Pathways to Sustainability: How China's Belt and Road Initiative is Shaping Responsible Production and Consumption in Africa

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Abstract

Africa faces significant economic and environmental challenges, including waste generation, food insecurity, and energy inefficiency, jeopardizing future generations. To address this, Africa has adopted the ten-year Sustainable Consumption and Production Framework for Africa (10-YFP), evident through national and local projects focusing on sustainable food and agriculture, technology transfer in water irrigation, and related initiatives. The Belt and Road Initiative (BRI) presents an opportunity for promoting green cooperation and sustainable development in Africa, though its impact on ethical production and consumption remains unexplored. This study evaluates the BRI's role in achieving Africa's Twelve Sustainable Development Goals (SDGs) and catalyzing responsible consumption and production. Through interviews and Focus Group Discussions (FGDs) involving 42 participants from 19 African countries, thematic patterns emerged using the Thematic Inductive method. Findings indicate that BRI initiatives effectively integrate advanced technologies to enhance sustainable agriculture and industrial production. Notably, BRI investments in countries like Morocco, Algeria, Ethiopia, Kenya, and Zambia are fostering renewable energy projects to provide electricity to underserved communities. A stronger alignment between national sustainable development plans and the green BRI is essential to maximize the benefits without compromising BRI principles of inclusivity, coordination, coherence, and capacity building. This research fosters dialogue among academics, educators, government officials, business leaders, and investors about the transformative potential of China's BRI in African nations. By shedding light on the positive strides made by BRI programs, this study underscores the need for strategic synergy between international cooperation efforts and localized sustainability agendas, ultimately propelling Africa toward its long-term development goals.

Keywords: *Belt and Road Initiative (BRI), Sustainable Consumption and Production (SCP), United Nations, 10-Year Framework Programme (10-YFP), Sustainable Development.*

1. Introduction

Global consumption and production patterns form part of the fundamental driving forces of the worldwide economy (United Nations, 2020), which relies mainly on the number of goods and services produced, fueled by natural resources (United Nations, 2021). Although, the production and consumption of goods and services are essential contributors to environmental and social impact (human survival). Mismanagement and depletion of global natural resources by individuals and enormous organizations are staggering in many parts of the world. On the contrary, setting standards and assessing the environmental impact of producing and consuming goods and services is a fundamental step towards achieving Sustainable Development Goal (SDG) 12 (United Nations, 2022).

As the population of Africa is expanding, the continuous pressure of heavily relying on the use of the natural environment and resources is inevitable. Unfortunately, the negative impact is reflected in continuous restructuring on the use of natural resources (United Nations, 2022). According to the United Nations (UN) (2021), environmental degradation, including deforestation, mining, the production of industrial waste, and carbon emissions into the atmosphere, endangers the very systems that development and survival depend on. This has been the case in many developing African countries over the past century. This emphasizes the growing importance of observing and ensuring the continuous practice of 'Sustainable consumption and production' to preserve our natural ecosystem.

According to the United Nations (2015), "Sustainable consumption and production" means fostering resource and energy efficiency, sustainable infrastructure, ensuring access to essential services, creating green and decent jobs, and improving everyone's quality of life. By strengthening economic competitiveness, lowering future economic, environmental, and social costs, and reducing poverty, its implementation helps to realize overall development plans. Sustainable development is centered on shifting towards more SCP, which requires international cooperation. African leaders at the Johannesburg Summit in 2002 recognized this. They called for creating a 10-YFP to support local, state, and federal initiatives to hasten the transition to the SCP pattern, which would encourage social and economic development while maintaining ecosystem health.

With the continued contribution to ensuring Africa achieves its SCP target by integrating the 10-YEP, this study's direction is significant. It opens a different dimension of China-Africa's economic development through industrialization that aligns with SCP measures. Recently, the Belt and Road Initiative (BRI) presented an opportunity to advance ecofriendly collaboration and sustainable development in African countries (Lewis et al., 2021; CCICED, 2019). Conversely, how China's BRI can influence Sustainable Consumption and Production in African countries is unknown. Therefore, this study aims to assess the contribution that the BRI has made to achieving Africa's twelve Sustainable Development Goals (SDGs). The report encourages debates about how China's BRI might modernize ethical production and consumption in African nations among academics, educators, businesses, and government representatives. The report also emphasizes how crucial China's BRI strategy is to attaining success in economic growth and examines whether BRI implementation is consistent with the SDGs.

1.1 Africa 10-YFP and SCP

In terms of SCP implementation, Africa is at the forefront. The Ten-Year Framework Program on Sustainable Consumption and Production (SCP) for Africa was introduced as a sign of commitment to SCP implementation on the continent. The group has drawn attention to the significance of SCP in achieving sustainable development in Africa due to the emergence of national and local SCP programs in many African nations. For instance, Partnership is essential for achieving sustainable development and reducing poverty in Africa, as evidenced by the Marrakesh Task Force for Cooperation with Africa's support for PCD in the region (United Nations, 2015).

An updated overview of sustainable production and consumption activities in Africa over the previous ten years is provided in this publication. Most of these initiatives were under the African 10-Year Plan for SCP. The adoption of the Global 10-YEP on SCP at Rio+20 will create a platform to increase collaboration and support for the implementation of SCP models through existing regional initiatives, including the creation of the African Framework Program with the Belt and Road Initiatives (BRI) (United Nations, 2015; 2020).

Considering the Belt and Road Initiative's impact on the environment, society, and economy, very little emerging research has begun exploring the role of BRI ambitions in realizing SDG 12: Sustainable Consumption and Production (SCP) since the launch of the 2030 Agenda for Sustainable Development in 2015 (Cao, 2019). With rapid population growth, Africa is the most affected if adequate enforcement of policies is not correctly structured (United Nations, 2015). BRI's commitment to Africa is a positive mission; however, evaluating the role of BRI projects and ensuring that the activities align with critical environmental and economic indicators such as water efficiency, industrial waste management, energy consumption, and food production is essential to build a sustainable global economy (United Nation, 2022).

1.2 Objectives of the Research

This study aims to assess the perception of integrating advanced technologies in BRI projects on sustainable consumption and production. Therefore, to address the stakeholder needs for a sustainable future, equalizing economic, social, and environmental development.

1.3 Contribution of the Research

This study aims to make several contributions. This study contributes to progressing research on analysis to support the assessment of 2030 SDG 12 targets for sustainable consumption and production. This study contributes significantly to the literature with insights into environmental perceptions of sustainable consumption behaviors and the difficulties that influence sustainable consumption behaviors. This study explores current literature beyond economic growth and the contribution of energy efficiency to sustainability. This paper synthesizes insights into the challenge of sustainable consumption for effective policies contributing to demand-side carbon emissions reductions, such as regulation, prohibition, taxation, and infrastructure. This study

contributes to progressing research on renewable energy and sustainability by achieving sustainable consumption and production goals and the main measures in BRI countries.

2. Literature Review

Africa, the Persian Gulf, and the Middle East have all seen increased BRI investments from China. China accounted for 17.5% of all imports into Africa in 2016, making it the continent's top exporter. More than 10,000 Chinese-owned businesses were already active in Africa by the middle of 2017. Between 2001 and 2018, China's loans to African nations ($126 billion) exceeded its foreign direct investments ($41 billion). As a result, China's and African nations' political positions became more aligned. Between 2007 and 2020, $23 billion was invested in infrastructure projects in Africa by China's two central overseas development banks. Thus, the World Bank, African Development Bank, United States International Development Finance Corporation, and European Development Banks (United Nations, 2021) have a combined total of $8 billion less than the top eight lenders. It is interesting to note that only Iran, Laos, Pakistan and Venezuela are among the nations classified high country risk loans (see Figure 1). A few findings (Jin et al., 2023; Deng et al., 2022) have revealed that one major issue with BRI-Africa is the nature of loans provided by China to African countries. Thus, China often extends loans to these countries with higher interest rates, which they struggle to repay debt, leading to a cycle of debt dependency. Unfortunately, several African countries have indeed defaulted on their loan obligations, and there have been instances where they have had to renegotiate terms or seek debt relief.

The core elements of China's relationship with Africa in terms of development are trade, investment, and technical support for achieving sustainable development goals. Thanks to its dedication, China has been Africa's top trading partner since 2009. For Africa to achieve the SDGs and Agenda 2063 of the African Union, high-quality infrastructure must be provided. Increasing economic productivity and long-term economic growth are dependent on infrastructure. As one of the least developed continents in the world in terms of transportation, technology, electrification, communications, and sustainable agriculture, Africa has long been recognized as needing infrastructure and sustainable consumption and production. According to the African Development Bank, the continent's infrastructure helps it meet its 10-YEP on SCP needs, estimated to be between $130 and $170 billion annually, with a financing gap of between $68 and 108 billion. This gap represents the disparity between the available funds and the funds needed to support sustainable consumption and production practices across the continent. Therefore, bridging the financing gap is essential to ensure that Africa can invest in the necessary infrastructure projects that facilitate SCP practices (United Nations, 2022).

