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TECHNOLOGICAL CAPABILITIES IN ARAB GULF COUNTRIES: CASE OF BAHRAIN

Dr. Mohamed Sayed Abou El-Seoud[1]

[1]Associate Professor
Economics and Finance Department,
Faculty of Business Administration,
University of Bahrain
Bahrain
&
Economics Department,
Sadat Academy for Management Sciences,
Egypt

ABSTRACT

The study aims to measure the technological capability in Arab Gulf countries and particularly Bahrain during the period (2000-2014). The study methodology depends on both descriptive and comparative approaches and employs ArCo methodology. Measuring the technological capability of Bahrain shows that Bahrain has achieved improvement in technological infrastructure and literacy rate, while the innovative capability indicators are still less than the required standard compared with other Arab Gulf countries, moreover the tertiary science and engineering enrolment declined during the study period. The study recommends some steps that might improve the technology capability of Bahrain during the next years.

KEYWORDS: *Technology, ArCo, GCC, Bahrain, Telecommunications, Per Capita Income, Investments, Trade*

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1.INTRODUCTION

Arab Gulf countries (GCC) play strategic role in the global economy because they hold almost 40% of world oil supplies and therefore affect the trends of oil supply and market. At the regional level, oil provides a significant contribution for developing the economies and social welfare in GCC, where it leads to higher per capita income. During the last twenty years, GCC faced serious challenges posed by oil being an exhaustible resources as well as the uncertain and volatile revenues from oil due to the instability of oil prices; Accordingly, GCC began to adopt new economic growth and sustainable development strategy that depends on shifting the focus from oil resources based economy to a technology and skill based economy and on economic diversification.

Kingdom of Bahrain as one of GCC started to shift from oil based economy to a technology based economy since 1940, where the government of Bahrain believed that in a rapidly globalization world, the ability of Bahrain to be in the league of the newly industrializing countries and possibly catch up with the developed countries lies in the extent to which technology capabilities can be accumulated. Bahrain Petroleum Company "BAPCO" was the first company in the region that implemented automated machines for its oil operation in 1940. In the late of 1970s Bahrain took another step forward when the Bahrain Airport implemented a system called LOPAC for passenger check-in and it was connected to other GCC countries. The technological revolution in the kingdom

gathered pace when Bahrain became the first country in region that implemented touch-screens in offshore banks within their dealing rooms. Recently the Information and communications technology sector is booming where Bahrain succeeded in being up-to-date in many technological fields. Now telecommunications companies are providing services to the population of Bahrain. Moreover mobile computing became very well established in the country, and not only for commercial purposes, but also to conduct governmental services and transactions on mobiles

The current study aims at measuring the technological capability at country level by adopting one of the most recent measures which is Archibugi and CoCo (ArCo) international technology index. The study will focus on the kingdom of Bahrain as a case study of the Gulf countries; thus the study tries to measure the technological capability of Bahrain during the period (2000-2014). The study mainly depends on the database published by international institutions such as the World Bank (WB), International Telecommunication Union (ITU), and United Nations Development Program (UNDP).

The importance of the current study that helps both policy analysts and academic researchers who need new and improved measures of technological capability on the performance of nations to understand economic and social transformation. With regard to policy analysis, this has relevance for public and business practitioners. Governments constantly require information about the performance of their own country, and this is often better understood in comparison to the performance of their partners and competitors. Business must make decisions on the geographical scope of their investments, trade, and joint ventures based on technical expertise embedded in the various national innovation system.

The study organized as follows: Section two illustrates ArCo technological index theoretical framework. Section three, shows technological capabilities indicators of Bahrain during the study period. Section four illustrates the ArCo technological index measurement of Bahrain.

2.TECHNOLOGICAL CAPABILITIES INDEX (ArCo)

The process of knowledge creation and dissemination is a complex and multifaceted aspect of economic growth. Technological capability of a country is strictly related to a number of different aspects, such as the basic and advanced human capital base, the infrastructures that support the industrial production and innovation activities, and the country's ability to create, imitate and manage a complex pool of advanced technological knowledge.

