

Yukari Shirota (Gakushuin University)

Takako Hashimoto (Chiba University of Commerce)

Kenji Yamaguchi (Ochanomizu University)

Riri Fitri Sari (Universitas Indonesia)

## 1. Introduction

Indonesia is an emerging country and is a very important spot from business point of view. We would like to analyze the women empowerment status in Indonesia. Indonesia consists of 34 provinces with a lot of cultural diversity (See Figure 1). The map in Figure 1 was drawn by Wolfram Mathematica. The areas are from the west to counterclockwise, Sumatra, Jawa, Bali, Nusa Tenggara, Bali (Bali), Papua, Maluku (Moluccas), Sulawesi, and Kalimantan. Regional analysis of Indonesia is conducted widely. Especially the report[1] has analyzed the provinces deeply. However, the book was conducted the survey from a viewpoint of Japanese companies planning to expand into Indonesia and the purpose of the survey is different from ours. In the paper, we shall investigate the regional comparison concerning Gender Empowerment by provinces.

We mainly analyze Gender Empowerment Index (hereafter GEI). GEI is an index that indicates whether women can participate in political participation, business activities, and decision-making. It is one of the Human Development Index (HDI) and was introduced by the United Nations Development Program (UNDP). It is calculated using the percentage of women in diet members, professional and technical positions, managerial positions, etc., and the estimated income of men and women [2-5]. UN Women which is the United Nations entity dedicated to gender equality and the empowerment of women describes the status in Indonesia as follows: *The Government of Indonesia has made various efforts to push forward women's human rights. Despite progress, gender inequalities remain a critical issue in Indonesia. The challenges to gender equality remain in discriminatory attitudes which prevent women from exercising their rights, limited access to justice, women's participation as negotiators in conflict situation is brushed aside, and despite the General Election Law, women's participation in parliament is far below the quota. In addition, women and girls continue to faced violence, harassment, and harmful traditional practices.* (cited from "<https://asiapacific.unwomen.org/en/countries/indonesia/about>" accessed on 20<sup>th</sup> August, 2020)

In the paper, we shall analyze the GEI in Indonesia by provinces. The data we used is from Statistics Indonesia (<https://www.bps.go.id/>). The original website name is "Badan Pusat Statistik Indonesia"(BPS), a non-department government agency directly report to the president. The BPS is instituted by Law Number 16, 1997 on Statistics; Government Regulation Number 51, 1999 on Statistics Undertakings[6]. Therefore, this website's data is very reliable and suitable for researches.

In Section 2, we shall analyze the relationship between GEI and three variables that are women's revenue percentage, women's professional percentage, and women's parliament percentage. In Section 3, we shall analyze the growth of GEI together with Gender Development Index (GDI). There the time series changes of the four years will be analyzed, so that we could find which provinces relatively made progresses concerning the GEI and GDI.

