Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 12, 1636-1648

The Effects Of Information And Communication Technology On The Human Development In MENA Countries

Ahmed Aljazea[1] , Mounir Belloumi[2]

[1]Department of Business Administration, College of Administrative Sciences, Najran University, Najran, Saudi Arabia Email: amaljazea@nu.edu.sa
[2]Department of Business Administration, College of Administrative Sciences, Najran University, Najran, Saudi Arabia Email: mrbelloumi@nu.edu.sa

Abstract

Information and communication technology (ICT) has transformed the life around us. In the Middle East and North Africa (MENA) countries, ICT has a significant role in human development. This work investigates the impact of ICT on human development in a selected sample of 15 MENA countries over the period 1995-2018 using the panel ARDL model. Overall, the results show that the three indicators of information and communication technology (fixed telephone subscriptions per 100 people, mobile cellular subscriptions per 100 people, and proportion of individuals using the internet) have a positive and significant impact on the human development index in the long-run whereas only mobile cellular subscriptions indicator is significant in the short-run. Therefore, a policy based on improved ICT indicators could strengthen the long-term human development index for some countries in the Middle East and North Africa.

Keywords Information and Communication Technology, Human Development Index, Panel ARDL, MENA Countries.

1. Introduction

Undoubtedly, we are in the information era. In emerging, developing and developed countries the use of the internet and communication technologies can be easily observed throughout our daily life work. It allows us to search for information and to communicate with each other, so it has been improving our living standards. It may touch many aspects of our daily life such as education, health, commerce, and social networking platforms. It is the digital age where the gadget of ICT is seen in everywhere such as computers, smartphones, laptops, etc. People, as such, are interested to be updated with the most recent trends and moving up in life with the use of ICTs. From this point of view, the impact of ICT on the human development index will be investigated and before that, the definition and importance of ICT and HDI will be discussed as follows.

Internet and Communication Technology (ICT) is defined as “a diverse set of technological tools and resources used for the transmission, storage, creation, sharing or exchange of information. These technological tools and resources include computers, the Internet (websites, blogs, and e-mails), live broadcasting technologies (radio, television, and web broadcasting), recorded broadcasting technologies (podcasting, audio, and video devices and storage devices), and telephony (fixed or mobile, satellite, video conferences, etc.)" UNESCO (2021)[1].

Within the last two decades, the number of internet users has increased from around 400 million in 2000 to around 7 billion in 2021[2]. The latter figure is almost the same as the world's population. In other words, the use of mobile internet promotes connectivity between people and plays a great role in easing governmental and private organizations to reach their clients (Lee et al., 2017). Additionally, ICT opens remote universities and educational centers for non-residential people, which in turn improves the spread of knowledge around the world (Asongu et al., 2018). This knowledge reflects in economic growth and vice versa. Consequently, the higher the education level the higher the number of innovations and hence the strong the economy will be (Ogundari and Awokuse, 2018).

ICTs has transformed societies across the world and almost touched all activities of our daily life. Theoretical and empirical studies have uncovered the critical role of ICT in economic and social development. Its impact on many countries' economies has been widely discussed. For example, Niebel (2018) discussed the impact of ICT on economic growth in developed, emerging, and developing countries. Qureshi and Najjar (2017)investigated such an impact on 32 very small island states while Sepehrdoust and Ghorbanseresht (2019) studied this impact on OPEC developing countries. Other studies investigated such an impact in the MENA region such as (Sassi and Goaied, 2013).

The human development index (HDI) is a measurement that was developed by the United Nations to measure various countries' levels of social and economic development (Stanton, 2007). It consists of four main components: 1) education and knowledge are measured based on mean years of schooling and expected years of schooling; 2) long and healthy life is measured based on life expectancy at birth, and 3) income or a decent standard of living is measured based on national gross income (NGI) per capital. Although there is a new measurement of HDI called IHDI which includes inequality as a factor to measure such an index, this research used the original HDI and the latter will be investigated in another research.

