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-RESEARCH ARTICLE-

ROLE OF KNOWLEDGE ECONOMY USING INFORMATION TECHNOLOGY AND ITS POTENTIAL IMPACT ON ACHIEVING ECONOMIC GROWTH IN MALAYSIA

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─Abstract─

Information technology is a fundamental pillar of the knowledge economy because of its importance in influencing the overall economy and subsequently affecting aggregate demand, as well as being one of the governments means to generate job opportunities, reduce unemployment, and thus stimulate growth for the country's overall economy. From this standpoint, the research aims to demonstrate the impact of the knowledge economy on the Malaysian economic growth during the research

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period, and then measure and analyze the knowledge economy and its impact on the Malaysian economic growth, using advanced standard methods such as autoregressive distributed lag (ARDL) to investigate the association among variables. As the research found that some variables are static at the level and others are static at the first difference, according to the unit root test, which means rejecting the null hypothesis due to the lack of direction in analyzing the data, and the model does not suffer from the problem of self-correlation and the problem of variance. And the existence of a long-term relationship between the variables. The results also exposed a positive nexus between information technology and the economic growth of the country. This study guides the policymakers regarding developing policies related to the information technology used for economic development.

Keywords; Knowledge-Economy, Information Technology, Economic growth, total economy

1. INTRODUCTION

Information technology has witnessed a great position in developed countries, as well as in most developing countries, and it was the main engine in pushing the wheel of economic growth, which reflected positively on the structure of society, so many names appeared, including the knowledge society, the information society (Sukharev, 2021). It indicates that this age is the age of information and knowledge, and it can be mentioned that information technology is owned by developed countries, which appeared in the so-called digital divide between developed and developing countries, which led to a focus on the technology sector in developing countries in order to reduce the size (Bogoviz, 2019). The technology gap and economic knowledge, and thus achieving the success of the development plans of the countries concerned, as some developing countries created an appropriate environment to attract investments in the information and communication technology sector, especially the State of Malaysia, as they worked to shift from the traditional economy to the knowledge economy based on informatics and computing (Dima, Begu, Vasilescu, & Maassen, 2018). The knowledge economy is the means that affects the investment in attracting investments and then influencing the economic growth of the country concerned. Malaysia is like the rest of the countries affected by the knowledge economy. The research aims to clarify an integrated view on the role of investment in the knowledge economy and information technology, how it affects the achievement of development goals, and to know the relationship between the knowledge economy and Malaysian economic growth (Bahrini & Qaffas, 2019; Hancock, 2019). The research problem is that a lack of interest in the knowledge economy will generate a big problem in attracting foreign investment. The research starts from the hypothesis that there is a close relationship between the knowledge economy and economic growth in Malaysia, according to economic theory.

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In line with the quality of the research, the descriptive, analytical and inductive approach was adopted in order to reach the conclusion of conclusions and then develop appropriate recommendations for the research (Asongu & Odhiambo, 2020a; Haftu, 2019). The research was divided into three sections, as the first one dealt with the theoretical aspect of the knowledge economy in general, while the second research took the analytical aspect of the knowledge economy in Malaysia, and the third research concerned the standard aspect of the extent of the knowledge economy's impact on the Malaysian economic growth. The origin of this term is due to an ancient Greek word derived from two syllables: Techno, which means technical skill or industrial operation, and logia, which means science or methodology, so the term "technology" means knowledge of skill or arts, meaning the study of skills in a logical way (Pradhan, Mallik, & Bagchi, 2018). To perform a specific function, and technology brings out the concept of science for its interaction in the applied fields. Technology is knowledge of the qualitative or the means, while science represents knowledge of the causes, as it brings theories and general laws and transforms technology into methods and applications in various activities, while science is a source of basic knowledge and a basic foundation for technology (Haftu, 2019; Lu, 2018).

Information technology is defined as technology-based on electronics that can be used to collect, store, process and places this information in integrated packages that are sent with high accuracy and efficiency through the exchange and use of this information in its various forms and then access to knowledge (Latif et al., 2018; Usman, Ozturk, Hassan, Zafar, & Ullah, 2021). While the World Bank defines information technology as "a group of activities that facilitate the processing, transmission and presentation of information by electronic means, and with the emergence of new information and communication technology, the knowledge-based economy met with an appropriate technological base, which led to a joint promotion between the flourishing of intensive activities in knowledge, production and the spread of new technology (Ahmed, 2021; Lee et al., 2018). Technology began with the beginning of man's life on the face of the earth and was embodied from its first beginnings in the form of various tools and artefacts of metal, trees and stone, and this idea, knowledge and information grew up gradually through the experience of the man from ancient times, and the information was formed as a symbol and abstraction in its various moral and material forms, And human information represented the development of man, the truest representation in counting, speech, language, drawing, reading, writing, even photography, and other stages of the increasing development of human beings (Afroz, Muhibbullah, & Morshed, 2020). Through his life's association with science and technology, the man was able to have for himself a unique world of information that he would elevate from time to time. Through Table (1), we can show the historical development of information technology: -