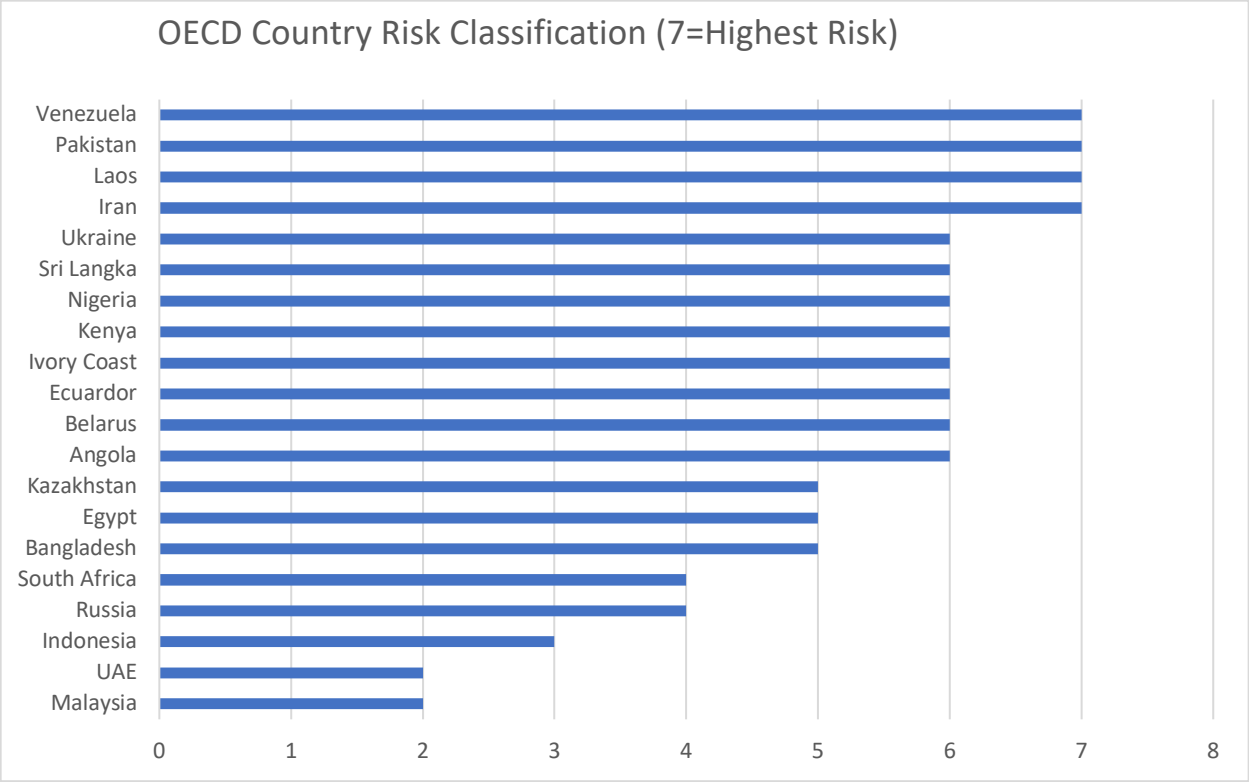

Figure 1. China's High-Risk Loans
Source: Adopted from United Nations (2021).

"Sustainable Consumption and Production" refers to a holistic approach that aims to minimize the negative impacts of consumption and production processes on the environment, society, and economy. It involves resource efficiency, minimizing waste, and promoting responsible consumption patterns (Wan et al., 2022; Khan et al., 2019). Interestingly, very limited studies have highlighted that the BRI project's focus on encouraging the adoption of SCP is still new. In contrast, numerous studies and literature have highlighted that the impact of BRI is mainly on infrastructure development (Khan et al., 2019). Doing more and better with less is how SCP is defined by the United Nations (2020). It also aims to promote sustainable lifestyles, improve resource efficiency, and uncouple economic growth from environmental deterioration. The United Nations (2021) emphasized in separate reports that efforts to achieve the 12th SDG (sustainable consumption and production) could significantly contribute to the reduction of poverty and the shift to low-carbon and green economies. China announced plans to start an infrastructure connectivity initiative at the Johannesburg summit. The initiative will be centered on a China-Africa infrastructure cooperation plan with the African Union (Sharif et al., 2019).

Despite the China-Africa BRI projects' ambitious goals, several developments have faced challenges and fallen short at different stages of project execution. The initiative, which aims to foster economic cooperation and infrastructure development between China and African countries, has encountered obstacles that have hindered the successful implementation of certain projects. For example, in nations like Zambia and Sierra Leone, the failure of some infrastructure projects financed by China failed numerous local businesses (Shinn, 2023; Sharif et al., 2020). The Chinese government has successfully established several Chinese companies through the BRI to strengthen

cooperation on energy, transport, information, telecommunications, and cross-border water resources. These companies will build infrastructure through investment-construction-operation and concentrate on crucial connectivity projects that ensure the transfer of technology capabilities to help increase industrial output. Consequently, carbon emissions, chemical exposure, and waste management are all reduced. Significantly, Chinese firms have erected ports, manufacturing facilities, industrial parks, and railroads in countries like Tanzania, Ethiopia, Kenya, Djibouti, Nigeria, and Kenya (CCICED, 2019).

According to the United Nations, BRI's mission towards global development is significant and the right course to push poor and developing countries out of extreme poverty. However, discussions about the BRI mission in Africa have been questioned. Some challenges to BRI implementation include China's struggle to balance or compromise its primary ambition for African economic development and sustainable growth (United Nations, 2020). There are doubts surrounding the effectiveness of China-Africa cooperation in achieving the 10-YEP on SCP due to certain objectionable actions carried out by some Chinese institutions operating in Africa. These actions have resulted in direct environmental consequences and raised concerns about sustainable development practices in the region (Deng et al., 2022; Bai et al., 2021). Chinese institutions have been involved in activities that directly impact the environment, leading to negative consequences such as deforestation, habitat destruction, carbon emissions, and ecosystem disruption.

These actions run counter to the goals of SCP (Sharif et al., 2022; Sharif et al., 2020). The BRI's ultimate mission is to continually focus on expanding economic development through sustainability. Their commitment is driving economic forces in African society. Still, the lack of adequate policies to support China's commitment to building resilient economies based on SCP is the fundamental challenge to ensuring that Africa achieves its 10-YFP on SCP. Moreover, implementing ambitious BRI infrastructure projects faced significant management and operational challenges due to Africa's lack of skilled workers (United Nations, 2021). However, for many, China-Africa cooperation on economic growth targeting infrastructure and environmental development has positioned most African countries towards economic redemption (Lewis et al., 2021; CCICED, 2019). Several strategies and policies have been designed to promote SCP, e.g., the management of waste pollution that comes with industrial development. Hence, the outcomes of such policy implementation are yet to be realized in most African countries. In response to these worrying developments on the continuous struggle to practice proper economic growth, the goal of establishing insightful research on this topic is of vital importance towards understanding the role of China's BRI on SCP implementation and providing economic and environmental measures to fulfill the 10-YFP agenda come 2030 (CCICED, 2019; United Nations, 2020).

3. Method & Materials

This study applied a qualitative research methodology involving individual and focus group discussion (FGD) interview sessions. The study targets a total of 50 interviewees from different parts of Africa, primarily focusing on countries with Belt and Road Initiative (BRI) projects backed by government policy and they have signed an MoU with China's BRI, implemented some BRI projects, or in the process of executing projects under the BRI programs. Algeria, Ivory Coast, Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, Tanzania, Tunisia, Uganda, Zambia, Anglo, Djibouti, Eritrea, Gambia, Namibia, Sudan, and Zimbabwe are among the 19 developing countries that fall into these categories. These countries fit the study scope because they all have MoUs with

China's BRI and have implemented BRI projects to boost infrastructure development (CCICED, 2019; United Nations, 2021).

The targeted research participants of this study are industry players holding various strategic roles (e.g., CEOs, managers, directors, entrepreneurs) whose actions and decisions influence the execution of BRI projects towards building sustainable consumption and production. The targeted participants also include academicians (like lecturers and researchers) whose research exploration and examination highlight new findings and directions in understanding the impact of BRI towards achieving the Sustainable Development Goal (SDG) 12. While some participants have direct or indirect experience and understanding of China's BRI infrastructure and economic development agenda in Africa, others have relevant research publications on the subject matter. In addition, most of the participants reside in the capital cities of their various countries. Therefore, they have insightful knowledge about the BRI and its impact on economic development.

3.1. Data Collection and Interview

This study adopted a purposive recruitment approach to gathering responses from the participants. The method is applied to target participants concerning their experience, knowledge, and qualifications in their respective areas of expertise. Participants selected to be part of the research have at least five years' experience in their knowledge and contribution towards sustainable development. Fifty potential participants from various African countries were searched for through social and academic platforms like LinkedIn, Twitter, Facebook, and corporate websites. Each of them is notified via email to be granted the chance to contribute to the research after properly assessing their profiles and credentials, and ensuring they meet the requirement to be part of the interview. Of the 50 individuals, 42 accepted the request to be part of the participants for the research. Therefore, these 42 individuals are also qualified to be part of the interview, given their geographical location. The participants were then organized (into face-to-face interviews and FGDs) to be part of the interview via Zoom application.

