Locating the Economic and other Performance Centres of Asia using Geodetic Coordinates, Haversine Formula and Weiszfeld’s Algorithm

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Abstract. Due to the increasing economic activities in Asia, the Global Economic Centre is moving towards China from the Atlantic Ocean. According to the “Global Growth Generators, Citi Investment Research and Analysis, 2011” report, in the year 2050, India will become the world’s largest economy (GDP: 85.97 trillion USD) closely followed by China (GDP: 80.02 trillion USD). US may slip to the third position with a GDP of 39.07 trillion USD followed by Indonesia (13.93 trillion USD). Japan may be at a distant ninth position with 6.48 trillion USD. The objective of this paper is to locate the performance centres of Asia that include the “Economic Centre” and “Population Centre” for the years 2005, 2010 and 2018. These centres will provide some idea about the concentration of the population and economic activities at a particular point of time. Identifying such Centres can help in supply chain management to establish the optimal ‘Facilities’ to manufacture, distribute or collect. The estimated three Economic Centres confirm the movement of Economic Centre towards China, especially Beijing. Haversine formula is used in combination with the Weiszfeld’s algorithm to locate the centres from the geodetic coordinates.

1. Introduction
The Asian continent is the most populous and largest continent located in the Eastern and Northern Hemispheres with about 30% of the Earth’s total land area and roughly 60% of the planet’s population. It has extremely diverse cultures, climatic conditions and geographic features. It is widely believed that Asia continent is the birthplace of many religions including Hinduism, Judaism, Jainism, Buddhism, Confucianism, Christianity, Islam and Sikhism. As of 2018, China, Japan, India, South Korea, Turkey and Indonesia are the top economies of the continent.

In the year 2010, China overtook Japan to become world’s second largest economy. It is predicted that in the coming decade, China may occupy the top slot in the world and India may overtake Japan. It is widely accepted that 4 out of 5 most sorted office locations are in Asia: Hong Kong, Singapore, Tokyo and Seoul. Asia has three dominant economic centres, Hong Kong, Tokyo and Singapore. According to UN [1], Asia has 50 countries as its members and has more millionaires than Europe.

The popular Citigroup in its “The Wealth Report 2012” [2] claims that the world’s “Economic Centre of Gravity” is continuously moving towards East. The London School of Economics professor Danny Quah forecasts that by 2050, the world’s economic centre of gravity, a theoretical measure of the focal point of global economic activity based on GDP, will have shifted from Atlantic ocean (1980) eastwards to lie somewhere between China and India (2050). This paper tries to locate the
economic centre of gravity of Asia in addition to a few other centres. Codes are generated in MATLAB R2012b and run in an i5 PC with 4 GB RAM.

2. Objective and Methodology used
The objective of this paper is to estimate the following “Performance Centres” of Asia:
- Economic Centre - a point of economic activity based on GDP
- Mass Centre – a physical point at the algebraic mean of the coordinates
- Access Centre – a point (geometric median) estimated without any weight, only Euclidean distance
- Population Centre - a point obtained by considering the % population share as the weight
- Area Centre - a point obtained by considering the % area share as the weight
- Literacy Centre - a point obtained by considering the fraction literacy rate as the weight.

For evaluating these centres, following two assumptions have been made:
- All the countries are represented by their respective capital cities.
- Only Euclidean distances are considered.

All the required data pertaining to the 50 countries; official names, capital cities, 2018 population, area in square kilometres, GDP (in million current USD) for the years 2005, 2010 and 2018 are collected from UN’s official website [3] and presented in Table 1. The countries are grouped under Southern Asia, Western Asia, South-Eastern Asia, Eastern Asia and Central Asia. The latitudes and longitudes of the capital cities are extracted from a single popular website [4] to minimise the errors, if any and listed in Table 2. This site has been referred in the official “My NASA Data” [5] site also.

