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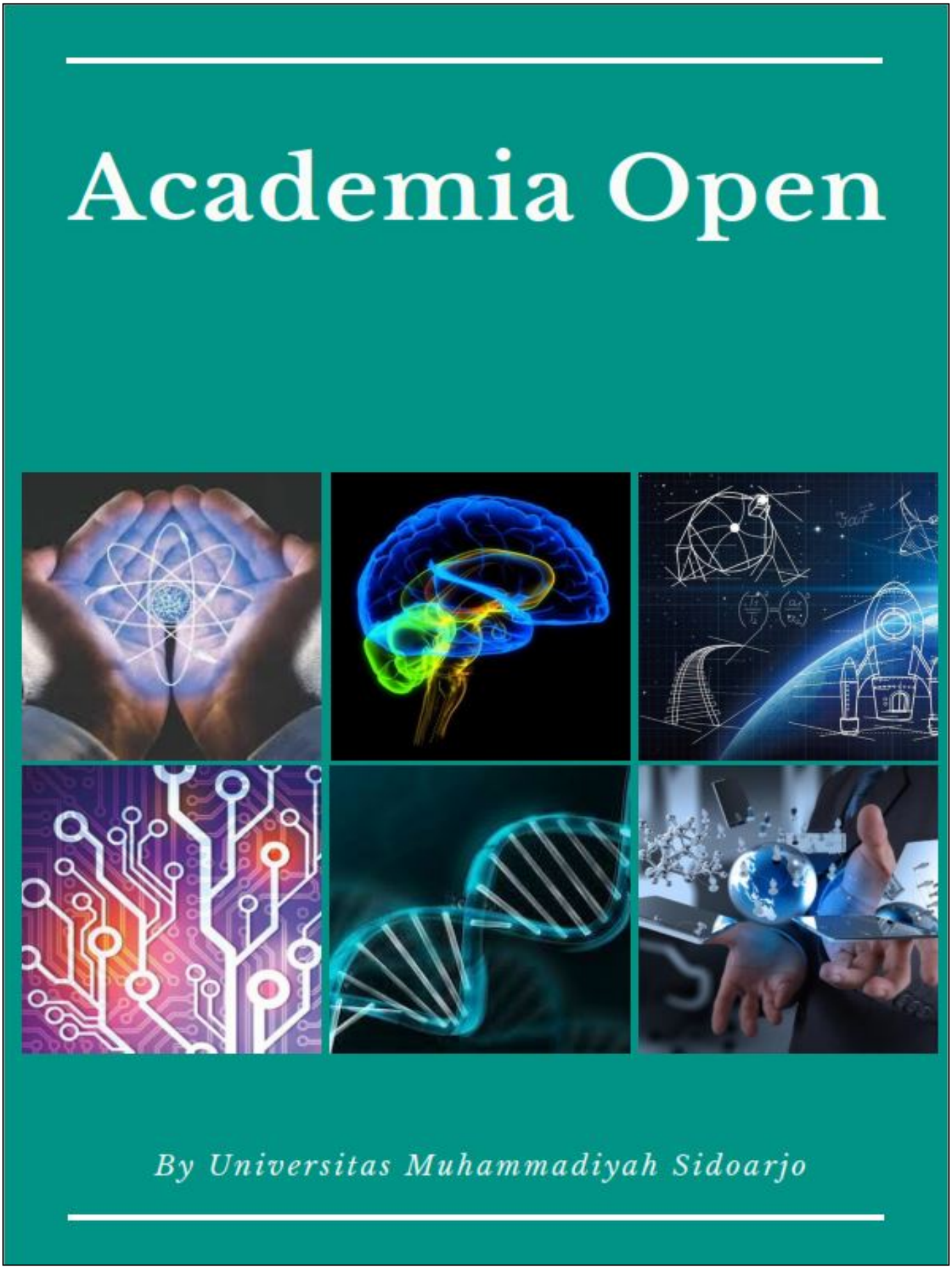

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Analysis of the Relationship between Green Technology and Sustainable Development (United Arab Emirates as a Model): Analisis Hubungan antara Teknologi Hijau dan Pembangunan Berkelanjutan (Uni Emirat Arab sebagai Model)

Analisis Hubungan antara Teknologi Hijau dan Pembangunan Berkelanjutan (Uni Emirat Arab sebagai Model)

