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The Circular Economy in Iraq : Obstacles of Transition and Opportunities for Achieving Sustainable Development

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Abstract. This study diagnoses obstacles to transitioning to a circular economy in Iraq and analyzes opportunities for sustainable economic development. It employs a comprehensive descriptive analysis of economic, social, and environmental data related to the circular economy in Iraq. The findings reveal a decline in per capita economic growth in Iraq, dropping from 10.8% in 2016 to 4.3% in 2022, with some years experiencing negative growth. This decline stems from the economy's heavy reliance on the oil sector, which accounts for 61.1% of GDP, and insufficient infrastructure for clean production models and resource recycling. The study recommends effective government strategies to diversify away from oil dependence by developing sustainable agriculture, green industries, and eco-tourism. It stresses the need to invest in waste recycling and renewable energy projects and to offer tax incentives for small and medium-sized enterprises (SMEs). Additionally, it concludes that collaboration with developed countries and international organizations could accelerate Iraq's transition to a circular economy, enhancing economic sustainability and improving living standards.

Keywords: Circular Economy, Sustainable Development, Recycling, Economic Sustainability.

1. INTRODUCTION

The world is witnessing a radical shift towards adopting more sustainable economic models that guarantee the rights of future generations. Therefore, there has become an urgent need to rethink economically the method and patterns of consumption and production using natural and economic resources. Whereas the circular economy represents one of the most prominent models, it aims to balance economic growth and environmental protection by effectively reducing and recycling waste and resources. This concept was first introduced in 1989 by economists David Pearce & R. Kerry Turner, who highlighted the complementary relationship between ecosystems and economic systems to achieve benefits for current and future generations.

Iraq has faced many challenges and obstacles, including its excessive dependence on the oil sector, which contributes 61.1% of the gross domestic product to the economy. This makes the Iraqi economy, with its sectors and institutions, vulnerable to external economic shocks, which may be one of the reasons hindering the use of the circular model in Iraq.

Despite this, the circular economy presents broad and significant opportunities to promote and achieve sustainable economic development in Iraq by improving the efficiency of natural resource use and increasing economic diversification. The Iraqi economy needs to shift towards embracing the circular model by enhancing the recycling process to achieve optimal and sustainable use.

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The circular economy offers innovative solutions to the challenges faced by the Iraqi economy by improving investment in available natural and economic resources more efficiently. It also contributes to creating new job opportunities and fostering sustainable economic growth. Implementing the circular economy in Iraq requires developing infrastructure, raising environmental awareness, and activating supportive legislation. Additionally, establishing an effective partnership between the public and private sectors is crucial to ensure the success of the circular model.

2. LITERATURE REVIEW

This analysis highlights the role of the circular economy as an effective mechanism for achieving sustainable economic development in Iraq. It offers an innovative framework designed to address waste reduction and improve the efficiency of natural resource utilization. Given the country's economic and environmental challenges, exploring the barriers to transitioning to this model is crucial. This exploration will aid in formulating effective strategies to overcome these obstacles through a thorough examination of the opportunities present within the Iraqi economy. Such prospects will foster economic diversification in Iraq by enabling the development of new sectors, including recycling and renewable energy. Furthermore, they will provide scientific insights that support economic policymakers and stakeholders in making informed decisions to enhance economic, social, and environmental sustainability outcomes.

A significant challenge hindering Iraq's transition to a circular economy is the numerous obstacles it encounters despite its vast economic potential and abundant resource opportunities. This prompts us to ask: How can Iraq transition to a circular economy given these existing challenges? What opportunities exist to promote sustainable economic development in Iraq?

The study seeks to achieve the following: A. Diagnosing the main obstacles to the transition toward a circular economy in Iraq and assessing their impact on resource efficiency. B. Exploring the opportunities available to the Iraqi economy that promote sustainable economic development by applying the circular economy approach, represented by recycling and using renewable energy.

This leads to overcoming current obstacles and enhancing cooperation between the public and private sectors to achieve the goals of the circular economy in Iraq. C. Explain

the importance of applying the circular economy approach and its multiple benefits to achieve sustainable economic development in Iraq by providing recommendations targeting Iraqi society and economic sectors.

3. DATA AND METHODOLOGY

Circular Economy

The term circular economy appeared 1989 in the book "The Economics of Natural Resources and the Environment" by economists David Pearce and R. Kerry Termes David Pearce & R. Kerry Turner. The book explained the complementary relationship between the ecosystem and the economic system, between the deviations that occur in the ecosystem and the economic effects resulting from this system. The two economists distinguished between the term linear economy, in which consumption of natural resources is open, and the term circular economy, which works to recycle resources in order to benefit and preserve the values of products and resources for an extended period, by recycling these resources and reducing the amounts of waste generated from Production. Thus, the book distinguishes the circular economy from the linear economy in that the latter is based on taking, making, and disposing, where natural resources are extracted and then used to manufacture products (commodities), after which these products are consumed, and in the end they are disposed of as waste without focusing on reuse. Use or recycling (Fatima, 2022, p. 8).

This, the circular economy is an organized approach to economic development that maximizes the benefits of investors, society, and the environment by recycling waste using the latest technological methods. It is "a reform economy that aims to preserve the usefulness and value of products, components and materials" (WHO, 2018, p. 4).

The circular economy has also been defined by the Economic and Social Commission for Western Asia as "a systems approach to accelerating the achievement of the Sustainable Development Goals, by addressing three development challenges: resource scarcity and depletion, the effects of climate change, and environmental pollution.". Therefore, economics must rely on circular processes and solutions that help reduce greenhouse gas emissions, adapt to future climate changes, clean the environment of waste, reduce air pollution and its health effects, and provide water to communities. The circular approach also supports economic diversification, increases employment opportunities, promotes

empowerment to access resources and services, and recycles these resources within the circular system (ESCWA, 2023, 12).

Several factors call for a transition from a linear economy to a circular economy, including the following (Al-Kawaz, 2014, p. 7):

A- Demand for raw materials: During the past hundred years, the world has increased its use of raw materials by about 34 times, 27 times more than minerals, 12 times more than fossil fuels, and 3.6 times more than biomass.

B-Dependence on the outside: The economies of several countries depend on external economies in order to obtain raw materials, some of which are rare, for processing

When the prices of raw and rare materials increase, local activities lead to political tensions and adverse effects on local economies.

C-Resource uses: Using primary (natural) resources damages natural capital and increases the emission of harmful gases, including carbon dioxide.

D-Waste generation: Carrying out various productive and economic works generates many wastes, which require recycling, reusing operations, repair, and maintenance. These operations lead to positive results in economic growth and more efficient and effective resource distribution.