### Table 1. Countries of Asia, their Capitals and other Data.

| S.No. | Country                        | Population (2018) | Area (km²) | Capital     | GDP (million current USD) |
|-------|--------------------------------|-------------------|------------|-------------|--------------------------|
|       |                                |                   |            |             | 2005                     | 2010 | 2018 |
| 1.    | Afghanistan                    | 36373             | 652864     | Kabul       | 6622                     | 16078| 20235|
| 2.    | Armenia                        | 2934              | 29743      | Yerevan     | 5226                     | 9875 | 10572|
| 3.    | Azerbaijan                      | 9924              | 86600      | Baku        | 13245                    | 52906| 37847|
| 4.    | Bahrain                        | 1567              | 771        | Manama      | 15969                    | 25713| 32179|
| 5.    | Bangladesh                      | 166368            | 147570     | Dhaka       | 57628                    | 114508| 220837|
| 6.    | Bhutan                          | 817               | 38394      | Thimphu     | 819                      | 1585 | 2213 |
| 7.    | Brunei Darussalam               | 434               | 5765       | Bandar Seri Begawan | 10561| 13707| 11400|
| 8.    | Cambodia                        | 16246             | 181035     | Phnom Penh  | 6293                     | 11242| 20017|
| 9.    | China                           | 1415046           | 9600000    | Beijing     | 2308800                  | 6066351| 11218281|
| 10.   | China, Hong Kong SAR            | 7429              | 1106       | Hong Kong   | 181569                   | 228639| 320912|
| 11.   | China, Macao SAR                | 632               | 30         | Macao       | 12092                    | 28124| 45311|
| 12.   | Cyprus                          | 1189              | 9251       | Nicosia     | 18694                    | 25561| 20046|
| 13.   | Democratic People's Republic of Korea | 25611             | 120538     | Pyongyang   | 13031                    | 13945| 16789|
| 14.   | Georgia                         | 3907              | 69700      | Tbilisi     | 6411                     | 11638| 14333|
| 15.   | India                           | 1354052           | 3287263    | New Delhi   | 812059                   | 1650635| 2259642|
| 16.   | Indonesia                       | 266795            | 1910931    | Jakarta     | 304372                   | 755094| 932259|
| 17.   | Iran (Islamic Republic of)      | 82012             | 1628750    | Tehran      | 226452                   | 491099| 425403|
| No. | Country                  | Latitude | Longitude | Population | GDP GDP PPP | Capital          | Population | GDP GDP PPP | Capital          |
|-----|--------------------------|----------|-----------|------------|-------------|------------------|------------|-------------|------------------|
| 18  | Iraq                     | 39.340   | 43.5052   | 36.268     | 117.138     | Baghdad          | 160.021    |             |                  |
| 19  | Israel                   | 34.9058  | 36.1272   | 124.163    | 23.3611     | Jerusalem        | 31.7748    |             |                  |
| 20  | Japan                    | 37.7930  | 135.4101  | 47.255410  | 57.00098    | Tokyo            | 49.36212   |             |                  |
| 21  | Jordan                   | 28.9138  | 22.9318   | 125.899    | 26.425      | Amman            | 36.2565    |             |                  |
| 22  | Kazakhstan               | 48.0408  | 82.2402   | 5.71251    | 1.48047     | Astana           | 1.35005    |             |                  |
| 23  | Kuwait                   | 25.1781  | 47.1818   | 80.7978    | 11.5416     | Kuwait City      | 1.10346    |             |                  |
| 24  | Kyrgyzstan               | 41.633   | 99.9949   | 24.460     | 47.944      | Bishkek          | 6.551      |             |                  |