In 2002, Archibugi and CoCo created a new indicator of technological capability for developed and developing countries (ArCo). ArCo technological index builds up on many learnt lessons on the nature of technological change and on other previous attempts to measure it. (Archibugi and Coco, 2002). They measured the technological capability by taking into account eight indicators that represent distinct aspects of the process of national technological accumulation and capacity building, namely the innovative capability of a nation (patents and scientific articles), its endowment in terms of -new and old types- technological infrastructure (Internet, telephony and electricity), and its advanced and basic education level (tertiary enrolment, mean of schooling and literacy rate), as shown in table (1).

Although there are several technological indicators that created by governmental and nongovernmental institutions and international organizations such as the world Economic Forum Technology Index, the United Nations Development Program Technology Achievement Index, the United Nations Industrial Development Organization Industrial Development Scoreboard, the World Bank Knowledge Assessment Methodology (KAM), the Science and Technology Capacity Index developed by the RAND Corporation and associated partners, (a) ArCo technological index has several advantage compared to them as follows: It can account the country's technological capabilities that include a variety of sources of knowledge and innovation, where some of the capabilities are embodied in equipment, machinery and infrastructures, while others are embodied in human skills. Moreover, technological capabilities affected by the innovations associated to different waves of industrial development. (Chinawut C., 2007).

Table (1) ArCo technological capability indicators at a country level.

Indicator	Definition and calculation
Innovative capability	
1- Patents	-It measures the technological innovations generated for commercial purposes, and it represents a form of knowledge generated by profit-seeking firms and organizations. -It calculated based on the utility patents-that is invention patents-registered at the USA patent and trademark office.
2- Scientific articles	-It represents the knowledge generated in the public sector, and most notably in universities and other public research institutes. -It measured by the number of technical journal articles that published and indexed. -In order to get data about the scientific literature published in the world, ArCo depends on the Science Citation Index generated by the Institute for Scientific Information, it includes almost 8000 journals that covered several fields which are: earth and space sciences, clinical medicine, biomedical research, physics, biology, chemistry, mathematics, and engineering and technology.
Technological infrastructure	
1- Internet penetration	-It accounts for this new form of technological infrastructure, which facilitates the transfer of knowledge, where internet is a new technology that has quickly become the keystone of the Information and Communication Technology. - It illustrated by the number of internet users per 1,000 inhabitants. -The main sources of data come from International Telecommunications Union (ITU) and World Bank (WB) annual reports.
2- Telephone penetration	-Telephony, both in fixed and mobile forms, constitutes a fundamental infrastructure for business purposes, and it allows tracing populations with human skills and acquiring technical information. - It could be illustrated by Sum of telephone mainlines and mobile phones per 1,000 inhabitants. -The main sources of data come from ITU, WB and UNDP annual reports.
3- Electricity consumption	-It measures the production of power plants and combined heat and power plants, less distribution losses, and own use by heat and power plants. -It is also a proxy measure for the use of machinery and equipment since most of it is generated by electric power. -It could be illustrated by the number of kilowatts of electricity consumed per hour per capita. -The main sources of data come from WB and UNDP annual reports.
Advanced and basic education level	
1- Tertiary science and engineering enrolment	-It measures the formation of advanced human capital in science and technology, which represents a necessary requirement for acquiring and managing advanced technological knowledge. -It could be presented by the share of tertiary students in science and engineering in the population of that age group. -The main sources of data come from WB and UNESCO annual reports.
2- Mean years of schooling	-It constitutes a widely used proxy of the level of basic human skill. -It is shown by the average number of years of school completed in the population over 14 years old. -The main sources of data come from WB and UNDP annual reports.
3- Literacy rate	-It is a necessary precondition for the development of human skills and of basic and advanced human capital. -It is illustrated by the percentage of people over 14 years who can, with understanding, read and write a short, simple statement on their everyday life. - The main sources of data come from WB and UNDP annual reports.