Table 1: Historical development of information technology

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Historical development in information technology	**Years**
Making the first accounting tool by the Chinese called "Abacus"	**B.C. 6500**
Discovery of the metal machine for printing in animated letters by Kutenberg in Germany	**1436**
The invention of the Scottish scientist John Napier (Napier Machine) for counting and arithmetic	**1618**
Discovery of the first mechanical calculator by the French scientist Blaise Pascal	**1642**
Joe Tiffred's creation of William Lips is a more sophisticated calculator called the Lips Calculator.	**1671**
The English scientist William Slurgon discovered electromagnetic waves	**1824**
The discovery of the automated calculation machine, as if it were called Babbage.	**1833**
The discovery of the telegraph by Samuel F. B. Morse is the first long-range digital communication system	**1837**
Phone discovery by Alexander Granam Bell in the UNITED States	**1876**
Radio or radio waves detected by the Italian scientist Gelilmoni Marconi where the sound was transmitted to long distances without wires	**1895**
Discovery of the first electro-mechanical computer named Mark	**1941**
The first long-range direct phone call, without a function.	**1951**
Launch of the first SPUTNLK satellite launched by the former Soviet Union	**1957**
View Word Processor	**1964**
Videotext start-up service in USA	**1973**
The first display of the laptop and the first appearance of (CD) and the launch of the European satellite for communications and multi-purpose	**1982**
View of multimedia/multimedia desktops	**1993**
The emergence of the internet telephony service	**1997**
Digital HDTV broadcasting	**1998**
Microsoft introduced Windows XP and XP7 in all its components	**2000**
Facebook launch by Mark Zuckerberg	**2004**
Google introduced the rarest hand mobile phone system	**2010**

The overall framework for e-investment is based on the provision of satellites, international communications, a range of personal computers, internet subscriptions, the design of corporate websites and the use of e-mail to prepare and send instant financial reports and information. Malaysia is an Islamic royal federal state founded in 1963 with its capital, Kuala Lumpur, located in Southeast Asia, with a total area of about (328,550 KM^2) square kilometres, with a population of about (29,901,997) million in 2014, and Malay's account for (68%) per cent of the population. Of the total population, the Chinese race constitutes (20%) They are followed by Indians and other nationalities,

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who make up (12%) cent of the population (Solarin, Shahbaz, Khan, & Razali, 2021). The Malaysian economy became one of the most dynamic economies in the world during the early 1990s, and the period was characterized by the cooperation of businessmen and the government is playing a reciprocal role in achieving the objectives of economic and social development, especially in the industrial and service sector, while the contribution of the industrial sector to GDP did not exceed 19% at the beginning of 1990 (Afroz et al., 2020). However, its contribution jumped to 31.5% in 1994, industrial exports jumped to 77.5% of total exports during the same year, while external public debt rose from $18.6 billion in 1991 to $33.4 billion in 1994 and jumped to $44 billion in 1997 (Mat, Johari, Azis, & Hashim, 2018). The Malaysian government began a serious policy in 1998 to develop domestic demand by providing significant incentives to absorb ICT tools through the establishment of a number of leadership projects, particularly in building a complete electronic village, turning schools into smart (electronic) schools and developing all aspects of economic and social life (Ali & Haseeb, 2019).

The present article is comprised of several parts. After the introduction to the research, the 2nd part is a review of the previous studies conducted for analyzing the relation of knowledge economy using information technology like mobile phone users, internet users, fixed phone users, ICT imports, and ICT exports to achieve economic growth. The 3rd part throws light on the process adopted by the authors for the collection of data and the analysis of the required nexus, which helps to find results. In the 4th part, the results are confirmed in the light of recent studies. Afterwards, the study implications, study conclusions, and limitations are stated.

2. LITERATURE REVIEW

Investment in information technology plays a strategic role in increasing the rate of economic growth and recognizing the concept of investment in information technology, so the economic and financial concept of investment as well as e-investment must first be addressed:- Investment is defined as a stream of new spending on capital goods such as factories, machinery, roads, homes or addition slotting stocks such as raw materials, intermediate goods or finished goods over a certain period of time (Pradhan, Mallik, et al., 2018). The financial concept of investment means investing funds in various fixed and current assets, also described as the number of financial resources that the organization risks when accepting the investment proposal (Lu, 2018; Toader, Firtescu, Roman, & Anton, 2018).

