

The Experience of Green Technology in Malaysia and its Role in Enhancing Sustainable Development

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Abstract

Green technology is one of the modern concepts that has received the attention of many countries because it clearly affected the perception of people about the environment and the negative effect they leave on that environment and the results out of the unwise use of its resources. Thus, green technology has its ability to improve the environmental performance and decrease the negative effects of the human activities in what contributes to enhancing the sustainable development through encouraging and incentivizing clean energy production and its uses, green housing, green transportation, and waste recycling. This research aims at exploring the ongoing developments in green technology indicators and indices

The most important findings that this study reached is that Malaysia has done very noticeable progress in using modern technologies in many walks of life like health, education, energy, and transportation. The studied walks have witnessed a noticeable increase as well.

Keywords

Green Technology, Enhancing, Development, International economy.

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Part one

Introduction

Malaysia has managed to develop its economy through adopting development plans and depending on green technology. It has witnessed an economic development that made it spring from being a developing country with high poverty into a developed country with an important role in the international economy.

Significance of the study

Green technology experience in Malaysia is considered one of the successful experiences that proved its importance through having an effective role in the process of sustainable development and in decreasing the economic and social problems like poverty and unemployment, as well as decreasing pollution.

Objectives of the study

- 1- Exploring the concept of green technology and its significance.
- 2- Exploring the up-to-date developments in the indices and indicators of green technology in Malaysia
- 3- Exploring the most important applications of green technology in Malaysia and its role in rationalizing the available resources in solving and addressing the environmental problems through the use of sustainable energy, green housing, and environment-friendly transportation as well as the sectors of health and education.

The problem of the study

The problem of this study is situated in the following question: *Has the use of green technology in Malaysia contributed to the enhancement of sustainable development?*

The hypothesis of the study

This study addresses the following hypothesis: Green technologies in Malaysia has a significant effect in enhancing sustainable development through the use of renewable energy and sustainable transportation, smart cities, green education, and smart health.

The study methodology

This study has used the analytical descriptive approach as one of the most appropriate approaches for the focus of the study. It used the primary and secondary resources and references as well as the reports, periodicals, and online websites.

Part two

First: A theoretical approach to green technology and sustainable development

The word "technology" is of a Greek origin, as "Techno" meaning a profession, skill, or an art; and "Logy" meaning study or science. Thus, the word "technology" means the science of application or performance. This concept has appeared in the modern time after the industrial revolution where equipment and machines started to take path into the industrial production. Accordingly, technology was defined as a set of processes that make, re-make, know, and use equipment, machines, crafts, technologies, systems, and ways of systematizing them to solve a problem, achieve a goal, or address something else related to the production process or to doing a specific job (Sareifi, 2009).

It is noted that technology had a clear impact on the society and the surrounding in different

ways that contributed to the economic development to make it more developed through finding new technologies and techniques such as airplanes, cars, renewable energy (such as nuclear and atomic energy), Nano-technology, airspace, etc. where all of these things changed the way of life and blessed people with ease and comfort.

There are researchers who consider technology as the scientific knowledge branch that deals with innovation and the technological means and their applications in human life, environment, and the society depending on the applied sciences, engineering, and industrial arts as well as research. Sustainable development is also considered a modern concept which came to use in the modern development literature widely. Thus, sustainability has become a standing international thinking approach spreading in most developing and developed countries. It has been adopted by official and social institutions that called for its application as a development approach aiming at rationalization and deals with the economic activities that intend to achieve an economic development rate from one side and keeping the natural and environmental resources from another side. It represents the only means to achieve a high quality life for the population in the current time and the coming generations. The word "sustainability" has more than one meaning in Arabic (longstanding, continuity, and endurance). It relates to ecology where sustainability was used to refer to the development and the form of the dynamic systems that are subject to changes which lead to changes in their elements, features, and the relationship among these elements.

In respect to the development thinking, sustainability was used to refer to the relationship of economics and ecology as these sciences both have the same Greek derivation as they have "Eco" meaning "house" and thus ecology refers to the management of the environment elements and economics as meaning the study of the elements of this house (Guneim & Zant, 2010).