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Abstract

General Background: Green technology has emerged as a critical driver in addressing environmental degradation, climate change, and resource depletion while supporting global sustainability goals. **Specific Background:** The United Arab Emirates (UAE) has positioned itself as a regional leader in adopting green technologies, investing heavily in research, development, and infrastructure across energy, education, transportation, and health sectors. **Knowledge Gap:** Despite global interest, limited empirical research examines how national strategies, technological indicators, and innovation outputs collectively shape the UAE's sustainable development trajectory. **Aims:** This study aims to analyze the relationship between green technology and sustainable development in the UAE, focusing on its policies, applications, and challenges. **Results:** Findings reveal that increased R&D expenditure, growth in scientific publications, expansion of renewable energy projects, and rising patent registrations significantly contributed to advancing smart cities, energy efficiency, and environmental sustainability. **Novelty:** The research provides an integrated assessment of technological, economic, and institutional dimensions, offering a comprehensive view of how green technology drives sustainability in an Arab context. **Implications:** The study highlights the UAE's experience as a transferable model for emerging economies, emphasizing the need for continuous investment, policy alignment, and private-sector engagement to strengthen the global transition toward sustainable development.

Highlight :

1. Green technology plays a key role in achieving sustainable development in the UAE.
2. Smart city projects and renewable energy are main applications of green technology.
3. Research, development, and patents strengthen innovation and sustainability.

Keywords : Green Technology, Sustainable Development, Smart City, Renewable Energy, Patents

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Introduction

Green technology is a modern, environmentally friendly term that preserves the environment for future generations by achieving environmental sustainability using modern technologies to protect the environment and living organisms, address global warming, and reduce carbon emissions by meeting consumer demands without depleting natural resources and preserving natural resources from depletion. The UAE's success in achieving green technology stems from increased spending on research and development, while creating a suitable environment to attract foreign investments interested in producing green technologies that can reduce pollution and improve the efficiency of economic resources. The research seeks to analyze the relationship between green technology and sustainable development in the context of the UAE experience, and the extent to which these technologies impact economic, social, and environmental development indicators.

Methodology

A. Research objective

The research aims to clarify the nature of green technology and its indicators, understand the challenges that hinder the development of the technology, and analyze the reality of green technology and its relationship to sustainable development in the United Arab Emirates.

B. Significance of the Research

The importance of the research stems from its topic, green technology, and the potential for its application in certain areas to achieve sustainable development. It also explores the extent to which some countries, particularly the United Arab Emirates, have benefited from it.

C. Research Problem

The research problem lies in the challenges and obstacles facing the implementation of green technology and its applications, as well as the lack of funding for developmental areas. Therefore, the research aims to analyze the relationship between green technology and sustainable development in the UAE, a country that has been successful in terms of spending on this field. .

D. Research Hypothesis

The research assumes that there is a clear and strong positive relationship between the application of green technology and sustainable development in the UAE, which in turn is reflected in the achievement of sustainable development goals in the UAE .

LITERATURE REVIEW

First Topic

Green Technology and Sustainable Development

a. First: The Concept of Green Technology

Green technology is defined as environmentally sustainable technology designed and used in a manner that does not harm the atmosphere and conserves natural resources. Green technology is also known as sustainable technology and sustainable energy. Its goal is to meet societal needs without harming or depleting the planet's natural capital, and to meet current demands without sacrificing quality.(1)

The term "green technology" emerged as a technological application that works to protect the environment and contributes to developing technological solutions to reduce carbon emissions and global warming. Green technology represents a significant shift in terms of using technology to achieve optimal resource utilization, significantly improve services, and achieve goals with higher quality, greater sustainability, and at lower costs. Green technology has played an effective role in the emergence of the green economy as a new approach to effectively address technology applications in industry, positively impact the economy, and address environmental damage to humans and the surrounding environment.(2)

Green technology aims to reduce the environmental impacts caused by traditional technology, such as air pollution, ozone depletion, climate change, and biodiversity loss. This is intended to preserve the environment and achieve sustainable environmental development by using environmentally friendly methods to exploit and recycle natural resources, thus reducing the amount of waste and pollution caused by traditional technology. Today, the international pursuit of human security is not limited to military security alone, but also includes environmental security, given its significant role in achieving food, water, and health security, given the threat posed by environmental disasters today to all aspects of human life.(3)