It is possible to illustrate the chain of transition from a linear economy to a circular economy through the following Figure1

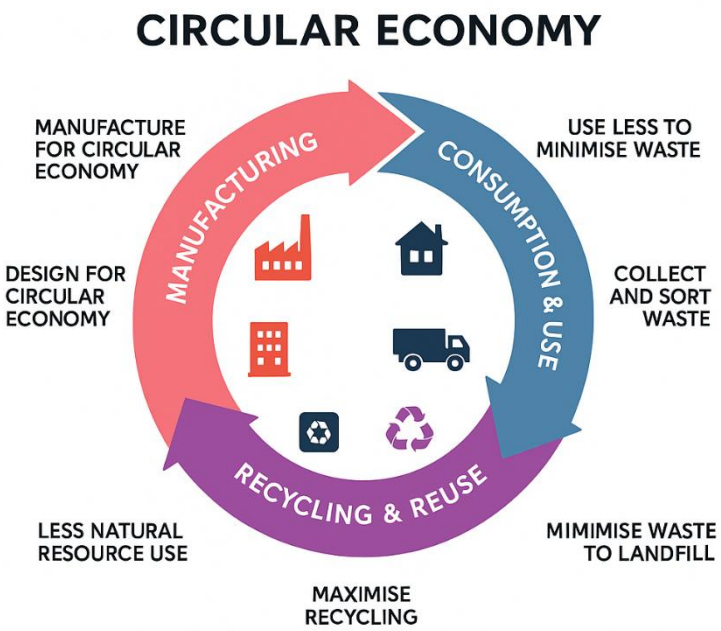

Figure 1. Transition chain from a linear to a circular economy

From the above, it is clear that the circular economy "is an economic model that aims to reduce waste and increase the efficiency of using natural resources, by designing production and consumption systems based on the reuse of these resources, recycling of waste, and renewing it, instead of the traditional linear model based on Extraction - production - consumption - disposal."

Advantages of the circular economy

The circular economy has the following features (El Khoury, 2020, p. 108):

A. The circular economy is one of the most important contributors to using and benefiting from all resources, energy, minerals, and raw materials, recycling processes, and abandoning waste dumping and product waste .
B. The circular economy helps redevelop consumer and health systems, focuses on the importance of using products, and determines the value of things.
C. It creates many investment and economic opportunities suitable for institutions and companies and social and environmental advantages .
D. The circular economy requires the proper use of equipment and products to preserve them for the longest possible life. The more recycled or remanufactured products, the less demand for other modern raw materials. In any crisis, the circular economy contributes to reducing its effects .

E. It works to strengthen environmental efficiency and reduce the use of non-renewable energy sources .
F. Reducing the cost of raw materials, reducing the costs necessary for waste management, and working to create and innovate new industries .
G. Strengthening cooperation in all economic fields, making significant use of resources, contributes to creating and innovating new jobs.

The relationship of the circular economy to the Sustainable Development Goals:

In 2015, the United Nations officially launched seventeen goals within the Sustainable Development Plan for the year 2030. These goals seek to address social, economic, and environmental challenges to liberate humanity from poverty, secure a healthy planet for future generations, and build healthy and inclusive societies for all countries. The developed and developing world must ensure a decent life for humans and society (United Nations, 2017, p. 2).

The Sustainable Development Goals (SDGs) have been described as "a blueprint for achieving a better and more sustainable future for all" by 2030, and these goals and targets are increasingly being adopted by actors in the public and private sectors within a regulatory framework and in follow-up to sustainability initiatives. These goals have also given importance to the circular economy because it has acquired a broad economic framework over the past few years, as it is seen as offering "an approach that seeks to achieve local, national and global sustainability." It is an approach designed to reduce and eliminate waste and pollution to preserve the economy's products and materials in use and regenerate the environment's natural systems (United Nations, 2021, 50).

The Seventy-third United Nations General Assembly in 2018 also set several necessary goals in revitalizing the circular economy to achieve the sustainable development goals, which are the following: (EMF, 2021, 2-5) and (Bayoumi, 2023)

Goal Seven: Ensure access to reliable and sustainable modern energy services:

Efforts have focused on addressing climate change through the transition to renewable energy, complemented by energy efficiency. The circular economy can contribute to completing the picture of reducing emissions by changing the way products are made and used.

Goal Eighth: Decent work and economic growth:

New circular business models are a primary potential source of increasing resource effectiveness and efficiency, estimating the volume of waste and green jobs. Implementing the circular economy is a multi-billion euro opportunity globally, with an annual net benefit of €1.8 trillion in the EU alone by 2030.

Goal Eleven: Security of cities and sustainable communities:

With three-quarters of the world's population expected to live in cities by 2050, the transition to a circular economy is necessary to reduce the impacts of cities on resources and environmental impacts. On the other hand, circular economy principles, such as Adaptable and flexible building design, enable access to housing for low-income groups.

Goal Twelve: Sustainable consumption and production patterns:

Economic and social progress over the past century has been characterized by environmental degradation that has threatened the very systems on which our future development and survival depend. There will be a need to change consumption and production patterns. Otherwise, irreparable environmental damage will occur. In addition, regarding consumers, households consume about 29% of global energy, contributing 21% of the resulting carbon dioxide emissions. There are many of the aforementioned circular practices that are closely related to achieving the twelfth goal of the Sustainable Development Goals, for example, water management, waste management, sustainable products and services, sustainable supply chains, as well as cooperation with renewable energy, as circular economy practices can reduce pollution—industrial water and soil. The cyclical rules of rethink, reduce, redesign, reuse, repair, refurbish, remanufacture, recycle, and reuse are fundamental principles of that specific problem.

Goal Thirteen: Confronting climate change:

Circular economy efforts to combat climate change have focused primarily on the critical role of renewable energy and energy efficiency measures. Achieving climate goals will also require addressing emissions associated with making products. When applied to some industries, circular economy strategies can help reduce emissions by 40% in 2050, and when applied to a system, they can help reduce emissions by 40%.

Food reductions can reach 49% in the same year, bringing emissions 45% closer to their zero emissions targets.

Goal Fourteen: Underwater Life:

Reducing waste generation and leakage from land-based activities through circular economy practices will reduce waste entry into the oceans. This also includes recovering nutrients from wastewater streams before entering the oceans. The circular economy's contribution to addressing climate change will indirectly reduce the increase in ocean pH.

Goal 15: Life on Earth:

Sustainable and renewable agriculture and agroforestry practices that embrace and protect biodiversity and return biological materials to the soil as nutrients, essential for restoring terrestrial ecosystems, must be adopted to restore natural capital.