In the face-to-face interviews and FGDs, all interviewees were asked to share their insights and recommendations based on the interview questions. The interview process was conducted in separate sessions, with the first individual interview session consisting of 22 interviewees, followed by the FDG consisting of 20 interviewees. 1) Individual interviews involve an online "question and answer" session where the interviewee is asked a series of questions relating to the research, and their answers are recorded accordingly. Each person is given a maximum of 1 hour and a minimum of 30 minutes to complete a session. and 2) For the FGDs, interviewees were divided into four groups (5 people in each group) to discuss and argue each other's points constructively for two and a half hours. Individual interviews and FGD sessions were recorded as live programs. The acquired data was transcribed, examined, and then analyzed using inductive thematic analysis.

3.2. Interview Questions

This study created 19 interview questions, of which six focused on the participants' demographics, such as "Country of Origin?" "Enterprise/Company Name?" and "Position in the Company? ". The

remaining 13 questions directly relate to the connection between BRI initiatives and SDG 12 on sustainable consumption and production. The questions include, "How do China's BRI projects contribute to sustainable development, including reducing industrial waste and improving waste management?" and "How do China's BRI projects help BRI-Africa countries implement the 10-year sustainable consumption and production framework developed by the United Nations?"(see Table 2). Four senior academicians validated the research instrument to ensure consistency and reliability as part of the face-to-face validity test. The total number of questions was capped at 15 following a series of evaluations conducted under the guidance of four academicians from the same field of study (see Table 1). Regarding "Ethical Approval" for this research, all procedures carried out in the study involving human participants were in compliance with the institutional research committee's ethical standards. The research board members received the official application to request approval for the research, and the approval was given following the research standards.

Table 1. Interview Questions

Perspective	Questions (Selected)
BRI and Sustainable consumption and production	1. What do BRI infrastructure projects cover in your country?
	2. How will China's BRI projects help your country to implement the 10-year sustainable consumption and production framework developed by the United Nations?
	3. How will China's BRI projects speed up the progress of halving the per capita food waste in your country?
	4. How do China's BRI projects enhance the development of the responsible management of chemicals and waste in your country?
	5. How did China's BRI projects contribute to the development of your country's reduced waste generation substantially?
	6. How do China's BRI projects in your country encourage companies to adopt sustainable practices and sustainability reporting?
	7. How do China's BRI projects support your country's scientific and technological capacity for sustainable consumption and production?
	8. How do China's BRI projects help develop and implement your country's tools to monitor sustainable tourism?
	9. How are China's BRI projects contributing to reducing market distortions that encourage wasteful consumption in your country?

Source: Own adjustment

3.3 Inductive Thematic Analysis

This study employed an inductive thematic approach to conduct the qualitative data analysis. The application of this approach is particularly useful for this kind of exploratory research, where we seek to uncover new insights and identify indicators because of the significant impact of the Belt and Road Initiatives (BRI) on how it encourages and supports sustainable development. This qualitative approach is employed to discern and dissect patterns, themes, and underlying meanings within textual data. It is a powerful tool to unravel intricate phenomena and extract insightful revelations. To embark on this method, qualitative data is collected, ranging from interviews and focus group discussions to open-ended survey responses. This raw material is then meticulously transcribed and organized for systematic examination using ATLAS.it software. Firstly, the researchers engage in a thorough process of reading and re-reading the data, fostering a deep familiarity with its contents (Chetty, 2021). The data is meticulously segmented with the help of the software, with relevant portions identified in alignment with the interview request. These segments are assigned codes, functioning as markers for their core content. As the coding progresses, a clustering of similar codes emerges, forming preliminary themes. A critical stage involves a comprehensive review and refinement of themes, aligning them with the originally coded data. Each theme is meticulously described, enriched with illustrative examples extracted from the data, and clear and descriptive names are assigned to each theme, capturing their essence succinctly. A seamless integration of these themes into the research narrative follows, where their significance is explained in detail. Ultimately, the themes are contextualized within the broader scope of the research question and objectives, enriching the overall understanding of the phenomenon under investigation (Amenu-El, 2019).

4. Analytical Report

4.1 Demography Analysis

Forty-two out of the expected 50 responses were able to join interviews and FGDs. The reactions were acquired from individuals from 19 developing countries in Africa. Data distribution shows Algeria, Ivory Coast, Egypt, Ethiopia, Ghana, Morocco, Tunisia, Uganda, Zambia, Anglo, Djibouti, Eritrea, Cambia, Kenya, Namibia, Sudan, and Zimbabwe represent 4.5% of each response. Nigeria and Tanzania represent 9.1% and 13.6%, respectively (see Figure 2). 36.4% of the respondents were managing directors, 18.2% were managers of companies, 13.6% were CEOs from various renowned organizations, 27.1% were academic researchers, and 4.7 were industry experts (see Table 2). All respondents have direct and relevant knowledge about the impact of the Belt and Road Initiatives on the countries' efforts to fulfill sustainable consumption and production. In addition, respondents demonstrated sufficient insightful discussions concerning each interview question. The 42 responses are categorized into two sessions: 22 for individual interviewee sessions and 20 for focus group discussions (FGDs). Both interview sessions are in the form of discussions, questions, and answers sharing sessions. The responses were coded into theme categories using ATLAS software based on inductive analysis. During this study, the responses or answers from each interview question were transcribed and thematically coded, mainly dissecting the response and forming critical components based on the relevance and significant role the component plays in highlighting the link to the study's objective.

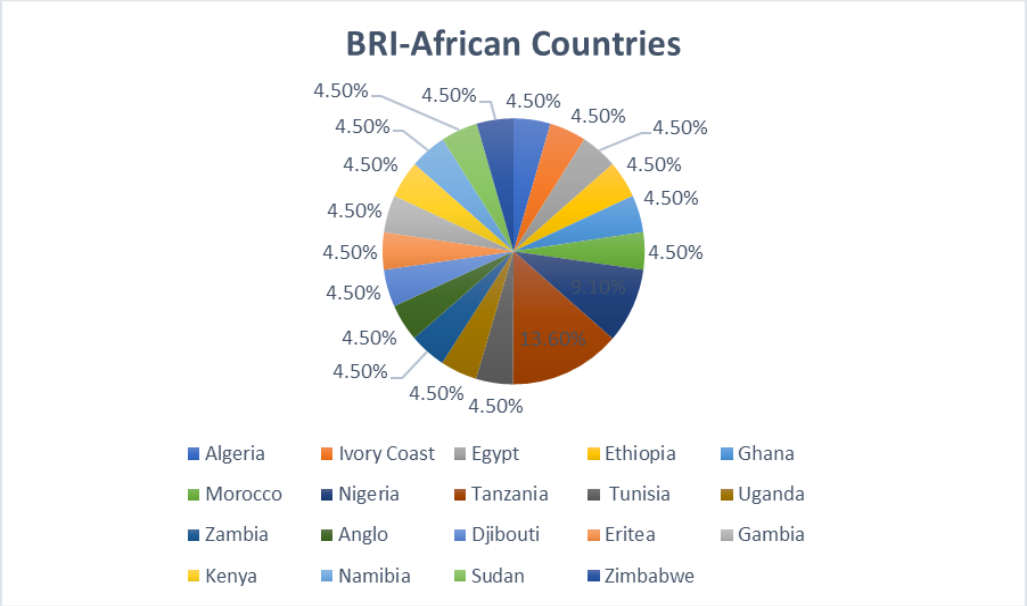

Figure 2. China's Belt and Road Initiatives – African Countries

Table 2: Demographic Profile of the Respondents

Demographic Variables	**Percentage (%)**	**Demographic Variables**	**Percentage (%)**
Age		*Education*	
35-45	49.8%	Bachelor's degree or equivalent	36.4%
46-50	18.6%	Master's degree or equivalent	36.4%
51-60	31.6%	Doctor of Philosophy (Ph.D./DBA)	22.7%
		Diploma	4.5%
Gender		*Profession*	
Male	59.1%	Managing Director	36.4%
Female	40.9%	Manager	18.2%
		CEO	13.6%
		Academic	27.1%
		Industry Expert	4.7%
Total:	**100%**		**100%**

Source: Analytical Report

4.2 Thematic Inductive Analysis

The data analysis process involves careful segmentation of the data, aligning it with the interview question and the study objective. Each segment is then assigned a code, essentially serving as a

label for its primary content. As the coding continues, similar codes start to cluster together, giving rise to the formation of themes to produce the analytical outcome. The result of the study is structured into ten themes derived directly from each question separately. These include: a) Theme 1: BRI impact on infrastructure development; b) Theme 2: BRI impact the 10-year SCP framework; c) Theme 3: BRI impact on halving the per capita food waste; d) Theme 4: BRI impact on the management of industrial chemical waste; e) Theme 5: BRI impact on substantially waste management; f) Theme 6: BRI impact on the adoption of sustainable practices and reporting; g) Theme 7: BRI impact on the scientific and technological capacity for SCP; h) Theme 8: BRI impact on the implementation of tools to monitor sustainable tourism; i) Theme 9: BRI impact on reducing market distortions that encourage wasteful consumption; and j) Theme 10: Challenges to Achieving Sustainable Consumption and Production (SCP). Therefore, Theme 10 highlights the countries' sustainable consumption and production challenges.