Some define it as a comprehensive term that explains how it is applied and uses science to protect and preserve the

environment for future generations and ensure its sustainability through the use of numerous tools that contribute to this achievement, such as environmental monitoring and stimulating and encouraging the production and use of clean energy. It has been described as "green" because the color green has always represented nature. Therefore, this technology has enjoyed rapid development and growth in various parts of the world. (4)

b. Second: Benefits and Advantages of Green Technology

There are numerous benefits resulting from the use of green technology, as follows:

1.It contributes to the development of production methods and the introduction of appropriate modifications to the product life cycle, which includes the extraction of raw materials, their manufacture, transportation, storage, and use of these products.

2.It contributes to bringing economic and social benefits to specific areas, such as rural areas

3.It requires less maintenance

4.It is economical in many uses (5)

5.It prevents all forms of pollution and works to slow the effects of global warming by reducing carbon dioxide emissions.(6)

6.It can be manufactured locally

7.It contributes to the conservation of natural resources and energy

8.It is renewable, meaning it will never run out

9.It encourages the recycling of waste materials of paper, glass, metal, and plastic for further utilization.

3. Third: Green Technology Objectives

Green technology seeks to achieve a set of objectives, as follows:

1.Developing and enhancing the skills of employees, managers, and technology investors

2.Reducing costs, reducing the size of the production system, improving productivity, and introducing appropriate modifications.

3.Monitoring successive technological changes and their impact on society, and how to deal with technological devices and equipment, to regulate their performance, maintenance, and development.(7)

4.Creating new products, developing marketing methods and techniques, and identifying new management models..

5.Treating water and wastewater, and treating and managing waste in an environmentally safe manner

6.Conserving raw materials and energy(8)

7.Working to integrate health and environmental considerations into all production processes. (9)

Second Topic

Technology Indicators in general, and Green Technology in particular

To measure the technological development taking place in a country, it is necessary to rely on specific indicators, which are acquired according to several mechanisms, including.(10)

a. First: Research and development expenditures: Investment in research and development is one of the most important drivers of sustainable economic growth. Spending on research and development at all social and technical levels will raise the prevailing level of technology in the economy, improve productivity, and contribute to solving problems facing the country due to the poor performance of economic sectors or irrational decisions at the sectoral or aggregate level. It also supports decision-makers in the country with the necessary research and studies that help clarify the vision in the medium and long term in light of international and local variables. (11) Spending on research and development includes calculating all total expenditures on research and development, such as government spending on research and development, spending by private companies and non-profit institutions, and spending on higher education. It also includes contributions from abroad. Various methods are used to evaluate a country's technology and scientific specializations through research, development, and patents.(12)

b. Second: Scientific publications: Sometimes called scientific literature, they include publications that present theoretical and experimental results and evidence in the natural and social sciences. Publishing is the process of producing and

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disseminating information in various forms. The term also refers to the distribution of printed works such as newspapers, magazines, and books. With the emergence of green technology, the internet, and information systems, the scope of publishing has expanded to include electronic resources such as electronic versions of periodicals, books, and websites. Publishing encompasses the stages of development, printing, production, and distribution of magazines, newspapers, books, literary works, computer programs, and other works that deal with information, including electronic media. (13)

Quantitative data in science focus on a specific set of national researchers' scientific publications in the international arena and are a means of evaluating the results of specific research activities, allowing for the creation of two types of indicators. (14)

A-Indicators of scientific specializations by subject .

B-Indicators with a scientific focus.

1.High-tech international trade

A country's high-tech trade activity is a reliable indicator of its competitiveness. It is an important measure for calculating the percentage of trade and the proportion of high-tech products in a country's total exports, which include electrical products, power generation equipment, communications and data processing equipment, space equipment, optical scientific instruments, etc.(15)

2 - Patents

Most countries around the world seek to create and improve an environment conducive to innovation, invention, intellectual property applications, and research and development (R&D) as engines for building the future global economy. Therefore, they have sought to develop legislative, legal, and environmental frameworks that support innovation, stipulating the granting of a patent for each new invention. (16)

A patent grants you exclusive rights to your inventions for up to 20 years from the application date. This type of intellectual property protection encourages innovation and allows inventors to control and benefit from their unique inventions To obtain a patent, your invention must be novel, non-obvious, industrially applicable, and meet other legal requirements for granting patents in the UAE.