It is possible to clarify the relationship between the circular economy and the Sustainable Development Goals with the following Figure 2:

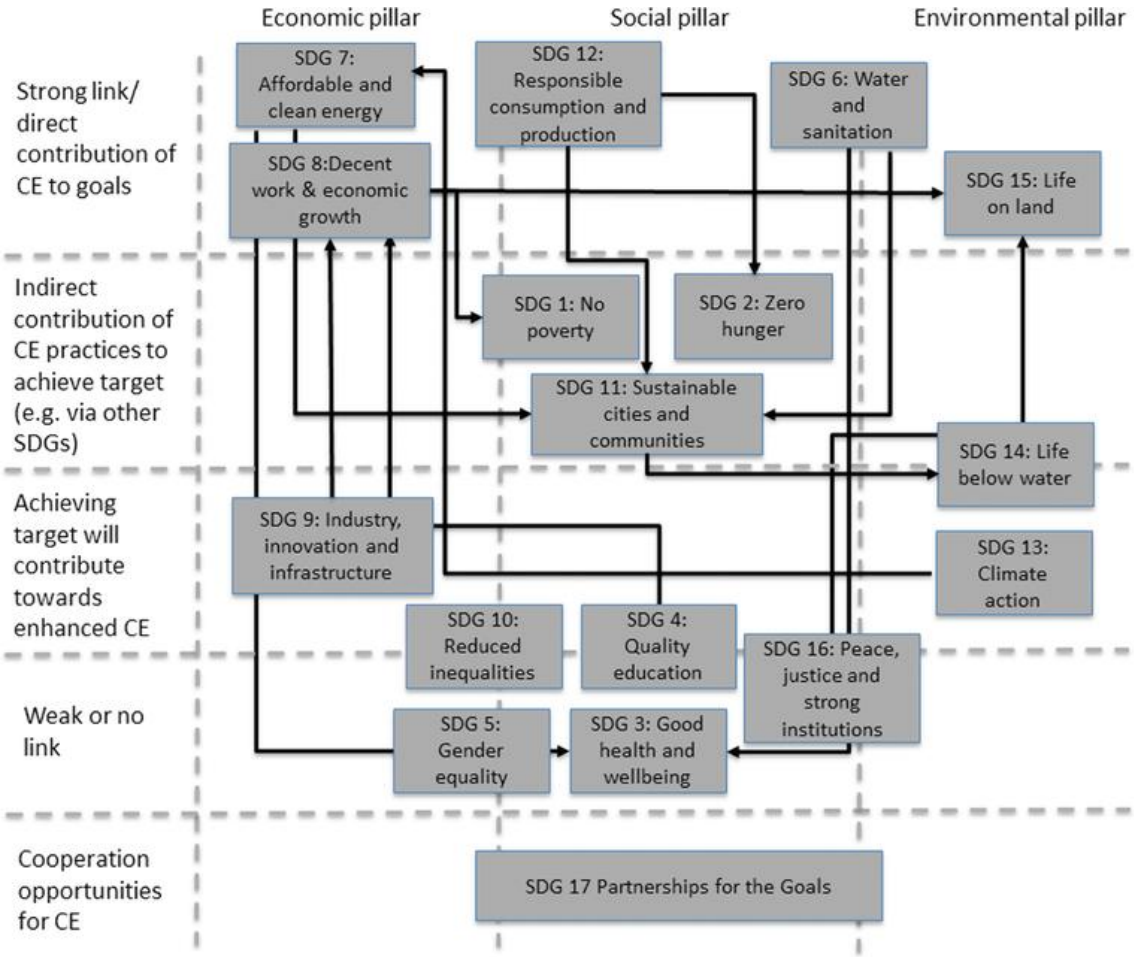

Figure 2. The relationship between the circular economy and the Sustainable Development Goals

Analysing the sustainable economic situation of Iraq under the circular economy:

Iraq tried to achieve the Sustainable Development Goals according to Vision 2030 by mobilizing and directing economic sectors and government institutions towards achieving economic, social, and environmental progress. The Iraqi Ministry of Planning developed a unified vision for a road map and a national framework to integrate Iraq with these goals. The General Secretariat approved this vision. To the Iraqi Council of Ministers on 3/31/2019, according to Book No.010199 (Iraqi Ministry of Planning, 2023, 1).

It is possible to read and analyze the sustainable economic situation in Iraq according to the goal indicators

Sustainable Development

Sustainability and distribution of real economic growth: The Iraqi economy is one of the oil-dependent economies that relies heavily on a single sector (crude oil production and export), making it vulnerable to external shocks tied to fluctuations in crude oil prices and global markets. This reliance complicates efforts toward economic diversification. In Iraq, the sustainability of resources depends on utilizing oil imports in ways that foster real development of non-oil sectors. Furthermore, the depletion of oil resources threatens the rights and needs of future generations.

Table 1 indicates that real oil output has dominated the Iraqi economy, despite its modest compound growth rate of 0.6% during the period (2016 – 2022), compared to a compound growth rate of 1.7% for non-oil output. The dominance of oil, with slow growth in the remaining non-oil sectors, resulted in a small compound growth in GDP (at constant prices) of just 0.2%.

Oil output continued to predominate at rates ranging from 58.3% to 64.8%, averaging 61.1%. In contrast, the contribution rates for non-oil sectors ranged from 35.2% to 41.7%, averaging 38.9%. This situation may jeopardize the economic sustainability required for diversifying the Iraqi economy, potentially adversely affecting future generations.

Table 1. The relative contribution of oil and non-oil output to total GDP (at constant prices 2007 = 100) in Iraq during the period (2016 – 2022)

YEARS	The relative importance of non-oil output (%)	For non-oil GDP (million dinars)	Relative importance of oil (%) output	Oil GDP million) (dinars	Total GDP million) (dinars
2016	35.2	73538774.9	64.8	135393334.8	208932109.7
2017	36.7	75290515.6	63.3	129839551.3	205130066.9
2018	39.1	82373362.4	60.9	128159524.8	210532887.2
2019	40.0	88865897.5	60.0	133275332.2	222141229.7
2020	40.4	79003046.3	59.6	116399503.2	195402549.5
2021	41.7	82716983.1	58.3	115779557.4	198496540.5
2022	39.0	82853995.7	61.0	129554661.6	212408657.3
Compound growth rate (%)	–	1.7	–	0.6	0.2
Average percentages (%)	38.9	—	61.1	—	

As is clear in Table 2, the per capita economic growth rate in Iraq during the previously mentioned period has tended to decline relatively due to the dominance of a single sector over the total real output in Iraq. This rate decreased from 10.8% to 4.3%, and some years recorded negative rates of growth between(14.3% and 0.02%), which indicates the weakness of achieving continuous and sustainable economic growth that achieves a decent living for the Iraqi individual, and helps the growth and prosperity of the Iraqi economy. To serve future generations.