Although studying the impact of ICT on HDI was broadly investigated, this research has contributed to the knowledge in two aspects. The first one is the use of the panel autoregressive distributed lag model to investigate such an impact has uncovered new results. The second one is that this research is more comprehensive in the matter of data compared to the past studies where most MENA countries' data is included in this research.

The remaining of this research is organized as follows. The literature is reviewed in section 2. Data and research methodology are discussed in section 3. Empirical results and discussions are given in section 4. In section 5, this research concludes and suggests future work.

2. Literature review

In this section, the literature regarding the impact of ICT on HDI will be discussed. During recent decades, much research has been conducted to investigate the effect of ICT on the growth of the economy (Oulton, 2002, Kuppusamy and Santhapparaj, 2005,

[1] UNESCO 2021: Definition of ICT. https://uis.unesco.org/en/glossary-term/information-and-communication-technologies-ict Accessed date 16 Nov 2022.

[2] Statista.com. https://www.statista.com/topics/779/mobile-internet/#topicHeader__wrapper Accessed date 20 May 2022.

Bollou and Ngwenyama, 2008, Farhadi et al., 2013, Salanova et al., 2014, Toader et al., 2018). In the literature, a large number of studies investigating such an effect by studying the impact of ICT on education, health, human development, and firms' profitability (Gholami et al., 2010). For instance, the impact of IT on SMEs is investigated by Chege and Wang (2020), and the results showed that technological innovations have positively influenced job creation in small businesses and act as drivers of economic development. These findings are supported by Das et al. (2020) the results of a study where the technological environment supports SMEs development and creates jobs.

Other studies showed the linkage between ICTs and human development. For example, Ngwenyama et al. (2006) studied the impact of investment in ICT and health on human development. This study finds a positive correlation between ICT and human development. Another study by Gholami et al. (2010) analyzes the impact of ICT on human development where the human development index is used as an indicator. This study showed that there is a more significant positive impact of ICT on human development in less developed countries than in highly developed countries. Bankole et al. (2011) investigated the impact of ICT on different human development components. The result of this study showed that ICT has a different impact on each component of human development and differs in low-, middle- and high-income countries.

The impact of ICT on human development has been analyzed in different regions. For example, in Sub-Saharan Africa, Asongu and Le Roux (2017) investigated the role of ICT in enhancing human development and found that the diffusion of mobile phones, the internet, and the telephone improves inclusive human development. De la Hoz-Rosales et al. (2019) studied the impact of ICT on human development using two indicators: HDI and Social Progress Index (SPI). The results of this study showed a significant impact of ICT on HDI at the individual level. In the Gulf Cooperation Council (GCC) countries, Balouza (2019) analyzed the role of ICT on human development living in this region. He finds the effect of ICT is inconsistent among such countries as it is positive in some of the GCC countries and negative in others.

The role of ICT in enhancing human development has been analyzed in different regions using different methods. In this research, however, the concentration of such a role will be limited to the MENA region by applying the panel autoregressive distributed lag model. Additionally, this research is more comprehensive in the matter of data compared to the aforementioned studies since most MENA countries' data are included.

3. Data and research methodology

This section presents the source of data and the used methodology to demonstrate the impact of ICT on HDI in MENA countries.

3.1. Data

The investigated variables and countries are carefully chosen according to the disposal of the data and the objective of the study. We use the annual data for the period 1995-2018 for a sample of 15 MENA countries: Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Mauritania, Morocco, Qatar, Saudi Arabia, Tunisia, Turkey, and the United Arab Emirates. The human development index (HDI) is used as a dependent variable. ICT indicators (Fixed telephone subscriptions (per 100 people), Individuals using the Internet (% of population), and Mobile cellular subscriptions (per 100 people) are employed as independent variables. They are noted by FT, IUI, and MC, respectively (Figure 1). Population growth and urban population growth are used as controlled variables. They are noted by PG and UPG, respectively. All the data used are obtained from the world development indicators of World Bank database (WDI, 2019) and the United Nations Human Development Program.