Source: created by researcher from (Archibugi and Coco, 2004)

(b) It uses large number of indicators that are able to provide a more precise characterization of countries' positions in the process of knowledge creation and dissemination than if we were using one single indirect measure such as Total Factor productivity (TFP), where this is particularly important in a country that characterized by very different levels of technological and economic development. (Fulvio, 2008:5-6). (c) It helps to monitoring the existing capabilities that identify the nature and intensity of the technology gaps and the appropriate strategies to bridge it. (Growiec J., 2010). (d) Because of the integration of new technology systems requires the mastering of previous technologies, ArCo index allows economic agents to build up competencies cumulatively, where the new systems make obsolete previous ones. (Archibugi and Coco, 2004)

ArCo technological index built by summing of the simple mean of the three category indexes, where each one of these three categories have the same weight, exactly one third. The index of each category is calculated by the same procedure applied for the final index that is through the simple mean of sub-indexes, which therefore maintain the same weight for each category they represent.

Archibugi and CoCo applied their index on the sample consists of 162 countries whose technological capabilities are measured at two different period of time, (1987-1990) and (1997-2000). Accordingly they classified the countries according to the value of ArCo index into four categories which are: Leader countries (0.5-1): which are countries that able to create and sustain technological innovation, Potential leaders (less than 0.5-0.4): which are countries that have invested in the formation of human skills and have diffused technology widely but have so far innovated little, Latecomers (less than 0.4-0.2):which are countries that try to grow in their technology content as in their development degree, by starting with the last two categories of the index the exploitation of technology and the formation of human capital, and finally, Marginalized (less than 0.2): which includes marginalized countries, which do not have large access even to the oldest technologies, like electricity and telephony. (Archibugi and Coco, 2002:13-16)

3.BAHRAIN'S TECHNOLOGICAL CAPABILITIES : AN OVERVIEW

Based on the eight technological indicators that created by ArCo, in this section the study will illustrate the development of these indicators in Bahrain during the period (2000-2014) as follows:

Patents : The U.S. Patent and Trademark Office report for all patents granted from year 1977 to the end of year 2014 shows that the number of patents granted in Bahrain before 2000 was five, the period (2000-2007) witnessed no granted patents, while the period (2008-2014) the number of patents granted were seven patents. It's obvious the number of patents granted in Bahrain is very low, this might be due to low percentage of Bahrain's GDP which spending on research and development (R&D) that does not exceed 0.2% of GDP during the study period. This rate is less than the average spending on R&D in both developed and developing worlds, where it was 2.4% and 1.1% respectively. According to the U.S. Patent and Trademark Office report about GCC's granted patents, Saudi Arabia (KSA) comes in the first place, where the number of granted patents during the study period is 993 patents. Kuwait (KUW) comes in the second place with 331 patents, it followed by United Arab of Emirate (UAE), Qatar and Oman with 175, 26 and 21 patents respectively.

Scientific articles: During the study period, Bahrain's scientific and technical journal articles that published and indexed were not stable, where the average number of journal articles was 21 articles in 2000, and raised to 41 articles in 2006, and it decreased to 48 articles in 2007. During the period(2008-2014) the average number of journal articles increased and the average number of journal articles reached its maximum in year 2011, (48.4 articles). Despite of the number of published scientific articles increases during the study period but it is still less than the average number of published scientific articles in other GCC countries, where the average number of published scientific articles in KSA, Kuwait, UAE, Qatar, and Oman, are 7233, 2282, 2345, 551, and 1718 respectively during the period (2000-2014). (WB, World Development Indictors)