The study by Haftu (2019)examines the ICT users impacts on economic growth with evidence from Sub-Saharan Africa. The authors take mobile phone users and internet users for the analysis of their impacts on economic growth. The panel data technique of research was employed, and the sample for data is based on forty economic in Sub-Saharan Africa for the period from 2006 to 2015. The robust two-step system GMM was employed. The study reveals that mobile phones are useful for promoting businesses.

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Mobile phone usage helps organizational entrepreneurs to assist and expand the business through offline and online sources as it assists in information management and communication practices. So, the increase in the number of mobile phone users enhances the chances of economic growth for a country. Likewise, the study of Al-Momani and Mohd Noor (2009) stresses on the businessmen to increase the mobile phone usage for higher business performance and economic growth. The study shows that the removal of space and time barriers can be useful to the business management and other personnel to enhance their awareness, learn more, and express themselves timely. This is possible under the increased use of mobile phones, which through SMS, MMS, search engines, and social media plate-forms remove the space and time barriers and add to the economic growth rate.

The research was conducted by Rangkakulnuwat and Dunyo (2018), to explore the role internet in achieving high economic growth in emerging economies. Through panel data technique, the information about the two factors and their relationship was collected from a sample of nineteen African countries for the period of 2003-2014. The Fixed Effect-Iterated Generalized Least Square (FE-IGLS) estimation was employed for autocorrelation and heteroscedasticity. The study implies that in African economies, internet usage has a positive impact on economic growth as the use of the Internet in educational institutions, professional educational institutions, and the business organization during training increases the knowledge of users for their subject or professional and train them. This results in enhanced economic growth. The research by Haini (2020) investigates the impacts of internet penetration on economic growth. Ten ASEAN economies are the sample of analysis for the analysis of internet penetration and economic growth for the period of 1999-2017. The authors employed a fixed-effects method of moment's quantile regression. The results show a positive link between internet penetration and economic growth. The study suggests that the improvement in the internet infrastructure and the training of the organizational personnel to use the different search engines, websites, and chat-bots, improves the communication systems and assists in acquiring the information which is necessary for business effectiveness. This, consequently, increases the economic growth of the country.

Through empirical research Donou-Adonsou (2019) investigates the telecommunications infrastructure, education, and economic growth with comparative research on the economies which have large access to the fixed phone, mobile phones, and other telecommunication infrastructure and those which have less access. The panel data was taken from forty-five Sub-Saharan African countries for the period of 1993-2015. The fixed-effects, two-step system GMM estimator was taken for the estimation of the relationship among factors under study. The study implies that the countries where the individuals or businesses, including educational institutions, have access to improved telecommunication infrastructure like fixed phones, mobile devices, and Internet etc., have well-informed, skilled, and efficient labour-force which perform their functions

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effectively and lead the economy towards higher growth. In an article Bahrini and Qaffas (2019) present their views on the influences of ICT on economic growth. The sample consists of selected developing countries in the Sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA) region for the period of 2007–2016 was taken, and a panel GMM was employed for the evaluation of the nexus among the predictor of ICT like fixed phone, mobile phone, digital devices, and Internet etc. The results showed a strong positive relation between ICT infrastructure and economic growth in MENA countries as compared to SSA countries because of more attention to the ICT infrastructure. The study suggests that for higher economic growth, the governments must form policies with attention to the promotion and adoption of ICT infrastructures like fixed phones, mobile phones, digital devices, and Internet etc.

