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THE IMPLICATIONS OF ICT-DEVELOPMENT AND INNOVATION ON COMPETITIVENESS: CASE OF EURO-MEDITERRANEAN COUNTRIES

*Mohamed Neffati

Al Imam Mohammad Ibn Saud Islamic University (IMSIU), College of Economics and Administrative Sciences Department of Economics, Riyadh 11623, Saudi Arabia

ABSTRACT

The world economic recession was a consequence of the contagion of the subprime crisis which was began in the United States at the end of 2007 and has left deep scars. Indeed, this problem, which characterised by the difficulty to be quantified, has been transmitted in the most advanced and transition economies by a loss of competitiveness during several years. Thus, many economies are facing complex situations. In order to resolve this problem, this paper show that the recovery of both economic performance and growth situations request a reactivation of innovation and improving the global competitiveness. Moreover, digital has invaded all areas and sectors of the economy which contributes to the largest share of wealth. This diffusion of ICT affects the competitiveness of enterprises and countries in world markets. This paper summarizes briefly the theoretical and empirical context of ICT-development and innovation shows its implications on the process of competitiveness in the Euro-Mediterranean countries. It focuses mainly on the analysis of the role of ICT diffusion and issues related to the evolution of productivity and enabling innovation as key indicators of the overall competitiveness of a country.

INTRODUCTION

The global economy suffers in recent years from economic recessions and a worsening problem of unemployment deriving from the USA financial crisis. The recession lefts deep scars and it seems hard to quantify them with precision. A key feature is that they create competitiveness losses in the economies of many countries including transitions countries. This problem persists for several years. The economic literature shows that the recovery of economic performance and competitiveness, demand reactivation of innovation and productivity. The conditions of mobilisation of these components were now more than 15 or even 20 years. Today, digital has invaded all areas and sectors of the economy of information and communication contributes to the largest share of wealth. There is, therefore, a trend accelerated during the last 15 years to economy tangibility.

Corresponding author: Dr. Mohamed Neffati
Al Imam Mohammad Ibn Saud Islamic University (IMSIU), College of Economics and Administrative Sciences Department of Economics, Riyadh 11623, Saudi Arabia.

This diffusion of ICT affects firm competitiveness and country level on international markets. Hence, our problematic here is how ICT development affects the global competitiveness? Our aim is to investigate the impact of ICT development on competitiveness through effects on innovation and productivity in transition countries. We tend to propose solution and recommendations around this field. This paper studies the impact of Information and Communication Technology development and innovation on economic growth through analysing competitiveness in Euro-Mediterranean economies space. Indeed, it is organized as follows: firstly, we argue theoretically relationship between competitiveness, innovation and ICT development and economic growth. In the second section, we present the data and methodological framework in order to justify the theatrical arguments. Section 3 shows the empirical findings, in which we will use panel data analysis for the sample of 35 countries in 2008-2012, in order to examine the relationship between ICT-development, Global innovation and global competitiveness in Euro-Mediterranean space. Finally, concludes the article with a few issues on policy implications.

Theoretical background

Competitiveness and economic performance

In an era of globalization, free trade and economic integration, economic performance and it success are determined by the gain form comparative advantage in the global market. This is only possible with a high level of competitiveness. A multitude of factors have been identified in the literature as factors that condition the competitiveness of a region, a nation, an industry or a company. However, in open economy, countries' competitiveness offers invaluable insights into the policies, institutions, and factors driving productivity and, thus, enables sustained economic growth and long-term prosperity.

ICT-development as a key factor for economic performance

The Information's Technologies revolution has sharply reduced the cost of information and increased its availability. This revolution is also said to be creating a New Economy in which the old rules of economics no longer apply (Harbhajan and Varinder, 2005). In fact, ICT is one of the fastest growing areas in terms of innovation and is increasingly adopted in a wide variety of applications. As such, educators and researchers in this area need to spend extra effort to keep up with its rapid growth and to be current with its trends, Mubarak and Lawan (2011). Indeed, the ICT was integrated in a wide range of new economy in different areas, such as e-business, e-commerce, e-banking and health care and bioinformatics. It also includes information security, strategic information technology and risk management in ICT. Communication technologies and networking is also covered in terms of its applications and technology development.

