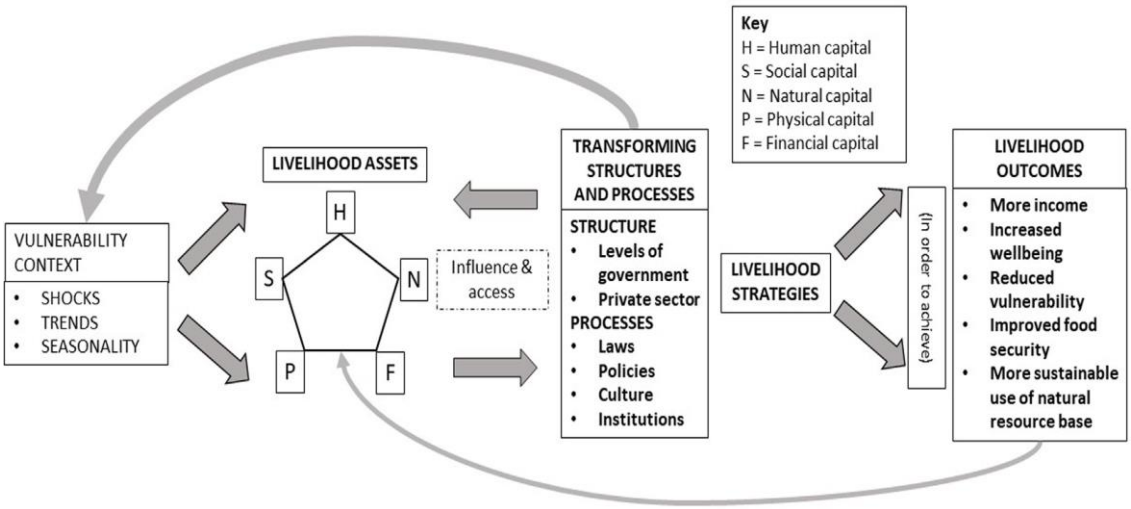

Figure 2: Household livelihoods Framework (Adopted from Soonest, 2015).

Empirical Review

There are studies on the effect of circular economy on livelihood. Naila, Kazi, Saira, Jamaliah and Nor (2024) analyzed the effects of four categories of circular economy including renewable energy consumption, recycle, reuse, and repair on human development in Germany using time series data covering the period 1990-2021. The study used dynamic ARDL simulation technique for empirical analysis. The findings show that renewable energy consumption has positive and significant impact on human development, reuse and recycle have an inverse and significant influence on human development. The control variables, environmental tax and industrial employment have negative impacts on human development.

Cris, Ortiz-de-Montellano, Pouya and van der Meer (2023) analyzed the impact of 27 circularity strategies on each of the 17 SDGs and their associated 169 targets. The results suggest that circular economy strategies can contribute to all SDGs, but most effectively to SDGs 8, 12, and 13, and least to SDGs 4, 5, 10, and 16. Similarly, Haga (2023) estimated the impact of CE on sustainable development in Qatar and Kuwait using multiple regression analysis. The findings indicate that awareness on CE is not sufficient to spur activities in the sector. The findings implies that the betterment of law-and-order situations in the community is required and awareness campaigns and tactics should be focused on.

Abayomi and Ayo-Balogun (2023) examined the relation between CE and sustainable development in Nigeria using regression analysis. The result revealed a significant positive relationship between recycling activities and sustainable development. Govind, Anamika, Nirali, and Navnath (2022) assessed an integrated rural livestock development project on CE in rural India. The results indicate the important of blended traditional and modern practices in livestock keeping along with biomass management through appropriate technologies conjoined with green value chain-based enterprises for monetizable incentive.

Nithya, Andrew, Jonathan, and Suhardiman (2022) investigated sustainable livelihoods framework effectiveness in the 21st century. The study found that foregrounding a structural, spatially-disaggregated, dynamic and ecologically-coherent approach to framing rural livelihoods are important. Similarly, David, de Quevedo, Pérez-Cornejo, and Thomas (2022) analyzed the effect of CE on three dimensions of sustainable development (economic, social and environmental) at the country level. Panel data analysis was used covering 25 European economies for the period 2010-2019. The findings show CE has positive effects on the economy, environment and society though the impact varies according to CE value source on three sustainable development dimensions.