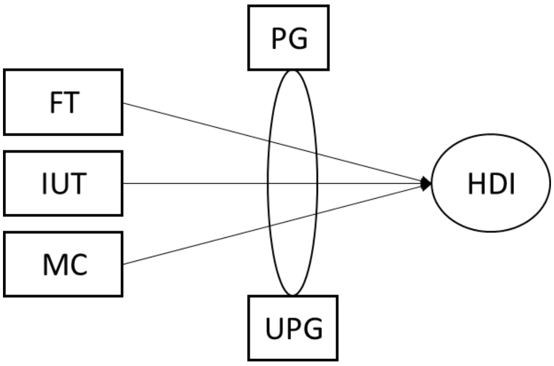

Figure 1: Independent, controlled and dependent variables

The sample is converted to a panel data format. The main advantage of panel data is that they have the particularity of considering the temporal dynamics (adjustment time, expectations, etc.) in explaining the dependent variable due to frequent cross-sectional observations, thus improving policy effectiveness (decisions, actions, etc.). Additionally, the use of panel data reduces the problem of heteroscedasticity, which frequently happened in individual time series. In contrast, in the case of the static model, the instant explanation of which (immediate or not spread out over time) gives only part of the variation of the dependent variable.

Table 1 displays the descriptive statistics of the different variables investigated in this study.

Table 1: Descriptive statistics

	UPG	PG	MC	FT	IUI	HDI
Mean	3.421545	2.925490	73.15076	16.42922	27.92795	0.717430
Median	2.510543	2.039273	83.47811	13.39235	17.88230	0.731000
Maximum	17.76250	17.51095	212.6390	50.04392	100.0000	0.916000
Minimum	0.539269	0.176677	0.000000	0.399761	0.000000	0.418000
Std. Dev.	2.563346	2.594967	55.07097	12.05481	29.14924	0.109402
Skewness	3.006104	3.048113	0.242908	0.941447	0.886526	-0.62734
Kurtosis	13.91768	14.10144	2.229589	3.256363	2.589235	2.893473
Observations	360	360	360	360	360	360

3.2. Methods

The research methodology used in this research project will be based on estimating the panel autoregressive distributed lag (panel ARDL) model and the static panel data model using the annual data of HDI and ICT indicators for 15 MENA countries (Algeria, Bahrain, Egypt, Jordan, Iran, Iraq, Israel, Kuwait, Mauritania, Morocco, Qatar, Saudi Arabia, Turkey, Tunisia, United Arab Emirates) over the period 1995-2018. The methodology of panel ARDL is undertaken in different steps. In the first step, the different panel unit root tests are applied to look over the stationarity of the different time series. These tests are those of (Breitung, 2001, Hadri, 2000, Levin et al., 2002, Choi, 2001, Im et al., 2003, Pesaran, 2007). In the third step, the test for the existence of cointegration between HDI and ICT indicators is performed by employing the Pedroni cointegration test and Kao residual cointegration test. In the last step, this study estimates the panel ARDL model originally developed by Shin et al. (2014) using the Pooled Mean Group estimator to detect the short and long-run effects of ICT indicators on HDI in the selected sample of 15 MENA countries.

In this study, the influence of ICT indicators on HDI is analyzed by including population growth and urban population growth as control variables. The model linking HDI to ICT indicators takes the following form:

$$HDI = f\ (ICT, PG, UPG) \qquad (1),$$

where HDI is the human development index, ICT represents the information and communication technology indicators (FT, IUI, MC). PG and UPG represent population growth and urban population growth, respectively.