The research study by Nguyen and Pham (2020) examines the impacts of trade of ICT, including import and exports ICT products along with government role on economic growth. The data were collected from the World Bank database of 21 states in the East Asia-Pacific region for 12 years during 2006-2017 for evaluation of the influences of ICT imports and exports with effective government role on economic growth. For research, Panel corrected standard error model, and the Dynamic panel data method was applied. The study implies that the export of ICT products is useful for leading the economy towards success. The ICT exports impacts on economic growth do not affect the change in control of corruption, government effectiveness, and tax factors. While, usually, the ICT import proves to be an accelerator for economic growth, the rise in government taxes may have a negative impact on economic growth. Pradhan, Arvin, Hall, and Bennett (2018), present their arguments on imports of ICT goods, Mobile telephony, financial development, foreign direct investment and economic growth with evidence from the G-20 countries. The Panel set of the G-20 countries for the fourteen years period from 1990–to 2014 and a multivariate framework for co-integration analysis were employed. The research findings show that there is a causal relationship between imports of ICT products and the economy both in the short and long run. The authors Raheem, Tiwari, and Balsalobre-Lorente (2020)integrate the relationship between ICT trade, financial development, and economic growth. G7 countries for the period during 1990-2014 are the sample for research, and PMG was used to analyze factors. The study implies that ICT exports drive economic growth by motivating the country to focus on innovation in information and communication technologies country's GDP and that an increase in foreign exchange stimulates economic activity and add to the financial development, which determines economic growth in the result. The research by Niebel (2018) was about ICT and economic growth with the comparison of returns on investment on ICT exports among developing, emerging and developed economies. The high-quality study sample is comprised of fifty-nine countries from 1995 to 2010. Various panel data regressions were applied for the confirmation of the positive relationship between ICT exports returns and economic growth as reported by previous studies. The study reveals that the returns on investment on ICT exports

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improves the financial development within the country and thereby lead to an increase in economic growth. So, there is a positive relationship between ICT exports and the economic growth of the country.

3. RESEARCH METHODS

This research includes the introduction of the standard methods used in testing the data of the model adopted in the estimation and theoretically, in terms of stillness first, and secondly in dealing with the sleep test of the time series and then estimating it according to the normal micro boxes this research is the extent to which the cognitive economy affects the economic growth represented by the Malaysian GDP, for the duration (2002-2018). This stage is one of the most prominent stages in the applied aspect because it is based on the experience and skill of the economist and what enables him to know the economic about the problem studied, as this stage is interested in the identification of the relationship that exists between the variable or the independent variables and the dependent variables, by using economic theory in order to find this semantic relationship that exists between independent variables and dependent variables And then put it in the form.

External variables, called several labels, include: (explanatory variables, explanatory variables, independent variables), and it is known that explanatory or explanatory names are the most prevalent, and the independent variable is valued by several factors and is outside the model. The current study has used "number of mobile phone users", "number of internet users", "number of fixed phone users", ICT imports and ICT exports as the predictors of the study. Table 2 shows the index of the number of internet users is fluctuating, reaching (7,812,414) in 2002 and then (1,035,200) in 2007. The number then increased to (2,938,800) in 2013 with a compound growth rate of (7.77%), and then to (2,696,000) in 2018, and the decline indicates that Malaysian society is moving away from using the Internet for economic or psychological reasons. This is also accompanied by a continuous increase in the number of mobile subscribers, and during 2002 the number of subscribers (9,053,000) was used, which in turn led to an increase in the year 2007 to (23,347,000) in use and continues to increase to 2013, which reached (43,005,000) users and a composite capacity growth rate (13.27%). However, there is a fluctuation in the number of fixed telephone subscribers in 2002 (4,669,903), which in turn leads to a marked decrease in subscriber numbers in the two years from 2004 to 2007, reaching (4,350,000) users in 2007 and then the increase In 2010, the number of subscribers (4,609,800) was in use and in 2013 it decreased to (4,535,800) at a compound rate of (-0.23%), and the negative signal indicated the disparity between the few years and in this case Mobile phone users are more than fixed phone users, then in 2018 rose to (6,433,300) users. In addition, Table 2 also show that in 2000, exports of ICT goods amounted to approximately ($52.7) million. The government's policy of "taking into account the needs of the people of The O'Hare" is a major concern for the government. When we look at imports of information technology goods in 2000, they amounted to

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about ($40.9) million in 2001, but in 2001 they decreased to ($39.0) million. In 2008, there was a decrease in imports of ($23.4) million due to the financial crisis in Southeast Asia, then again in 2010 and reached (22.6) million dollars in 2013 at a compound rate of (2.42%), and then increased in 2017 to reach (25.2) million dollars.