The Ministry of Economy processes applications in the UAE under Federal Law No. (17) of 2021 Concerning the Regulation and Protection of Industrial Property Rights. Please note that applying through the Ministry of Economy will only grant you protection in the UAE. If you wish to protect your intellectual property rights in other countries or regions, you must submit the application through the intellectual property offices of those countries.

c. Third: The Most Important Green Technology Applications for Sustainable Development in the UAE

We will review a number of applications that contribute to promoting sustainable development in the UAE, which rely on the use of green technologies to accomplish their tasks, including the following:

1.The Smart City Project (Masdar as a Model)

UAE cities have achieved remarkable achievements in developing smart cities, according to the IMD Smart Cities Index 2024. Abu Dhabi and Dubai have entered the list of the top 20 smart cities worldwide compared to 2023. Abu Dhabi climbed three places to rank tenth, while Dubai jumped five places to rank twelfth. It is worth noting that Abu Dhabi and Dubai are the only two cities in the Middle East to be included in the top 20. This achievement reflects the UAE's commitment to innovation and sustainability, and highlights it as a model for smart urban development.(18)

Working strategies have been developed for the Emirate of Abu Dhabi, represented by Masdar City, the Zayed Smart City Project, and the Abu Dhabi Economic Vision 2030.

- -Planning for Masdar City since 2006: Masdar City is one of the world's most sustainable urban communities, encompassing a growing low-carbon, clean-tech community, a free zone, residential areas, restaurants, retail, and parks. Masdar's philosophy of sustainable urban development is based on the three pillars of economic, social, and environmental sustainability. Masdar City represents a "green footprint" for sustainable urban development in cities, offering practical solutions in water, energy efficiency, and waste reduction.(19)

- -Zayed Smart City Project: In 2018, the Abu Dhabi Department of Urban Planning and Municipalities launched the pilot phase of the five-year plan for smart cities and artificial intelligence (2018-2022) under the name Zayed Smart City Project. The project aims to manage infrastructure elements using Internet of Things technology, anticipating the future, activating innovation, and achieving world-class infrastructure.(20)

- Abu Dhabi Economic Plan 2030

The "Abu Dhabi 2030 Urban Structure Framework Plan" was designed to help the Abu Dhabi government establish a clear vision to meet the current and future needs of the Emirate of Abu Dhabi, promote a new way of thinking to enhance the

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Emirate's progress, and provide conceptual solutions to anticipate its growth over the next quarter century. Plan Abu Dhabi 2030 was prepared by the Abu Dhabi Urban Planning Council. The plan establishes a clear vision for the sustainability of the Emirate of Abu Dhabi, meets its current and future needs, develops and enhances the community, and promotes a new way of thinking to enhance the Emirate's position and long-term vision. The plan presents conceptual solutions for the Emirate's development over the next quarter century, addressing key issues including the environment, land use, transportation, land and space, and the capital city.(21)

Among the most important projects completed in Masdar City are: (22)

A.Converting landfill gas into energy. This project was established in 2011, and its objectives include reducing the emission of harmful gases such as carbon dioxide and carbon dioxide by converting it into energy.

B.An energy management system for smart homes.

C.Identifying geothermal energy as a source of global cooling.

D.Models for environmentally friendly buildings.

2 -Renewable energy

Renewable energy can be defined as energy derived from natural resources that are inexhaustible and constantly replenished. Renewable energy is also defined as energy produced from natural resources that are replenished at a rate greater than their consumption. Renewable energy is also referred to by several terms, including clean energy and green energy. Renewable energy uses are concentrated in generating electricity, while other uses, such as water heating and cooling, as well as transportation, remain underutilized.(23)

A.Establishing Masdar City: Masdar City's private companies are responsible for pursuing the development and deployment of high-tech renewable clean energy technologies to build Masdar City, the world's first carbon-neutral city. (24) This city contains clean energy projects and research centers, such as the wind farm, the Shams Hydroelectric Power Plant in Abu Dhabi, the Umm Al Nar Plant, and the Noor Solar Energy Project.(25)