1- The definition of green technology and sustainable development

Green technology is related to different technological trajectories including a mix of innovations that lead to improvements in productivity and the quality of environment. This concept resonates with protecting the environment and knowing the extent to which technologies contribute to decreasing the emission of carbon and global warming and decreasing the consumption of energy. Many definitions have emerged in respect to green technology. The European committee for economic protection defined green technology (clean technology) in 1979 as the management and technical execution to prevent pollution and it had determined three criteria for this kind of technology: less emissions, less waste, and less demand for natural resources. Some researchers defined green technology as doing processes and operations of ongoing development in all industrial walks and all services and products that are produced in order to reduce the use of natural resources to keep them out of shortage and scarcity for next generations, as well as decreasing pollution that emerges out of the operations and processes of production and use. Thus, green technology is environment-friendly and keeps the environment from pollution and the scarcity of resources as well as it contributes to preventing the pollution from its own source and decreases it to the lowest level possible. Then, it works on dealing with the wastage from the operations and getting rid of it or recycling it.

Some other researchers have defined green technology as the technology related to the climate and the environmental techniques which are considered as adaptation techniques. Accordingly, it is used to encourage sustainability and decreasing gases emission and global warming, and helps to evaluate the answers to the climatic changes and defending the environment through sustainability in the energy production operations and all walks of technological operations (John, Chime, Benedict, Ekenechukwu et al., 2017).

It is noted that green technology has many aspects as it means any work humans do which can keep the environment safe and reduces consumption such as good construction that does not need much air conditioning where it can be cool in summer and warm in winter as well as the industries that use the lowest level of natural resources and recycling the wastage and the use of transportations that use less fuel. Green technology is considered a new concept relating to the timetable of environment protection and the sustainability of earth. If there is a technological change, it is to enhance green growth and with lowest cost. Henceforth, green technology can be seen as a comprehensive concept referring to the way of using and applying technology and science to protect the environment through different ways such as

environmental observation. Information emphasizes that this kind of technology contributes to reviving the damaged environmental system and giving it life. It is also an approach that has witnessed rapid development and growth in different places around the world. Green technology encourages the generation and production of clean energy. It was called green in reference to the green color of nature ([The concept of green technology](#)).

2- The goals of green technology and its significance

Green technology aims at achieving the following goals:

- 1- Developing the skills of workers, managers and investors.
- 2- Decreasing costs and the size of the production system and developing productivity and doing the necessary changes.
- 3- Reinvigorating and expanding telecommunication networks and innovating new means.
- 4- Following up with the rapid technological changes and their impact on the community and how to deal with the equipment and technological means.
- 5- Creating new products and developing methods of marketing and sorting out new ways of management.
- 6- Rationalizing the use of the available resources to solve the environmental problems.
- 7- Treating wastage and draining waters and safely managing them.
- 8- Providing renewable energy, green housing, and environment-friendly transportation.
- 9- Keeping resources and raw materials and energy ([Shafiei & Abadi, 2017](#)).

In order for institutions to achieve the above goals, they have to blend the environmental side and dimension with all the activities and operations that they get involved with starting with amending the inputs to become cleaner than their precedents to production operations that need to be energy-efficient and reduce waste. They also need to relate that to the output which have to be environment-friendly and meet the customer's needs, satisfaction, and safety.

3- The contribution of green technology in achieving sustainable development:

Technology is an effective and main tool to deal with the development challenges and meet the goals of sustainable development such as protecting earth and space and decreasing poverty and managing the risks of nature and climate and achieving food security which were proven by different studies before and after formulating sustainable development till 2030. It is considered one of the incentivizing factors to accelerate the main pillars of sustainable development (economic growth, social blend, and sustainable development). The role of green technology is justified through the ninth goal of sustainable development that calls for encouraging innovation and incentivizing comprehensive production and building main frameworks and infrastructure that can stand changes. Moreover, it is a basic factor in many education-related goals, health, welfare, gender-equality, economic growth, and respectable labor, and the growth of sustainable cities and local communities, climate, and strong institutions, as well as companies ([Svoboda, 2018](#)).

ESCWA was part of the global movement since its foundation to lead a sustainable development plan for 2030 and its goals before 2015 till the execution of its plan in 2016 and its conviction in the significance of innovation and technology in the process of sustainable development. ESCWA has done many studies between 2017-2018 about technology, innovation, and sustainable development to help governments to learn more about technology and innovation and the best ways to use them to achieve sustainable development and its goals. Technology has proven its usefulness in different pioneering projects in the walks of sustainable development such as artificial intelligence, 3D printing, etc. In many countries, these aspects have proven effectiveness through using the huge data in dealing with electronic wastage and decreasing pollution and traffic jams, and using new resources of finance such as primary capital to generate solar energy ([UNDP, 2016](#)).