Internet penetration: the internet in kingdom of Bahrain becomes extremely important in many fields, education, healthcare, business and government. Bahrain is a progressive Gulf state, with an increasingly liberalized telecommunications sector as part of the Kingdom's wider VISION 2030 strategy. Telecommunications infrastructure in Bahrain is among the most basic infrastructure progress in the region, due to multi-modernization of the Internet network. Recent statistics of ITU shows Internet use has grown considerably in the last decade, where the number of Internet users increases from approximately 182,000 in 2005 –which represents 21.3% of the population- to 634,000 and 1240,000 which represent 53% and 91% of the population in years 2009 and 2014 respectively. The

percentage of Bahrainis using internet is very high compared with the average rate of internet users either in developed (79.5%) or developing (32.4%) countries. Due to the increase the number of internet users the internet service in the Kingdom has received big boost after completing the process of comprehensive modernization of the power bandwidth of the network in year 2015, where telecommunication companies doubling the capacity to link its network to reach more than 400 MB per second. This update enhanced network performance to a great extent and provides the ability faster browsing on the internet for all internet users. (ITU, 2014). Recent survey about "Internet use amongst young people in Bahrain" finds out that Bahraini young people use the Internet an average of 2.5 – 3.5 hours every day. They use the Internet for a number of different reasons; mainly for homework purposes, to play games or to interact with other people via instant messaging, chat rooms, games, blogging and Social Networking Sites (SNS). (Davidson et al., 2010). It is obvious that the growth in ICT plays both an essential role in the economic development of Bahrain heading towards 2030, and in equipping young people with essential skills. During the study period, and according to Internet penetration indicator, Bahrain comes in the first place among GCC, while UAE comes in the second place and it followed by Qatar, Kuwait, KSA and Oman. (ITU, 2014)

Telephone penetration: mobile-cellular and fixed telephone lines subscription penetration are the broadest and most common measurement of the degree of telecommunication development in Bahrain. There are three telecommunication companies in Bahrain: Batelco, VIVA and Zain. According to the database of ITU the fixed telephone penetration rates declined from 44% in year 2004 to 37% in year 2009 and to 36% in year 2014, on the contrary Mobile-cellular penetration rates exceeds 173% in year 2014 compared with 30.8% in year 2000. Recent ITU reports show that the fixed telephone penetration rates in Bahrain is less than the fixed telephone penetration rates in developed world (39.9%) while it is higher than the fixed telephone penetration rates in developing world (10%), as well as GCC countries; where the fixed telephone penetration rates in Qatar, Kuwait, UEA, KSA, and Oman are 18.41%, 14.2%, 22.26%, 13.36%, and 9.56%, respectively. On the contrary the mobile-cellular penetration rates in Bahrain is higher than the average Mobile-cellular subscription in year 2014 in both developed and developing world as well as Qatar, and Oman, where the Mobile-cellular penetration rates are 119.9%, 91.1%, 145.75% and 157.75% respectively, while it is less than the average number of subscriptions in KSA (179.56%), UAE (178.06%) and Kuwait (218.43%). (ITU, 2014).

Electricity consumption: The World Bank database of electric power consumption (*kWh per capita*) illustrates that Bahrain was one on the biggest countries in the consumption of electricity during the period (2000-2014), the main reason behind that to meet energy demand related to high economic growth in Bahrain during the study period. In 2000 the electricity consumption in Bahrain was199417 *kWh* and it raised to 21905 *kWh* in 2006 while the average world electricity consumption was 2496.1 kWh. Despite of the electricity consumption per capita in Bahrain started to decrease since 2007, the electricity consumption in Bahrain is still higher than the average world in addition to GCC. For example I n 2014 the electricity consumption per capita in Bahrain was 17395.3 *kWh*, the average world electricity consumption is 3064.5 *kWh,* while the electricity consumption per capita in Qatar, Kuwait, UAE, KSA, and Oman were 161831, 15721.8, 10465.6, 8303.5 and 6094.7 *kWh* respectively.