B.Bin Rashid Al Maktoum Solar Park: Renewable energy authorities have been working to build a complex in Dubai, led by the Water Authority. This complex was built in Dubai because it relies on photovoltaic and solar energy. The goal of this project is to provide clean energy to citizens, reduce greenhouse gas and carbon emissions, and achieve energy security. It is the largest solar energy complex in the world, and its production capacity is expected to reach 5,000 megawatts by 2030. Since its launch, the complex's projects have received significant attention from global developers, contributing to raising the capacity of solar energy projects in the complex to 1,013 megawatts using photovoltaic panels and concentrated solar power (CSP) technology. The capacity of projects under implementation amounts to 1,850 megawatts, with the goal of reaching 5,000 megawatts by 2030. It includes research and innovation centers and was initially operational in 2013 using solar energy.(26)

Section Three

The UAE's Experience in Implementing Green Technology

a. First: An Overview of the UAE Economy

The UAE economy has witnessed significant prosperity, placing the country among the top tiers in terms of several economic indicators, such as per capita income and per capita energy consumption. The gross domestic product reached $414 billion in 2018. (27) The UAE thus ranks second among Gulf countries, after Saudi Arabia, which holds the first place. It also ranks third in the Middle East and North Africa region, after Saudi Arabia and Turkey, and 29th in the world, according to World Bank estimates for 2018. It is worth noting that the UAE in general, and Abu Dhabi in particular, has the highest percentage of wealthy people in the world, with more than 75,000 millionaires, representing 8.8%. (28)

Previously, the region's economy relied heavily on agriculture, fishing, date trade, and pearls. However, the discovery of oil in the 1950s brought about a radical change in the structure of economic life, aided by its strategic location, government spending, economic diversification policies, and government efforts to transition to a knowledge-based economy by encouraging innovation and strengthening the regulatory framework for key sectors. (29) It is worth noting that the UAE ranked 31st in the Global Innovation Index in 2023, but fell to 32nd in the 2024 index. On June 19, 2024, the UAE topped the world in attracting high-net-worth individuals (HNWIs) who flocked to the country during 2023, according to the results of the "Personal Wealth Migration Report, 2023.(30) ."

The UAE also ranked first globally for the third consecutive year in the 2023-2024 Global Entrepreneurship Monitor (GEM) report, achieving a score of 7.7, a record high for the first time in the report's history. In 2024, the UAE ranked first in the "Most Economically Stable Countries" category, which falls under the "Best Countries in the World" index issued by US News.(31)

b. Second: Analysis of the development of green technology indicators in the UAE

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1)Research and development indicators in the United Arab Emirates

A. Research and development spending indicators

Total spending on scientific research is one of the most important indicators for measuring the progress of nations. Moreover, the volume of spending reflects the extent of a society's interest and appreciation in supporting the march of science and technological progress, advancing development, and achieving prosperity for its people.

R&D expenditures are current and capital expenditures (in both the public and private sectors) on innovative work undertaken systematically to advance knowledge, including human, cultural, and societal knowledge, and to utilize knowledge in new applications. Research and development covers basic and applied research and experimental development processes.(32)

Spending on research and development can be viewed as one aspect of human capital, which is defined as: Spending on research and development: The sum of knowledge experience and human capital, i.e., an individual's productivity, in addition to individual innovation and emotional intelligence. Human capital can also be defined as all human resources with distinct capabilities to fill positions, possessing creative, innovative, and superior abilities. This includes workers' advanced knowledge, their accumulated life and work experiences, and their technical and artistic skills. (33)

year	Research and development spending / percentage of GDP%
2011	0.49
2014	0.69
2015	0,90
2016	0.96
2017	1.13
2018	1.30
2019	1.3
2020	1.4

Table 1. Shows Spending On Research And Development/Percentage Of GDP In The UAE For The Period (2011-2019)
Source: Prepared by the researcher based on open data from the World Bank, available on the website. https://databank.albankaldawli.

Accordingly, and as a result of these programs and initiatives, we find that the percentage of spending on research and development as a percentage of the gross domestic product (GDP) has increased over the years of study, as shown in Table (1). This percentage rose from 0.49% in 2011 to 1.4% in 2020, qualifying it for the 24th position globally, according to data from the United Nations Educational, Scientific and Cultural Organization (UNESCO). This is a result of the UAE's significant focus on the R&D spending index, through increased spending on government investments in this field. This is due to the high spending on R&D and innovation. This is in addition to the support provided by the private sector, which nurtures creative talent, provides more funding for basic research, and invites prominent foreign scientists to visit and work with laboratories.