The high growth performance of the United States over the 1990s has attracted the attention of economists to the sources of growth in economy. Some studies (Scarpetta *et al.*, 2000) have shown that there is no single factor that affects on the growth performance, over the past few years. ICT plays two basic roles in this process, first through capital deepening which is the result of increasing the overall investment, second by contributing to Total Factor Productivity (TFP) growth. Many empirical studies (e.g. Colecchia and Schreyer 2001; Jorgenson *et al.* 2001; Ark *et al.* 2002) confirmed the effect of ICT investment on growth performance. The ICT investment is commonly associated with rapid technological progress and competition in the production of ICT goods and services, which have contributed to a steep fall in ICT prices and encourage investment in ICT.

Oliner and Sichel (2002) conclude that the US growth resurgence in the1990s is largely an information technology story. They calculated that about two-thirds of the rise in US labour productivity in 1996-99 is due to the increased use and production of information technology. On the other hand, there is some optimistic view which suggests that developing countries may have an advantage over advanced countries with respect to ICT diffusion. Antonelli (1991) mention that switching from the predominant technology paradigm to a new "ICT-oriented paradigm" imposed significant costs to

eveloped countries and simultaneously, important opportunities open up for less-industrialized countries. Farhadi and Ismail (2011) studied the impact of ICT development on economic growth in different countries and regions of the world. They improved a positive relationship between real GDP growth and ICT development (as measured by the ICT Development Index) for 153 countries over the world. This study also finds that ICT development in the upper-middle income group has a higher effect on economic growth than other countries. This implies that if these countries seek to enhance their economic growth, they need to implement specific policies that facilitate ICT development. Although many researchers have provided empirical evidences for the correlation between ICT investment and economic growth, study on the impact of ICT development on economic growth is still an unexplored area.

Innovation and growth

Innovation is a main determinant of growth and performance in the global economy. It gives origin to new technologies and new products that help address global challenges such as health or the competitive environment. Transforming the conditions of production of goods and provision of services, it boosts productivity, creates jobs and improves the global competitiveness of nation and the quality of life of citizens. Several studies have yielded support for these perspectives. The importance of innovation and its role in the growth has been much discussed in the economic literature. Also, it is confirmed by a number of empirical studies applied to some countries. The economists, Mohnen and Mairesse (1999), have highlighted the role of innovation, that these are new production technologies or new products, in economic growth. They also required quantifying the effects of these innovations. Lebel (2008) proposes a measure of economic growth through innovation, thus from a sample of 103 countries in different regions for the period 1980-2005. The results provide empirical evidence of the positive role of creative innovation in economic growth. The empirically study, of Hasan and Tucci (2010) link innovation to economic growth; their article examines the importance of the quality and quantity of innovation on growth. This research focuses on how innovation factors can be translated into per capita growth in different economic structures and stages of economic development. This study shows that countries that increase the level of patenting also attend a concomitant increase in economic growth.

Empirical model (Findings and Discussion)

This section defines the methodology of examining the global competitiveness determinants in order to test the relationship between innovation, ICT-development and economic performance presented by global competitiveness index.

Methodology and Data: Variables definitions and method of calculation

ICT development index

ICT-development index (IDI) is a composite index. It is built from 11 basic indicators divided into three sub-categories:

Table 1. IDI composition

ICT access	Ref. value	%
1. Fixed-telephone lines per 100 inhabitants	60	20
2. Mobile-cellular telephone subscriptions per 100 inhabitants	180	20
3. International Internet bandwidth (bit/s) per Internet user	280'337*	20
4. Percentage of households with a computer	100	20
5. Percentage of households with Internet access	100	20

ICT use	Ref. value	%
6. Percentage of individuals using the Internet	100	33
7. Fixed (wired)-broadband Internet subscriptions per 100 inhab.	60	33
8. Active mobile-broadband subscriptions per 100 inhab.	100	33