Based on theme 1: "BRI impact on infrastructure development," the result from the individual interview session reveals that all the participants reiterated "Transportation Facilities and Systems" as the main indicator, whereas the FGDs highlighted that 50% of individuals discussed "Technology Transfer" as the main indicator in terms of the impact of BRI on infrastructure development in the African countries. This is highlighted in the Submission as "*...a Chinese project in Algeria has already begun: the port of "Hamdania," located in the Tipasa gover norate, which is expected to become the largest port in Africa and the Mediterranean." {I5, Male, Algeria}. "…. A contribution from the Chinese government of $28 million was used in 2018 to build an Integrated Technology Training Centre (CINFOTEC) in the province of Huambo." {FGD1, P5} (see Table 3).* According to CCICED (2019) and Senadjki et al. (2022), the BRI has a significant impact on the development of transportation infrastructure, including roads, railways, ports, and airports, in African countries. The investment in these transportation projects aims to improve trade routes, enhance economic connectivity, and promote regional integration. By upgrading and expanding transportation networks, the BRI contributes to better access to markets, increased trade, and overall economic growth in participating African countries (Duodu & Mpuure, 2023). Apostolopoulou (2021) confirms that BRI projects, especially in the engineering space, facilitate the transfer of technology, expertise, and knowledge from more industrialized companies in China to African industry.

According to theme 2: "BRI impact on the 10-year SCP framework", 54.55% of the individual interview sessions reiterated "Renewable Energy Sources (Hydro, Wind, Solar)", and 22% of the FGDs reiterated "Recycling Industrial Wastes" as the main indicators concerning how China's BRI projects help African countries implement the 10-year sustainable consumption and production (SCP) framework. The interview submissions are captured as follows: *"China projects focus on strengthening the national power grid; Soubra Hydroelectric Dam, San Pedro Thermal Power Plan…."{I10, female, Ivory Coast} (see Table 3).* Although some BRI projects are executed in the area of sustainable energy generation, significant production and consumption of renewable energy have yet realized on the continent. The BRI has the potential to significantly impact infrastructure development in African countries by promoting the use of renewable energy sources such as hydroelectric, wind, and solar power. Many African countries have untapped hydroelectric potential. The BRI can facilitate the construction of hydroelectric dams and power plants, harnessing the energy from flowing water to generate electricity (United Nations, 2022). Some BRI companies help reduce pollution and the environmental impact of industrial processes by

recycling industrial waste to generate renewable energy and other usable plastic products. Therefore, by investing in recycling infrastructure, BRI can contribute to cleaner and healthier environments in African countries (Senadjki et al., 2022).

Based on theme 3: "BRI impact on halving the per capita food waste," 68.18% of the individual interview sessions reiterated "Farm-to-Market Transport connectivity", and 50% of the FGDs highlighted that the "Food Conservation System" is the main indicator concerning how China's BRI projects speedup the progress of halving the per capita food waste in your country. In the discussion, the following submissions were captured: *"Indeed, the construction of major transportation networks has made it possible for perishable goods such as agricultural products to reach markets and consumers early enough before they get worse and are wasted." {I3, Male, Tanzania} (see Table 3).* Senadjki et al. (2022) report confirms that the BRI projects have played a significant role in improving farm-to-market connectivity by investing in the development of roads, highways, and transportation networks in countries like Uganda, Zambia, Kenya, etc. These infrastructure projects economically reduce transportation bottlenecks, decrease transit times, and facilitate the movement of agricultural products from rural areas to urban markets. Moreover, according to Zhong et al. (2020), the BRI has aided in the construction of cold storage and refrigeration facilities around the African market. These facilities are crucial for preserving perishable agricultural products, reducing food waste, and extending the shelf life of goods.

According to theme 4: "BRI impact on the management of industrial chemicals waste," 86.36% of the individual interview session reiterated "Green Technologies Investments" as the key indicator that helps improve the African waste management process. And 50% of the FGDs highlighted that "R&D on Industrial Chemical Waste Management" is one of the main initiatives China's BRI projects are taking to enhance the development of the responsible management of chemicals and waste in Africa, especially in Egypt. In the discussion, the following submissions were captured: *"…. Farmers are partnering with Chinese investors to use green technologies that limit the use of harmful chemical inputs such as pesticides and fertilizers." {I8, Female, Egypt} (see Table 3).* Khan et al. (2022) emphasized that several projects under the BRI promote green technology investment, which fosters innovation through research and development. Other projects also promote the construction of green and sustainable buildings through investment in energy-efficient designs, materials, and technologies. This contributes to reducing energy consumption and promoting environmentally friendly construction practices. The establishment of engineering and scientific technology laboratories in some African countries supports R&D efforts to develop effective methods for managing industrial chemical waste. This includes safe disposal practices and advanced treatment technologies to prevent environmental contamination (Wang et al., 2020).

Based on theme 5: "BRI impact on substantial waste management," 59% of the individual interview sessions reiterated "Wastes Management Funding and Human Resources" as the key indicator that helps improve sustainable waste management in Africa by providing external financial resources in the form of loans. And 25% of the FGDs highlighted that "waste management technology" is one of the main initiatives China's BRI projects are introducing in the industry to enhance waste management practices using advanced technology in Africa, especially in Ivory Coast and Nigeria. In the discussion, the following submissions were captured: *"Some*

BRI projects determine to fund companies to convert the wasted food into biogas for energy through a process called fermentation…." {I10, female, Ivory Coast} (see Table 3). As part of the infrastructure investment by China in Africa, the BRI creates collaborations between the public and private sectors for waste management projects. The private sector's investments bring expertise, technology, and efficiency to enhance waste management practices (Abbas et al., 2020). Lewis et al. (2021) emphasize that such projects also support capacity-building programs to train local authorities and waste management professionals in modern waste management techniques. Besides, certain projects establish the capacity to adopt advanced waste treatment technologies, such as waste-to-energy systems, anaerobic digestion, and incineration with energy recovery.

According to theme 6: "BRI impact on the adoption of sustainable practices and reporting," 36.36% of the individual interview sessions reiterated "Integration of Sustainability Policy" as the key indicator that is helping to improve sustainable practices and reporting in Africa, which highlights the establishment of crucial sustainable policies to protect the ecosystem during the execution of the BRI projects. And 50% of the FGDs highlighted that "Business Technology Integration" is the significant technology transfer initiative China's BRI projects are introducing in the industry to enhance the application of technology in business production in African countries. In the discussion, the following submissions were captured: *"However, with the collaboration between China and Tanzania, the country is moving towards establishing regulations that will enforce such projects to reduce waste generation." {I2, Male, Tanzania} (see Table 3).* Previous studies (Abbas et al., 2020; United Nations, 2021; Chen et al., 2019) have shown that projects under BRI directly facilitate discussions and agreements between participating governments to adopt common sustainability standards and guidelines, fostering a shared commitment to sustainable development. According to the United Nations (2022), part of the BRI activities in Africa provides incentives, such as funding or favorable regulations, for projects that align with sustainability objectives. This subsequently encourages businesses to engage in environmentally and socially responsible initiatives.

Based on theme 7: "BRI impact on the scientific and technological capacity for SCP," 72.72% and 25% of the individual interview sessions and FGDs highlighted "Scientific Research Investment" as the signature program to build a reboots of research capabilities that have a higher potential to expand innovations and discoveries in Africa, especially in countries like Ghana and Egypt. In the discussion, the following submissions were captured: *"…. Investing and implementing a learning system in all the educational institutions to adopt a scientific approach to sustainability and management also, to make the communication easily accessible to the company's and populace at large." {I6, Male, Ghana} (see Table 3).* A study conducted by Chernysheva (2019) revealed that certain BRI projects in local community foster collaboration between countries, institutions, and researchers to collectively address challenges related to sustainable consumption and production through joint research. Research investment supports the development of new technologies, innovations and methodologies that promote sustainable SCP. These include innovations in resource efficiency, waste reduction, and eco-friendly manufacturing processes. Other discussions showed that BRI-funded research effectively contributes to the capacity-building of local researchers and institutions, enhancing their ability to conduct scientific studies, analyze data, and propose sustainable solutions (Abbas et al., 2020).