Rodriguez-Anton, Luis, Soledad, and Soraya (2022) analyzed the interaction between CE and SDGs in the context of 2030 Agenda and European CE strategy using correlation and and cluster analysis. The findings show that there is significant relationship between CE and SDGs in the EU and the behaviour of European economies is not homogeneous. Furthermore, Adam and Soloducho-Pelc (2022) assessed the impact of circular economy on green jobs creation using environmental goods and services sector among 28 European Union economies covering the period 2009–2019. Linear multiple regression approach was used for data analysis. The results indicate that CE supports the achievement of SDGs especially green jobs.

Methodology

Research design

The study employed survey research design which provides for a probability statistical inference that is largely representative in nature. A sample of respondents from the population of study was selected and standardized research instrument that is, structured questionnaire was administered. The study is a post-ante and a survey in nature. It used both descriptive and inferential statistics.

Population and sample of the study

The population of the study consist of formal and informal operators in the circular economy in Kaduna State who are engaged in various forms of circular economic activities including recycle, reuse and repairs in Kaduna metropolis.

Based on this population, a normal confidence level of 95% and error tolerance of 5% were used. We therefore will determine the sample size using adjusted Taro Yamane's) formula (Yamane, 1967):

Taro Yamane's formula is given as:

$$n = \frac{N}{3 + N(e)^2} \quad 1$$

Where n is sample size; N is study population; e is error of tolerance i.e. given as 5% or 0.05; 3 is statistical constant. From the formula where the population of the study is given and confidence interval of 95%, the sample size is approximately four hundred and five (315).

Instrument and Data Collection Method

The field survey was conducted using the Circular Economy Performance Evaluation Questionnaire (SEPEQ) as a major instrument used to gather data. It is designed to generate responses on questions relating to relevant variables including reuse, recycle and repairs of products, and challenges circular economy. The data obtained through the use of structured questionnaire. Structured questionnaire designed to provide demographic characteristics of the respondents, circular economy and related activities and challenges in the study area. Hence, the primary source provides mainly qualitative data (primary data). The secondary source on the other hand, will provide information using existing information or data derived through review of related literature.

Sampling Technique

A cluster and purposive sampling techniques was used for the study. The choice of the sampling approach is based on the nature of the study that relates to circular economy activities in Kaduna metropolis (Kaduna North and Kaduna South Local Government Areas covering sectors like agriculture or agricultural processing, building and construction, manufacturing, information and communication (ICT), textile and garments, etc. And its impact on household livelihood

Reliability and validity

Measurement data were obtained by using structured questionnaire. Each object is calculated on a 5-point Likert scale, with 5 strongly in agreement and 1 strong in disagreement. The exploratory factor analysis (EFA) of the items was confirmed using confirmatory factor analysis (CFA). The CFA model's factor loadings shows that each is statistically significant (p value $<$ 0.05). These are representative of the underlying latent construct of the items. This shows that the model meets the convergent validity (Anderson, 2007; Anderson and Gerbing, 1988). The Cronbach's alpha (Cronbach, 1951) composite reliability (CR) of each construct was examined with CR values of all constructs greater than 0.70 (threshold) as recommended by (Hair. Anderson, Babin, and Black, 2010).

Method of Data Analysis

The study will employ both descriptive and inferential statistical tool of analysis. The descriptive statistics describe the statistical characteristics of the variables. The variables were specified and analyzed using logistic model. This technique help in determining whether relationship exists among circular economy variables, household livelihood and SDGs. The descriptive tools will use tables, frequency distribution, and percentage while inferential statistics employed STATA for estimation of logistic model (Creswell and Creswell, 2017).