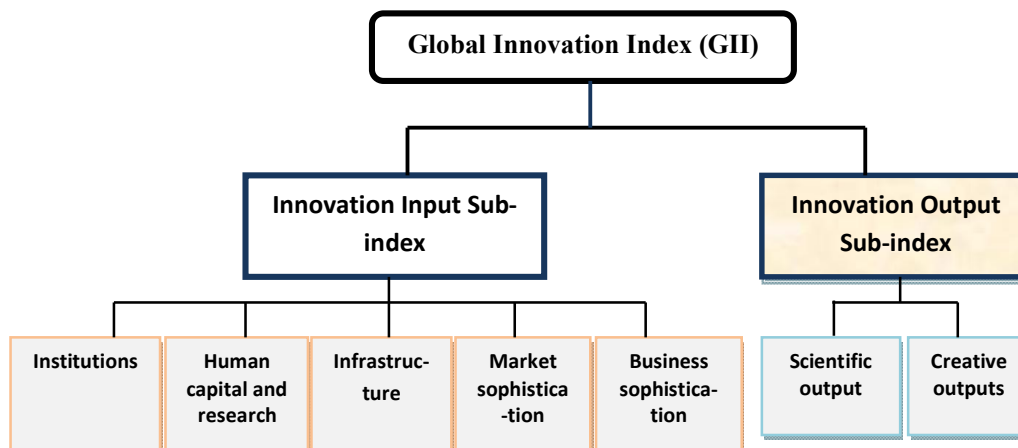| ICT skills	Ref. value	%
9. Adult literacy rate	100	33
10. Secondary gross enrolment ratio	100	33
11. Tertiary gross enrolment ratio	100	33

40

40

20

ICT-Development Index (IDI)

*Note: * This corresponds to a log value of 5.45, which was used in the normalization step.*
Source: ITU; Mesuring the Information Society, Rapport 2011.

access, skills and use of ICT. It includes indicators such as the rate of use of computers by households or penetration of broadband Internet etc…(ITU, 2011). As given, the ICT development index (IDI) allows comparing the development of the information society in 152 countries around the world. It can be considered as an indicator for measuring the digital divide. For example, According to this indicator (IDI), the world ranking is led by ITU report 2011; Korea ranks first, followed by Sweden and Iceland. Germany occupies the 15th position; France is ranked in 18th position and Belgium ranks 22nd. However, Ranking Euro-med-35 is led by Sweden, Denmark, Luxembourg and the Netherlands which occupied the ranks. The least accessed in ICT-development was the North Africa countries: Egypt Morocco, Syria and Algeria.

Global Innovation Index (GII)

The Global Innovation Index (GII) is an indicator of the important role that innovation plays as an engine of economic growth and prosperity. It also shows a need for an overview of innovation applies to both developed and emerging countries, which are added indicators that go beyond traditional indicators used to gauge innovation (such as the level of research and development in a given country).

The Global Innovation Index project was launched by INSEAD in 2007 with the simple goal of determining how to find metrics and approaches to better capture the richness of innovation in society. The GII is an indicator with has an important role, that innovation plays as an engine of economic growth and prosperity. It also shows a need for an overview of innovation applies to both developed and emerging countries, which are added indicators that go beyond traditional indicators used to gauge innovation (such as the level of research and development in a given country). The GII is a valuable tool for comparing to encourage dialogue between the public and private sectors, enabling policy makers, business leaders and other stakeholders to evaluate continuous progress. The figure above shows that the GII is based on two sub-indices: the Innovation input sub-index and innovation in output sub-Index, each built around pillars. For Innovation Input Sub-Index, is composed by five pillars capture elements of the national economy that enable innovative activities: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication. The second indexes, innovation in output-Index, are the results of innovative activities within the economy.