511 **Table 3: Entrants' Feedback 1**
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Question 1: What do BRI infrastructure projects cover in your country?	**No. of** Int**.**	**Indicators**	**Question 2: How China's BRI projects help your country to implement the 10-year sustainable consumption and production (SCP) framework developed by the United Nations?**	**No. of Int.**	**Indicators**
Theme 1: BRI impact on infrastructure development			**Theme 2:** BRI impact on the 10-year SCP framework		
Interviewees' Comments			**Interviewees' Comments**		
Individual Sessions (ISs)			*Individual Sessions (ISs)*		
"Build a bridge connecting Djerba, Tunisia's main tourist island, to Djorf in the mineral-rich Medenine region. Develop Tunisia's southern port of Zarzis into an economic and trade hub." {I7, Male, Tunisia}. *"…Chinese project in Algeria has already begun, the port of "Hamdania," located in the Tipasa governorate, which is expected to become the largest port in Africa and the Mediterranean." {I5, Male, Algeria}.* *"The construction of roads, railways and the like projects has eased and improved the transportation sector…."{I3, Male, Tanzania}.* *Extension of the autonomous port of Abidjan, Grand Bassam Highway, Renovation of the Ivorian road network, Extension of Abidjan Airport, The dry port of Farka." {I10, female, Ivory Coast}.*	22	Transportation Facilities and Systems	• *"….with the help of the Chinese government, completed a power increase project at the Kariba South Hydro Power Station by installing two generators with a combined capacity of 300 megawatts…."{I22, Male, Zimbabwe}.* • *"China projects focus on strengthening the national power grid, Soubra Hydroelectric Dam, San Pedro Thermal Power Plan…."{I10, female, Ivory Coast}.* • *"Two significant hydroelectricity projects in Uganda, the Karuma Hydropower Project and the Isimba Hydroelectric Power Station, have been sponsored by Chinese businesses…."{I20, Male, Uganda}.*	12	Renewable Energy Sources (Hydro, wind, solar)
Focus-Group-Discussion (FGD)			• *Focus-Group-Discussion (FGD)*		

"…. A contribution from the Chinese government in the amount of $28 million was used in 2018 to build an Integrated Technology Training Centre (CINFOTEC) in the province of Huambo." {FGD1, P5}. *In August 2020, it was revealed that Huawei and the Angolan Ministry of Foreign Affairs had signed a memorandum of understanding on the promotion of IT education….."{FGD3, P5}.*	10	Technology Transfer	• *"Currently, there are 102 businesses that are registered with the BRI project to collect, treat, and sell recycled material (94 of these businesses operate in the non-oil sector…." {FGD1, P5}.* • *"There's a growing establishment of waste recycling centres in the city by Chinese companies…. China is taking great advantage to selling huge tons of rubbish generated in Sub-Sahara Africa…."{FGD3, P5}.*	10	Recycling Industrial Wastes
Question 3: How do China's BRI projects speed up the progress of halving the per capita food waste in your country?			**Question 4:** How do China's BRI projects enhance the development of the responsible management of chemicals and waste in your country?		
Theme 3: BRI impact on halving the per capita food waste.			**Theme 4:** BRI impact on the management of industrial chemicals waste		
Interviewees' Comments			**Interviewees' Comments**		
Individual Sessions (ISs)			*Individual Sessions (ISs)*		
"Indeed, the construction of major transportation networks has made it possible for perishable goods such as agricultural products to reach markets and consumers early enough before they get worse and wasted." {I3, Male, Tanzania}. *"China's BRI improves infrastructure. They could help prevent post-harvest losses…." {I6, Male, Ghana}.*	15	Farm-to-Market Transport connectivity	*"….. Companies under the BRI are beginning to innovate technologies to limit the number of chemicals released into the air, water, and soil. There are plans to stop using and releasing dangerous chemicals and wastes into the environment as soon as possible." {I6, Male, Ghana}.* *"…. Farmers are partnering with Chinese investors to use Green technologies that limit the use of harmful chemical inputs such as pesticides and fertilizers…." {I8, Female, Egypt}.*	19	Green Technologies Investments

Focus-Group-Discussion (FGD)			*Focus-Group-Discussion (FGD)*		
"By implementing an awareness program to inform the populace on sustainable living lifestyle. …. Also monitoring the availability of foodstuffs in the market and ensure proper food conservation systems are intact." {FGD2, P5}. *"Due to the impact of BRI, local farmers have access to cold storage facilities, which is a primary factor in Kenya's high food waste……. As a consequence of this, funding for storage and waste avoidance technologies are supported by BRI initiatives to better aid farmers in villages" {FGD3, P5}.*	10	Food Conservation System	*"… The BRI project assists Egypt in minimizing its use of natural resources and the accumulation of potentially hazardous waste by providing the necessary innovation in the form of eco-design and product lifecycle management….." {FGD4, P5}.* *"…. Angola government is in partnership with China under the BRI in making investments in high-quality civic and scientific environmental education to ensure the successful implementation of the 2030 Agenda for SCP through R&D…." {FGD2, P5}.*	10	R&D on Industrial chemical waste management
Question 5: How did China's BRI projects contribute to the development of your country's reduced waste generation substantially?			**Question 6:** How do China's BRI projects in your country encourage companies to adopt sustainable practices and sustainability reporting?		
Theme 5: BRI impact on substantial waste management			**Theme 6:** BRI impact on the adoption of sustainable practices and reporting		
Interviewees' Comments			**Interviewees' Comments**		
Individual Sessions (ISs)			*Individual Sessions (ISs)*		
"Some BRI projects determine to funding companies to convert the wasted food into biogas for energy through a process called fermentation…." {I10, female, Ivory Coast}.	13	Wastes Management Funding & Human Resource	*"However, with the collaboration between China and Tanzania, the country is moving toward establishing regulations that will enforce such projects to reduce waste generation." {I2, Male, Tanzania}.*	8	Integration of Sustainability Policy

"BRI should focus on particular strategies for reducing food loss and waste to help the government with expertise and knowledge to develop, design, and adopt social safety nets for farmers to protect them from any price decreases that result from implementing FLW-reduction strategies. " {I17, female, Nigeria}.			*"The government is working with the Chinese counterpart to ensure Environmental performance, anchored by compliance with all environmental laws and regulations for corporate success…." {I12, Female, Ethiopia}.*		
Focus-Group-Discussion (FGD)			*Focus-Group-Discussion (FGD)*		
"…. with China's technology, the BRI would help food companies produce fewer food wastes, which would help them reach their waste reduction goal faster…." {FGD1, P5}.	5	Waste Management Technology	*"The Chinese BRI influence in the country directly provides new techniques, technology, software, systems, and efficient methods to local companies to enhance and develop the current practices and uplift the current practices to international standards." {FGD4, P5}.* *"……Although they stand to gain more based on their agenda, their investment directly provides necessary software, technologies, and techniques to local companies to apply and incorporate green and sustainable reporting in their businesses….." {FGD1, P5}.*	10	Business Technology Integration

Source: Analytical Report

Table 4: Entrants' Feedback 2

Question 7: How do China's BRI projects support your country's scientific and technological capacity for sustainable consumption and production?	No. of Int.	Indicators	Question 8: How do China's BRI projects help develop and implement your country's tools to monitor sustainable tourism?	No. of Int.	Indicators
Theme 7: BRI impact on the scientific and technological capacity of SCP			**Theme 8:** BRI impact on the implementation of tools to monitor sustainable tourism		
Interviewees' Comments			**Interviewees' Comments**		
Individual Sessions (ISs)			*Individual Sessions (ISs)*		
"….investing and implementing a learning system in all the educational institutions to adopt a scientific approach to Sustainability and management. Also to make the communication easily accessible to the company's and populace at large." {I6, Male, Ghana}. *"…Give Egypt assistance in improving its research and development infrastructure so that the country may embrace production and consumption practices that are less harmful to the environment…." {I8, Male, Egypt}.*	16	Scientific Research Investment	*"BRI Projects focus on building and developing the infrastructure in rural areas to boost the tourism industry. Developing transportation networks, facilities, and building technology hubs to increase the number of tourists…." {I17, Female, Nigeria}.* *"BRI projects should assist the government's ambition to grow the tourist sector. The BRI projects should provide support and technical know-how for the building and refurbishing transportation infrastructure and lodging facilities near tourist destinations…." {I13, Male, Eritrea}.*	13	Tourism Infrastructure
Focus-Group-Discussions (FGDs)			*Focus-Group-Discussions (FGDs)*		
"By offering financial help, BRI projects can help the Angolan government and local companies strengthen their scientific and technical capabilities, enabling them to adopt consumption and production practices that are less harmful to the environment." {FGD1, P5}.	5		*"…. Investments from China might benefit Djibouti's efforts to grow in a sustainable manner….The ever-expanding marine tourism industry is in need of the financial resources that may be obtained via BRI programs…" {FGD2, P5}.*	5	

Question 9: How are China's BRI projects contributing to reducing market distortions that encourage wasteful consumption in your country?					
Theme 9: BRI impact on reducing market distortions that encourage wasteful consumption					
Interviewees' Comments					
Individual Sessions (ISs)					
"To help local farmers and businesses compete, BRI projects supply cutting-edge technologies that replace polluting chemical fertilizers through BRI projects' funding of technologies." {I21, Male, Zambia}. *"The rising usage of pesticides is a direct result of the increased need to boost output as farming becomes more competitive…." {I20, Male, Uganda}.*	15	Agriculture Production Strategies			
Focus-Group-Discussions (FGDs)					
"Provide knowledge, expertise, and practical solutions that effectively reduce market inefficiencies in the agriculture and manufacturing sectors…… China shares its successful experiences and development that contributed to reducing market distortions". {FGD2, P5}.	5				