Tertiary science & engineering enrolment : Recent reports of UNDP illustrate that the enrolment in science and engineering colleges (% of 20-24 age group) declined sharply from 23% for the period (2005-2009) to 13% for the period (2010-2014) compared to the average world which equals to 22.8%.The main reason behind the reduction in enrolment in Science and Engineering Colleges and increasing the enrolment in Business, Arts and Teachers Collages due to changing in demand of the labor market in Bahrain over the past decade. Where there is increasing in demand for graduates of Colleges of Business and Teachers while there is a lack of demand for Scientific College's graduates. On the other hand, Most of Bahraini students prefer Business, Art and Teachers colleges rather than scientific colleges cause these colleges are easy than the other.(UNDP, Human Development Reports)

Mean years of schooling: The mean years of schooling in Bahrain is twelve years where the Pre-university educational system in Bahrain consists of four phases: a primary level that includes six years, but the system allows moving after the end of the third year of education to religious institute, to complete primary school, and then studying in middle school for two years, followed by high school in the same Institute for Three years. Intermediate level that includes three years. Secondary level which includes three years and also branched to Secondary General (scientific, Arts), industrial secondary and commercial secondary in order to get an industrial or commercial diploma.

Literacy rate: The WB database shows that the Literacy rate in Bahrain raised from 94.2% for the period (2000-2007) to 98.2% for the period (2008-2014). The literacy

rate rising during the study period due to adopting the Bahrain Economic Vision 2030, which aims to take progressive action for sustainability and competitiveness of future generations in terms of social and economic development of Bahrain. In order to achieve the goals the ministry of education put a plan for illiteracy eradication targeting the over 10 years of age. The purpose, in addition to eradicating illiteracy, is to provide them with the skills necessary for personal and professional development, including human and citizenship rights education. Moreover they put incentives system and rewards whereby no government jobs can be obtained without a certificate proving the completion of this course, or a signed agreement to enroll in it. Additionally, part of the plan's orientation is the development of an integrated educational system for adults that combines formal and non-formal educational curricula. This measure is aimed at enhancing the quality and relevance of adult education programmes and more closely linking them to social and economic development needs. The government of Bahrain, through the Ministry of Education, is also directing its efforts towards women by facilitating their enrolment in flexible programmes offered in the afternoons and evenings for those who cannot attend daytime classes. (Ministry of education, 2013). The World Bank statistics show that the literacy rate in Bahrain is above the world literacy rate which is 90.6%, while it equals to the literacy rate in most of the Gulf countries, this could be because most of gulf countries are adopting the same educational policies. (World Bank, 2014).

4.EMPIRICAL RESULTS

Bahrain's technological capabilities data shows obvious positive developing in technological capabilities indicators during the period (2000-2014) which might be reflected significantly on calculating ArCo technological index. In order to calculate ArCo technological index of Bahrain, the study follows ArCo approach where we divide the study period to two almost equal periods, the first period is (2000-2007), and the second period is (2008-2014), because the comparison of the coefficients of variations across the two periods allows notifying Bahrain is somehow converging or diverging in technological capabilities.

In order to identify the relationships and the trend of the eight indictors, we calculate the correlation coefficient among these indicators, as shown in tables (2), while table (3) shows the three category indexes respectively. Accordingly, we argue the following:

- All correlation coefficients are positive, as expected, however, the values are different, which indicate that the various indicators taken into account highlight different aspects of technological capabilities.
- The correlation is high among indicators that belonging to the same category of technology, and also sometimes the correlation among indicators that not belonging to the same category of technology, for example, the correlation between internet users and scientific articles and literacy rate is high (0.839), and (0.740) respectively. Moreover, it appears that more traditional expressions of technology are closer to each other rather than with more developed one; therefore, the creation technology indexes are little correlated with literacy rate, telephony and electricity diffusion.
- There is high correlation between ArCo index and the eight indicators, but with some exception, for example, patents show the weakest correlation, this might because Bahrain did not have good performance during the study period.
- Table (3) shows that the Innovative capability index is a little less correlated with other two indexes and with the final ArCo index.