Second: Studying green technology perspective in Malaysia

- 1- **A glance at the Malaysian economy:** Malaysia is a federal Islamic country located in

south-east Asia. It has thirteen states and three federal territories with a size of 328,550 square kilometer. Its capital is Kula Lumpur and it is populated with 32,365,998 people. Its GDP has reached 366.7 billion \$ according to 2020 statistics. The country falls into two parts divided by China Sea: the Malay Peninsula and the island of Borneo. Malaysia is bordered by Indonesia, Thailand, Brunei, and Singapore. It is also situated at Malacca Strait which is considered an important sea route for international shipping and navigation. Thus, it has an important role in international trading (Razak, 2007).

The Malaysian economy depends on agriculture, industry, and fishing. Malaysia is considered one of the most important countries in Asia in exporting tin and palm oil as it has a diverse economy where agriculture represents 9% from the GDP, mining 8.21%, and processing industries 35.61% and services 56.45 according to the statistics of 2020. Malaysia is considered the second producer of crude oil in south-east Asia and the second biggest exporter of gas. The value of the Malaysian exports of goods in 2019 reached 238 billion \$ to different destinations in the world; this value represents an increase of 18% in comparison to 2015 and a decrease of 3% in comparison to 2018. The value of its exports of electronic circuits was 55.5 \$ billion, refined petroleum was 19.1 \$ billion, and liquidized natural gas 11.4 \$ billion, and crude oil 10.4 \$ billion.

China and Singapore are the biggest commercial partners to Malaysia. It is considered the fourth biggest economy in south-east Asia and 38th in the world depending on the industries and the use of most up-to-date technologies in manufacturing and digital economy where it occupies the 23rd rank on the world (Malaysia economy, 2021), according to the global competitiveness report in 2017, which emphasizes that this country aims at making progress and development in the walks of economy and intended to be in the front of the advanced countries.

2- The analysis of the development indicators and indices of green technology in Malaysia

2.1. Indicators of research and development in Malaysia:

The indicators of total spending on research and development: the rapid progress that the world witnesses has different reasons. Interest in research and development is one of the main reasons for that progress. Many countries, especially the developed ones, have dedicated capacities to support scientific research through official and unofficial institutions because any scientific research is changed into an investment "product" supporting economic and social development (Al-Harthy, n.d) and Malaysia is one of these countries that support scientific research.

Table 1

The rate of total spending on scientific research from the Malaysian GDP for selected years the

Percentage	Year	Percentage	Year	Percentage	Year
1.1	2012	0.8	2008	0.5	2000
1.3	2014	1.0	2009	0.7	2002
		1.0	2010	0.6	2004
		1.0	2011	0.6	2006

Source: this table is prepared by the researchers based on the open-accessed data of the World Bank (2021).

Through looking at Table 1, the total spending on scientific research from the GDP in Malaysia has increased in the studied years where it increased from (0.5%) in 2000 to (1.4%) in 2016. This increase was due to the Malaysian conviction of the value of the scientific research through funding innovation in Malaysia by institution as the Sciences Fund, Research & Development Initiative, Bio-agriculture technology, the Initiative of Research and Development for healthy remedial foods, a program for main research grants in 2006. In 2009, a long-term research grants was released, and global research. Moreover, supporting and financing projects and private research in the field of technology was another aspect oriented toward the private sector.

2.2. Preparing researchers in research and development: scientific research contributes significantly to economic growth and social welfare. It opens new horizons for researchers to explore the different phenomena and reach scientific facts about himself and the surrounding and the world in general. Scientific research has an important role in economic and social

development plans as well as in the development concepts such as human development and sustainable development because these plans need comprehensive national research projects dedicated to provide radical solutions and not only partial treatments. It requires social effort, accurate planning, effective management, and collective social work. This perspective pushed many countries to start specialized institutions that support scientific research leading to the emergence of research centers and libraries which helped to increase researchers (Ali, n.d).

