Socio Political Economic Dimensions of Technological Advancement

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Abstract

The technological advancements of countries are varied, making the competition essentially uneven. Different studies had been made using a variety of determinants with the common objective of proposing theories on how to advance the technological capability of a country. This paper intends to look into the social, political and economic dimensions of countries that exemplify different degree of technological advancements, and determine how these factors affect the advancements. To derive the characteristics, data mining and multivariate clustering method were used. Technologically advanced countries demonstrate social and political characteristics that promote these advancements.

Keywords: Technological advancement

1.0 Introduction

In the 21st century, countries operate in an increasingly competitive environment when the playing field is essentially uneven because of the imbalance in their trends of technological advancements. In turn, the level of a nations' technological advancement is inextricably linked with internal government policies, economic and social agenda and the overall commitment of its citizenry to become globally competitive. This paper attempts to explore and identify the social, economic and political factors that facilitate technological advancement in selected countries across the globe.

Several studies in the past have linked technological development to various determinants. The World Bank (2008) conducted a study on the determinants of technological progress. Encouragingly the Bank assessed that the technological divide has narrowed between developing countries and highly developed ones. Nevertheless, this divide has grown large for most underdeveloped countries. The speed at which a country absorbs and adapts technology depend on; (a.) technologically-literate work force, (b.) proper investment climate, (c.) public sector support to technology, (d.) the in-country market forces. However, adoption and absorption may not be the only concerns relative to the issue. In a study by Shokoofeh Fazel (2003), Advances in Technology and Global Welfare described that the gap of the standard of living between the developed and developing countries has increased. This condition still remains true to date, as developing countries advances in technology, so thus the developed countries, so the gap will most likely to remain constant. According to J.C. Bolay and A. Kern (2011), the technological gap between rich and poor countries remains significant. Rich countries own resources that less advantaged countries do not possess, they have more individuals and companies with the skills needed to make most of the available technologies. J. D. Sachs and J. W. McArthur (2002) stated that if one economy is a technological innovator while the other is a technology adopter, the innovator will maintain a lead in income

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per capita relative to the adopter. Understanding the driving factors of technological advancements, as demonstrated by the developed countries, would be a good lead to truly developing another.

It is the intention of this paper to look into the social, political and economic dimensions of countries that exemplify different degree of technological advancements, and determine how these factors affect advancements. Specifically the study will look into the following variables; (a.) the type of governance; (b.) government support to technology advancements; (c.) government support to technology education; (d.) human development; (e.) technological literacy; (f.) technological capability; (g.) technological productivity; (h.) economic condition of the country.

Identifying a technologically advanced country is subjective, there are some definite indicators, and there are those variables that are not clear and debatable. According to opinion surveys, it can be safely generalized that a technologically advanced country should; a.) be at the forefront in the use of new technology, b.) have shown a degree of economic development, c.) somehow lead or contribute to the technological innovations. To classify a country as technologically advanced without the notion of it leading or contributing to technological innovations, is wanting. The figure below shows a simple internet opinion poll, which expresses the consistency of the general opinion of what a technologically advanced country is.

Robert M Solow, (1956) when he made a study of the United States economic growth between 1909 and 1949, showed that technological advancement was the key; the driver of the U.S. economic development during the period, ever since technological advancement has been espoused as a major determining factor for economic growth. In the technological age, technological advancement undoubtedly is the driving variable for economic growth. This is demonstrated today by many emerging countries in Asia which have shown rapid improvements in terms of technological advancements and at the same time have shown rapid economic developments.

The challenge of technological advancement is to progress from adoption to innovation. In the past fifty years, technological innovation is almost certainly the key driver of long-term economic growth, J. D. Sachs and J.W. McArthur on Technological Advancement and Long-Term Economic Growth in Asia. Every country has this capability in achieving this process. The challenging part, however, requires focus, attention, and institutional creativity or scientific attitude.

In economic development, human resource development must be given careful attention. Education is central to this process. It is a critical aspect for the economic transformation in general and the accumulation of technological capability in particular.

View Poll Results: Which country do you think is the most technologically advanced?