B. Number of Researchers in R&D

The UAE supports national cadres and motivates them to pursue scientific research, development, and innovation by harnessing the potential of human capital, attracting talent, and enabling scientists and researchers to access the latest equipment. Therefore, to encourage researchers and increase Their numbers launched the (Homeland Fund) program, which works to finance scientific research. This program seeks to support students and inventors from university students in undergraduate and graduate studies, as well as members of society interested in scientific research and technology, and to build a cadre of young researchers and promote the culture of research and innovation through three programs: the Emirati Researcher Program, the Applied Research and Development Program, and the Grants Program. (34)

By following Table (2), it can be noted that the number of researchers in the UAE has witnessed an increase during the study years, as the number of researchers increased from (1980.48) in (2015) to (2348.8) in (2021). This increase is a result of the great interest of the UAE government in the indicator of researchers in the field of research and development by increasing the country’s local spending on research and development and launching grants and initiatives that contribute to motivating researchers and encouraging them to conduct scientific research.

Year	Number of researchers in research and development in thousands
2015	1980.48
2016	2383.08
2017	2380.985
2018	2378.89
2019	2390.9
2020	2493.7
2021	2348 .8

Table 2. Number Of Scientific Research Projects In The Field Of Research And Development Per Million People In The UAE For The Period (2015-2018)
Source: Prepared by the researcher based on open data from the World Bank, available at: https://databank.albankaldawli.

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2- Scientific Publishing

Scientific publishing is the most important metric used to assess the level of scientific production, as knowledge is worthless unless it is published and made available to serve humanity, based on the premise that science is global and knowledge has no homeland. An examination of the state of scientific research in the UAE reveals that it ranked sixth in the Arab world and second in the Gulf during the period (2008-2018) in terms of published research and scientific papers. Electrical and Electronic Engineering ranked first with (5,003), followed by energy and fuel research. Meanwhile, the largest productive institution was Khalifa University for Scientific Research, with (7,083) research papers. (35) Table (3) shows the number of scientific publications and the annual growth rate for the year (2000-2024).

year	Number of scientific publications in thousands	Annual growth rate %	year	Number of scientific publications in thousands	Annual growth rate %	year	Number of scientific publications in thousands	Annual growth rate %
2000	330.44	___	2008	983	29.7	2016	3469	10.0
2001	380.58	15.1	2009	1219	24.0	2017	3848	10.9
2002	399.54	4.9	2010	1200	-1.5	2018	3974	3.2
2003	539.87	35.1	2011	1321	10.0	2019	4372.0	10.0
2004	555.02	2.8	2012	1685	27.5	2020	5578.0	27.5
2005	704.31	26.8	2013	2140	27.0	2021	7084.0	27.0
2006	824.69	17.0	2014	2343	9.4	2022	7748.0	9 . 4
2007	757.57	-8.1	2015	3151	34.4	2023	10416.0	34.4

Table 3. Shows The Number Of Scientific Publications In Thousands For The Years (2000-2023)
Source: Prepared by the researcher based on

(1) World Bank data, Data Bank, available at the following link: https://databank.albankaldawli

(2) Arab Scientific Community Organization, Studies and Research Unit, Glimpses of Scientific Research in Arab Countries (2000-2023), available at the following website: https://arsco.org/article-detail-1641-8

To know the extent of the development that occurred in this indicator during the study period, it can be clarified through Table No. (3), which shows that the number of scientific publications in the Emirates has witnessed an increase during the period (2000-2023), as it became clear through the growth rates between the rise and the decline, as shown in Table (3), where the number of scientific publications increased from (330.44) in the year (2000) to (3974) in the year (2023), and this increase in the number of scientific publications in the Emirates is the result of the increase in spending on research and development and the increase in support and grants provided to researchers and enabling them to access scientific laboratory equipment.