Table (2) Correlation coefficients among the eight indicators

	Patent index	Articles index	Internet index	Telephone index	Electricity index	Tertiary index	Schooling index	Literacy index	ARCO index
Patent index	1	0.650	0.325	0.560	0.233	0.540	0.845	0.260	0.440
Articles index	0.650	1	0.839	0.710	0.650	0.702	0.560	0.349	0.747
Internet index	0.325	0.325	1	0.850	0.870	0.740	0.590	0.770	0.764
Telephone index	0.560	0.710	0.850	1	0.791	0.826	0.628	0.775	0.755
Electricity index	0.233	0.3650	0.870	0.791	1	0.691	0.598	0.638	0.642
Tertiary index	0.540	0.702	0.740	0.826	0.691	1	0.801	0.587	0.694
Schooling index	0.845	0.560	0.628	0.598	0.598	0.801	1	0.757	0.878
Literacy index	0.260	0.349	0.775	0.638	0.638	0.587	0.757	1	0.650

Table (3) Correlation coefficients among the three dimensions of technological capabilities

	Innovative capability	Technological infrastructure	Advanced and basic education level	ARCO index
Innovative capability	1	0.459	0.613	0.670
Technological infrastructure	0.459	1	0.740	0.840
Advanced and basic education level	0.613	0.740	1	0.735

Table (4) shows the results of calculating the value of eight indicators, the three category indexes and the final ArCo technological index during the two periods (2000-2007) and (2008-2014), as follows:

- Five indicators achieve growth, while two indicators (Electricity & Tertiary) have negative growth, while schooling index does not change between the two periods of time.
- Two of three main indexes achieve growth, while Advanced and basic education level index has negative growth (-3.8%)
- ArCo index is 0.367 for period (2000-2007) and it raised to 0.429 for period (2008-2014), at growth rate 17%.
- All the indicators show a certain convergence from the past in particular with regard to patent and scientific articles which are very few compared with other countries.
- It emerges that the propensity towards convergence is much quicker in the technological infrastructure, including new technologies such as Internet, than in the Innovative capability
- Finally, according to Arco technological index countries classification, Bahrain is consider one of the potential leader countries where Bahrain has invested in the formation of human skills, has diffused technology widely but it has so far innovated little.

Table (4) Technological capabilities indexes coefficients during the period (2000-2014)

	2008-2014	2000-2007	Growth rate
Patent index	0.498	0.456	9%
Articles index	0.615	0.570	3.5%
Internet index	2.437	1.981	25%
Telephone index	1.195	1.031	23%
Electricity index	0.520	0.540	-3.7%
Tertiary index	1.042	1.241	-16%
Schooling index	0.591	0.590	0.01%
Literacy index	1.234	0.980	26%
Innovative capability index	0.584	0.570	2.6%
Technological infrastructure index	1.400	1.230	13.9%
Advanced and basic education level index	0.808	0.840	-3.8%
ARCO index	0.429	0.367	17%

CONCLUSION

Technology capability indicators of Bahrain during the period (2000-2014) shown that Bahrain ArCo index has raised from 0.367 for the period (2000-2007) to 0.429 for the period (2008-2014), this due to Bahrain achieved improvement in technological infrastructure and literacy rate, while the innovative capability indicators were less than the required standard compared with other Arab Gulf countries, moreover the tertiary science and engineering enrolment declined during the study period. Accordingly, the study recommends steps that might improve the some technology capability indicators of Bahrain as follows: technology capability accumulation in Bahrain during the next years should depend on steady investments to increase science education and to improve science, technology and innovation policy which will foster endogenous innovations. Thus, Bahrain should incorporate science education in curricula from primary and high levels in order to encourage research poles around existing university as one key step. Bahrain University research institutes should have partnerships with industry, this will be a key driver of improving the overall ecosystem making it attractive for human skills to return, including the return of skilled labors. Finally, broadening the culture of science, technology and innovations; therefore Bahrain should make science and technology accessible to all level of learning, including to the public via the media to show how research can drive high technology innovation and wealth creation.

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