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Based on theme 8: "BRI impact on the implementation of tools to monitor sustainable tourism," 59% and 25% of the individual interview sessions and FGDs highlighted "Tourism Infrastructure" as the effective program to build the development infrastructure such as transportation system, which include rail, bridges, roads, ports, etc., in Africa, especially countries like Eritrea, Kenya, Ethiopia, and Tanzania. The following submissions were captured in the discussion: *"BRI projects should assist the government's ambition to grow the tourist sector. The BRI projects should provide support and technical know-how for the building and refurbishing of transportation infrastructure and lodging facilities near tourist destinations." {I13, Male, Eritrea} (see Table 4).* Although the BRI effort and the implementation of tools to monitor sustainable tourism are not popular in the African region (Lisinge, 2020), the contribution towards building sustainable infrastructure, such as quality roads and bridges, is evident under the BRI projects (Wang et al., 2020). Several projects indirectly support sustainable tourism by developing quality infrastructure, including transportation networks (e.g., railways, roads, ports, etc.), accommodation facilities (e.g., hotels, etc.), and attractions. These infrastructure improvements enhance the overall tourism experience while minimizing negative environmental and social impacts (United Nations, 2021; Lisinge, 2020).

Based on theme 9: "BRI impact on reducing market distortions that encourage wasteful consumption," 68% and 25% of the individual interview sessions and FGDs highlighted "Agriculture Production Strategies" as significant measures to not only provide relevant agriculture technology to improve agriculture production but also to make available funds and experts in the area of the agriculture industry to share effective practices that will help boost agriculture production in Africa, especially countries like Zambia, Uganda, Kenya, Ethiopia, Tanzania, etc. The following submissions were captured in the discussion: *"To help local farmers and businesses compete, BRI projects supply cutting-edge technologies that replace polluting chemical fertilizers through BRI projects' funding of technologies." {I21, Male, Zambia} (see Table 4).* Evidence has indicated that some Chinese companies, in collaboration with local farmers, have established sustainable agriculture practices that minimize the loss of crops and maximize the development of local food systems that prioritize indigenous crops and traditional farming practices. This reduces overreliance on a single commodity, mitigating market distortions that might arise from monoculture practices (Lisinge, 2020; Wang et al., 2020).

Table 5: Entrants' Feedback 3

Theme 10: Challenges to Achieving Sustainable Consumption and Production (SCP)			
Interviewees' Comments	**Interview Question**	**No. of Int.**	**Indicators**
• *"…. inefficient use of resources this is also evidenced in the increase in corruption during the tendering and running of these BRI projects in my country." {I3, Male, Tanzania}.* • *"The concern on large-scale corruption and mismanagement, doubts puts doubt about projects feasibility, and sustainability imbalance raises serious questions about how well African leaders manage the opportunities they receive…."{FGD2, P5}.*	Q2 & Q3	16	Corruption

• *"It is anticipated that investments in the Belt and Road Initiative (BRI) would ameliorate the negative consequences of monopolized sectors and restricted competition, which are responsible for driving up costs and lowering quality across various goods and services." {FGD1, P5}* • *"… However, the monopolization of Chinese businesses makes it difficult for local businesses to comply with SCP regulation." {I18, Male, Morocco}*	Q7	11	Monopolized Market
• *"…. The current state of chemical waste management is a lack of regulation, rules, and infrastructure…." {I12, Male, Ethiopia}* • *"… reasons for the poor management of waste due to industrial production include weak organizational structures, lack of political will, low public awareness, corruption, political instability, weak legislation, etc....." {FGD3, P5}*	Q5 & Q4	19	Lack of SCP policy and enforcement

Note: FGD: (Focused Group Discussion), I; (Interview), P; (People), Q; (Question), F; (Female) and M; (Male)
Source: Analytical Report

On theme 10: "Challenges to Achieving Sustainable Consumption and Production (SCP)," the analysis reveals that despite highlighting key indicators of sustainable consumption and production (SCP), there are inevitably significant challenges most of the BRI African countries will or are facing, which form the basis for hindering progressive initiatives under the BRI projects to continually promote sustainable industrial production and consumption in areas such as agriculture, tourism, R&D, transportation, and others. The analysis shows that 72.72% of the interviewees emphasized "corruption" as the key factor hindering the successful establishment or completion of sustainability projects under the BRI programs. In a discussion, among the submissions was captured as *"…. inefficient use of resources. This is also evidenced in the increase in corruption during my country's tendering and running of these BRI projects." {I3, Male, Tanzania} (see Table 5).* According to Wondirad et al. (2020), political instabilities and conflicts in some African regions, such as West Africa, disrupt development initiatives, divert resources, and create an uncertain environment for businesses and investments. Such issues eventually weaken institutional capacity, including governance and administrative challenges, which hinder the effective implementation and management of sustainable initiatives.

Moreover, it is indicated that 50% of the respondents highlight the "monopolized market" as one of the challenges facing many local businesses, making it difficult to follow sustainability regulations. Some of the submissions captured in the discussion were: *"However, the monopolization of Chinese businesses makes it difficult for local businesses to comply with SCP regulation." {I18, Male, Morocco} (see Table 5).* Evidence shows that the concerns are due to the nature of Chinese market dominance, which limits healthy competition. Conversely, most local businesses expand production even if the process destroys the ecosystem. All to outperform the foreign businesses under the BRI programs (Xue et al., 2021). Han et al. (2020)

reveal this is a major problem because most African companies find ways to increase production without complying with sustainability regulations. To directly minimize the foreign market dominance in Africa, local resources should be allocated to establishing more local companies to produce locally-made products. Besides that, more resources should be invested in patronizing the consumption of local products instead of foreign products. Significantly, adopting technologies to facilitate rapid industrialization will increase African companies' potential to increase production and limit the importation of goods and services.

The analysis further reveals that 86% of the interviewees emphasized that the "lack of SCP policy and enforcement" provides room for most local firms in African countries not to comply with the sustainability regulation strictly. Some of the submissions reveal that *"... reasons for the poor management of waste due to industrial production include weak organizational structures, a lack of political will, low public awareness, corruption, political instability, weak legislation, etc." {FGD3, P5} (see Table 5).* Although most countries have some form of sustainability regulation to guide them in fulfilling the United Nations sustainable development goals (SDGs), most countries struggle to enforce stringent laws to punish offenders for breaching the SDG standards. Conversely, this further promotes ecosystem destruction in the name of maximum production to meet market demand for products (United Nations, 2022).

Sadly, pollution is the inevitable consequence of realizing economic growth, especially in most African developing countries (United Nations 2022). The impact of pollution is more severe in African countries than in developed countries because most countries often lack the technology and resources to mitigate waste associated with infrastructure development. This phenonium contradicts the agenda to implement the African 10-Year Framework Programme (10-YFP) on Sustainable Consumption and Production (SCP) (Lewis et al., 2021). Although the journey seems far from reaching its goals, significant effort has been made to realize it. As part of the effort to achieve the ultimate objective, China is partnering with countries including Tanzania, Nigeria, Uganda, Kenya, Tunisia, Ethiopia, and many others to undertake BRI projects in the area of 'The Green Silk Road and other sustainable industrial development (CCICED, 2019).

The established model based on the current analysis (see Figure 3) emphasizes that the Belt and Road Initiative (BRI) influences the correlation between the drivers of SDG (factors that promote sustainable practices) and SDG 12 (Sustainable Consumption and Production) positively by supporting initiatives aligned with responsible resource use. With possible sustainability challenges in most study countries, the BRI-African relationship addresses challenges related to SDG 12 by promoting good governance practices, fair competition, and policy enforcement. However, the extent of these influences may vary depending on the progress of the projects, amendments to policies, and partnerships established under the BRI in the future.