Eq. (1) can be rewritten with a time series specification on panel data, such as:

$$HDI_{i,t} = \beta_0 + \beta_1\, FT_{i,t} + \beta_2\, IUI_{i,t} + \beta_3\, MC_{i,t} + \beta_4\, PG_{i,t} + \beta_5\, UPG_{i,t} + \mu_i + \varepsilon_{i,t}\,;$$

$$where, i = 1, 2, \ldots, 15\ and\ t = 1, 2, \ldots, 24. \qquad (2),$$

where the index i $(i = 1, \ldots, N)$ indicates the country i of the sample, N is equal to 15, t $(t = 1, \ldots, T)$ represents the period or the years, T is the number of years (24). The panel is made up of 15 countries and 24 years, so the number of years (T) is superior to the number of countries (N). Thus, we have a heterogeneous panel. If the variables are not stationary at levels $(I\ (0))$ but they are probably stationary at their first difference $(I\ (1))$, this will imply that the model is dynamic and assumes the inclusion of lag-dependent variables as regressors. Hence, our model will be a heterogeneous dynamic panel data model. In this case, the ARDL model is most suitable. There are other various methods of dynamic models that can give rise to inconsistent estimates of the mean value of the parameters excepting that they are identical between countries. In addition, the ARDL model is relatively more efficient mainly in the case of a small sample size.

The estimated model then takes the form of the following panel ARDL model (p, q):

$$HDI_{it} = \alpha_0 + \sum_{j=1}^{p} \alpha_j\, HDI_{i,t-j} + \sum_{j=0}^{q} \delta_j\, ICT_{i,t-j}\ \beta_4\, PG_{i,t} + \beta_5\, UPG_{i,t} + \mu_i + \varepsilon_{it} \qquad (3)$$

By re-configuring the model given by eq. (4), it is transformed into the re-parametrized panel ARDL(p, q) error correction model:

$$\Delta HDI_{it} = \alpha_0 + \Phi_i\left(HDI_{i,t-1} - \rho_i ICT_{i,t}\right) + \sum_{j=1}^{p-1} \alpha_{ij}\, \Delta HDI_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}\, \Delta ICT_{i,t-j} + \beta_4\, PG_{i,t} + \beta_5\, UPG_{i,t} + \mu_i + \varepsilon_{it} \qquad (4),$$

where Φ_i is the group-specific coefficient of adjustment speed ($\Phi_i < 0$); p is the optimal lag for the dependent variable; q is the optimal lag order for the regressor; ρ represents the coefficients of attentiveness that measures the long-run impact of ICT indicators on HDI. $ECT = [(HDI_{i,t-1} - \rho\ ICT_{i,t})]$ is the error correction term; δ_{ij} are the coefficients of short-run dynamics; μ_i is the country-specific effects; and ε_{it} are random disturbances.

According to Pesaran and Smith (1995) and Pesaran et al. (1999), the model is given in eq. (4) can be estimated always by employing the Mean Group (MG) estimator. This estimator estimates the coefficients for each country and subsequently presents an average for the group. Nevertheless, the authors admit that if the long-term parameters are not heterogeneous from one group to another, it is more relevant to employ a more efficient estimator, namely the "Pooled Mean Group" estimator. The PMG estimator authorizes short-term coefficients to vary from one country to another but constrains the parameters to be homogeneous over the long term. The use of both methods of estimation needs that the variables must be integrated of order zero or one.

Finally, the Hausman test is employed to check if the static panel model given by eq. 2 will be estimated with random effects or fixed effects.

4. Empirical results and their discussions

In order to test the existence of unit roots in our data, we use the different panel unit root tests of (Breitung, 2001, Hadri, 2000, Im et al., 2003, Levin et al., 2002), and Fisher type tests (ADF and PP). In the Levin, Lin, and Chu (LLC) and Breitung tests, the null hypothesis assumes a common unit root process. In the tests of (Im, Pesaran, and Shin (IPS), ADF-Fisher and PP-Fisher), the null hypothesis assumes that the entire panel restrains to an individual unit root process. However, in Hadri test, the null hypothesis assumes the stationarity of the time series. In

Table *2* and Table 3, we present the findings of these various first-generation panel unit root tests.