Table 2. Annual growth rate of the Iraqi per capita share of total GDP (at constant prices 2007 = 100) during the period(2022 – 2016)

YEARS	2016	2017	2018	2019	2020	2021 *	2022 *	2021 *
rate(%)	10.8	-4.4	-0.02	2.8	-14.3	-0.9	4.3	-0.9

Sustainable Food Security

One of the goals of achieving sustainable development is to provide food security through sustainable agricultural production. This will double agriculture and the productivity of its workers and increase investments. This will enable every member of Iraqi society to obtain sufficient food, improving the living standards of poor and vulnerable groups.

It is possible to diagnose the above by studying and analyzing the growth rates of children under the age of five, as these rates recorded a decrease from 16.6% to 12.3%

between the years 2016 and 2018, that is, the emergence of cases of stunting among children, which is due to poor treatment of the nutritional needs of children and breastfeeding women, leading to a decrease in Weight gain among children increased from 7.1% to 6.1% in the two years mentioned previously. Cases of wasting appear among children, reaching between 3% and 7.8% for the same two years. The malnutrition rates among children in Iraq between 2016 and 2018 are shown in Figure 3 as follows:

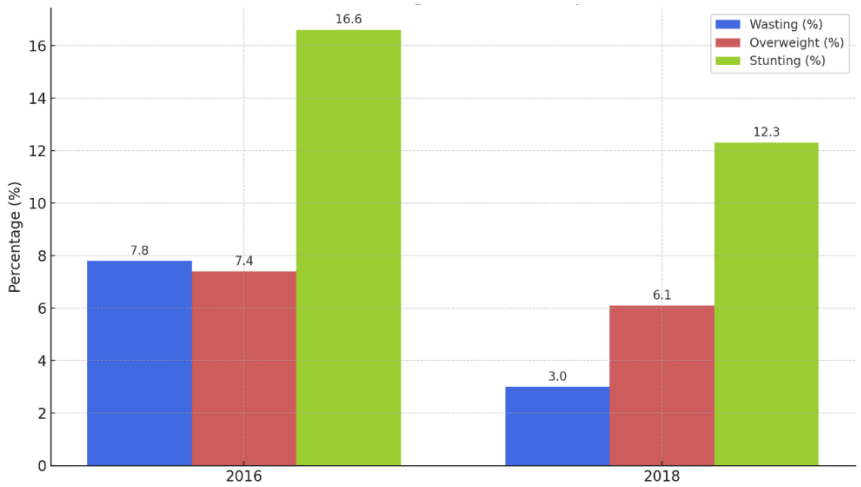

Figure 3. The malnutrition rates among children in Iraq between 2016 and 2018

Modern and sustainable energy:

The Ministry of Electricity in Iraq seeks to increase electricity generation by up to 100%. The Ministry worked to raise the percentage of the population benefiting from electrical energy processing services from 99% to 99.9% for the period (2016 – 2022). During the same period, the amount of electrical energy sold to the population increased from 39 to 56 million megawatts/hour, an increase of 43.6%, which may indicate an improvement in the percentage of beneficiaries of this energy. However, it must be noted that part of this energy is imported, as during the same period, the amount of energy imported amounted to between 12 and 21.5 million megawatts/hour, compared to the total electricity production.

It ranged from (80 – 139.6) million megawatts/hour (Iraqi Ministry of Planning, different years, different pages), which means that the contribution of imported energy to the total electrical energy produced is between (15% - 15.4%) for the same period, and this may expose the processing Electrical energy fluctuates in processing due to its connection to external influences.

In 2018, the population dependent on fuel and clean technology reached about 42.7%, which is used for cooking, heating, and lighting purposes. In the same year, the energy intensity ratios used for primary energy about the gross domestic product were recorded between (42.8% - 64.4%), and this intensity was concentrated in the consumption of liquefied petroleum gas. The share of renewable energy in the total final consumption of energy produced was about 3.3% for the year 2020, so that in the same year, the generation capacity of this energy reached about 101 kilowatt-hours (Iraqi Ministry of Planning, 2023, 38-39). The above shows the poor use of sustainable energy, which serves the environment by reducing pollutants from the processing of clean and renewable electrical energy.

Providing Decent Living and Decent Work

Due to the economic, social, security, and political conditions that Iraq has experienced, the standards of living and decent work have not improved significantly among the segments of Iraqi society. The number of poor people increased from 7,370 to 12,271 people during the period (2017 – 2021). They were below the poverty line, which was estimated during this period to be between (110,880 – 115,000) dinars Thus, the poverty rate increased between (20.5% - 29.6%), and the poverty gap reached between (4.1% - 6.3%), so the severity of poverty increased by rates ranging between (1.4% - 2.8%), as shown in Table (2) below:

Table 3. Poverty indicators in Iraq for the period(2021 – 2017)

Years	Severity of poverty (%)	Poverty gap (%)	The number of poor people is increasing	Poverty rate (%)	Poverty line (JD)
2017	2.8	6.3	–	21.3	–
2018	1.4	4.1	7.370	20.5	110880
2020	–	–	11.170	26.7	111000
2021	–	–	12.271	29.6	115000

One of the causes of poverty may be the general economic and social situation in Iraq, as well as high unemployment rates in some years, and Table 4 shows the development of these rates for the period (2016 – 2021):

Table 4. Development of unemployment rates in Iraq for the period(2021 – 2016)

Years	2016	2017	2018	2019	2020	2021
Unemployment rates(%)	10.8	16.0	8.2	8.2	12.8	16.5
Annual rate of change*(%)	–	47.9	-48.8	0.0	56.1	28.9

We note from Table 4 that unemployment rates in Iraq have recorded a relatively increasing increase, from 10.8% to 16.5% for the period (2016 – 2021), with annual rates of change ranging between (-48.8% - 56.1%) The high unemployment rates in Iraq are due to individuals losing their jobs in the economic sectors as a result of ISIS's control of some Iraqi lands in 2014, which led to an increase in people displaced from their areas and leaving their jobs and jobs, and as a result of economic, health (Corona pandemic) and social shocks (youth protests in 2019), and fluctuations in exchange rates. Foreign exchange and inflation will be reflected in the performance of economic sectors, especially in the fluctuation of local markets, and the lack of confidence of investors and traders in the monetary situation. This leads to reduced levels of investment and employment in Iraq's workforce.

Making cities safe and sustainable:

Making cities to these specifications requires providing appropriate and safe housing and services, and reducing the percentage of the population living in poor, informal, or decent neighborhoods for the Iraqi individual, as the percentage of the urban population living in such neighborhoods was estimated at 9.9% according to the results of the survey—random housing clusters for the year 2013. In 2020, no recorded cases of injured, deceased, or missing persons were due to natural disasters. Also, in 2021, the Iraqi Ministry of Health did not record any sexual assault (per ten thousand people) in Iraqi cities. The above indicates a relative improvement in providing a safe environment for Iraqi society.