Model specification

The theoretical and analytical framework adopted for the study is guided by the capability theory where households are empowered to exit poverty trap. The model used in the study by David, de Quevedo, Perez-Cornejo and Thomas (2022) on the effect of CE on sustainable development indicators in 25 European economies was adapted for our study. The model is of the form:

$$HOLV = \beta_0 + \beta_1 REUS + \beta_2 RECY + \beta_3 REPA + \ldots.. + U_1 \quad 1$$

Equation 1 denotes the model for effect of circular economy on livelihood, while equation two specified the effect on SDGs. Specifically, the SDGs variables include SDG 1 (eradicate poverty); SDG 6 (clean water and sanitation); SDG 7 (affordable clean energy); SDG 14 (life below water); SDG 15 (life on land); and SDG 16 (reasonable production and consumption).

$$SGDs = \beta_0 + \beta_1 REUS + \beta_2 RECY + \beta_3 REPA + \ldots.. + U_2 \quad 2$$

The study employed logistic regression analysis to estimate the model. The a priori expectation is such that reuse (RUS); recycle (RCY); repairs (REP), reduce (RED) are expected to positively influence livelihood and SDGs indicators positively. .

Empirical Analysis and Discussion of Findings

Descriptive statistics

Table 1 provides descriptive statistics of the variables. For instance, household livelihood and SDGS indicators. HLV has a mean of 0.082 with minimum of 0.028 and maximum of 0.963. The poverty (POV) has mean of 0.169, minimum of 0.013 and maximum of 0.802. Clean water and sanitation (CWS) has mean of 0.125, minimum of 0.976 and maximum of 1.009. The variable of life on land (LOL) indicates a mean of 1.201, while reasonable production and consumption (RPC) shows a mean of 0.532, standard deviation of 0.217. The total number of observations are 315.

Table 1: Descriptive statistics

Variables	Observations	Mean	Std Deviation	Minimum	Maximum
HLV	*315*	*0. 072*	*0. 529*	*0. 028*	*0. 963*
POV	*315*	*0. 169*	*0. 104*	*0. 013*	*0. 802*
CWS	*315*	*0. 125*	*1. 718*	*0. 976*	*1. 009*
ACE	*315*	*0. 306*	*0. 583*	*0. 300*	*1. 484*
LBH	*315*	*0. 926*	*0. 570*	*0. 182*	*1. 004*
LOL	*315*	*1. 201*	*1. 133*	*0. 210*	*1. 520*
RPC	*315*	*0. 532*	*0. 217*	*0. 028*	*0. 900*

Source: Computed by authors

Correlation Analysis

Table 2 provides the correlation analysis results. It shows that poverty (POV), clean water and sanitation (CWS), life below water (LBW), and life on ;and (LOL) are negatively correlates

with circular economy activities. However, affordable clean energy (ACE) and reasonable production and consumption (RPC) positively correlates with circular economy.

Table 2: Correlation Analysis

Variable	*HLV*	*POV*	*CWS*	*ACE*	*LBH*	*LOL*	*RPC*
HLV	*0.0000*						
POV	*0.0034*	*0.0000*					
CWS	*0.0172*	*1.6384*	*0.0000*				
ACE	*-2.6430*	*-0.8812*	*4.2946*	*0.0000*			
LBH	*1.9052*	*0.4078*	*-1.9793*	*2.3186*	*0.0000*		
LOL	*0.8961*	*3.4265*	*-2.3910*	*0.3785*	*-0.0324*	*0.0000*	
RPC	*-0.6770*	*-3.1166*	*1.2949*	*1.4748*	*-0.0099*	*1.8635*	*0.0000*

Source: Author's computation

Correlation Random Effect – Hausman Test

Table 3 presents the outcome of the Hausman test, employed to make a decision regarding the choice between random effects (RE) and fixed effects (FE) estimation results. Hausman test hypothesis for fixed and random effects states that if p-value < 5%, then use FE, if p-value > 5% then use RE. The p-value of 1.000 from the table exceeds the predetermined level of significance of 0.05. Therefore, the null hypothesis (H_0) that the random effect is appropriate for this model is accepted. The estimation of the model was conducted using a random effects approach, as indicated. Consequently, the random effects method was employed, and the outcome of the regression estimation is presented in Table 4.