Japan	141	46.38%
China	6	1.97%
South Korea	12	3.95%
Singapore	5	1.64%
Finland	5	1.64%
Germany	6	1.97%
France	4	1.32%
United Kingdom	8	2.63%
United States	99	32.57%
Australia	1	0.33%
Italy	0	0%
Switzerland	2	0.66%
Russia	3	0.99%
Other (specify)	12	3.95%

Voters: **304**. You may not vote on this poll

Figure 1. Technologically Advanced Countries

For effective technological advancement, developing countries will need to devote much of their energy to technical, tertiary education. Emphasis should be given to natural science, mathematics, information technology, and engineering. (J.D. Sachs and J.W. McArthur, 2002).

The World Bank (2008) in its report stated that domestic R&D capacity is critical in determining an economy's capacity both to generate new technologies and to absorb technologies from abroad. Foreign technologies frequently need to be modified so that they are suitable for domestic circumstances.

2.0 Design and Methods

The process used is data mining exploratory method. Data mining automates the detection of relevant patterns in a database. It uses a well established statistical technique, for exploring data sets. It is used to look into current and historical data that can then be analyzed to predict future trends and to extract useful information from the data. (Thearling, K.)

Data mining is exploratory by design. The essential part of the data mining process is the discovery aspect of the important data patterns or extracted information from the database. This discovered knowledge can then be used to predict or describe future trends. Data mining, currently is regarded as the key element of the much more elaborate process called Knowledge Discovery in Databases (KDD). It is used to search for valuable information in large volumes of data. Data mining may produce one or more output values for a given set of inputs. (Han, J. and Kamber, M., 2006)

When the data mining algorithm is programmed to a computer system the whole process becomes automated, and the extracted information is then readily available by a click or for other use. The procedure can also be manually implemented as may be the case in this study. Data were manually retrieved, and data pre-processing were manually administered. The resulting "clean data" were then submitted for a statistical treatment, in this study, MINITAB V 13.2 software. The statistical method is the multivariate-cluster observation. The result is the clustering of the samples into groups of similar characteristics. The similarity of the characteristics is measured in terms of statistical distance from a centroid or prototype. Countries having similar achievements are most likely to belong in one group, like developing countries, and may also be graduated into different cluster depending on the strength of the indicators. An analysis of the clustered patterns is then made, minding each of the countries' characteristic. Discovered knowledge and theories may be made and validated. Data mining is a well suited method to process an otherwise large and meaningless database.

Data were retrieved from various reliable world statistics sources. A sample of 25 countries was drawn with the following information; type of Governance, Human Development Index, Expenditure in R&D per capita, GNP per capita, Top 100 Engineering Universities in the world, number of Researchers per million, number of Patents and Internet users per hundred. (www.nationmaster.com)

a. Type of government – refers to the degree of civil and political liberties, the numerical values

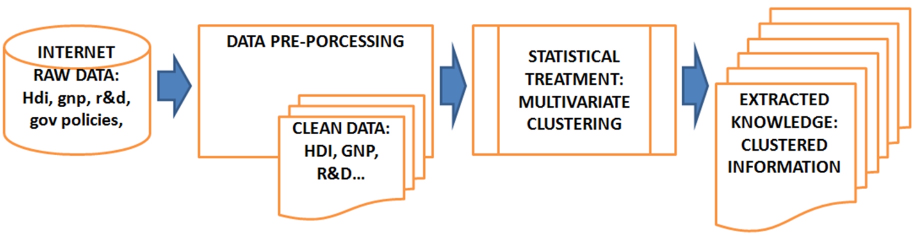

Figure 2. Data Mining Exploratory Method

are between 0 – 6, where 6 being the highest degree of democracy, and 0 as the value for or similar to a communist restrictions.

b. Government support to technology advancements – refers to the commitment of a government to technological advances and innovations. Indicators use is the government spending on research and development per capita.

c. Government support to technology education – refers to the provision/availability of quality engineering education, in this study the indicator is top 100 engineering schools worldwide, and the number present in a country. (Top 100 Engineering Universities)

d. Human development – is the measure of how far the country has developed its own people. Indicator used is the HDI (human development index); it is a summary, a composite index that measures a country's average achievements in three basic aspects of human development: longevity, knowledge, and a decent standard of living. (Human Development Report 2009)

e. Technological literacy – is the ability of the populace to work with or use technology, the indicators use is the number of internet user per 100 of a country.

f. Technological capability – this refers to the capability of the populace to do research or produce technical innovations or inventions, this is measured by the number of researchers in the country (researchers per million).

g. Technological productivity – refers to the actual output in terms technical innovations, inventions, the indicator use is the number of registered patents. (World Intellectual Property Organization)

h. Economy - economic condition of the country, the indicator use, is the GNP/capita. GNP per capita of a country shows the average value of goods and services produced by each person per year divided by the total population. It represents the average earnings per person.