As for providing a sustainable green environment in Iraqi cities, the rates of collecting solid waste and discharging it on a regular and final basis in urban areas varied between (44.1% - 65.4%), with an average of 58.8% for the period (2016 – 2022), as shown in Figure 4. as follows:

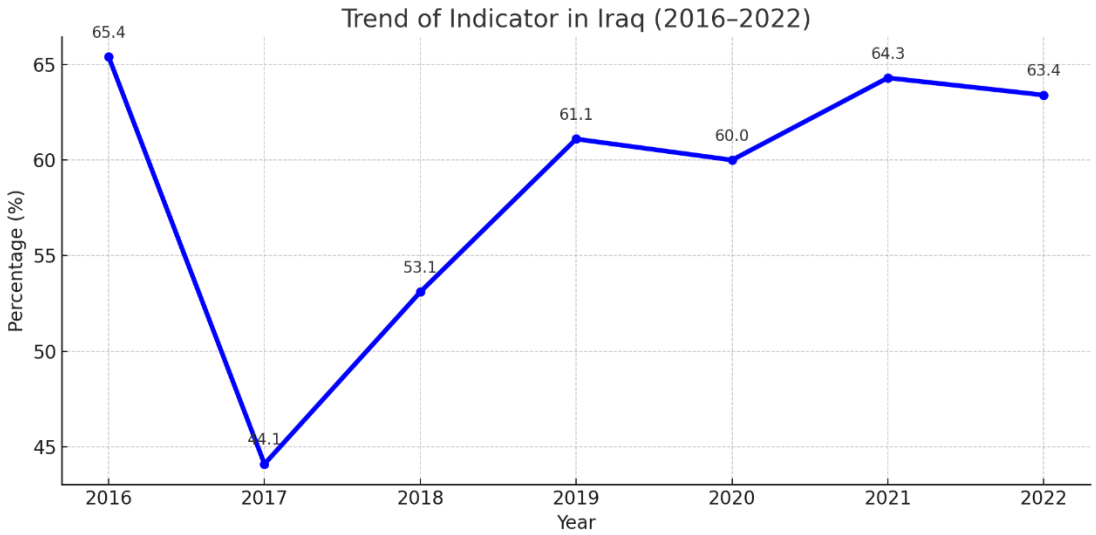

Figure 4. Trend of the Indicator in Iraq

Sustainable management of natural resources:

This management reduces poverty rates and achieves progress in sustainable economic development in Iraq. This is done by treating waste and dangerous materials that pollute the environment, affecting the individual's health, soil, air, and water in Iraq.

From observing Table (5), the per capita waste production in Iraq increased during the period (2016 – 2022) from 942,430 to 2,773,170 kg/year, with varying annual rates of change that ranged between (67.3% - 247.3%), and a compound growth of 16.7%.% %. Waste is generated in Iraq due to the increase in the economic activities of the production units of factories, farms, and the activities of homes and families. In addition, this waste is generated due to population increase, the population's orientation towards urban areas, and trade openness to the outside world, which leads to changing patterns of consumption and production in the Iraqi economy. This waste is disposed of by collecting it and burying it under layers of soil, which leads to contamination of the lands and areas near the landfill sites, the total number of which in 2021 reached about 221 sites and distributed among the governorates of Iraq, bringing the number to 72 sites that have obtained environmental approval from the competent authority, at a rate of 32.6%.% of the total sites, and 149 sites that do not have environmental approval, representing 67.4% of the total sites (Iraqi Ministry of Planning, 2024, Miscellaneous pages).

In order to revitalize the reality of the circular economy in the country, efforts and attempts have been made to manage waste by some stations and laboratories specialized in the process of recycling and treating waste. Their total number in 2021 reached about 90

stations, distributed among the governorates of Iraq, with 20 regular stations, representing 22.2% of the total. Stations, and between 70 irregular stations (temporary waste collection sites), representing 77.8% of the total stations. The total number of waste sorting and recycling plants was about 4, distributed among Baghdad Governorate, three plants, and Dhi Qar Governorate, with only one plant (Iraqi Ministry of Planning, 2024, separate pages.

Table 5. Waste quantities and recycling rates in Iraq for the period 2016 – 2021)

Years	2016	2017	2018	2019	2020	2021	2022	Compound growth rate(%)
Quantities of waste (kg/year)**	942430*	1191780	926748	3218670	1053000	2052000	2773170	16.7
Annual rate of change (%)	–	26.5	-22.2	247.3	-67.3	94.9	35.1	–
Recycled quantities (tons/year)**	–	7955	7955	11495	11495	1045	915	-30.3
Annual recycling rate**(%)	–	10	10	10	10	13.1	12.1	–

Addressing Climate Change

In line with the Sustainable Development Goals, national plans and strategies seek to address climate change and its adverse effects on the environment and the economy. Achieving economic progress and prosperity requires a clean environment that operates in economically active units and helps all groups. An unhealthy environment harms society, especially the poorest and most vulnerable, and has health and economic consequences.

Therefore, it was necessary to reduce harmful environmental emissions, including greenhouse gases such as carbon dioxide (CO2) and nitrous oxide (N2O), contributing to climate change and global warming. CO2 is usually produced from the extraction and burning of fossil fuels (such as oil and natural gas), industrial activities, and the destruction of vegetation. N2O gas is a potent greenhouse gas produced by agricultural activities, and it may also appear from fuel-burning operations and fossil energy leaks. These gases can be used to study the reality of the circular economy in Iraq. For this purpose, Table 6 was prepared, which shows the annual changes in greenhouse gas emissions resulting from economic activities in Iraq for the period.(2022 – 2016)

Table 6. Annual changes in greenhouse gas emissions resulting from economic activities in Iraq for the period(2022 – 2016)

Years	Annual rate of change(%)	N2O Gas *(MtCO2-eq)	Annual rate of change(%)	CO2-gas *(MtCO2-eq)
2016	–	0.1643	–	48.4995
2017	2.3	0.1681	3.1	49.9988
2018	0.7	0.1692	1.2	50.6237
2019	1.6	0.1719	2.0	51.6295
2020	-5.7	0.1621	-6.5	48.2853
2021	2.0	0.1653	1.6	49.0677
2022	2.6	0.1696	3.4	50.7553
Compound growth rate (%)	–	0.5	–	0.7

It is noted from Table 6 that the general trend in CO2 emissions in Iraq reached a compound growth rate of 0.7% throughout the study. These emissions increased during the period (2016 – 2019), from 48.4995 to 51.6295 megatons of CO2 equivalent, with annual rates of change between (1.2% - 2%), indicating an increase in economic activities related to the fossil energy sector (such as extracting or refining oil and natural gas).). In 2020, these emissions decreased to 48.2853 megatons of CO2 equivalent, with a negative annual change rate of -6.5%, and this may be due to the COVID-19 pandemic, which led to a decline in industrial and fossil activities in Iraq. After this year, these activities resumed their work, which led to an increase in CO2 emissions in 2021 and 2022, reaching 49.0677 and 50.7553 megatons of CO2 equivalent (respectively), with annual rates of change of 1.6% and 3.4%, respectively.