| 25  | Lao People's Democratic Republic | 39.61   | 106.8000  | 23.6800    | 6.7313      | Vientiane        | 15.806     |             |                  |
| 26  | Lebanon                  | 30.964   | 104.52    | 21.490     | 38.420      | Beirut           | 50.458     |             |                  |
| 27  | Malaysia                 | 32.042   | 33.0323   | 143.534    | 25.018      | Kuala Lumpur     | 29.6531    |             |                  |
| 28  | Maldives                 | 12.444   | 13.30     | 11.63      | 25.88       | Male             | 4.224      |             |                  |
| 29  | Mongolia                 | 31.22    | 156.4116  | 29.265     | 71.89       | Ulaanbaatar      | 11.160     |             |                  |
| 30  | Myanmar                  | 53.856   | 67.6577   | 11.931     | 41.445      | Nay Pyi Taw      | 6.698      |             |                  |
| 31  | Nepal                    | 29.624   | 147.181   | 8.259      | 16.281      | Kathmandu        | 20.914     |             |                  |
| 32  | Oman                     | 48.38    | 30.9500   | 31.082     | 58.641      | Muscat           | 6.3171     |             |                  |
| 33  | Pakistan                 | 32.8081  | 79.6095   | 11.7708    | 17.4508     | Islamabad        | 28.2506    |             |                  |
| 34  | Philippines              | 106.512  | 30.0000   | 10.3072    | 19.9591     | Manila           | 30.4906    |             |                  |
| 35  | Qatar                    | 1.5265   | 1.1160    | 4.3998     | 12.3627     | Doha             | 15.2452    |             |                  |
| 36  | Republic of Korea        | 5.1164   | 100.284   | 8.98137    | 10.94499    | Seoul            | 14.11246   |             |                  |
| 37  | Saudi Arabia             | 32.5544  | 22.06714  | 32.8461    | 52.8207     | Riyadh           | 63.9617    |             |                  |
| 38  | Singapore                | 5.792    | 7.19      | 12.7418    | 23.6420     | Singapore        | 29.6946    |             |                  |
| 39  | Sri Lanka                | 20.950   | 65.610    | 27.932     | 56.726      | Colombo          | 81.322     |             |                  |
| 40  | State of Palestine       | 5.053    | 6.020     | 4.832      | 8.913       | East             | 13.397     |             |                  |
| 41  | Syrian Arab Republic     | 18.284   | 181.508   | 28.397     | 6.0465      | Damascus         | 22.163     |             |                  |
| 42  | Tajikistan               | 9.107    | 114.2600  | 23.12      | 5.642       | Dushanbe         | 69.52      |             |                  |
| 43  | Thailand                 | 69.183   | 101.3120  | 18.9318    | 34.1105     | Bangkok          | 40.7026    |             |                  |
| 44  | Timor-Leste              | 13.24    | 141.991   | 1.850      | 3.999       | Dili             | 2.703      |             |                  |
| 45  | Turkey                   | 8.1917   | 78.3562   | 50.1423    | 7.71877     | Ankara           | 86.3712    |             |                  |
| 46  | Turkmenistan             | 58.52    | 48.8100   | 14.182     | 22.583      | Ashgabat         | 36.180     |             |                  |
| 47  | United Arab Emirates     | 9.542    | 83.6000   | 18.2978    | 28.9787     | Abu Dhabi        | 34.8744    |             |                  |
| 48  | Uzbekistan               | 32.365   | 44.8969   | 14.396     | 39.526      | Tashkent         | 67.779     |             |                  |
| 49  | Viet Nam                 | 9.6941   | 33.0967   | 57.633     | 11.5932     | Hanoi            | 20.5276    |             |                  |
| 50  | Yemen                    | 28.915   | 52.7968   | 19.041     | 29.031      | Sana'a           | 25.374     |             |                  |