Table 1. Raw Data

Worksheet 1 ***

	C1-T	C2	C3	C4	C5	C6	C7	C8	C9	C10
		Types of Gov.	HDI	expnditure rnd/capita	GNP per capita	top 100 eng universiites world	researchers /million WB	patents /	internt user/100 WB	
1	Canada	6.0	0.908	704.79	34380	6	4236	5183	71.6	
2	USA	6.0	0.910	1109.47	43170	36	4633	207687	68.3	
3	Japan	5.5	0.901	1034.18	31150	4	5385	367960	66.2	
4	China	0.5	0.667	53.99	4090	4	856	93485	8.5	
5	Philippines	4.5	0.644	3.34	3040	0	81	210	5.4	
6	India	4.5	0.547	17.08	2190	4	136	4721	2.4	
7	Russia	2.0	0.755	123.69	11560	0	3230	23644	15.3	
8	Iran	1.0	0.707	66.14	9060	0	706	4051	8.1	
9	Cuba	0.0	0.776	5.48	996	0	493	105	9.7	
10	France	5.5	0.884	631.10	29910	2	3320	14327	41.4	
11	Saudi Arabia	0.0	0.770	8.31	20780	0	41	119	12.7	
12	Pakistan	1.5	0.504	9.64	2190	0	80	143	6.3	
13	UK	5.5	0.863	579.38	33490	9	4129	17833	70.0	
14	Venezuela	3.0	0.735	0.00	9770	0	122	0	12.6	
15	Libya	0.0	0.760	97.51	13930	0	361	0	3.9	
16	Australia	6.0	0.876	579.42	31320	5	4093	2555	63.0	
17	Korea	5.0	0.876	635.00	22760	3	3822	122188	71.8	
18	malaysia	2.0	0.761	68.88	11480	0	495	522	48.6	
19	thailand	4.5	0.682	14.61	6350	1	307	891	15.0	
20	singapore	5.0	0.886	927.03	42330	2	5576	569	61.0	
21	finland	6.0	0.941	1073.58	30850	1	7548	1830	74.5	
22	UAE	1.5	0.849	0.00	67920	0	0	0	40.0	
23	germany	5.5	0.930	783.60	31470	3	3297	48367	68.8	
24	mexico	4.5	0.814	49.08	11970	0	412	584	17.2	
25	new zealand	6.0	0.933	269.61	23650	1	4169	1893	62.7	

3.0 Results and Discussion

The samples were clustered into twelve (12) level groups. Clustering the samples in less than 12 levels will clump the majority of the countries in one group, which defeat the purpose of understanding the characteristic of the different level of development. Greater than twelve will spread the groupings, and for this purpose, this will give a better view of the range of development. In a grand single cluster, see figure below, Japan (observation 3) and the United States (observation 2) are outliers. Both had created a proportionately large gap with the rest that it makes the other variance relatively small. Outliers in this case are an important aspect as these will give a general direction or point of reference, to create the necessary hierarchal level. A statistical post process is introduced; this is shifting the centroid on the farthest outlier (P.N. Tan, M. Steinbach, V. Kumar, 2006). Japan and the United States cannot be considered under-developed; therefore, it could only mean highly advanced status. This also shifted our prototype to the "most technologically advanced" country.

The following table shows the result of the post process step and the ranking according to the statistical distance of the new centroid to the other clusters.