As for N2O gas emissions resulting from economic activities in Iraq during the study period, their production volume was lower than that of CO2, but the emissions of the two gases were similar in the general trend. Hence, the compound growth rate of N2O gas reached 0.5% throughout the study. Gas emissions increased during the period (2016 – 2022) gradually from 0.1643 to 0.1719 megatons of CO2 equivalent, with annual rates of change between 0.7% and 2.3%. Then it decreased in 2020 to 0.1621 megatons of CO2 equivalent, with a negative annual rate of change of -5.7%. It then increased slightly in 2021 and 2022, as gas emissions reached 0.1653 and 0.1696 megatons of CO2 equivalent (respectively), with annual rates of change of 2% and 2.6%, respectively. The annual changes in N2O gas are due to the same reasons that led to the changes in CO2 gas.

It must be noted that the reason for the large volume of CO2 gas emissions from the Iraqi economy, which may reach 99.7% of the total megabyte equivalent of CO2 each year,

compared to N2O gas emissions, which may constitute a small percentage of up to 0.3% of the total megabyte equivalent of CO2 each year, is due to the nature of the energy sector in Iraq, which relies excessively on the production of crude oil and natural gas To cause significant emissions of CO2 gas as a result of extraction and refining, which has a harmful and negative impact on the Iraqi environment and the sustainability of other resources necessary for the needs of future generations.

Protecting ecosystems:

It consists of preventing pollution of the ecosystems of both water and land, in a way that ensures the sustainability and continuity of these systems, avoids the adverse effects of economic activities, and enhances the ability of these systems to withstand and sustain them for the benefit of future generations. The wealth of these systems contributes to achieving economic benefits that increase the country's economic growth and sustainability, so the amount of resources is necessary

resulting from these systems to demonstrate the extent to which sustainable management of water resources and vegetation cover is achieved, and to treat the land from desertification and degradation.

A-Sustainable management of aquatic wealth production: It is possible to identify levels of sustainable management by studying and analyzing the development of the quantities of river and marine fish caught in Iraq for the period (2016 – 2021), shown in Table 7, as follows:

Table 7. Evolution of the quantities of river and marine fish caught in Iraq for the period(2022 – 2016)

Years	2016	2017	2018	2019	2020	2021	Compound growth rate (%)
Anadromous fish (tonnes/year)	48986	52771	75719	62022	45006	96662	2.1
Annual rate of (%) change	–	7.7	43.5	-18.1	-27.4	114.8	–
Marine fish (t/year)	6879	10539	14220	12858	14143	9794	12.7
Annual rate of (%) change	–	53.2	34.9	-9.6	10.0	-30.8	–

It is clear from Table 7 that there will be large fluctuations in the production of river fish in Iraq from 2016 to 2021. The peak production was in 2021, reaching 96,662 tons/year, and a significant increase at an annual rate of 114.8%. This may be due to improved conditions—the environment surrounding the river's wealth or increased investments in

these fish. As for the sharp declines in the years 2019, 2020, and 2022, production reached 62,022, 45,006, and 56,701 tons/year (respectively), at negative annual rates of -18.1%, -27.4%, and 41.3%, respectively. This may be due to several reasons, including climate change and decreased rainfall. Weak river imports from the Tigris and Euphrates And the economic conditions surrounding the Covid-19 pandemic, which caused weak demand for river fish as a result of the impact on the real incomes of the Iraqi consumer, especially in the years 2019 and 2021, in addition to the improper management of Iraqi rivers, which affects the sustainability of their fish resources and their economic contribution. Therefore, this management requires applying some techniques such as recycling Water in fish farming, which reduces freshwater consumption and uses marsh water treatment and purification to support the sustainability of fish wealth.

The compound growth rate of river fish production has reached a low rate of 2.1%, which shows the general instability of this type of fish.

As for the production of marine fish in Iraq, it was more stable and growing than that of river fish during the studied period. The compound growth rate for the production of these fish reached 12.7%. As production of these fish increased from 6,879 to 15,894 tons/year during the period of the study, and at varying annual rates that ranged between (-30.8% - 62.3%), the improvement in marine fish catches indicates an improvement in marine fishing practices, or the result of some investments being directed towards Marine fisheries, as for the years that recorded negative annual rates of change, such as 2021, when the annual rate of change reached a negative rate of -30.8%, the reason for the decrease may be related to seasonal or environmental factors, such as climate fluctuations, water pollution, or a decrease in the volume of marine reproduction. This requires a greater increase in investment to increase the production of river and marine wealth through the use of processing and recycling some fish waste, such as skins and entrails, to produce organic fertilizers and feed for fish feed in general, in addition to developing modern fish farms that rely on sustainable nutrition, such as using food waste after processing it. Treatment and recycling operations will enhance the economic benefits of fish and human waste, increasing the agricultural sector's contribution to the domestic product.

As Table 7 shows, river fish production is higher than marine fish production, reflecting the great economic importance of the Iraqi rivers (the Tigris and Euphrates rivers) in contributing to local production. Despite this, the importance of developing the maritime sector to increase its economic contribution to Iraq must be noted.

B-Sustainable management of natural vegetation cover and treatment of desertified and degraded agricultural lands: To study and analyze the levels of this management of the area of natural vegetation cover (forests) and the extent of agricultural land degradation and desertification in Iraq for the period (2016 – 2022), the following table (8) has been prepared:

Table 8. Area of desertified and degraded forests and agricultural lands in Iraq for the period(2022 – 2016)

Years	2016	2017	2018	2019	2020	2021	2022
Forestry (%)	3.1	3.1	3.1	1.6	1.6	1.3	1.4
Annual rate of change (%)	–	0.0	0.0	-48.4	0.0	-18.8	7.7
Desertified and degraded (%) lands	*66.3	79.8	79.8	69.5	69.5	69.8	–
Annual rate of change (%)	–	20.4	0.0	-12.9	0.0	0.4	–

It is noted from Table 8 that the percentage of forests out of the total area of Iraq from 2016 to 2018 remained constant, then witnessed a relatively significant decline in 2019 by 1.6%, with an annual decline rate of -48.4%. The decline continued from 2021 to 1.3%, with an annual decline rate of -18.8%. A slight increase in the percentage for 2022 to reach 1.4%, with an annual increase rate of 7.7%. The above indicates changes resulting from desertification, climate change, or the removal and lack of care for forests and protection from grazing and bulldozing, which affects the natural vegetation cover. It also indicates weak management procedures for this cover for its sustainability. In addition, the percentage of forests out of the total area of Iraq (less than 4%) reflects the desert nature of Iraq, so forests (natural cover) must be taken care of in order to reduce the phenomenon of land erosion, preserve the soil, and regulate and moderate the local climate.