Table 2: Shows Infrastructure Indicators in Malaysia

Years	Number of Internet users	Number of mobile phone users	Number of fixed phone users	ICT goods exports (% of total exports of goods)	Imports of ICT goods (% of total imports of goods)
2002	7.812.414	9.053.000	4.669.903	52.7	40.9
2003	8.711.729	11.124.000	4.571.561	51.5	39.0
2004	10.653.337	14.611.000	4.446.265	50.7	37.9
2005	12.663.298	19.545.000	4.365.647	48.5	42.8
2006	13.690.091	19.463.722	4.342.100	45.2	39.2
2007	1,035,200	23.347.000	4.350.000	43.4	38.0
2008	1,329,300	27.713.000	4.514.000	42.7	36.1
2009	1,553,600	30.144.000	4.524.000	39.4	33.5
2010	2,097,800	33.858.700	4.609.800	24.5	23.4
2011	2,506,700	36.661.300	4.522.900	36.5	30.1
2012	2,920,900	41.324.700	4.588.900	34.0	29.8
2013	2,938,800	43,005,000	4.535.800	29.4	25.6
2014	3,061,000	44,928,600	4,410,200	27.9	23.1
2015	3,063,800	44,104,000	4,489,500	28.2	22.6
2016	2,718,800	43,465,000	4,837,200	28.7	23.1
2017	2,687,800	42,338,500	6,578,200	30.0	24.0
2018	2,696,000	42,413,400	6,433,300	30.5	24.7

Source: World Bank Indicators

Internal variables located within the model, often called (variable or dependent variables), as the dependent variable, unlike the independent variable (external variables), determines its value from within the model, and it is worth noting that the process of determining the independent and variable of the dependent step is important and fundamental in the model characterization phase. The contribution to the GDP of any country represents the most important returns expected from investment operations in general and investment in the IT sector in particular, and Table 3 reveals to us the economic indicators in Malaysia for the duration (2000 - 2018).

Table 3 shows that the GDP composition increased from ($93,789,736) billion in 2000 to ($230,813,597) billion in 2008 at a growth rate of (19.25), and then decreased during 2009 to ($202,257,586) billion at a rate of growth of ($12.37) billion. Gross domestic

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product (GDP) increased significantly until 2014 to ($338,103,822) billion, and then in 2019, it rose to (364,701,517), which made Malaysia improve its ranking among internet technological readiness and domain subscriptions. Broadband, this new technology, helps in the speed and efficiency of business transactions and reduces operating costs, opening up important opportunities for local companies, especially small and medium-sized to reach the international market, especially in light of the adoption of e-commerce and penetration (broadband), All of this improves the importance of technology in GDP formation, making Malaysia in the refineries of developed countries that rely on research and development and modern technologies in the composition of their GDP

Table 3: Economic Indicators in Malaysia

Years	Average GDP per capita	Annual Growth Rate GDP%
2000	7.936	----
2001	7.674	- 3.301
2002	8.160	6.333
2003	8.729	6.973
2004	9.675	10.837
2005	10.900	12.661
2006	12.095	10.963
2007	14.087	16.469
2008	16.458	16.831
2009	14.147	- 14.041
2010	17.526	23.884
2011	20.157	15.011
2012	20.973	4.048
2013	21.281	1.468
2014	21.972	3.247
2015	19.336	- 11.997
2016	19.077	- 1.339
2017	19.934	4.492
2018	22.117	10.951

Source: World Bank Indicators

That this phase involves a number of steps, and one of the most prominent of these steps is identifying the most prominent variables of the model: In this step, the variables contained in the model are determined when studying any economic problems, based on the logic of economic theory and according to the available data. Determining the mathematical shape of the model: In this step, the type of equation contained in the model is determined, as well as the number of equations, the degree of linearity and homogeneity of the model to be studied.

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Determining preliminary (advance) forecasts: This step is very important, as the expected signal of the estimated parameters and the size of the parameters of the model is determined by the economic relationships of the variables. Based on the above, it is now possible to identify the most prominent variables that will be examined, so five variables have been used in this research. The equation of the study is given as under:

$$GDP_t = \alpha_0 + \beta_1 LNMPU_t + \beta_2 LNIU_t + \beta_3 LNFPU_t + \beta_4 LICTI_t + \beta_5 ILCTE_t + e_t \quad \textbf{(1)}$$

Where

GDP	=	Gross domestic product
t	=	Time
LNMPU	=	Log of number of mobile phone users
LNIU	=	Log of number of internet users
LNFPU	=	Log of number of fixed phone users
LICTI	=	Log of ICT imports

The current article has run the descriptive statistic that shows the minimum values of the variables, maximum values of the constructs, the mean and standard deviation of constructs. Furthermore, a correlation matrix has also been run by the researchers to check the directional linkage among variables. In addition, the stationarity of the constructs has also been examined using ADF test. The equation is mentioned as under:

$$d(Y_t) = \alpha_0 + \beta t + \Upsilon Y_{t-1} + d(Y_t(-1)) + \varepsilon_t \quad \textbf{(2)}$$

The characteristic of the ADF test is that it check the stationarity of the constructs individually. Hence, the individual education of ADF test for each construct are given as under:

Gross Domestic Product

$$d(GDP_t) = \alpha_0 + \beta t + \Upsilon GDP_{t-1} + d(GDP_t(-1)) + \varepsilon_t \quad \textbf{(3)}$$