The results of the different tests show that all the time series are either stationary at their levels or their first differences (I(0) or I(1)). For HDI, four out of six tests indicate that the variable is integrated of zero, which means that it is stationary at its level. According to five tests out of six, the variables FT, IUI and MC are integrated of order one. Five out of six tests indicate that the variable population growth is integrated of order one. Finally, all unit root tests yield that the variable of urban population is I(1). Therefore, it is essential to consider the estimation of a panel ARDL model.

Table 2. Results of panel unit root tests for the various variables at their levels

Variables	LLC test	Breitung test	Hadri test	IPS test	ADF-Fisher test	PP-Fisher test
	H_0 : Common unit root		H_0 : stationarity	H_0 : Individual unit root		
HDI	-6.67*	5.73	13.77*	-1.32***	67.97*	67.46*
FT	-2.67*	-1.04	10.48*	-0.363	37.55	17.00
MC	-3.39*	2.16	12.36*	0.736	25.85	16.69
IUI	6.56	7.25	13.18*	10.94	1.60	0.77
PG	-0.72	4.39	0.48	-4.41*	71.59*	32.73
UPG	-2.48*	1.98	7.58**	-5.28*	86.14*	50.83*

Notes: Significance level: *** p-value<10%, ** p-value<5%, * p-value<1%; the p-values for Fisher tests are determined by employing the asymptotic Chi-square distribution; in the other tests, we suppose normality; the automatic lag selection is done by employing the Schwartz information criteria (SIC).

Table 3: Results of panel unit root tests for the variables at their first differences

Variables	LLC test	Breitung test	Hadri test	IPS test	ADF-Fisher test	PP-Fisher test
	H_0 : Common unit root			H_0 : Individual unit root		
HDI	-7.08*	2.65	3.97*	-7.98*	129.83*	136.57*
FT	-5.91*	-1.39***	2.96*	-6.08*	96.30*	112.4*
MC	-3.70*	0.49	1.27	-4.45*	77.23*	84.00*
IUI	-3.92*	-1.93**	4.75*	-3.89*	94.28*	123.6*
PG	-1.29***	4.71	0.86	-4.69*	107.4*	49.8**
UPG	-2.24*	-2.02**	0.92	-5.450*	94.63*	69.01*

Notes: Significance level: *** p-value<10%, ** p-value<5%, * p-value<1%; the p-values for Fisher tests are determined by employing the asymptotic Chi-square distribution; in the other tests, we suppose normality; the automatic lag selection is done by employing the Schwartz information criteria (SIC).

Besides, we test for cross-sectional dependence in the variables of HDI and ICT indicators. The results of different tests are shown in

Table *4*. All test statistics report the rejection of the null hypothesis of no cross-sectional dependence for all variables at a significance level of 1%. These findings imply the presence of cross-sectional dependence in HDI and ICT indicators over the selected 15 MENA countries. These results can consolidate the idea that the economies of the MENA countries are linked due to many reasons of culture, geography, and integration. Thus, any change in any indicator of ICT affecting HDI of one country may also affect HDI in other MENA countries.

Table 4: Results of the cross-sectional dependence test

Variables	Null hypothesis: No cross-section dependence

	HDI	FT	MC	IUI
Breusch-Pagan LM Stat.	2166.52 (0.00)	1001.74 (0.00)	1868.78 (0.00)	2159.09 (0.00)
Pesaran scaled LM Stat.	142.25 (0.00)	61.88 (0.00)	121.71 (0.00)	141.74 (0.00)
Bias-corrected scaled LM Stat.	141.93 (0.00)	61.55 (0.00)	121.386 (0.00)	141.41 (0.00)
Pesaran CD Stat.	46.39 (0.00)	3.56 (0.00)	39.90 (0.00)	46.25 (0.00)

*Note: the values between parentheses are p-values.