Regarding Malaysia, it has increased the number of researchers through developing the national research capacities so it has put a national strategic plan for education for the after 2020 period with the intention of graduating 100000 holder of PhDs in addition to increasing the rate of participation in higher education from 40% to 50%. In order to know the development in the number of researchers in Malaysia, we can see Table 2 where it shows an increase in this indicator except for 2005 and 2006 where there was a decrease in comparison to 2004 which reached 436.45 researchers in 2005 and 370.0 in 2006 whereas it was 502.9 researchers in 2004. This can be attributed to a large extent to the cooperation among universities and industry and the stagnation in the research institutions and the problems with the policies of coordination. Yet, in the rest of the years, there was an increase in the research indicator reaching 2396.5 researchers in 2016 with a growth rate of 3, 8 %. This increase stems out of the focus of the Malaysian government on the research indicator in relation to research and development through increasing the grants and total spending on scientific research in this respect.

Table 2

Researchers per one million in Malaysia between 2000 and 2016

Growth rate	Number	Year	Growth rate	Number	year
77.887	1067.5	2009	---	276.9	2000
37.002	1462.5	2010	3.395	286.3	2001
12.746	1648.9	2011	3.283	295.7	2002
8.600	1790.7	2012	14.745	339.3	2003
7.357	1922.45	2013	48.217	502.9	2004
6.853	2054.2	2014	13.213-	436.45	2005
12.356	2308.0	2015	-15.226	370.0	2006
3.834	2396.5	2016	31.095	485.05	2007
			23.719	600.1	2008

Source: This table is prepared by the researchers based on the open-accessed data by the World Bank (2021).

2.3. The scientific publications: the scientific publications in Malaysia have increased rapidly since 2005 and focused mainly on the field of engineering and chemistry (Rasi & Archard, 2021) where 64.4% of the Malaysian publications were co-authored with foreign researchers for the period 2008-2014 and that 8.4% and the rate of Malaysian research were one of the 10 % most quoted between 2008-2012. The medium of Malaysian quoted publications for 2008-2012 was 0.83%. The UK and India are the main foreign partners in the field of scientific research for the period 2008-2014. Through reviewing Table 3, the development in scientific research in Malaysia for the studied period shows that this indicator has increased and has reached its highest point in 2008 with 54.6% and that the number of scientific publications increased from 1,326.3 in 2000 to 23,661.3 in 2018. This interest in the scientific research by the Malaysian government was due to a governmental decision for supporting distinction in many research-oriented universities such as UPM, University of Malaya, UTM, etc. and the governmental grants for university research where these universities received 71% of governmental funding.

Table 3

The Malaysian scientific publications for 2000-2018

Growth rate	Number	Year	Growth rate	Number	Year	Growth rate	Number	Year
11.177	17,378.8	2014	19.469	3,877.0	2007	---	1,326.3	2000
7.230	18,635.3	2015	54.594	5,993.6	2008	-11.830	1,169.4	2001
9.834	20,467.8	2016	33.499	8,001.4	2009	26.278	1,476.7	2002
8.745	22,257.8	2017	40.432	11,236.5	2010	19.801	1,769.1	2003
6.306	23,661.3	2018	23.288	13,853.2	2011	18.004	2,087.6	2004
			4.379	14,459.9	2012	18.576	2,475.4	2005
			8.104	15,631.7	2013	31.098	3,245.2	2006

Source: This Table was prepared by the researchers based on the open-accessed data by the World Bank (2021).

2.4. International trading of Hi-tech: the commercial activity of hi-tech for any country is situated in its ability of competition which is considered one of the significant measures to evaluate the rate that trade represents, the amount of hi-tech from the overall exports of the country which includes the hi-tech and electric products and energy-generating machines, and the supporting equipment and data-processors and airspace and optical equipment, etc. Advanced technology exports also include all products that require the resources and different research for development and production. It is not unexpected that advanced countries spend a lot on hi-tech exports on research development because it enables these countries to develop their own technologies and gain exports of very advanced technologies. In this respect, Malaysia is considered one of the biggest exporters of semiconductors, electric products, and information and telecommunication technologies. Inviting multinational companies has had an important role in expanding manufactured products and thus made Malaysia as one of the biggest electronics and electric equipment exporters where in 2013, it has occupied 6.6% of the international exports of integrated circuits and electronics. This expand in electronic exports helped Malaysia become a main center for producing hi-tech products adding to make 60% out of its products including airspace equipment, computers, pharmaceutical materials, advanced equipment, electric equipment (World Bank, 2021) etc. Table 4 shows the percentages of exports of advanced products produced in Malaysia between 2009 and 2019 and being the highest in 2018 with 53.27%.