Logarithm of Number of Mobile Phone Users

$$d(LNMPU_t) = \alpha_0 + \beta t + \Upsilon LNMPU_{t-1} + d(LNMPU_t(-1)) + \varepsilon_t \quad \textbf{(4)}$$

Logarithm of Number of Internet Users

$$d(\mathrm{LNIU}_t) = \alpha_0 + \beta t + \Upsilon \mathrm{LNIU}_{t-1} + d(\mathrm{LNIU}_t(-1)) + \varepsilon_t \quad \textbf{(5)}$$

Logarithm of Number of Fixed Phone Users

$$d(\mathrm{LNFPU}_t) = \alpha_0 + \beta t + \Upsilon \mathrm{LNFPU}_{t-1} + d(\mathrm{LNFPU}_t(-1)) + \varepsilon_t \quad \textbf{(6)}$$

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Logarithm of ICT Imports

$$d(\text{LICTI}_t) = \alpha_0 + \beta t + \Upsilon \text{LICTI}_{t-1} + d(\text{LICTI}_t(-1)) + \varepsilon_t \quad \textbf{(7)}$$

Logarithm of ICT Exports

$$d(\text{LICTE}_t) = \alpha_0 + \beta t + \Upsilon \text{LICTE}_{t-1} + d(\text{LICTE}_t(-1)) + \varepsilon_t \quad \textbf{(8)}$$

The current article has also used the ARDL model to test the linkage among constructs. The ARDL model is applicable when some constructs are stationary at the level, and some constructs are stationary at the first difference, but no construct is stationary at the second difference. Moreover, this statistical approach estimated the short and long-run results together. The ARDL equation is mentioned below:

$$\Delta GDP_t = \alpha_0 + \sum\delta_1 \Delta GDP_{t-1} + \sum\delta_2 \Delta LNMPU_{t-1} + \sum\delta_3 \Delta LNIU_{t-1} + \sum\delta_4 \Delta LNFPU_{t-1} + \sum\delta_5 \Delta LICTI_{t-1} + \sum\delta_6 \Delta LICTE_{t-1} + \varphi_1 GDP_{t-1} + \varphi_2 LNMPU_{t-1} + \varphi_3 LNIU_{t-1} + \varphi_4 LNFPU_{t-1} + \varphi_5 LICTI_{t-1} + \varphi_6 LICTE_{t-1} + \varepsilon_1 \quad \textbf{(9)}$$

4. RESEARCH FINDINGS

The current article has run the descriptive statistic that shows the minimum values of the variables, maximum values of the constructs, the mean and standard deviation of constructs. The figures highlighted that the mean value of the GDP was 8.763 while the average value of LNMPU was 3.982. In addition, the findings also show that the mean value of LNIU was 4.983 while the average value of LNFPU was 3.892. The results also show that the mean value of LICTI was 6.762, and the average value of LICTE was 7.982. Table 4 shows these figures given below:

Furthermore, a correlation matrix has also been run by the researchers to check the directional linkage among variables. The figures highlighted that the LNMPU, LNIU, LNFPU, LICTI and LICTE have positive nexus with the GDP. Table 5 shows the correlation matrix.

Table 4: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
GDP	8.763	1.652	6.576	15.982
LNMPU	3.982	1.872	1.872	7.093
LNIU	4.983	2.763	2.761	7.662
LNFPU	3.892	1.892	1.982	5.872
LICTI	6.762	2.871	4.983	13.870
LICTE	7.982	1.982	5.982	13.981

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Table 5: Correlation Matrix

Variables	GDP	LNMPU	LNIU	LNFPU	LICTI	LICTE
GDP	1.000					
LNMPU	0.632	1.000				
LNIU	0.532	0.762	1.000			
LNFPU	0.428	0.651	0.656	1.000		
LICTI	0.434	0.653	0.440	0.780	1.000	
LICTE	0.392	0.532	0.357	0.522	0.342	1.000

The stillness of time series can be tested through the root of the unit, which contains a set of tests, the best and most famous test used in the time series silence id is the Dickey-Volar Extended Test (ADF) instead of the simple Diciki-Volar, because the simple DF test is valid only if the time series of variables is self-regression of the first degree. Otherwise, the simple regression model will be self-related, making the results of the estimate inaccurate, so Daki Volar suggested an alternative test for their first test as the Dickey-Fuller (ADF), if there is a self-correlation between errors, the values extracted are compared with the scheduling values that are associated with e-views results, and the decision is made after the stillness of the time series is made. After using the ADF for each series, it was determined that the variable time series GDP became static at the first difference and at None no direction and no categorical and that the calculated t of (-6.882) became larger than (-1.96) and the second evidence of the morale of this series is prob (0.000) which is less than the freedom of 5% required. The time series of the variable LNMPU became static at the first difference and at the direction and the calculated t (-4.433) became greater than (-1.96) and the second proof of the morale of this series is prob and the amount (0.021) which is less than the degree of freedom 5% which is required.