The methodology used can be summarised as follows:

- The geodetic coordinates will be converted to Earth Centric Earth Fixed (ECEF) x, y and z coordinates.
- The Geometric Median in terms of x, y and z coordinates will be estimated using Weiszfeld’s algorithm.
- The Geometric Median will be converted back to geodetic coordinates.
- The physical location will be identified from the geodetic coordinates.
- Great circle distance between any two points will be computed using the latitudes and longitudes wherever required.
Haversine formula [6] is used to find the distance between two points with known geodetic coordinates, (Lat, Lon).

\[
d = 2r \sin \left( \sqrt{\sin^2(\frac{\text{Lat}_2 - \text{Lat}_1}{2}) + \cos(\text{Lat}_1) \cos(\text{Lat}_2) \sin^2(\frac{\text{Lon}_2 - \text{Lon}_1}{2})} \right)
\]

Where, ‘r’ is the Earth’s radius.

Table 2. Geodetic Coordinates of Capitals of Asian Countries.

| S.No. | Country                      | Capital   | Latitude  | Longitude | Altitude, m |
|-------|------------------------------|-----------|-----------|-----------|-------------|
| 1     | Afghanistan                  | Kabul     | 34.555347 | 69.207489 | 1,791       |
| 2     | Armenia                      | Yerevan   | 40.179188 | 44.499104 | 990         |
| 3     | Azerbaijan                   | Baku      | 40.409264 | 49.867092 | -28         |
| 4     | Bahrain                      | Manama    | 26.228516 | 50.586048 | 7           |
| 5     | Bangladesh                   | Dhaka     | 23.810331 | 90.412521 | 4           |
| 6     | Bhutan                       | Thimphu   | 27.577391 | 89.623016 | 2,334       |
| 7     | Brunei                       | Bandar Seri | 4.903052 | 114.939819 | 16          |
| 8     | Cambodia                     | Phnom Penh | 11.556374 | 104.928207 | 12          |
| 9     | China                        | Beijing   | 39.904202 | 116.407394 | 44          |
| 10    | China, Hong Kong SAR         | Hong Kong | 22.396427 | 114.109497 | 552         |
| 11    | China, Macao SAR             | Macau     | 22.210928 | 113.552971 | 26          |
| 12    | Cyprus                       | Nicosia   | 35.185566 | 33.382275 | 220         |
| 13    | Democratic People's Republic of Korea | Pyongyang | 39.039219 | 125.762527 | 5           |
| 14    | Georgia                      | Tbilisi   | 41.715137 | 44.827095 | 770         |
| 15    | India                        | New Delhi | 28.613939 | 77.209023 | 216         |
| 16    | Indonesia                    | Jakarta   | -6.175110 | 106.865036 | 8           |
| 17    | Iran (Islamic Republic of)   | Tehran    | 35.689198 | 51.388973 | 1,189       |
| 18    | Iraq                         | Baghdad   | 33.312805 | 44.361488 | 34          |
| 19    | Israel                       | Jerusalem | 31.768318 | 35.213711 | 754         |
| 20    | Japan                        | Tokyo     | 35.689487 | 139.691711 | 40        |
| 21    | Jordan                       | Amman     | 31.945368 | 35.928371 | 1,000       |
| 22    | Kazakhstan                   | Astana    | 51.169392 | 71.449074 | 347         |
| 23    | Kuwait                       | Kuwait City | 29.375858 | 47.977406 | 306         |
| 24    | Kyrgyzstan                   | Bishkek   | 42.874622 | 74.569763 | 800         |
| 25    | Lao People's Democratic Republic | Vientiane | 17.975706 | 102.63102 | 174         |
| 26    | Lebanon                      | Beirut    | 33.893791 | 35.501778 | 19          |
| 27    | Malaysia                     | Kuala Lumpur | 3.139003 | 101.686852 | 66          |
| 28    | Maldives                     | Male      | 4.175496  | 73.509346 | 2.4         |
| 29    | Mongolia                     | Ulaanbaatar | 47.886398 | 106.905746 | 1,350       |
| 30    | Myanmar                      | Nay Pyi Taw | 19.671480 | 96.069893 | 115         |
| 31    | Nepal                        | Kathmandu | 27.717245 | 85.323959 | 1,400       |
| 32    | Oman                         | Muscat    | 23.585890 | 58.405922 | 8           |
3. A Few Observations

Mainland Asia roughly ranges through about 77° of latitude and 195° of longitude. If translated into distance, it comes about 8,560 km long by 9,600 km wide. The data compiled by UNESCO Institute for Statistics for Youth (age 15-24) are available at UNICEF [7] site for the literacy Rate (updated 2015). The data shows that three countries have literacy rate below 80% (Afghanistan – 47%, Pakistan – 71% and Bhutan – 74%); whereas, 14 Asian countries have an impressive record of 100% (Armenia, Azerbaijan, China, China - Hong Kong SAR, China - Macao SAR, Cyprus, Democratic People's Republic of Korea, Georgia, Kazakhstan, Kyrgyzstan, Singapore, Tajikistan, Turkmenistan and Uzbekistan). The female literacy rate is at the lowest level in Afghanistan which is 32% followed by Pakistan (62%) and Bhutan (68%). For a few countries, the data are not available and are collected from other sources. For comparison purpose, since the data are not available in UN site, Wikipedia [8] is referred for collecting the 2005 population.

If 2018 GDP is taken as the benchmark, Table 3 shows other parameters considered for the top 10 countries. With a 1.18% area and 2.81% population contribution, Japan’s GDP contribution was a mind blowing 39.72% in the year 2005 and in 2018, it is 18.28%.