Table 8 also notes that the percentage of desertified and degraded lands out of Iraq's total area has increased from 66.3% in 2016 to 79.8%, with an annual increase of 20.4%. This indicates the exacerbation of desertification in Iraq, which may be due to mismanagement of water resources, drought, and climate change.

The percentage of desertified and degraded lands out of the total area of Iraq has also stabilized relatively for the period (2019 – 2021), reaching between 69.5% and 69.8%, with varying annual rates amounting to between (-12.9% - 0.4%). The relative decline in 2019 of

-12.9% may be due to land restoration and remediation efforts by some agricultural institutions in Iraq. The increase in 2021 to 0.4% may indicate that the desertification phenomenon in Iraq is still a significant challenge for agricultural management.

Obstacles to the circular economy in Iraq:

The circular economy depends on recycling waste and resources, reducing waste, and promoting the sustainable use of natural resources in the local economy. Applying the above requires an appropriate economic and environmental infrastructure that is aware of the importance of the circular economy in order to sustain the economy. As for Iraq, it faces several obstacles and difficulties in implementing the circular economy, even though the Iraqi economy possesses capabilities that work and help achieve economic sustainability and ensure the needs of future generations. Among these obstacles are:

A. **Excessive dependence on oil:** As we previously indicated, the relative importance of oil production and exporting it abroad, as the Iraqi economy focuses on extracting primary (oil) resources in their raw form, and this matter may reduce investment in sustainable economic models such as the circular economy, which is concerned with the processes of recycling these resources. Resources and their products, or achieving their sustainability.

B. **Weak industrial infrastructure:** Implementing the circular economy in Iraq requires modern factories and technologies for recycling and waste management. Iraq suffers from deteriorating infrastructure due to decades of wars, sanctions, security conditions, and the spread of administrative and financial corruption, which makes establishing effective recycling systems a costly obstacle to reconstructing and building the infrastructure necessary to implement the circular economy in Iraq.

C. **Absence of a supportive legislative framework:** There is an absence of clear laws and legislation necessary to support the circular economy in Iraq, for example the presence of fees on waste resulting from productive and economic activities, and the provision of incentives for public and private companies and institutions that depend on the process of recycling waste and by-products resulting from production, and this legislative vacuum. It may hinder and discourage motivation for the private and public sectors.

D. **Lack of environmental and economic awareness:** Iraq's society, institutions, and economic units are unaware of the importance of the circular economy. Therefore,

widespread awareness campaigns are needed to change some consumer behaviors of individuals and institutions and encourage separating waste inside homes and companies and reusing and recycling this waste.

E. High rates of non-recycled waste: As we previously indicated, Iraq produces quantities of recyclable waste, but waste collection and recycling systems may not be modern or sufficient, which leads to the accumulation of waste instead of exploiting it as resources that achieve economic benefits for the country.

F. Limited financing and investment: Implementing the circular economy in Iraq requires financial resources and huge investments based on modernizing technology and strengthening infrastructure. However, Iraq may suffer from a deficit in financial allocations directed towards recycling operations and from directing priorities for public spending towards investment aspects instead of focusing on wasteful expenditures (Consumption), which may not support sustainable projects.

H. Instability of the security and political situation: Political and security tensions may disrupt planning in the short, medium, and long terms, which is necessary to achieve economic sustainability in Iraq by directing investments and funds towards projects such as building factories and factories that recycle. This requires stability that ensures the implementation of these projects and their follow-up and continuity.

G. The phenomenon of administrative and financial corruption: This phenomenon is considered one of the most prominent obstacles to the progress of the Iraqi economy, as reports and indicators of corruption perceptions by Transparency International indicated that this phenomenon has spread in some government administrative and service institutions in Iraq, where the degrees of corruption in Iraq during the period (2016 – 2022) reached Between (18 – 23) degrees, the average is about 20 degrees Globally, it ranked between (157 – 169) out of 180 countries, and between (12 – 15) out of 22 Arab countries, as Iraq is among the most corrupt Arab countries (Transparency International, 2016 - 2022, Various Pages). This corruption will be a significant obstacle to applying the principles of the circular economy in Iraq, as it negatively affects the economic, social, and environmental aspects of the circular model, which depends on the principles of reuse, recycling, and sustainability of resources. These are principles that require an environment in which there is transparency, good governance, and organized investment. If it is not available, the

investment process to achieve economic development, sustainability of resources, and beneficial economic exploitation will worsen.

H. **Natural resource degradation:** Water and soil depletion due to pollution, desertification, and mismanagement may hinder the sustainability of natural resources on which the circular economy depends, such as sustainable agriculture or water recycling.

Opportunities to support sustainable development in Iraq through the circular economy:

Despite the above, there are opportunities to achieve economic sustainability in Iraq by applying the principles of the circular economy, including the following:

A. **Utilization of young human resources:** Iraq has large youth cohorts of the working-age and economically active population (those under 40), constituting a young and dynamic workforce. This strength can be invested through specialized vocational training programs in areas of the circular economy, such as waste management, recycling, and sustainable design. Such as providing training and youth courses in the operations of recycling factories and their maintenance, or in developing small projects that work to transform waste into salable products that have economic benefits for this power and the country. This will provide new job opportunities, lead to reducing the unemployment rate in the Iraqi economy, and work to enhance societal and institutional awareness of the importance of sustainability for new generations.

B. **Possibility of recycling oil waste:** The oil industry is the backbone of the Iraqi economy, as it produces vast quantities of waste, including burning gases, polluted water, and chemicals. It is possible to convert these wastes into valuable resources using modern technologies. For example, converting it into fuel or electricity is possible instead of burning the natural gas associated with extracting crude oil and wasting it. Water from oil extraction operations can be treated for use after treatment in agriculture or industry. Oil chemical products can also be used in other industries, such as construction or cement. Treating and recycling oil waste helps reduce environmental pollution in Iraq, increases revenues from currently wasted resources, and supports economic diversification in Iraq away from heavy dependence on crude oil.

C. **The necessity of international support and global partnerships:** Iraq receives wide international attention due to its strategic geographical location and oil wealth, but it lacks local expertise in sustainability. Therefore, it is possible to obtain international grants and aid from organizations such as the United Nations and the World Bank, direct this aid towards financing circular economy projects, and benefit from it to finance the construction of waste recycling factories that rely on modern technology. Or through technology transfer and international waste management expertise, such as Germany and Japan. Establishing international partnerships helps develop important projects in large cities such as Baghdad and Basra (due to their economic importance). The above will accelerate the transformation towards economic sustainability, reduce the financial burden on the government. It will also enhance the economic position of Iraq, as it is one of the countries seeking to achieve the Sustainable Development Goals.