In addition, the time series of variable LICTI became static at the level and at the point and in the direction and the cutter and that the calculated t of (-2.008) became greater than the (-1.96) and the second proof of the morale of this series is prob and the amount (0.048) which is less than the degree of freedom 5% which is required. We also note that the time series of the variable LNIU has become static at the first difference trend and that the calculated t (-3.006) is larger than the (-1.96) and the second evidence of the morale of this series is prob and the (0.035) which is less than the 5% freedom score is required, as we note that the time series of the variable LNFPU became static at the first difference and direction and that the calculated t of (-2.132) became slightly larger than the table dissonance (-1.96) and the second proof of the morale of this series is prob (0.045) which is less than the degree of freedom of 5% which is required, The time series of the variable LICTE has become the inhabitant of the first difference and the direction and the calculated t (-6.727) is greater than the (-1.96) and the second proof of the morale

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of this series is prob and adult (0.000) which is less than the degree of freedom of 5% which is required. Table 6 shows the ADF test results.

Table 6: Unit Root Test

Augmented Dickey-Fuller Test (ADF)	Level	t-statistics	p-values
GDP	I(0)	-6.882	0.000
LNMPU	I(1)	-4.433	0.021
LNIU	I(1)	-3.006	0.035
LNFPU	I(1)	-2.132	0.045
LICTI	I(0)	-2.008	0.048
LICTE	I(1)	-6.727	0.000

The co-integration among the constructs is necessary to apply the ARDL model to test the associations among variables. The current study has used the ARDL bound test to check the co-integration. The results exposed that the calculated value of f-statistics (6.14) is larger than the critical values at a five per cent "level of significance". Thus, the co-integration exists, and the ATRDL model can be applied. Table 7 shows the ARDL bound test results.

Table 7: ARDL Bound Test

Model	F-statistics	Lag	Level of Significance	Bound test critical values	
				I(0)	I(1)
GDP/(LNMPU,LNIU,LNFPU,LICTI,LICTE)	6.14	4	1%	6.23	6.57
			5%	5.47	5.99
			10%	4.54	4.99

Table 8 results exposed that the LNMPU, LNIU, LNFPU, LICTI and LICTE have significant nexus with the GDP. On the other hand, the value of R square of 0.598 means that independent variables interpret the model as a whole by 59.8% in the GDP variable, which is very good, and that 40.2% is due to factors that have not been taken into account and which are called random variables. According to the economic logic, the LNIU independent variable should be positive and not negative, and this is contrary to economic logic, in other words when the use of the mobile phone will increase GDP directly or indirectly, but through the equation above, we note that the signal represents the opposite of economic logic, the rest of the independent variables that indicate positive and this is consistent with economic logic. Table 8 shows these short-run associations.

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Table 8: Short-run Relationships Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNMPU)	0.762921	0.376221	2.027853	0.0453
D(LNIU)	-0.872621	0.372827	-2.340552	0.0323
D(LNFPU)	4.987530	1.572382	3.171958	0.0128
D(LICTI)	1.283427	0.378222	3.393317	0.0042
D(LICTE)	1.548620	0.472620	3.276670	0.0052
CointEq(-1)*	-1.562720	0.392873	-3.977672	0.0020
R-squared	0.598221	Mean dependent var		-0.040852
Adjusted R-squared	0.572821	S.D. dependent var		2.445322

Table 9 results also exposed that the LNMPU, LNIU, LNFPU, LICTI and LICTE have significant nexus with the GDP in the long run. According to the economic logic, the LNIU independent variable should be positive and not negative, and this is contrary to economic logic, in other words when the use of the mobile phone will increase GDP directly or indirectly, but through the equation above, we note that the signal represents the opposite of economic logic, the rest of the independent variables that indicate positive and this is consistent with economic logic.