Table 4

The percentage of advanced products exports of the overall Malaysian exports for 2009-2019

The percentage of exports	Year	The percentage of exports	Year
48.49	2015	50.87	2009
49.07	2016	49.31	2010
51.13	2017	47.22	2011
53.27	2018	47.50	2012
51.85	2019	48.47	2013
		49.23	2014

Source: This table was prepared by the researchers based on the open-accessed data by World Bank (2021).

Table 5

The percentage of exports and imports of technological goods from the overall exported and imported goods in Malaysia for the period 2000-2017

Percentage of imports	Percentage of exports	Year	Percentage of imports	Percentage of exports	Year
30.1	7.1	2009	41.2	1.9	2000
29.8	6.1	2010	39.0	2.9	2001
25.6	6.2	2011	37.9	2.8	2002
23.1	7.2	2012	42.8	3.1	2003
22.6	6.8	2013	39.2	4.3	2004
23.1	6.6	2014	38.0	5.3	2005
24.0	7.6	2015	36.1	5.3	2006
24.7	7.2	2016	33.5	5.0	2007
25.2	7.2	2017	23.4	5.3	2008

Source: This table was prepared by the researchers based on the open-accessed data by the World Bank (2021).

Table (5) refers to the indicator of exports and imports of technological telecommunication goods as a rate of the gross exports and imports where the rate of exports of technological and communication goods for the period of 2000-2017 reached the highest level in 2015 with 7.6% and the imports reached the highest level in 2003 with 42.8%. the rate of exports increased from 1.9% in 2000 to 7.2% in 2017; whereas the rate of imports decreased from 41.2% in 2000 to 25.2 in 2017. The exports and imports included technological and communication goods, computers, electronic ingredients, communication equipment, etc. This increase is attributed to the Malaysian interest in increasing technological exports and decreasing imports.

2.5. Patents: the process of discovery and patent registration is considered an important aspect leading Malaysian competitiveness oriented towards exporting and growth strategy.

Malaysia's National Applied Research and Development Center (MIMOS), which is a pioneering center in research and development, was privatized in 1992 with 45-50% in patents in Malaysia in 2010 but the few quotes that stemmed out of these patents refer to a decrease in the rate of commercial marketing, and the Malaysian government has founded the Malaysian agency of innovation to encourage marketing research and the Malaysian foundation of technology that put efforts to help the companies to make the marketing grants into products applicable and its efforts have a little succeeded in marketing for a few number of organizations including the Malaysian council of palm oil, the institute of Malaysian rubber research, and UPM, and USM (World Data Atlas, 2021).

Table 6

The number of patents registration requests in Malaysia between 2000 and 2019.

Growth rate	total patents	The number of patents registration requests for Malaysia- non-residing personal	The number of patents registration requests for Malaysia-residing personal	Year	Growth rate	total patents	The number of patent for Malaysia-non-residing personals	The number of patents registration requests for Malaysia-residing personal	year
11.2	6383	5152	1231	2010	---	6227	6021	206	2000
-30.2	4452	3376	1076	2011	-4.7	5934	5663	271	2001
55.8	6940	5826	1114	2012	-16.8	4937	4615	322	2002
3.8	7205	6006	1199	2013	2.5	5062	4686	376	2003
5.7	7620	6267	1353	2014	7.5	5442	4920	522	2004
1.4	7727	6455	1272	2015	15.5	6286	5764	522	2005
-6.3	7236	6127	1109	2016	-23.6	4800	4269	531	2006
-2.2	7072	5906	1166	2017	-50.5	2372	1702	670	2007
3.1	7295	6179	1116	2018	123.5	5303	4485	818	2008
3.5	7551	6480	1071	2019	8.1	5737	4503	1234	2009

Source: this table was prepared by the researchers based on the open-accessed data by the World Bank (2021).

To follow the development in the patents in Malaysia, we can note Table 6 which refers to the number of patents for the residing and non-residing personals in Malaysia for the period 2000 to 2019. Witnessed an increase during the study period, as the number of patent applications for residents increased from (206) in (2000) to (1071) in (2019), as for non-residents, patent applications increased from (6021) in (2000) to (6480) in (2019), while growth rates ranged from (206) in (2000) to (1071) in (2019). In patent applications between high and low rates, reaching negative rates in some years, and the reason for this is the low rate of commercialization of research, the lack of cooperation between universities and industry, and the stagnation of research institutions. In addition, universities restrict the marketing of their research results in specific areas, such as health and information technology. and communications.