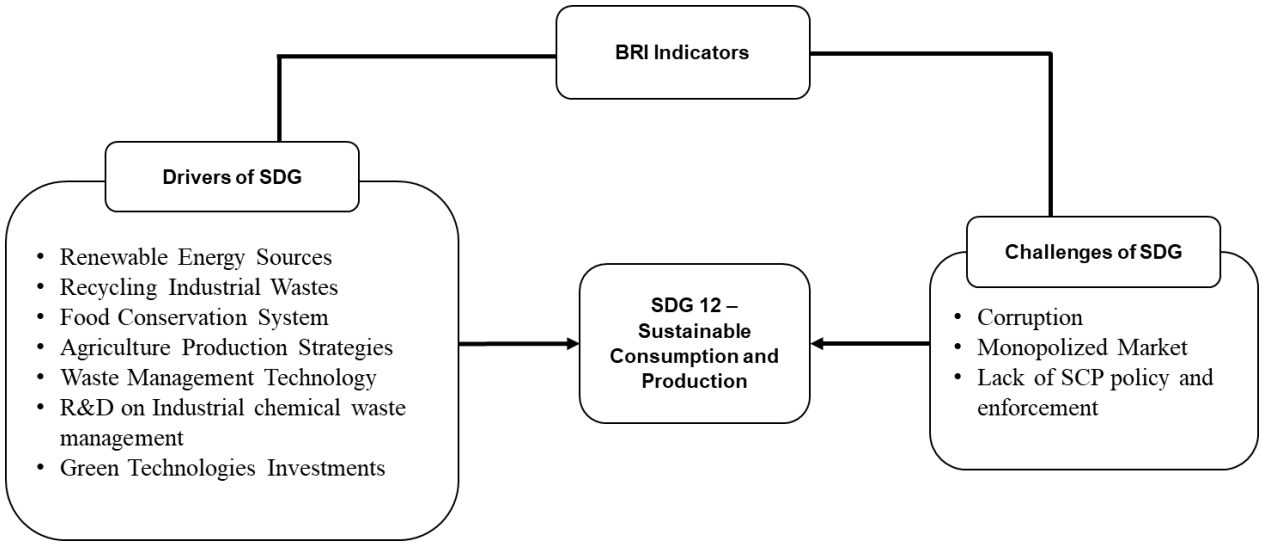

Figure 3: BRI Indicators Correlation Effects

Table 6: Summary of Findings

Question No.	Themes	Indicators	Supporting References
Q1	*Theme 1:* BRI impact on infrastructure development	• Transportation Facilities and Systems • Technology Transfer	Apostolopoulou (2021) Senadjki et al. (2022)
Q2	*Theme 2:* BRI impact on the 10-year SCP framework	• Renewable Energy Sources • Recycling Industrial Wastes	Senadjki et al. (2022)
Q3	*Theme 3:* BRI impact on halving the per capita food waste.	• Farm-to-Market Transport connectivity • Food Conservation System	Zhong et al. (2020) United Nations (2022)
Q4	*Theme 4:* BRI impact on the management of industrial chemicals waste	• Green Technologies Investments • R&D on Industrial chemical waste management	Khan et al. (2022) Wang et al. (2020)
Q5	*Theme 5:* BRI impact on substantial waste management	• Wastes Management Funding • Waste Management Technology	Abbas et al. (2020) Lewis et al. (2021)
Q6	*Theme 6:* BRI impact on the adoption of sustainable practices and reporting	• Integration of Sustainability Policy	United Nations (2022)

		• Business Technology Integration	Chen et al. (2019)
Q7	*Theme 7:* BRI impact on the scientific and technological capacity of SCP	• Scientific Research Investment • Agriculture Production Strategies	Chernysheva (2019) Abbas et al. (2020)
Q8	*Theme 8:* BRI impact on the implementation of tools to monitor sustainable tourism	• Tourism Infrastructure	Lisinge (2020) & Wang et al. (2020)
Q9	*Theme 9:* BRI impact on reducing market distortions that encourage wasteful consumption	• Agriculture Production Strategies	Wang et al. (2020)
Q10	*Theme 10:* Challenges to Achieving Sustainable Consumption and Production (SCP)	• Corruption • Monopolized Market • Lack of SCP policy and enforcement	Wondirad et al. (2020) Xue et al. (2021) (United Nations, 2022

Source: Analytical Report

5. Discussions

The study discovered that the continuous intervention of infrastructure development in African countries is still in the transportation infrastructure, including bridges, railways, ports, airports, and roads (see Table 6). Now, the new trend under the BRI emphasizes building green roads to fulfil the objective of constructing a green silk road to show commitment to promoting global environmental cooperation (CCICED, 2019). Similar discoveries by Ehizuelen et al. (2018) and Ehizuelen (2017) highlighted that the primary mission of the Chinese government is to build links with many countries around the globe, especially African countries, through the BRI to expand its trade relations and natural resource exploitation. Other initiative interventions cover the construction of standard gauge railways, highways, and flyovers, as well as the construction of complex Bridges, a network of roads, a network of railway transport, a network of ports and harbors, and a network of airline transport (Githaiga et al., 2019; Ehizuelen et al., 2018). Senadjki et al. (2022) contended that constructing transportation infrastructure under the BRI contributes to rural development and upliftment by enhancing transport connectivity. Local farmers gain improved market access, increasing sales, and better product prices.

Again, the study discovered that the transfer of technology between China and African countries promotes the adoption and integration of technology in critical economic sectors, such as telecommunication, agriculture, education, construction, tourism, and research, to

increase production sustainably (see Table 6). Despite the progressive developmental intervention, others criticize the ambition of such intervention without building a permanent security infrastructure to control technology systems in some African countries (Senadjki et al., 2022). However, Khan et al. (2022) found that effective BRI programs are directed at equipping local businesses with the necessary technology and knowledge to contribute to better economic growth, especially sustainability, to accelerate poverty reduction. For example, "a contribution from the Chinese government of $28 million was used in 2018 to build an Integrated Technology Training Centre (CINFOTEC) in the province of Huambo in Angola (Spinner, 2021; Githaiga et al., 2019). Another study also confirms that the focus on equipping local businesses with technology and knowledge suggests an emphasis on capacity building and skill development within the host countries. This approach not only addresses the immediate economic needs of the people but also contributes to long-term sustainable growth (Cuiyun & Chazhong, 2020).

The study further reveals that the Chinese government's BRI programs effectively focus on integrating advanced technologies to enable more "green agriculture and industrial production" (United Nations, 2021). This is to ensure that BRI activities comply with sustainable consumption and production while simultaneously promoting sustainable development. According to Feng et al. (2019) and Li and Zhu (2019), as a confirmation of the findings of this study, most of the green agriculture production in Africa comes in the form of green investment in organizational output, which emphasizes aiding the reduction of biodiversity loss, the conservation of ecosystems, and preservation of farm products. This is to ensure poverty alleviation, the enhancement of sustainable livelihoods, and the adaptation to the reality of climate change through experience, innovation, and societal transformation. A group of studies (Cui & Song, 2019; Li & Zhu, 2019; Ehizuelen, 2017) also stressed that green industrial production under the BRI comes from technology transfer and direct financial investment. Both programs are keen on reducing greenhouse gas emissions due to industrial production.

The findings show that in African countries like Uganda, Tanzania, Zambia, Morocco, and Algeria, many Chinese investments under the BRI program are going into renewable energy to build electricity for deprived communities (United Nations, 2022). The collaboration between China and African countries strengthens the energy sectors and promotes the region's electricity consumption and production. For example, "in September 2018, China Power Construction, a Chinese state-owned company, and S. Energies of Ivory Coast agreed to finance jointly and construct a 700-megawatt hydropower station in San Pedro (Rauf et al., 2020). Other studies have revealed that introducing renewable energy technologies (which include solar, wind, biofuels, etc.) through the BRI programs significantly encourages energy efficiency in industrial production (Abbas et al., 2020; Chen et al., 2019; Chernysheva, 2019). In addition, Khan et al. (2021) argued that introducing renewable energy sources promotes energy sustainability and encourages sustainable agriculture production through farming, ploughing, and irrigation.

This study's findings emphasized China's implementation of industrial waste management strategies and technologies in its BRI projects. However, some findings debunk China's efforts in managing and preventing industrial waste and state that more Chinese-sponsored industrial projects (in the manufacturing sector) have loopholes in their compliance with SCP regulations in countries like Gambia, Ghana, Togo, and others (Cuiyun & Chazhong, 2020; Han et al., 2020). Our result found a contrary discovery. It indicates that BRI projects established in some African countries actively integrate advanced technologies and human expertise with reliable

industrial strategies to reduce industrial wastes (such as chemical wastes, carbon emissions, and solid wastes) and recycle them into reusable products. Despite such discoveries, the impact of pollution because of some Chinese production companies is endangering the livelihood of many Africans (e.g., Sierra Leone) due to a lack of adequate technology and resources to mitigate waste associated with industrial production (United Nations, 2021; CCICED, 2019).

On the contrary, our study discovered some challenges in achieving sustainable consumption and production. In the context of the China-African bilateral relationship, challenges, including corruption, market monopolization, and a lack of policy and enforcement, are the biggest obstacles towards ensuring BRI sustainable development (United Nations, 2020 & 2021). The study shows that the mismanagement of resources due to corruption activities on a large or small scale directly limits the successful completion of projects in Africa, especially in Kenya, Cameroon, Ghana, and other developing countries under the BRI program. Previous findings (Muhammad & Long, 2021; Githaiga et al., 2019; Ehizuelen, 2017) on BRI-African projects highlight most African countries' inability to properly allocate resources to fund projects under the BRI due to personal financial interests. Hence, the inefficient use of resources was also evidenced by increased corruption during my country's tendering and running of these BRI projects. Xue et al. (2021) stressed that although 90% of the BRI projects are under loan contracts, which already put the borrowing country in high-debt capacity, the primary concern is the mismanagement process. Unfortunately, this hinders the practice of SCP due to misplacing priorities due to corruption (United Nations, 2020).