Table 3: Correlated random effects - Hausman Test

Correlated Random Effects - Hausman Test				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		0.000	7	1.000
Cross-section random effects test comparisons:				
Variable	*Fixed*	*Random*	*Var(Diff.)*	*Prob.*
HLV	*-0.108*	*0.086*	*0.005*	*0.006*
POV	*-0.144*	*-0.208*	*0.003*	*0.288*
CWS	*0.23*	*0.292*	*0.004*	*0.336*
ACE	*-0.937*	*-1.050*	*0.006*	*0.170*
LBH	*0.6149*	*0.4518*	*1.3610*	*0.1886*
LOL	*0.3696*	*0.0940*	*3.9307*	*0.0008*
RPC	*-0.0279*	*0.0313*	*-0.8731*	*0.4080*

Source: Author's computation from STATA output, 2025

Random Effect Regression Model Estimates

The result of the random effect regression is presented in Table 4. The constant term (C) with coefficient value of 16.73 and t-statistic value of 0.941 shows it is not statistical significance ($p > 0.05$). The coefficient associated with household livelihood (HLV) is 0.89 and significant, suggesting that an increase in circular economy activities by 1% can influence household livelihood by 0.89%. This finding is supported by Mileno, Vladimir and Imrre (2023); and Nithya, Andrew, Jonathan and Suhardiman (2022).

Table 4: Random effect regression model estimates

Cross-section random effects test equation:				
Dependent Variable: HLV				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	*16.728*	*17.759*	*0.941*	*0.348*
HLV	*0.895*	*0.411*	*2.177*	*0.043*
POV	*1.922*	*0.530*	*3.627*	*0.008*
CWS	*0.842*	*0.349*	*2.412*	*0.038*
ACE	*-1.325*	*1.323*	*-1.002*	*0.104*
LBH	*0.116*	*0.066*	*1.960*	*0.063*
LOL	*-0.239*	*0.103*	*-2.318*	*0.0042*
RPC	*0.502*	*0.218*	*2.211*	*0.050*
	Effects Specification			
R-squared	*0.885*	*Mean dependent var*		*11.295*
Adjusted R-squared	*0.714*	*S.D. dependent var*		*14.402*
F-statistic	*13.089*	*Durbin-Watson stat*		*1.931*
Prob(F-statistic)	*0.000*			

Source: Author's computation from STATA output, 2025

Furthermore, poverty, and clean water and sanitation are also positive. The findings are supported by Zhuang, Shih and Wagin (2023); Puntillo (2023); and David, de Quevedo, Perez-Cornejo and Thomas (2022). life below water and life on land are also significant though negative. The findings is supported by Adam and Soloducho-Pele (2022); and Schoeder, Aggraeni and Weber (2022). Reasonable production and consumption is significant and supported by the findings of Omar and Romdhana (2023); and Mauss, Bulner and Fottner (2023).

Conclusion and Recommendations

The study examines the relation among circular economy, household livelihood and selected Sustainable Development Goals (SDGS) in Northern Nigeria using Kaduna State as case study. The main instrument employed for data collection was structured questionnaire. Both descriptive and inferential statistics were used for analysis. The logistic regression model was employed to estimate the model.

The findings of the study show that circular economy significantly influence household livelihood and SDGS positively and statistically significantly in influencing household livelihood and selected SDGs like poverty eradication, clean water and sanitation, life below water, life above land, and reasobale production. However, it is not significant in influencing affordable clean energy. Based on the findings the following suggestions are proffered: Providing sound regulatory and an effective enforcement mechanism of legislation can drive circular economy as a strategic tool for the progressive realization of sustainable development goals. The need for capacity building and skill acquisition to ensure appropriate skills are acquired to take advantage of circular economy activities through technical education drive is essential for sustainability. Government should come up with an action plan with a clear blue print on environmental awareness and circular economy business model with a view to promote sustainable household livelihood.

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