As none of the time series is integrated of order two, we employ the cointegration test to check the existence of a long-run association between the human development index and ICT indicators and then estimate a panel ARDL model. The cointegration is checked using the Pedroni test (Pedroni, 1999, Pedroni, 2004) and the Kao residual cointegration test (Kao, 1999). The Pedroni and Kao tests approaches are based on residual testing. When the time series are cointegrated, the residuals must be stationary. In both tests, the null hypothesis suggests the absence of cointegration, in which the residuals ε_{it} will be integrated of order one. The results of the Pedroni and Kao cointegration tests are presented respectively in Table *5* and Table *6*.

The Pedroni cointegration test results show that four out of seven tests are significant at 5% level of significance (the Panel v-Statistic, Panel ADF-Statistic, Group PP-Statistic, and Group ADF-Statistic)[3]. Therefore, we reject the null hypothesis of the absence of cointegration between the human development index and ICT indicators. We can deduce that there is a long-run association between the human development index and ICT indicators. Results of the Kao cointegration test shown in Table *6* report also that we reject the null hypothesis of no cointegration. This finding confirms the previous results of the Pedroni test that indicate the absence of cointegration between the different variables investigated.

Table 5: Results of the Pedroni cointegration test

Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	P-value	Statistic	P-value
Panel v-Statistic	1.408***	0.07	2.114**	0.03
Panel rho-Statistic	1.646	0.95	2.040	0.97
Panel PP-Statistic	-1.091	0.13	-0.864	0.19
Panel ADF-Statistic	-2.529*	0.00	-2.696	0.00*
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	3.511	0.99		
Group PP-Statistic	-1.914**	0.02		

[3] Note that the panel PP-statistic and group PP-statistic have the best properties. These two statistics are more reliable.

Group ADF-Statistic	-4.467*	0.00

Notes: Null hypothesis is no cointegration; Significance level: *** p-value<10%, ** p-value<5%, * p-value<1%.

Table 6: Kao residual cointegration test results

Null Hypothesis: No cointegration	
ADF t-Statistic	P-value
-1.963**	0.05

In

Table *7*, we report the results of the PMG estimates. The results are presented for the long-run and short-run equilibrium for the entire sample. The findings of the overall model suggest that the three indicators of information and communication technology (fixed telephone subscriptions per 100 people, mobile cellular subscriptions per 100 people, and proportion of individuals using the internet) have long-run effects on the human development index in the selected 15 MENA countries. The three long-run coefficients of ICT indicators are positive and significant at 5% level. These results indicate that any improvement in any ICT indicator will lead to an improvement of the human development index in the long run for the selected MENA countries. Thus, a policy based on improving ICT indicators can lead to enhancing the human development index in the long run for the selected MENA countries.

Short-run dynamics modelling yields details on how adjustments are made between different time series to re-establish the equilibrium in the long term. The long-term equilibrium association is detained by the ECT. The ECT coefficient indicates the speed of adjustment, that is, the speed at which the system comes back to equilibrium after a shock. The presence of a long-run association can be assumed when the coefficient sign of the ECT is significantly negative and varies between -1 and -2. Looking at Table 7, we observe that the estimated coefficient for the ECT is negative but not significant (-0.053), confirming the non-existence of a long-run association between HDI and ICT indicators for the selected sample of MENA countries. It is also reported that all short-run coefficients of control variables (population growth and urban population growth) and ICT indicators are not significant, except mobile cellular subscriptions.