3-UAE Trade in Technology

The UAE is a leading center for international trade and business in the Middle East and North Africa region, and a competitive market in the information and communications technology (ICT) sector. As part of its efforts to reduce dependence on oil revenues and develop the private sector, the UAE government has launched initiatives aimed at building a competitive knowledge economy and creating an open, efficient, effective, and globally integrated business environment. The UAE is taking several steps to advance the development of a knowledge-based economy. Net inflows from the computer and communications sectors within the UAE reached AED 13.1 billion, a growth rate of 2.5%, during 2016, according to statistics issued by the Central Bank of the UAE.(36) It can be noted that the percentage of medium and high-technology manufactured exports, such as chemical products, machinery, transportation equipment, and communications equipment, amounted to (113) of Dubai’s manufactured exports in the year (2018), while its percentage was about (4%) in the year (2010). This increase in the share of exports from high-technology industries indicates the relative success of the Emirate of Dubai in achieving industrial diversification, and it seeks to accelerate the manufacturing of high-technology products since the announcement of the Dubai Industrial Strategy (2030), which entered into force in the year (2017). (37)

Regarding the development in advanced and high-tech technology from the total manufactured exports in the United Arab Emirates as a percentage of goods exports, it can be clarified through Table No. (4), which shows the percentage of these exports for several years, as it is clear from it that this percentage has ranged between high and low, and its highest percentage was in the year (2023), as it reached about (3.40%), while its lowest percentage was in the year (2020), as it reached (2.62%).

year	High-tech exports as a percentage of total manufactured exports	year	High-tech exports as a percentage of total manufactured exports
2008	3.36	2016	2.90
2009	3.77	2017	3.20
2010	3.61	2018	3.45
2011	10.36	2019	3.88
2012	5,31	2020	2.62
2013	2.62	2021	2.85
2014	2.72	2022	3.10

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2015	3.05	2023	3.40

Table 4. Percentage Of Advanced Technology Exports To Total Manufactured Exports In The UAE For The Period (2008-2023) Prepared by the researcher based on the World Bank's open data, available at: https://databank.worldbank.org/data/

year	Percentage of exports of information and communications technology goods to total exports of manufactured goods	Percentage of imports of information and communications technology goods to total imports of manufactured goods (%)	year	Percentage of exports of information and communications technology goods to total exports of manufactured goods	Percentage of imports of information and communications technology goods to total imports of manufactured goods (%)
2007	2.72	4.96	2017	7.46	17.19
2008	1.95	4.50	2018	7.06	13.30
2012	7.49	10.99	2019	7.79	11.99
2013	1.78	3.30	2020	8.10	12.50
2014	2.25	4.38	2021	8.65	13.90
2015	2.51	4.90	2022	9.20	14.80
2016	2.09	5.54	2023	9.75	15.60

Table 5. Shows The Percentage Of Exports And Imports Of Information And Communications Technology Goods From The Total Exports And Imports Of Manufactured Goods In The UAE For The Period (2007-2023) Prepared by the researcher based on the World Bank's open data, available on the following website: - https://databank.albankaldawli

As for the development in the percentage of exports and imports of ICT goods from the total exports and imports of the UAE, Table (5) can be seen, as it is clear that the percentage of exports of these goods ranged between high and low during the study period and reached its highest rate in the year (2023) when it reached (7.79%), while the highest rate of the percentage of imports reached in (2017) and was about (17.19%), which indicates the UAE's interest in raising the percentage of exports of these goods as well. It began to decline after this year until it reached 9.75% of the percentage of exports of ICT goods from the total exports of manufactured goods and 15.60% of the percentage of imports of ICT goods from the total imports of manufactured goods.

4. Patents

The UAE seeks to create a stimulating environment for innovation, invention, intellectual property applications, and research and development, establishing them as engines for building the economy of the future. Therefore, it has developed legislative, legal, and environmental frameworks that support innovation. This includes Federal Law No. (31) of 2016, amending Federal Law No. (17) of 2002, which stipulates that a patent shall be granted for every new invention resulting from an innovative idea or innovative improvement in all areas of technology, both of which are scientifically based and capable of industrial exploitation, whether related to new industrial products, novel industrial methods or means, or a new application of known industrial methods or means. Patents shall not be granted for inventions whose publication or exploitation would violate public order or morals, research, plant or animal species, or biological methods for plant or animal production, with the exception of microbiological methods.(38) Patents shall be registered through the International Patent Registration Center of the Ministry of Economy within the UAE.