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Global Innovation Index (GII)
├── Innovation Input Sub-index
│   ├── Institutions
│   ├── Human capital and research
│   ├── Infrastructure
│   ├── Market sophistica-tion
│   └── Business sophistica-tion
└── Innovation Output Sub-index
    ├── Scientific output
    └── Creative outputs
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Source: INSEAD, report (2012)
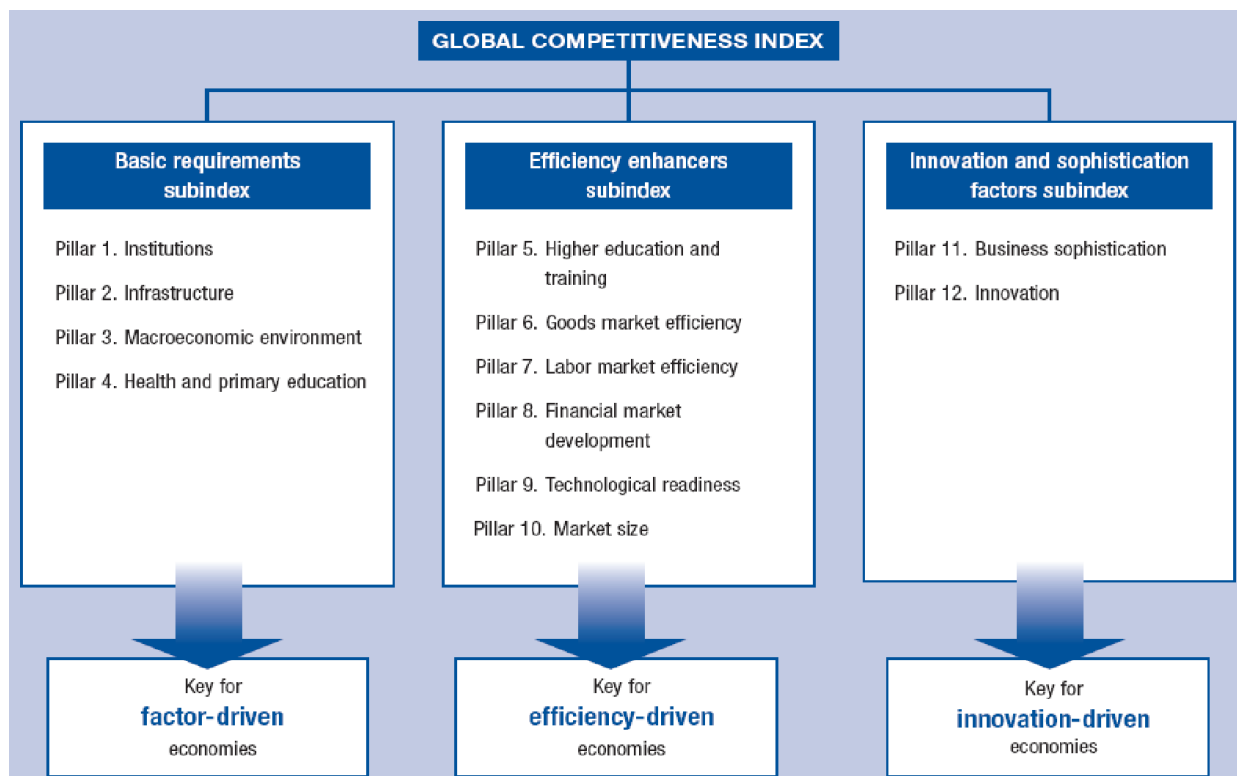
Figure 1. The GII composition

There are two pillars output: Outputs (6) knowledge and technology and outputs (7) Creative. The output of the innovation sub-index is the simple average of the last two pillar scores.

Global Competitiveness Index (GCI)

Competitiveness is defined as the set of institutions, policies and factors that determine the level of productivity of a country that determines, in turn, the level of economic prosperity. The productivity level also determines the rates of return obtained by investments which are the factors behind the growth potential of an economy. The central role of competitiveness, as the engine of economic growth, is supported by a large body of data, macroeconomic and sectoral, which composed it, (World Economic Forum (WEF), 2012). So, Global Competitiveness Index was compouned by 12 pillars arranged on three subindex: basic requirements subindex, efficiency enhancers subindex and Innovation and sophistication factors subindex as guived in figure 3 bellow.

global competitiveness over the two periods 2004-2008 and 2009-2012, we clarified its development at regional and international levels. The calculation of the variation among international and Euro-med ranking "Δrank" shows that the overall level of competitiveness of most countries in the region has decreased.

The most affected country is Greece, which fell in the world ranking with 33 places and with 5 places in the Euro-med ranking. In The same order for Denmark, Israel, Portugal, Syria, Egypt, Jordan, Latvia and Slovak Republic, ranking level was dropped with a remarkable way and this due to the effects of the contagion that has turned to a financial crisis and economic crisis and due to the Arab Spring revolutions. We also note that there are some countries that have improved their competitiveness such as, Germany, Netherlands, France, Belgium, Italy, Turkey, Romania, and Bulgaria. But the country which has most improved its competitiveness is Poland.

Source: The Global Competitiveness Report 2012–2013, p.8.