Let us define the GDP-Population Ratio 2018 as, \[ \text{Ratio} = \frac{\text{GDP share in percentage-2018}}{\text{Population share in percentage-2018}} \]

If we consider the countries with a minimum 2018 GDP share of 1%, Singapore is ranked first with a ratio of 8.58 (Table 4). China - Hong Kong SAR is at second place with a ratio of 7.23. This is followed by Japan (6.49), Israel (6.29) and UAE (6.11). China has a low ratio of 1.32.
Table 3. Top Ten Countries considering 2018 GDP as Benchmark.

| Country             | % GDP Share | % Area Share | % Population Share (2018) | % Literacy Rate (2015) |
|---------------------|-------------|--------------|--------------------------|------------------------|
| China               | 41.54       | 29.75        | 30.08                    | 100                    |
| Japan               | 18.28       | 27.95        | 1.18                     | 99                     |
| India               | 8.37        | 8.09         | 10.30                    | 86                     |
| Republic of Korea   | 5.22        | 5.37         | 0.31                     | 97.9                   |
| Indonesia           | 3.45        | 3.70         | 5.99                     | 99                     |
| Turkey              | 3.20        | 3.79         | 2.45                     | 98                     |
| Saudi Arabia        | 2.37        | 2.59         | 6.91                     | 99                     |
| Iran (Islamic Republic of) | 1.58 | 2.41 | 5.10                     | 98                     |
| Thailand            | 1.51        | 1.67         | 1.61                     | 97                     |
| United Arab Emirates | 1.29        | 1.42         | 0.26                     | 95                     |

If no restriction is imposed on the quantum of GDP (Table 5), China - Macao SAR is the best performer that has a ratio of 12.0 followed by Qatar (9.47). With a ratio of 0.28, India is at 39th overall position followed by Pakistan and Bangladesh. Nepal, Democratic People's Republic of Korea and Afghanistan occupy last three positions.

Table 4. GDP – Population 2018 Ratio with min. 1% GDP Share.

| Country                  | GDP – Population 2018 Ratio | Approx. 2018 GDP % share |
|--------------------------|----------------------------|--------------------------|
| Singapore                | 8.58                      | 1.10                     |
| China, Hong Kong SAR     | 7.23                      | 1.19                     |
| Japan                    | 6.50                      | 18.28                    |
| Israel                   | 6.29                      | 1.18                     |
| United Arab Emirates     | 6.12                      | 1.29                     |
| Republic of Korea        | 4.62                      | 5.22                     |
| Saudi Arabia             | 3.19                      | 2.37                     |
| Turkey                   | 1.77                      | 3.20                     |
| Malaysia                 | 1.55                      | 1.10                     |
| China                    | 1.33                      | 41.54                    |

Table 5. Countries with high GDP – Population 2018 Ratio.

| Country                  | GDP – Population 2018 Ratio | Approx. 2018 GDP % share |
|--------------------------|----------------------------|--------------------------|
| China, Macao SAR         | 12.00                      | 0.17                     |
| Qatar                    | 9.47                       | 0.56                     |
4. Weiszfeld’s Algorithm

In geometry, Fermat point in a triangle refers a point such that the sum of distances from the vertices is the minimum. If the largest angle is $\geq 120^o$, the Fermat point lies at the obtuse angled vertex; else, the point lies inside the triangle. In the latter case, the solution point is constructed such that the straight lines connecting the point and vertices are at $120^o$ to each other. In location theory, the popular Weber problem [9] requires finding a point in a plane that minimises the sum of weighted distances. This solution point is termed as the “Geometric Median” from which the sum of (weighted) Euclidean distances to all the points is the minimum. Simply ‘Median’ represents the ‘Middle Value’ whereas; ‘Geometric Median’ is the ‘Average Factor’. Geometric median is the positive root of product of many positive integers.

Mathematically, Geometric Median = $(x_1, x_2, x_3, \ldots, x_n)^{1/n}$

In the scope of operations and supply chain management, a geometric median of a discrete set of points in a Euclidean space is the point that minimizes the sum of distances to the sample points. Fig. 1 explains the concept of ‘Geometric Median’ for a set of 8 given points. The red dot (GM) is the ‘Geometric Median’ of all the 8 black points. The sum of the distances of all the black points from the red point is the minimum. Finding such a point is often referred as a ‘Minisum’ problem. The ‘Mass Centre’ is the algebraic mean of all the points which may not coincide with the ‘Geometric Median’ in many cases.
Torricelli provided a geometrical solution in 1645. In 1972 only, a direct numerical solution was devised by Tellier [10] for a triangular case. Baskar [11] analysed and generalised the trigonometric solutions, with and without repulsion. Cem Iyigun and Adi Ben-Israel [12] proposed a method for multi-facility location problems which is a natural generalization of Weiszfeld's method [13] to several facilities. Weiszfeld’s algorithm has been effectively used by researchers in facility location problems for finding the ‘Geometric Median’. Weiszfeld’s algorithm is an iterative algorithm that finds the ‘Geometric Median’ of a set of ‘p’ given points in ‘n’ dimensional space. This algorithm computes a new point from the present point using the relationship:

\[
y_{i+1} = \frac{\sum_{j=1}^{p} \frac{x_j}{\|x_j - y_i\|}}{\sum_{j=1}^{p} \frac{1}{\|x_j - y_i\|}} ; y \in \mathbb{R}^n
\]  

(4.1)

The initial point may be taken as the origin. In general, the algorithm converges for any initial point. The mass centre is taken as the initial point in most of the cases and the geometric median is obtained after a finite number of iterations.

5. Computational Results

The codes written in MATLAB 2012b are run in a PC with 4 GB RAM. To validate the codes, the geodetic coordinates of some capitals with varying ranges of latitudes and longitudes were considered. Ankara (39.93365, 32.859741), Ulaanbaatar (47.886398, 106.905746), Singapore (1.352083, 103.819839), Seoul (37.566536, 126.977966) and Dili (-8.556856, 125.56031) were used in this process, along with their altitudes. The latitudes, longitudes and altitudes were converted to ECEF coordinates and back to geodetic using the functions. They were observed to be perfectly matching with the actual coordinates. In addition, two problems used by Cooper and Katz [14] were analysed to check the accuracy of Weiszfeld’s algorithm. The results obtained endorse the accuracy and match with Cooper and Katz both in terms of magnitudes and number of iterations. Subsequently, the Asian data are processed and the obtained Centres are listed in Table 6. However, it becomes very difficult to compare the results as not much literature is available about the Performance Centres of Asia.
It is widely accepted that the Economic Centre of the entire globe has come back to Asia and is now at the China region. Géza Tóth and Zoltán Nagy [15] claims that the economic centre of gravity of Asia, Australia, and Oceania (they considered them together) has been in the territory of the People's Republic of China, from 1970 to the present day. In the 21st century, they add, the centre increasingly shifted to the west, with one axis pointing to the oil-rich Middle Eastern countries and the other axis to India. In this context, it is noted that Asia’s 2010/2018 Economic Centre (39.9041776, 116.4073548) is virtually collinear with Beijing (39.904202, 116.407394) that represents China. In the year 2005, the Economic Centre was at the Yellow Sea, near South Korea. The Geometric and Literacy Centres are located in Pakistan whereas; the Mass Centre is in India. Table 7 gives the distance between any two centres computed using Haversine formula. If all the countries have the same literacy rate then, the access centre and literacy centre will become the same. But, they are separated by 79.06 km. Similarly, if the population is proportional to the area of any country and; if the GDP indicators are proportional to the population share of the respective countries then, the Area Centre, Population Centre and Economic Centre should coincide.

However, if the Access Centre is taken as the reference, the Area Centre is observed to be 1656.26 km away from the Access Centre and the Population Centre is 1471.31 km away from it. The 2005 Economic Centre and 2010/2018 Economic Centres are 4855.93 km and 4025.73 km away from the Access Centre, respectively.

**Table 6. Location of Performance Centres.**

| S.No | Performance Centre                  | Latitude       | Longitude       | Location                                      |
|------|-------------------------------------|----------------|----------------|-----------------------------------------------|
| 1.   | Mass Centre                         | 30.4540460     | 77.5689514     | Puruwala Santokhgarh, Himachal Pradesh, India |
| 2.   | Geometric Centre (Distance)         | 32.4281358     | 72.0128661     | Quaidabad Tehsil, Punjab, Pakistan            |
| 2.   | Access Centre [Ref.]                | 32.2974735     | 92.5772441     | Nyainrong, Nagqu, Tibet, China                |
| 3.   | 2005 Population Centre              | 31.1554599     | 87.5325588     | Nyima Nagqu, Tibet, China                     |
| 5.   | Area Centre                         | 37.536898      | 89.1379272     | Ruoqiang, Bayingol, Xinjiang, China           |
| 6.   | Literacy Centre                     | 32.6710536     | 71.2195498     | Isakhel, Mianwali, Pakistan                   |
| 7.   | 2005 Economic Centre                | 37.6737697     | 125.7421912    | Yellow Sea (MPFR+GV Yeonpyeong-myeon, Ongjin-gun, Incheon, South Korea) |
| 8.   | 2010 Economic Centre                | 39.9041776     | 116.4073548    | Beijing People's Government, Dongcheng Qu, Beijing Shi, China, 100006 |
| 9.   | 2018 Economic Centre                | 39.9041776     | 116.4073548    | Beijing People's Government, Dongcheng Qu, Beijing Shi, China, 100006 |
Table 7. Distances between Centres.