Table 7: Global model: PMG-ARDL long run and short run estimates

Long run equation			
Variables	Coefficient	t-Statistics	P-value
FT	0.004*	3.007	0.002

MC	0.0005*	2.896	0.004
IUI	0.003*	7.786	0.000
Short run equation			
Variables	Coefficient	t-Statistics	P-value
ECT	-0.053	-1.333	0.18
D(FT)	0.0002	0.505	0.61
D(MC)	6.43E-05***	1.635	0.10
D(IUI)	-0.0002	-1.149	0.25
UPG	0.060	1.528	0.12
Constant	0.012	0.659	0.51

Notes: The maximum lag order used the dependent variable and the regressors is equal to 3; the model selection method used is the Schwarz criterion (SIC); the model selected is ARDL(1,1,1,1); Significance level: *** p-value<10%, ** p-value<5%, * p-value<1%.

5. Conclusion

ICT has eased the way of dealing with many things in our daily life and became a key factor to succeed many businesses around the world. This study has investigated the impact of ICT on human development in the MENA countries. As such, data of a selected sample of 15 MENA countries over the period 1995-2018 is collected using the panel ARDL model. After that the panel autoregressive distributed lag model is applied to reveal such an impact. Overall, the results show that the three indicators of information and communication technology (fixed telephone subscriptions per 100 people, mobile cellular subscriptions per 100 people, and proportion of individuals using the internet) have positive and significant impact on human development index in the long-run whereas only mobile cellular subscriptions indicator is significant in the short-run. Therefore, a policy based on improved ICT indicators could strengthen the long-term human development index for some countries in the Middle East and North Africa.

Acknowledgments

The authors are thankful to the Deanship of Scientific Research at Najran University for funding this work under the Research Priorities and Najran Research funding program through grant research code (NU/NRP/SEHRC/11/12).

References

1. ASONGU, S. A. & LE ROUX, S. 2017. Enhancing ICT for inclusive human development in Sub-Saharan Africa. Technological Forecasting and Social Change, 118**,** 44-54.
2. ASONGU, S. A., NWACHUKWU, J. C. & ORIM, S.-M. I. 2018. Mobile phones, institutional quality and entrepreneurship in Sub-Saharan Africa. Technological Forecasting and Social Change, 131**,** 183-203.
3. BALOUZA, M. 2019. The impact of Information and Communication Technologies on the Human Development in the

gulf cooperation council countries: An empirical study. Management Studies and Economic Systems, 4, 79-113.
4. BANKOLE, F. O., SHIRAZI, F. & BROWN, I. 2011. Investigating the impact of ICT investments on human development. The Electronic Journal of Information Systems in Developing Countries, 48, 1-19.
5. BOLLOU, F. & NGWENYAMA, O. 2008. Are ICT investments paying off in Africa? An analysis of total factor productivity in six West African countries from 1995 to 2002. Information Technology for Development, 14, 294-307.
6. BREITUNG, J. 2001. The local power of some unit root tests for panel data. Nonstationary panels, panel cointegration, and dynamic panels. Emerald Group Publishing Limited.
7. CHEGE, S. M. & WANG, D. 2020. Information technology innovation and its impact on job creation by SMEs in developing countries: an analysis of the literature review. Technology Analysis & Strategic Management, 32, 256-271.
8. CHOI, I. 2001. Unit root tests for panel data. Journal of international money and Finance, 20, 249-272.
9. DAS, S., KUNDU, A. & BHATTACHARYA, A. 2020. Technology adaptation and survival of SMEs: a longitudinal study of developing countries. Technology Innovation Management Review, 10.
10. DE LA HOZ-ROSALES, B., BALLESTA, J. A. C., TAMAYO-TORRES, I. & BUELVAS-FERREIRA, K. 2019. Effects of information and communication technology usage by individuals, businesses, and government on human development: An international analysis. IEEE Access, 7, 129225-129243.
11. FARHADI, M., SALEHI, H., EMBI, M. A., FOOLADI, M., FARHADI, H., CHADEGANI, A. A. & EBRAHIM, N. A. 2013. Contribution of information and communication technology (ICT) in country'S H-index. arXiv preprint arXiv:1311.3034.
12. GHOLAMI, R., HIGóN, D. A., HANAFIZADEH, P. & EMROUZNEJAD, A. 2010. Is ICT the key to development? Journal of Global Information Management (JGIM), 18, 66-83.
13. HADRI, K. 2000. Testing for stationarity in heterogeneous panel data. The Econometrics Journal, 3, 148-161.
14. IM, K. S., PESARAN, M. H. & SHIN, Y. 2003. Testing for unit roots in heterogeneous panels. Journal of econometrics, 115, 53-74.
15. KAO, C. 1999. Spurious regression and residual-based tests for cointegration in panel data. Journal of econometrics, 90, 1-44.
16. KUPPUSAMY, M. & SANTHAPPARAJ, A. S. 2005. Investment in information and communication technologies (ICT) and its payoff in Malaysia. Perspectives on global development and technology, 4, 147-168.
17. LEE, S.-O., HONG, A. & HWANG, J. 2017. ICT diffusion as a determinant of human progress. Information Technology for Development, 23, 687-705.
18. LEVIN, A., LIN, C.-F. & CHU, C.-S. J. 2002. Unit root tests in panel data: asymptotic and finite-sample