E. **Exploitation of geographical location and natural resources:** Iraq has a strategic location between Europe and Asia, and has abundant natural resources such as water (Tigris and Euphrates rivers) and large areas of agricultural land. It enables it to produce and export recycled materials (such as plastics or metals) to neighboring countries such as Turkey and Jordan. It enables us to recycle water by developing modern water treatment systems to reuse wastewater in agriculture or industry, especially in light of water scarcity due to climate change and Turkish dam policies. It is also possible to benefit from solar energy and integrate renewable energy into operating factories and laboratories that the local economy needs, as Iraq enjoys many sunny days. The above will help and enhance Iraq's economic independence, reduce dependence on imports, and contribute to confronting regional environmental challenges.

F. **Strengthening the role of local communities and small initiatives:** The activities of civil society organizations and individual initiatives are limited in Iraq's recycling and economic sustainability field. Therefore, these organizations and initiatives must strive to support small and medium enterprises that focus on the circular economy, such as encouraging waste collection and sorting operations at the local level with the help of youth and entrepreneurs, and working to establish cooperative societies that help convert organic waste into materials and fertilizers used in the agricultural sector. Initiatives should also encourage handicrafts using recycled materials (such

as converting plastic into decorative products). All of the above will help improve the standard of living of groups in rural and marginalized areas, work to strengthen the local economy, and help build a culture of economic sustainability at the popular level.

The issue of implementing the circular economy in Iraq may face obstacles. However, with strategic planning and investment in education and infrastructure, achieving important steps towards economic sustainability is possible, which enhances Iraq's capabilities to confront future problems. In particular, Iraq has important and wide-ranging opportunities to achieve economic sustainability by adopting the circular economy principles. These opportunities require extensive investments and a change in economic and financial policies, enabling the Iraqi economy to shift from a linear model that depletes natural and economic resources to a circular model that enhances sustainability in the country.

4. CONCLUSIONS

Since 2016, per capita economic growth in Iraq has decreased from 10.8% to just 4.3%, with a decline of 14.3% in 2020. This downturn indicates that the economy is unstable and that achieving sustainable development is challenging. In this context, a circular economy can enhance sustainability in Iraq by reducing waste, improving resource use, and cutting harmful emissions by as much as 40% by 2050. However, Iraq faces challenges in transitioning to a circular economy, including an overreliance on oil, comprising 61.1% of GDP, and outdated industrial plants that fail to produce cleanly. Supporting the circular economy can help develop other economic sectors. For example, it can promote recycling and clean energy, creating jobs for those struggling to find work. Iraq must collaborate closely with global partners and leverage international knowledge, funding, and technology to enhance its circular economy. Raising awareness about the circular economy among households is crucial, given that they consume 29% of all global energy and emit 21% of CO_2. Educating people through public campaigns and school lesson plans can change how we consume products. In summary, developing strategic approaches to reduce oil dependency, invest in clean energy sources, stimulate green innovation, collaborate with other countries, and educate everyone about circular systems is essential for Iraq to transition to sustainable development successfully.

REFERENCES

Ahmed, H. A. (2021). Indicators of the sustainable development goals in Iraq (2016–2020). Al-Bayan Center for Studies and Planning.

Al-Dabbagh, D. F. (2022). Percentage of desertified lands threatened by desertification in Iraq for two years (2016–2020). Iraqi Council of Representatives, Research Department.

Al-Khoury, A. M. (2020). The new global economy between the knowledge economy and its modern concepts, the digital economy, and accelerated innovation and technology (Part 1). Council of Arab Economic Unity of the League of Arab States.

Bayoumi, S. (2023). The circular economy as an economic model for sustainable development: Opportunities for transformation in light of modern environmental challenges. Egyptian Enterprise Center for Policy and Strategic Studies. Retrieved March 14, 2025, from https://egyptianenterprise.com

Economic and Social Commission for Western Asia (ESCWA). (2023). Accelerating the transition to a circular economy in the Arab region. United Nations.

Ellen MacArthur Foundation. (2021). Completing the picture: Executive summary. Retrieved March 13, 2025, from https://emf.thirdlight.com/file/24/XoGiOySXvopGQ9Xo4d6XnKIvUh/Completing%20the%20picture%20-%20%20Executive%20summary.pdf

Fatima, D. (2022). The role of the circular economy in achieving sustainable development: The Tunisian experience as a model. Creativity Magazine, 12(2).

Fawaz, A. (2019). The circular economy: The concept, applications, and proposals concerning an Arab experience. In Proceedings of the 15th Scientific Conference of the Arab Society for Economic Research (Arab Development between Current Challenges and Prospects of the Fourth Industrial Revolution), Lebanon.

Ghalab, F. (2021). The circular economy: Selected concepts and experiences. Journal of Development Research and Studies, 8(2). Bordj Bou Arreridj University, Algeria.

Iraqi Ministry of Planning. (2017). Iraq poverty survey 2017. Central Bureau of Statistics.

Iraqi Ministry of Planning. (2019). Statistical report on sustainable development goals for 2019. Statistics and Geographic Information Systems Authority, Human Development Statistics Section.

Ministry of Planning - Iraq. (2016–2022a). Reports on electricity indicators (2016–2022). Central Statistical Organization, Directorate of Industrial Statistics.

Ministry of Planning - Iraq. (2016–2022b). Annual statistical abstracts (2016–2022). Central Statistical Organization, Directorate of National Accounts.

Ministry of Planning - Iraq. (2019). Iraq: The first voluntary national review on sustainable development goals 2019 – A triumph of national will. Central Statistical Organization.

Ministry of Planning - Iraq. (2021a). Statistical report on sustainable development goals 2021. Directorate of Statistics and Geographic Information Systems, Department of Human Development Statistics.

Ministry of Planning - Iraq. (2021b). The second voluntary national review on the achievement of the sustainable development goals 2021 – Iraq: Back on the development path. Central Statistical Organization.

Ministry of Planning - Iraq. (2023). Statistical report on sustainable development goals 2023. Directorate of Statistics and Geographic Information Systems, Department of Human Development Statistics.

Ministry of Planning - Iraq. (2024). Statistical abstract (2022–2023). Central Statistical Organization, Directorate of National Accounts.

Transparency International. (2016–2022). Corruption perceptions index (CPI) reports. Retrieved March 18, 2025, from https://www.transparency.org/en/cpi

United Nations. (2017). 2017 sustainable development goals report. United Nations.

United Nations. (2021). 2021 sustainable development goals report. United Nations.

World Bank. (2016–2022). World development indicators. Retrieved March 15, 2025, from http://data.worldbank.org/data-catalog/world-development-indicators