Table 9: Long-run Relationships Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMPU	1.398274	0.567322	2.464692	0.0362
LNIU	-4.192823	1.392826	-3.010299	0.0139
LNFPU	1.392822	0.398223	3.497593	0.0034
LICTI	3.482722	0.982727	3.543936	0.0025
LICTE	2.593823	0.967268	2.681597	0.0205
C	0.998327	0.287256	3.475391	0.0035

5. DISCUSSIONS

The results have indicated that the number of mobile phone users representing the knowledge economy has a positive relation to economic growth. These results agree with Asongu and Odhiambo (2020b), which states that mobile phones are the type of information technology; it enhances the information and keep the knowledge of users updated all the time. So, in the economies where there is a large number of active mobile phone users, all the economic sectors, along with education, grow well on the up-to-date standards. These results agree with Haftu (2019), which reveals that now, the

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smartphones which give the facility of the Internet provide the chance to the users to keep in contact with the peers or seniors in their own economic fields over the globe, the increased knowledge improve their world performance and their share in the economic growth. So, the increased number of mobile phone users has a positive influence on economic growth.

The results have indicated that the number of internet users representing the knowledge economy has a positive relation to economic growth. These results agree with Habibi and Zabardast (2020), which shows that internet usage is a source of getting information, knowledge, and training, expression of thoughts or knowledge, advertisement, marketing. These all are the essential elements of the leading economy. The increase in the number of internet users, whether they are individuals or organizations, open the door to high economic growth. These results are also supported by Myovella, Karacuka, and Haucap (2020), who argue that when there is an increase in the number of internet users in the different areas of the economy, the economy runs on up-dated principles and have innovation which leads to higher growth.

The results have indicated that the number of fixed phone users representing the knowledge economy has a positive relation to economic growth. These results agree with Tchamyou, Asongu, and Odhiambo (2019), who have the opinion that the usage of fixed phones in an organization or industry provides a convenient and useful communication network and becomes a source of information when used to share ideas or knowledge. This assists in getting timely information and applying it for making the right decision and performing the business activities efficiently. Thus, the increasing number of fixed phone users enhances the economic growth of the country. Similarly, the study of Chatterjee (2020) states that the increased usage of fixed phones keeps the business personnel in contact with one another in the same industry or otherwise. As a result of communication through phone usage, strong relations are formed and lead the economy towards growth.

The results have indicated that the ICT import, representing the knowledge economy, has a positive relation to economic growth. These results agree with Bhujabal and Sethi (2020), who state that sometimes the countries that themselves are not proficient in manufacturing ICTs but feel their need in the economic progress can import the required ICTs and use them for information purposes in the economy. The economies where it is allowed to import the ICTs have a high growth rate. These results also agree with Azam, Rafiq, Shafique, and Yuan (2021), which examines the role of ICTs in accelerating the economic growth rate. This study suggests that for developing innovation in the economy and placing it on the track to high growth, the ICTs development through manufacturing, invention, or import is required for the use of ICTs in different businesses creates innovation, reduces the risks elements, and improve their performance.

The results have indicated that the ICT export, representing the knowledge economy, has a positive relation to economic growth. These results agree with Iqbal, Peng, and Hafeez (2020), which states that ICT exports lead the economy towards higher growth, as it motivates the country to focus on the innovation in technologies for information and communication purposes which themselves contribute to the country's GDP and the increase in the foreign exchange encourages economic activities and thereby, increases economic growth. These results are in line with Adeleye and Eboagu (2019), which shows that the ICTs exports, with the development of technologies, creativity, innovation, and increase in the manufacturing of technological parts or instruments, increase the economic growth.

6. CONCLUSIONS AND RECOMMENDATIONS

The researchers found a relationship between the knowledge economy and the growth of the Malaysian economy. Malaysia's GDP is increasing, and this indicates an improvement in the national economy. The researchers also found that the general budget is financed not only by a fraction of its revenues. The majority of the Malaysian people use ICT, particularly the economically active group. The social and psychological effects of ICT on Malaysia must be taken into account. Malaysia has an abundance of economic resources, so it is necessary to make the optimal use of resources in order to sustain resources. It is necessary to pay attention to and expand the Malaysian knowledge economy because of its great importance in the national economy. Attention to national development plans and coordination with the outside world in order to achieve sustainable and comprehensive development. The need to continue to follow the approach of the economy and lead the policy in order to continue the national economy.

The present study is still exposed to several limitations. These limitations require attention from future authors. The present study just examines the role of the knowledge economy in achieving high economic growth. It is not only the knowledge economy that directly brings improvement in the economic growth rather requires better management, financial resources, and effective policies. So, it is the duty imposed on the future authors to address other necessary elements for economic growth as well. The study takes the limited period of 2002-2018 to examine the role of the knowledge economy in achieving high economic growth for Malaysia. The future authors must take an extended period for examining the role of the knowledge economy in achieving economic growth.

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