The study found that monopolizing the market by China's firms is one of the significant obstacles to achieving sustainable consumption and production in many areas of Africa. The complete dominance of firms (under the BRI programs) in the market directly limits competition and creates instability in the price of goods and services (United Nations, 2020). According to Corre (2018), this situation affects purchasing power, i.e., it drives up costs and lowers quality across various goods and services, negatively affecting consumption and production. Product demand will drop if the price increases (Khan et al., 2018; Corre, 2018). Yao et al. (2020) emphasized that stocking a large quantity of consumable products, such as perishable food stock, might generate substantial waste, contradicting the objectives of SCP. The study also shows that the lack of adequate policy and policy enforcement remains the source of progressive development. Unlike the West and some of Asia, most African countries struggle to enforce sustainability policies to strictly practice sustainable development among a large portion of their respective populations (Han et al., 2020; Carmody et al., 2022). Although a significant part of the problem relies on the lack of proper infrastructure to help enforce and ensure compliance, the lack of compliance is due to a lack of education to create awareness. Unfortunately, this remains the main disadvantage to slowing down efforts to ensure SCP practice. Therefore, with proper education on sustainability, enforcement and compliance become achievable (Cuiyun & Chazhong, 2020; Hurley et al., 2019).

5. Conclusion

Based on a continuous debate on China's African mission concerning infrastructure development through substantial financial and technological investments. This study aims to discover the role of Belt and Road Initiative (BRI) projects in achieving the practices of sustainable consumption and production (SCP) in the African 10-Year Framework Programme (10-YFP). We can conclude that the most promising intervention in infrastructure development for fulfilling SCP practices under the BRI programs occurs in the transportation and industrial

development sectors. From a technology integration perspective, the transfer of technology between China and African countries is advancing the adoption and integration of technology in vital economic sectors such as telecommunication, agriculture, education, construction, tourism, and research to increase production sustainably. BRI programs under the Chinese government are effectively advancing the integration of advanced technologies to enable more sustainable agriculture and industrial production. More significantly, the BRI investments in most African countries, such as Morocco, Algeria, Ethiopia, Kenya, Zambia, and others, establish sustainable renewable energy to build electricity for deprived communities.

Furthermore, many of China's BRI projects focus on implementing industrial waste management strategies and technologies to contribute to mitigation measures to achieve the 12th SDG in Africa. Regrettably, the encouraging bilateral relationship between China and Africa is confronted by crucial economic issues like corruption, monopolized markets, and a lack of policy and enforcement. This practically impedes continuous efforts to ensure proper observation of the SCP agenda.

5.1 Policy Implication

Although both China and African developmental initiatives comply with the United Nations SDG regulations, the struggle to enforce measures to practice or observe long-term SCP in Africa can be significantly mitigated by introducing other sustainability strategies that include by-laws between China and African countries. This is crucial for assisting Africa in creating a solid sustainability foundation, which is lacking in many regions of the continent, to promote sustainable consumption and production in the ongoing fight against poverty. It is vital to improve the strategic coordination between national plans for implementing sustainable development and the green BRI without compromising the BRI's inclusion, coordination, consistency, and capacity-building pillars. The concept of green development must also be integrated into efforts to achieve the "Five Goals" (namely, policy coordination, facility connectivity, unhindered trade, financial integration, and people-to-people bonds) and lessen the negative impact on the ecological environment during the BRI's implementation. This can be done by understanding the core principles of the green BRI. The focus is on organizing initiatives to support "facilities connectivity" and "unrestricted trade," and the "five goals" may serve as policy, particularly in Africa.

Cross-border cooperation is crucial to promoting sustainable development. Therefore, BRI collaboration can promote green development. Governments will perceive FDI as positive for green growth. The BRI countries can focus on energy savings. In the meantime, BRI countries can be cautious about FDI to prevent the pollution haven phenomenon where production activities of "dirty" industries are shifted abroad.

There is also a need to observe responsible consumption and production goals from a comprehensive perspective. It should be a shared responsibility of the government, firms, and civil society organizations to broadcast knowledge and generate environmental awareness. Governments promote environmental activities that positively impact the planet Earth. They know that achieving responsible production and consumption goals requires pressure and regulation. They implement reforms to raise the percentage of renewable energy. They should review regulations on imported goods from low-energy-intensive sectors.

Compared with advanced economies, there is still a gap in infrastructure for green travel, including telecommunications, railroads, and seaports. Public transport can be made available

and cost-effective in BRI economics. Furthermore, there can be improvements in supporting facilities, such as new energy vehicles. Research and development on the core technology of new energy vehicles can be strengthened to overcome the barriers to the technology of battery charging. The sufficient installation of charging piles encourages consumers to purchase new energy vehicles without worry. Between 2000 and 2014, renewable energy investment in OECD and G20 countries was driven mainly by targeted investment incentives such as feed-in tariffs (FiTs), tradeable renewable energy certificates, and public tenders (OECD, 2019). Therefore, more financial and policy support with transparency can be allocated in BRI countries to promote R&D innovation and speed up industrial green technology upgrades.

In addition, public–private partnerships in renewable energy can be adopted. BRI industrial parks or free trade zones specializing in international trade can be established, and local firms can be given incentives and support to compete with Chinese firms. Firms must embrace this change and provide products and services in response to consumers' preferences. Firms must tackle a critical challenge concerning the environmental impact of the waste they cause with overpackaging.

Parents and teachers have the most profound influence on the environmental awareness of students. They should be responsible for fostering their children's and students' green travel and low-carbon lives. Sustainable consumption by individuals can also be displayed in habits towards sustainability that could solve waste by recycling. Only when a low-carbon life is intensely rooted in the hearts of the people can the carbon-neutral goal be realized.

In addition, the BRI projects between China and Africa can adopt and uphold the following focused areas. First, the use and integration of more energy-efficient and renewable energy technologies (solar, wind, and biofuels) can be promoted through all BRI projects in all phases of agriculture, from ploughing and irrigation through planting and chemical application to harvest and transportation. Second, focus on inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions. Third, required more physical investment in agricultural storage facilities, suitable technology, and support for the private sector to boost agricultural development can be priorities for development. Forth, guarantee that prosperity is fairly shared throughout society, BRI projects must equip local businesses with the necessary technology and knowledge to contribute to sound economic growth on a sustainable basis and accelerate poverty reduction. Five, invest in renewable energy to reduce the consumption of firewood and fossil fuels that cause pollution. Six, investments in the latest cutting-edge technology in the agricultural industry that can contribute to reducing PHL include providing expertise and techniques that can reduce the high crop perishability not only in one economy but in all relevant areas of development. Seven, contribute to developing practical methods for ensuring the **security of the construction** process (in transportation and industry) and the disposal of chemicals during industrial production activities. Eight, BRI industrial parks or free trade zones with firms using green technology in production specializing in international trade can be established while local firms are given incentives and support to compete with Chinese firms. Thus, encouraging green production and carbon intensity reduction in BRI countries. Nine, the promotion of cross-border e-commerce will also enable producers, such as farmers with products from responsible production in suburban areas, to sell their products not only in the cities but also overseas.

5.2 Limitations & Future Research

Due to limited research funding, this study covers 18 developing countries in Africa, mainly from the eastern region. With the vast range of expansion of the Belt and Road Initiative, the findings of the study are relatively limited to these 18 countries compared to the total number of more than 40 countries on the list of BRI programs. Although the result can be generalized significantly on the basis that the selected 18 countries have a much more substantial contribution from BRI as compared to the rest of the countries, the inclusion of the rest of the countries in the further study would provide a more holistic or extensive view of the role of BRI in sustainable consumption and production. This can also offer a much broader, comprehensive understanding of BRI's direction on African economic and environmental development, mainly to innovate solutions to tackle pressing economic, social, and ecological problems in African development as a whole. Again, the conscious effort was to acquire at least five participants from each selected country. However, due to the challenging process of reaching out to potential respondents, the study recruited at least one participant from each country. Conversely, the potential for more distinctive opinions about the research questions that could broaden the understanding of the study may be limited. Therefore, further study should consider broadening the dimension of the area of study by acquiring more participants from each country.

Observing ethical standards

Conflict of Interest: All of the authors affirm that they have none.

Study Participants Who Are Either Humans Or Animals

Ethical approval: All methods used in research projects involving human subjects were approved by the institutional research committee (UTAR + GD-IPSR-R&D-011).

Informed Approval

All study participants gave their consent after being given all relevant information. All participants whose identifying information is used in this article gave their additional informed consent.

Consent to Publish

The authors affirm that human research participants provided informed consent for publication.

Author contributions

Conceptualization: A.S.; formal statistical analysis: I.M.A.; Data collection: A.S. and M.J.K.B.; Investigation: A.S., M.J.K.B., and H.N.A.Y.; methodology: A.S. and J.H.C.; supervision: A.S.; writing final draft: I.M.A.; review and editing: H.N.A.Y., and J.H.C.

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Data Availability Statement

The datasets generated during or analyzed during the current study are available from the corresponding author upon reasonable request.

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