3. The most important applications of green technology supporting sustainable development in Malaysia.

There are many applications that used green technology which contributed to achieving sustainable development through using the available resources and protecting the environment from pollution and decreasing wastage.

1-Smart cities: economic cities represent one of the axes of innovation that lead to development. Yet, the growth of cities has a negative effect on the environment and people. In order to address the modern challenges and provide high quality life for people, there must be work on using information and communication technologies and thus leading to the emergence of smart sustainable cities that use modern technologies which decreases the emerging negative effects out of the economic growth (ITO, 2021).

The main cities started in Malaysia:

Cyberjaya city: it is located 30 Km away from Kula Lumpur and it is considered a center and technological base to achieve a comprehensive scientific development in the heart of

Malaysia. It occupies 2894 hectare and is considered a smart city. It was opened in 1999 and its main goal is to be a center for technology companies where investors were encouraged to start companies. The development of this city was as a route for the multi-means that aim at connecting many smart cities and towns starting from the middle of Kula Lumpur at the twin towers to the north until Kula Lumpur new international airport to the south. It is a project of two smart cities which are Putrajaya and Cyberjaya. The first one is a governmental services center whereas the second is a center for many international tech companies in addition to having a technology specialized center for research and smart schools. This project aims at attracting international technology industries to Malaysia to do research and development to grant opportunities to small and medium industrial companies to use the infrastructures that this project provides with all its services. This project provides the smart city Cyberjaya with many incentives to attract multi-media companies including providing a wide range of international qualities and modern technologies (Grimaldi & Fernandez, 2017; Safoor, n.d).

The smart cities depended on a set of technological applications:

- 1- Electronic government: electronic government is applied in management centers through using information and technology to enhance the communication among people, companies and the government.
- 2- Multi-purpose card (mycard): it is a multipurpose card used as an ID, bank card, driving license card, and health card.
- 3- Centers of research and development: of the main goals of this project is the multi-media path to conduct research related to information and communication technologies.
- 4- Smart schools: these schools are provided with internet and information technologies which enable students with virtual classes and acquire information through technology use.
- 5- Online Health care: this project aims at providing health care services online through information and communication technologies.
- 6- Electronic works and activities: it aims at attracting national and international companies to work in the internet and multi-media sector.

2-Renewable energy: the connection between economy and the climatic change and technology contributed to a constant change in the global energy system. The growth in population as well as the improvement in life standards and the increase in focus on the urban areas on the energy supply and the increase in awareness of the emerging risks from the climate change all have encouraged people and governments all over the world to discover new methods of energy production and the work to decrease global warming and gases emission and other harmful effects on environment. It contributed to understanding the financial risks and encouraged Malaysia to use renewable energy such as solar energy that contributed to the supply of electricity and the capacity to use it with 8 to 10 hours at the 5 hours recharging and a budget of 854.29 million euros. The use of green housing and renewable energy has contributed to 0.72 of Malaysia GDP. Malaysia has allocated a budget for renewable energy of 15.88 billion euros in 2020 from the private sector revenues as well as 339.14 million euros from the government public budget in addition to 50000 jobs in constructing renewable energy plants. According to statistics Malaysia has 16.6 mega-watt from solar energy plants, and 17 hydroelectric station, and 62 routes with a total area for water of 2944 square km. the government called for using LED light bulbs to save electricity where their use provides a million hour of use where Sarawak state depends on, and the Malaysian Borneo uses the renewable energy from water and thus aims at achieving three goals of sustainable energy through investing in electricity where it has 55 rivers with a length of 3.300 km and three hydroelectric stations with a capacity of 3.452 mega-watt from renewable energy. This has led to a decrease in carbon emission in that state since 2009 with 77%. This decrease has helped Malaysia to achieve the decrease goal of 21% by 2045 that the UN conference of climatic change has determined. Due to the geographical diversity in that state, it has started to use hybrid water systems and solar energy to provide electricity for the rural areas and scattered places.

The use of a blend of renewable energy resources by Malaysia will make a model for other countries in south-east Asia to liberate themselves from depending on coal and gas in generating electricity that contributes to achieving sustainable energy goals using renewable energy and reducing carbon emission emerging out of the use of traditional energy resources (Seetao.com, 2021).