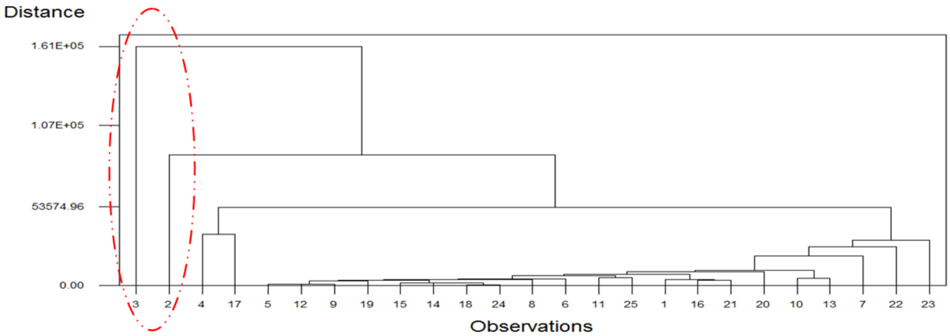

Figure 3. Cluster Dendogram

Table 2. Cluster Ranking

rank	country groups	statistical distance	cluster
1	Japan	0	3
2	USA	160724.8802	2
3	South Korea	245920.4555	9
4	China	275844.6033	4
5	Germany	319600.0791	12
6	Russia	344880.7788	6
7	UK and France	351884.6093	7
8	Canada, Australia and Finland	364772.2266	1
9	Saudi Arabia and New Zealand	367078.5107	8
10	Singapore	367561.1341	10
11	Philippines, Pakistan, Cuba, Thailand, Libya, Venezuela, Malaysia, Mexico, Iran and India	367661.2419	5
12	UAE	369833.2908	11

Japan as the centroid leads the tally, along with the United States 2nd. Japan places 3rd in technological capability to Finland (1st) and Singapore (2nd). It is 5th in economic standing, but government support to research is 2nd to the highest which is the United States.

While near the bottom of the list, are the ten countries, clump in one level including the Philippines. These countries have variances in the development that can be considered from low to medium while India and Iran may be considered the most technically competent and productive among this group. Malaysia, on the other hand, is more technically advanced and economically richer than the Philippines, yet its variance is not exactly large enough to break away from the cluster.

The ranks 1 to 8 are the undisputed developed countries. Saudi Arabia ranks 9 with New Zealand.

United Arab Emirates (UAE) is the richest country among the group and may not exactly be considered under-developed in terms of technological advancements, but it does not have a clear list of contribution for technological innovations. UAE may be considered a technology consumer. This, therefore, brings the question if technology consumerism can be categorized as technologically advanced. Technology consumerism can buy the country advanced gadgets and equipments, but it does not necessarily make the populace technologically productive. Leading countries on the list, especially the ranks 1 to 8, are technology innovators.

On observations, the degree of technological advancement tends to increase with technological productivity of the country. The leading countries are technologically productive. Japan, Unite States, South Korea and China are among the most productive with China leading the list. Take the case of China and Singapore; both had contrasting status in terms of technological capability, economics, and type of governance. China is rank 4 and Singapore rank 9. It takes enough number people having the right motivation and intentions to build and create innovations or new technologies. Leading countries also have shown that to be technologically productive, a country has to have a good number of researchers, and a far greater number of technologically literate populace. Developing countries, most often are trapped into technology consumerism, buying new ones and discarding the old without the benefit of real production or output. Owning gadgets like mobile phones and the internet may seem advancement, but if use for social purposes or other than being productive then it merely adds to the cost of living. These do not improve the economy as described by Fazel (2003).

A high index on technological literacy and capability does not guarantee technological advancement because such do not guarantee technological productivity. Technological literacy is important since it precedes capability and productivity. However to jump from being literate to being productive, requires motivation and intent. Take the example of Japan, South Korea and China; these countries are very strong because of the number of output whether in terms of products, ideas or patents per year. These countries demonstrated a very high ratio of output for every technologically able person. Malaysia and Singapore both have very good literacy index and have a good number of capable researchers, however, the productivity ratio are not as much. Technological literacy and capability are steps in the ladder towards advancements.

The degree of advancement of the developed countries tends to increase proportionately with the political support, and it is not directly affected by the type of governance restrictive or democratic. All leading technologically advanced countries have a very good support system for technology development, in terms of research, technology education and human development. The type of governance does not directly affect advancement; take the case of China and United States and most of the developing countries.

A Good economy can hasten technological advancement. Resources can buy technology, but it does not make the populace technologically productive, what it present is the luxury or the availability of use. Available technology and resources can well be used to boost technology education and promote productivity. UAE and Singapore both have the potential, but China and France are far more production able.