| Centre                          | Latitude  | Longitude  | Centre                          | Latitude  | Longitude  | Distance, km |
|---------------------------------|-----------|------------|---------------------------------|-----------|------------|--------------|
| Access Centre [Ref.]            | 32.4281358| 72.0128661 | Mass Centre                     | 30.4540460| 77.5689514 | 570.49       |
| Access Centre [Ref.]            | 32.4281358| 72.0128661 | 2018 Population Centre          | 31.1554599| 87.5325588 | 1471.31      |
| Access Centre [Ref.]            | 32.4281358| 72.0128661 | Area Centre                     | 37.536898 | 89.1379272 | 1656.26      |
| Access Centre [Ref.]            | 32.4281358| 72.0128661 | Literacy Centre                 | 32.6710536| 71.2195498 | 79.06        |
| Access Centre [Ref.]            | 32.4281358| 72.0128661 | 2005 Economic Centre            | 37.6737697| 125.7421912| 4855.93      |
| 2005 Economic Centre            | 37.6737697| 125.7421912| 2010 Economic Centre            | 39.9041776| 116.4073548| 845.18       |
| Access Centre [Ref.]            | 32.4281358| 72.0128661 | 2018 Economic Centre            | 39.9041776| 116.4073548| 4025.73      |
| 2005 Population Centre          | 32.2974735| 92.5772441 | 2018 Population Centre          | 31.1554599| 87.5325588 | 493.34       |

In 2005, the Economic Centre (Red upward arrow) was located near Korea and Japan due to the dominant performances of Japan (39.72%) and Republic of Korea (7.50%) in the initial years of this century. China’s share was a mere 19.28%.

However, after the emergence of China, the Centre shifted towards Beijing, China (Green upward arrow) due to its mammoth economic growth after 2005 till 2018. China’s share was 29.75% against Japan’s 27.95% in 2010 and a massive 41.54% in the year 2018 against 18.28% of Japan. India’s share was 6.78% in 2005, 8.09% in 2010 and 8.37% in the year 2018.
Figure 2. Performance Centres of Asia.

Figure 3. Movement of Population and Economic Centres.

Figure 3 shows the movement of Population Centre and Economic Centre from the year 2005 to 2018. It clearly indicates, the Population Centre is moving away from China and Economic Centre is moving towards China.

6. Conclusion
It is evident that in this twenty first century, Asia is becoming main economic region of the world. Started from Asia in AD1, the Economic Centre travelled towards US till 1950 and then, reversed its direction towards Asia again. Estimating the centre of any particular activity will help in decision making. For example: if simply an administrative setup is to be created in any region then geometric centre shall be taken as the reference. If new manufacturing facilities or financial facilities are to be
established then, the economic centre can help in identifying the new location. Similarly, literacy centre can help in identifying the literacy scenario in any area and can suggest new areas that shall be considered for planning improved/new educational institutions. This paper analysed the basic geometric, population, literacy and economic data of the 50 Asian countries listed by UN by taking their respective capital cities as the representatives of the countries and located the performance centres. The 2010/2018 Economic Centre is clearly at Beijing, the capital of China. The Population Centre has moved 493.34 km in southwest direction when considered from 2005 to 2018. The Economic Centre moved 845.18 km, in the same period, in northwest direction.

Improving the GDP will directly have impacts on all other activities. Reduced interest rates coupled with increased purchase power will improve the industrial growth and employment. In countries that have a large population base like India and China, improved employment opportunities spread across the country will improve the GDP growth. As the country's GDP is increasing, it is more productive which in turn leads to more people being employed. This increases the wealth of the country. Higher economic growth also leads to extra tax income for government spending, which the government can use to develop the economy.

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