Table 7

The net production of electricity generation from renewable energy resources in Malaysia for the studied period (billion kilo-watt per hour)

Power	Year	Power	Year	Power	Year	Power	Year	Power	Year	Electricity generation
0.0	2019	0.0	2015	0.0	2013	0.0	2010	0.0	2008	Wind
26.73	2019	15.37	2015	11.68	2013	6.41	2010	7.39	2008	Hydropower
1.35	2018	0.75	2015	1.15	2013	1.01	2010	0.0	2008	Bio mass
--	--	1.2	2014	1.0	2013	0.7	2010	0.7	2003	Nuclear power
0.80	2019	0.27	2015	0.14	2013	0.01	2010	0.01	2008	Solar power, tiding, and sea waves

Source: Prepared by the researchers based on the [World Data Atlas \(2021\)](#).

Table 7 shows the net production of electricity generation from renewable energy resources in Malaysia where the generated electricity from the Hydroelectricity was in the lead in 2019 with 26.73, and the other resources were less than it.

3-Sustainable transportation: it aims at improving the best access to services and improving their quality and reducing noise and harmful emission and improving the quality of air. The public transportation in Malaysia focuses on people and the plan of having fresh healthy air. Moreover, the Malaysian National Council of Green Technology encourages the use of low-carbon technology that covers the transportation sector. Malaysia works on enhancing and developing train system where it is more sustainable, and replacing cars and boats that use diesel and oil with the ones that use electricity generated by renewable energy. It also plans to connect the islands with a public transportation network where the rapid transportation of light trains and buses that improve transportation and the capacity of access and the sustainability of cities. For example, we can note that Putrajaya city works on executing the urban sustainable transportation strategy, and finding ways to improve the consumption of energy such as electric vehicles and hybrid ones and plans for having supporting facilities such as services stations and environment-friendly buses that operate with compressed air. It considers encouraging public transportation the main element to achieve sustainable transportation where the use of public transportation reached 57% while private transportation was 43%. Malaysia has employed communication technologies and electronics in transportation systems to gain information about the performance of transportation sectors and the demand on it as well as the mutual connection among vehicles themselves as well as with equipment supported on the sides of roads, in addition to road accidents that are more likely to happen in order to address road problems and starting more efficient networks through providing cars and infrastructure with smart systems that enhance connection among vehicles and these infrastructures (Institute of Rare Earths and Strategic Metals, 2020) through the use of many applications that contribute to reducing harmful emission by using clean fuel and decreasing noise pollution.

4-Green education: the progress and strength of nations nowadays are not measured by what they have of natural resources but rather by the human resources and minds that are able to engineer knowledge and find innovative solutions to address problems to reach the distinctive level of knowledge income that supports the welfare of countries and develops them in all walks of life. Thus, developing the educational system in the current time has become a high necessity in order to have an empowered generation with thinking skills and ability of self-education to reaching sustainable development through the basic requirements of the education policy that creates an incentivizing environment to build innovation and creation skills through using modern and advanced technologies that help to protect the environment and rationalize consumption, time-saving, and effort in education.

In this respect, we can note that Malaysia puts high effort in education and focuses on educating the young and adults through free primary and secondary education and emphasizing quality education. It has found a necessity in enhancing the development of human capital, providing highly skilled laborers, increasing productivity, and improving investment. It has made changes in the curricula that helped to cope with the new challenges

in relation to the growth in Malaysia that reflects its investment in human resources, building strong educational system which has provided it with skilled labor strength and made it move from a traditional agricultural economy into an industrial advanced economy and also inviting and attracting foreign workforce to help building smart schools that cope with the ongoing development in information technology where the Malaysian government signed contracts with the smart schools company Telecom Smart in 2012. It started a basic educational system and computerized schools connected to the internet in 1999 with almost 90% and 45% in the classes computerized and computational. It has connected more than 10000 public schools through a virtual environment and high-speed internet where teachers can upload materials on the platforms and making that available to 5000000 students and 500000 school all over Malaysia. It has also founded a lot of educational platforms for this purpose. Regarding the infrastructure, schools and universities in Malaysia have been connected with an optical fiber network that helps to transmit and transport huge waves of information to serve multi-media and videos and also to guarantee quality education. It has also worked on developing curricula according to the up-to-date global technology (Megahed, 2020).