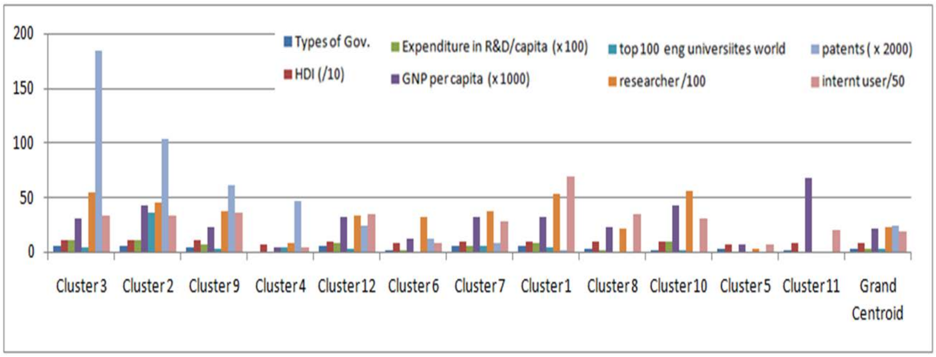

Figure 4. Clusters, Rank from left to right

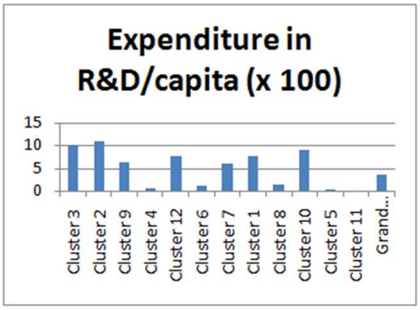

Figure 5. Expenditure in R&D (x 100)

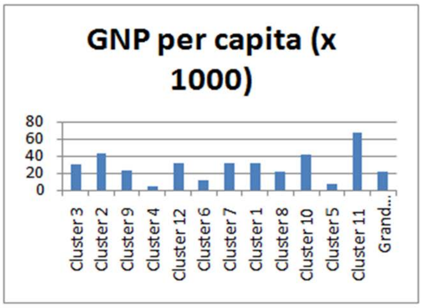

Figure 6. GNP per Capita (x 1000)

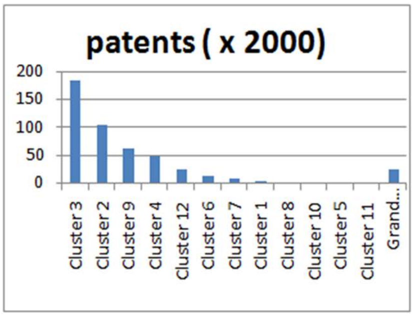

Figure 7. Patents (x 2000)

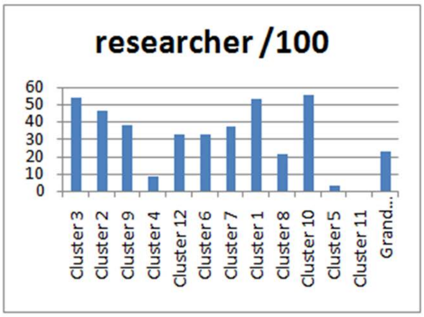

Figure 8. Researchers / 100

4.0 Conclusion

The creation of suitable social, political and economic climate is an important factor for advancement. For social it means a good number of technologically literate, capable and productive populace. For political it is the provision of quality training facilities for technology, a sufficient support to research and development, a firm agenda for human resource development. For economics, having the resources to jump start development programs for technological advancement is always an advantage. Specifically these factors must be given attention.

The country must focus on productivity. Technological literacy is an important factor, but it must produce. It is necessary that the country should invest to dramatically increase its technologically literate populace. Technologically productive people can only be derived from the technologically educated.

The country must innovate. J. D. Sachs and J.W. McArthur (2002) the country should find its way to develop its own niche in the technological market. For long standing development, the country must be an innovator. The prevalence of the developing countries of becoming technologically dependent is high. The concept of buying instead of making their own is convincingly tempting. Technological consumerism, merely feeds the economy of the technology provider and do not improve the economy of the adopter.

Political support to technology advancement must be persuasive. Governance does not have to be restrictive or forceful, but it has to be able to compel its populace to be productive. Government must continually provide a good support for research and human resource developments. It should provide a good support for technology education that can positively produce more technology literate human resource and eventually a good percentile of productive populace.

Technological advancement of a country is progressed by the social and political intent of its citizens and leaders, to be technologically productive, and resources should be used to facilitate the process.

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