In this regard, the UAE has established the (Takamul) program affiliated with the Abu Dhabi Technology Development Committee. This program provides financial and legal support to inventors and enables them to register their patents internationally, which contributes to encouraging researchers and inventors. In addition, there is the role played by Emirati universities in presenting inventions that lead to building a knowledge economy, providing solutions to challenges, and contributing to achieving the goals of sustainable development and quality of life, and supporting the country's position in the field of inventions. For example, we find that the UAE University contributed to increasing the percentage of patents granted until the year (2019), as the number of inventions in the university reached (128), including (39) in the year (2019), of which the College of Engineering had (18) patents, (6) for the College of Science, (6) for the College of Medicine and Health Sciences, (7) for the College of Food and Agriculture, and (2) for the College of Information Technology. (39)

The development of patents in the UAE during the study period can be seen in Table (6), which shows that the total number of patent applications for residents and non-residents in the UAE during the study years has increased, as the number of patents increased from (26) patents in (2011) to (58) patents in (2024) for residents within the UAE. As for patents for non-residents within the UAE, they increased from (1325) patents in (2011) to (1870) patents in (2024). This is due to the support provided by the UAE to inventors, innovators and technology pioneers in registering patents and working to provide the necessary requirements for their application on the ground and marketing.

year	Patent applications for residents in thousands	Patent applications for non-residents (in thousands	Total patent applications thousands)	Growth rate %	year	Patent applications for residents in thousands	Patent applications for non-residents (in thousands	Total patent applications thousands)	Growth rate %
2011	26	1325	1351	___	2018	56	1727	1783	0.9-

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2012	20	1331	1351	0	2019	55	1846	1904	6.7
2013	18	1408	1426	5.5	2020	52	1696	1748	8.2_
2014	29	1443	1472	3.2	2021	48	1679	1727	1.2_
2015	15	1738	1753	19.0	2022	50	1796	1846	6.9
2016	33.5	1743	1776.5	1.3	2023	53	1830	1696	2.0
2017	52	1748	1800	1.3	2024	58	1870	1679	2.2

Table 6. Total Patent Applications For Residents And Non-Residents In The UAE During The Period (2011-2023)
Source: Prepared by the researcher based on World Bank open data, available at: https://databank.albankaldawli

Conclusions and Recommendations

First: Conclusions

1.Green technology is a modern concept that has gained attention in many countries, as it seeks to improve environmental performance and reduce the negative impacts of human activity.

2.Green technology is an effective and essential tool for addressing development challenges and achieving sustainable development goals by providing high-quality goods and services in various development sectors.

3.Numerous applications of green technology have emerged in various fields in the United Arab Emirates, such as smart cities, renewable energy, smart transportation, and smart education, and have played a significant role in promoting sustainable development.

4.The United Arab Emirates has adopted numerous investments in environmentally friendly technologies related to these fields. It has also adopted a vision to focus on e-learning, disseminate curricula based on artificial intelligence, promote innovation in teaching methods and approaches, and develop medical innovations that contribute to providing health services to citizens more quickly and efficiently.

5.Green technology has contributed to the development of countries' economies by creating new technologies that have changed people's lifestyles and provided comfort.

6.The UAE's clear commitment to achieving sustainable development goals, through the launch of pioneering initiatives such as the UAE Energy Strategy 2050, UAE Vision 2030, solar energy projects, and smart cities.

Second: Recommendations

1.Work to raise the level of use of modern technology in the education and health sectors by providing an efficient technological infrastructure and harnessing scientifically developed hardware and software in the fields of education and health, such as electronic presentation tools and multimedia, in the educational process, and improving and developing health control systems.

2.Establish specialized centers for technology research in all fields, and support and strengthen bodies specialized in scientific research, as this leads to the creation of a knowledge society capable of keeping pace with technological developments.

3.Benefit from the UAE's experience with the Emirati Researcher Program, the Applied Research and Development Program, and the Grants Program..

4.Prepare and qualify the working human cadres as the fundamental pillar for achieving development and sustainability concepts by adopting an educational system capable of producing knowledge and skills and keeping pace with global technological developments.

5.This is achieved by providing scholarships and sending students abroad for study, training, and development.

6.Promote investments in research and development in the field of green technology locally, to reduce reliance on imported technology and develop solutions that are compatible with the local environment.

7.Encouraging the private sector to actively participate in adopting green technology, through tax incentives and legislation that supports sustainable projects.

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