Moreover, Malaysia has technology and innovation centres that include international experts and scientists such as the centre of Technology and Innovation (CTI) in Asia Pacific University to achieve efficiency and effectiveness in the educational system in addition to the focus on the educational processes in the classes and the educational management boards. This all has led the Malaysian universities to occupy advanced rank in the international rankings as well as adopting the biggest modern educational projects such as Abser platform for electronic education in Arabic.

In this respect, the UTM is considered one of the first universities that used online learning systems through its centre of teaching and learning (CTL) which was one of the first centres of online remote learning founded since 1998. Table 8 refers to the first ten universities in Malaysia according to the international ranking.

Table 8

The rank of the first ten Malaysian universities internationally

International ranking	University name	Serial	International ranking	University name	Serial
979	UPM	6	642	UTM	1
1329	Universiti Utara Malaysia (UUM)	7	675	University of Science, Malaysia	2
1599	International Islamic University Malaysia	8	745	University Malaysia Perlis	3
1605	Multimedia University	9	878	University of Malaya	4
2330	Universiti Malaysia Pahang	10	963	UniversitiKebangsaan Malaysia	5

Dakisi (2021).

5- Electronic health: Digital innovations help to accelerate the rapid transformation toward modern industries to equip health care providers with more technological options to support the ongoing care based on data and using the new systems that improve the experiences of health care providers to patients with services including information and clinical technology and clinical equipment to help the workers in the medical sector and make things more efficient and quicker. In this respect, the health sector in Malaysia is considered one of the best in south-east Asia because it has very good medical institutions and hi-tech equipment as well as very skilled medical staff. It also works on developing policies and programs specialized in providing health care that meet the medical needs for all people in order to reach the highest level of health care.

In this respect, the ministry of health in Malaysia has started electronic primary health care as well as electronic management of clinics that help paramedics and working doctors in the isolated areas to help provide efficient health care and benefiting from checking and diagnosing and following up with health situations and epidemics to contribute to the betterment of life in these isolated areas. Moreover, the blending of medical data in data networks and the national network will enable managing all sectors of health care services in the country efficiently and effectively. This all will help to invest in the digital transformation to

address the challenges and achieve good quality health services in Malaysia with reasonable prices. The initiatives were done by the government and the private sector and setting the Malaysian health data centre (My HDW) in 2017 by the Malaysian ministry of health, which is a national system for data collection and briefing, cover all aspects of governmental and private health care. Moreover, Malaysia signed a memorandum with Microsoft in 2016 to found a digital health centre that is considered the first of its kind and focuses on providing remote health care, smart access, and commitment to medicines. This centre also has the biggest digital health platform in Malaysia that connects patients with a wide network of 1500 doctors in the private hospitals and 100 practitioners in the public hospitals (United Nations, 2013). It has used many applications in the medical sector shaped by the new concept of "electronic health" and it refers to the mutual use of electronic communication and information technology in the health sector.

Finally, we can note that these applications have contributed to enhancing sustainable development in Malaysia through reducing excessive use of resources and decreasing pollution and producing health and educational services for all people through modern technologies.

Conclusions

- 1- Through reviewing green technology, it can be noted that it has led to developing the economy of Malaysia and transforming it from being a developing country with poverty into an advanced country with a significant role in the global economy.
- 2- Green technology has the capacity to improve environmental performance and reduce the negative consequences of the human activities which contributed to enhancing sustainable development through encouraging and incentivizing the production of clean energy and its use, green housing, green transportation, and wastage recycling.
- 3- The Malaysian experience with green technology is considered one of the most successful ones that has had an effective role in the process of sustainable development and reducing economic and social problems such as poverty, unemployment, and pollution.
- 4- One of the most important findings that the current study has reached is that Malaysia has made huge progress in using modern technologies in many sectors such as health, education, energy, transportation, and that many of the studied indicators have witnessed a notable increase, and growth rates have fluctuated in some other indicators.
- 5- The applications of green technology in Malaysia in the sectors of health, education, and transportation have witnessed success in respect to sustainable development.

Recommendations

- 1- The necessity to build green computational strategies in the economic, social, and environmental sectors.
- 2- The necessity to focus on renewable energy and increasing dependence on it.
- 3- The necessity of using modern technologies in health, education, and transportation sectors to increase their efficiency.

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