properties. Journal of econometrics, 108, 1-24.

19. NGWENYAMA, O., ANDOH-BAIDOO, F. K., BOLLOU, F. & MORAWCZYNSKI, O. 2006. Is there a relationship between ICT, health, education and development? An empirical analysis of five West African countries from 1997–2003. The Electronic Journal of Information Systems in Developing Countries, 23, 1-11.
20. NIEBEL, T. 2018. ICT and economic growth–Comparing developing, emerging and developed countries. World Development, 104, 197-211.
21. OGUNDARI, K. & AWOKUSE, T. 2018. Human capital contribution to economic growth in Sub-Saharan Africa: does health status matter more than education? Economic Analysis and Policy, 58, 131-140.
22. OULTON, N. 2002. ICT and productivity growth in the United Kingdom. Oxford Review of Economic Policy, 18, 363-379.
23. PEDRONI, P. 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and statistics, 61, 653-670.
24. PEDRONI, P. 2004. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric theory, 20, 597-625.
25. PESARAN, M. H. 2007. A simple panel unit root test in the presence of cross-section dependence. Journal of applied econometrics, 22, 265-312.
26. PESARAN, M. H., SHIN, Y. & SMITH, R. P. 1999. Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American statistical Association, 94, 621-634.
27. PESARAN, M. H. & SMITH, R. 1995. Estimating long-run relationships from dynamic heterogeneous panels. Journal of econometrics, 68, 79-113.
28. QURESHI, S. & NAJJAR, L. 2017. Information and communications technology use and income growth: Evidence of the multiplier effect in very small island states. Information Technology for Development, 23, 212-234.
29. SALANOVA, M., LLORENS, S. & VENTURA, M. 2014. Technostress: The dark side of technologies. The impact of ICT on quality of working life. Springer.
30. SASSI, S. & GOAIED, M. 2013. Financial development, ICT diffusion and economic growth: Lessons from MENA region. Telecommunications Policy, 37, 252-261.
31. SEPEHRDOUST, H. & GHORBANSERESHT, M. 2019. Impact of information and communication technology and financial development on economic growth of OPEC developing economies. Kasetsart Journal of Social Sciences, 40, 546-551.
32. SHIN, Y., YU, B. & GREENWOOD-NIMMO, M. 2014. Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. Festschrift in honor of Peter Schmidt. Springer.
33. STANTON, E. A. 2007. The human development index: A history. PERI Working Papers, 85.

34. TOADER, E., FIRTESCU, B. N., ROMAN, A. & ANTON, S. G. 2018. Impact of Information and Communication Technology Infrastructure on Economic Growth: An Empirical Assessment for the EU Countries. Sustainability, 10**,** 3750.