Figure 2. The GCI composition

According this explicative table of GCI indictor, which composed it from 12 pillars in three boxes, we were summarized the GCI scors and tranking of Euro-Med counties in table 2 below. Calculates the global productivity of country by the performance indicators presented in the annual reports of the World Economic Forum (2008, ..., 2012), is a good indicator of macroeconomic measure of competitiveness. It has possible to compare the level of competition between economies and measuring the comparative advantage of a country. This table shows the level of competitiveness of countries in the Euro-Med region before and after the supbrimes crisis. Indeed, the calculated average index of

The Conceptual Form of model

To empirically evaluate the contribution of innovation and ICT-development on the global competitiveness we used a linear model presented as follows:

$$G\,C\,I_{it} = \alpha_0 + \alpha_1 ID\,I_{it-1} + \alpha_2 G\,II_{it-1} + \varepsilon_{it}$$

With the variables: GCI; is a global measure of competitiveness, IDI, the variable measuring ICT - development and GII; measure of a country's global innovation.

Table 2. GCI score and international ranking of euro-med countries

countries/Indexes	GCI score		GCI rank international			Rank Euro-Med		
countries/periodes	2004-08	2009-12	2004-08	2009-12	Δ rank	2004-08	2009-12	Δ rank
Finland	5,79	5,19	3	5	2	1	2	1
Sweden	5,66	5,55	3	3	0	2	1	-1
Denmark	5,65	5,37	4	9	5	3	5	2
Germany	5,36	5,41	10	6	-4	4	3	-1
Netherlands	5,38	5,39	10	8	-3	5	4	-1
United Kingdom	5,31	5,32	11	11	0	6	6	0
Austria	5,18	5,15	17	18	1	7	8	1
Israel	5,07	4,95	20	25	5	8	11	3
France	5,06	5,13	22	18	-4	9	9	0
Belgium	5,00	5,14	23	17	-6	10	7	-3
Ireland	4,99	4,81	24	28	3	11	12	1
Luxembourg	4,97	5,03	25	22	-3	12	10	-2
Estonia	4,87	4,61	25	34	9	13	13	0
spain	4,82	4,55	29	37	7	14	15	1
Portugal	4,74	4,40	33	46	13	15	20	5
Czech Republic	4,58	4,57	35	36	1	16	14	-2
Slovenia	4,62	4,40	36	49	13	17	22	5
Tunisia	4,53	4,54	36	37	1	18	16	-2
Lithuania	4,46	4,37	40	47	7	19	21	2
Slovak Republic	4,42	4,22	42	62	20	20	26	6
Cyprus	4,50	4,44	43	45	2	21	18	-3
Malta	4,55	4,34	43	50	7	22	23	1
Latvia	4,39	4,20	45	64	20	23	28	5
Hungary	4,42	4,30	46	55	9	24	24	0
Jordan	4,37	4,23	46	63	17	25	27	2
Italy	4,36	4,39	46	45	-1	26	19	-7
Greece	4,32	3,95	52	85	33	27	32	5
Poland	4,14	4,44	53	42	-11	28	17	-11
Turkey	3,95	4,29	61	56	-5	29	25	-4
Egypt	3,97	3,91	67	88	20	30	33	3
Morocco	3,91	4,11	68	73	5	31	31	0
Romania	3,91	4,10	68	70	2	32	29	-3
Bulgaria	3,95	4,15	69	71	2	33	30	-3
Syria	3,99	3,80	79	96	17	34	34	0
Algeria	3,69	3,90	81	91	10	35	35	0

Source: Data collected by the Global Competitiveness Report 2004-05 to GCR2012-13

The Data

The database of variables was collected from all annual reports published as below:

- IDI from, International Telecommunication Union annual reports (2007-2012), "Measuring the Information Society". The reports was downloaded by Web site: http://www.itu.int/ITU-D/ict/.
- GII from, INSEAD annual report (2009-2011), "The Global Innovation Index". The reports was downloaded by web site:
  http://www.wipo.int/econ_stat/fr/economics/gii/
- GCI from, the World Economic Forum annual reports, (2008-2013) "The Global Competitiveness Report". The reports was downloaded by web site:
  http://www.weforum.org/reports/global-competitiveness-report-2014-2015

Estimation Results

After specifying the estimation model we present the main results. First, the study of Granger causality between the three variables GCI, IDI and GII. Then the result of matrix correlation between these three variables. And finally, the result of a linear regression, using OLS method, of IDI and GII (exogenous variables) on GCI (endogenous variable).

a- Causality tests

According this table of Granger causality tests, we confirm that GCI is caused by IDI and GII. Indeed, we have improved a double sense of Granger causality between IDI and GII. These results give us an idea about which are exogenous variables (IDI and GII) and endogenous one (GCI).

Table 3. Granger causality test between GCI, IDI and GII in Euro-Med countries, during 2007 to 2012

Pairwise Granger Causality Tests			
Null Hypothesis:	Nbrs. Obs	F-Statistic	Prob.
GII does not Granger Cause GCI	105	0.49931	0.6085
GCI does not Granger Cause GII		6.70624	0.0018
IDI does not Granger Cause GCI	105	1.59707	0.2076
GCI does not Granger Cause IDI		3.70357	0.0281
IDI does not Granger Cause GII	105	8.44678	0.0004
GII does not Granger Cause IDI		3.56939	0.0318

Source: Output EViews6.1

b- Correlation Matrix of Variables

The correlation matrix, given as by table 3, improves a fort correlation between GCI, IDI and GII. This empirical result confirms theoretical argument which, stipulated that the innovation and development of ICT are determinant of competitiveness.

Table 4. Correlation matrix

	GCI	IDI	GII
GCI	1	0.7712	0.7311
IDI	0.7712	1	0.8246
GII	0.7311	0.8246	1

It justifies the existence of a relationship of high empirical significance of these variables.

b- Result of estimation

Our estimation results, based on the Ordinary Least Scare estimation method, are summarized in Table 4. In which, they are three regressions: all Euro-med countries regression in column two, then EU-15 and in column 4 the regression of Euro-med transition countries.

Table 5. Estimation results

Endogenous Variable (**GCI**)			
	Euro-Med-35 Countries	EU-15 Countries	Euro-Med-20 Countries
Exogenous Variables	Coefficient	Coefficient	Coefficient
C	3.006***	5.87***	3.564***
	(0.0982)	(0.4191)	(0.092)
IDI	0.176***	-0.15***	0.094***
	(0.0277)	(0.0815)	(0.024)
GII	0.150***	0.04***	0.082***
	(0.0417)	(0.0422)	(0.039)
R-squared	0.6231	0,94	0.43
F-statistic	142.162	53.167	36.496
Prob(F-statistic)	0.0000	0.0000	0.0000
Nbr. Obs.	175	75	100

Note:
• T-statistic in parentheses;
• *** denotes statistically significant at 1%, respectively.

According these results of estimation we may be noted that:

▪ The global significance of the estimated equation is justified (Prob (F-statistic) = 0.000) and there is a strong explanatory power as measured by the correlation coefficient (R-squared) between the exogenous variables (IDI and GII) and endogenous variable (GCI), especially for the EU-15 (R-squared = 0.94).
▪ The Coefficients that measure the elasticity of IDI and GII compared to the GCI are significant and positive in the case of transition countries, while for EU-15 countries the coefficient of the IDI is significant but negative.

Conclusions and Implications

This paper concentrated on exploring the effect of ICT-development and innovation on global competitiveness of economies. Both a theatrical background and an analyses statistical data-base improved that ICT development and innovation have a significant effect on the global competitiveness of Euro-Mediterranean space countries. We can say that the Euro-med is the most competitive region in the world. Indeed, in the first 50 most competitive countries of the world there are 28 countries in the Euro-Med area. In addition, during the period 2009-2012, among the top ten competitive countries in the world, there are 5 European countries. Based on the empirical analysis, the coefficient measuring the effect of the ICT development and global

innovation on competitiveness were significant and positive, indicating that IDI and GII affect economic performance of the 35 sample countries in a positive way. The major research limitation of this study was the failure to collect data for a longer time period. Therefore future research for a longer time span would shed more light in the assessment of the relationship between ICT development, innovation and competitiveness. Consequently, ICT-development and innovation plays a vital role as a mean for competitiveness (Neffati, 2012). Therefore, it seems necessary for all countries to increase their ICT development index and global innovation index in order to improve first global competitiveness and boost economic growth inconsequence. It is essential for the countries to provide the society with information, up-to-date structures and educated people in other to access and use ICT efficiently (Neffati, 2012).

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