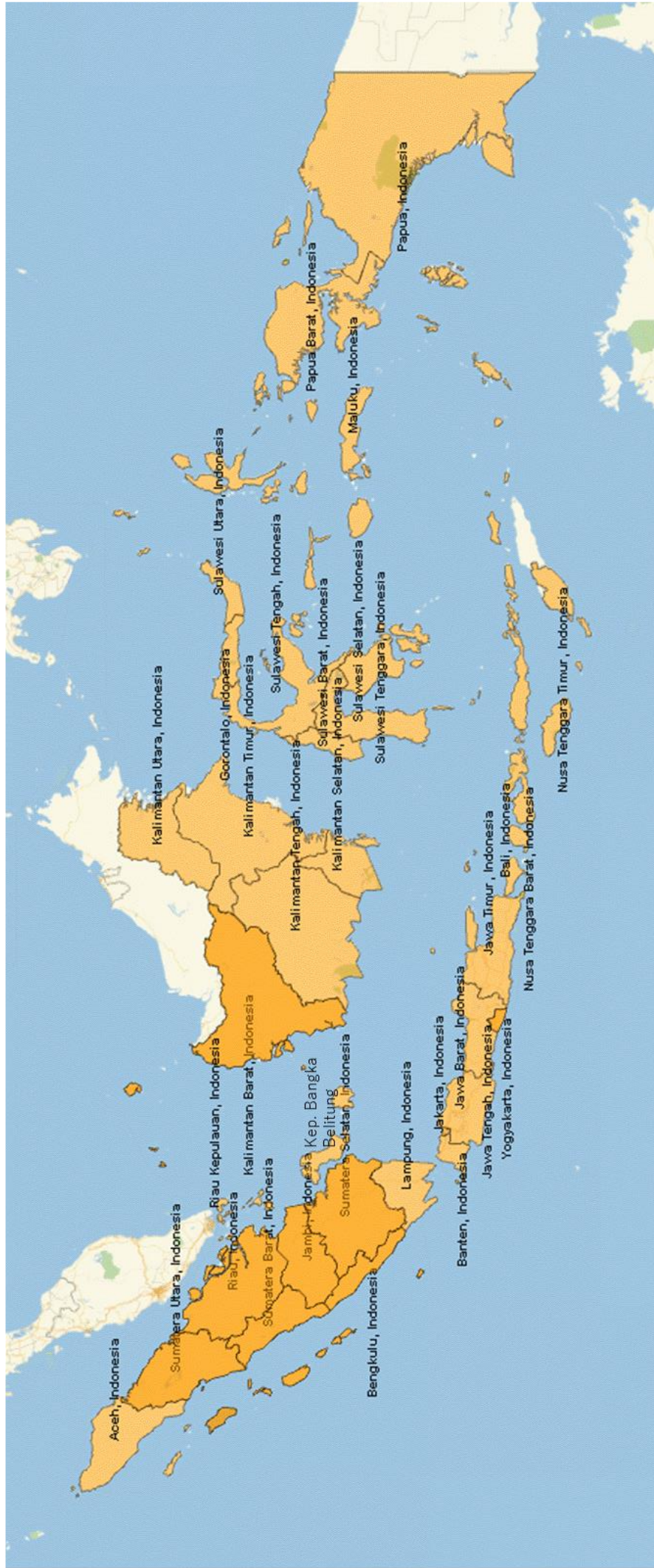


Figure 1. Provinces of Indonesia.

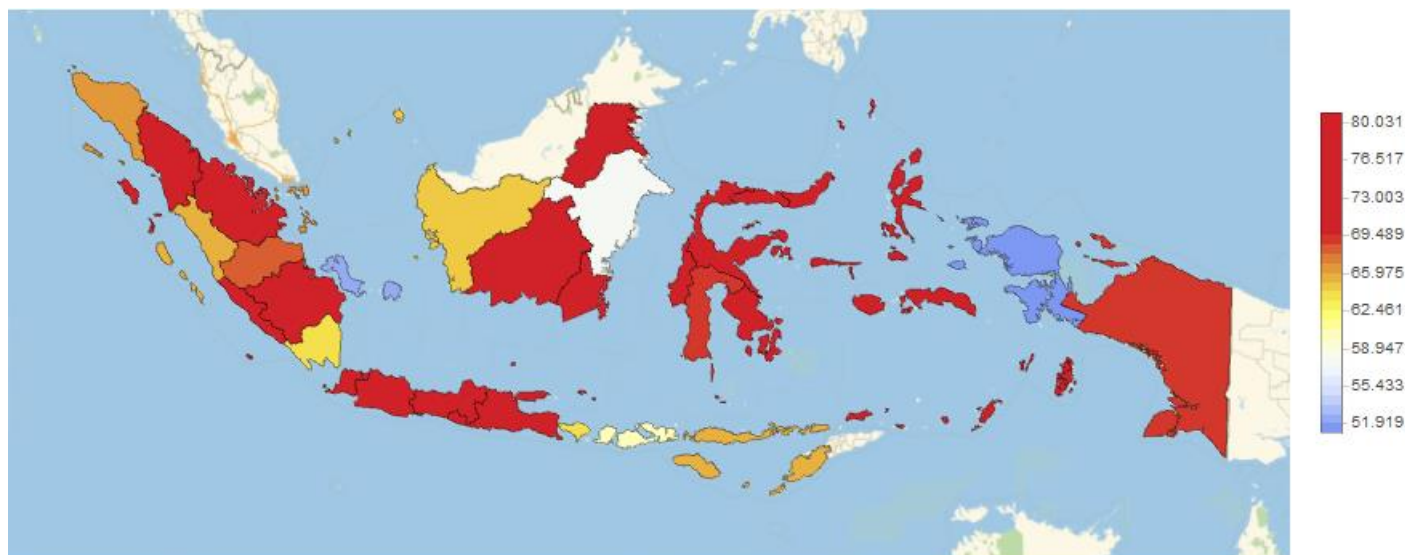


Figure 2. Gender Empowerment Index of Indonesia by provinces.

## 2. Gender Empowerment Index in 2018.

In the section, we shall first present the GEI distribution and then analyze the relationship between GEI and its three variables. The data is all one in 2018.

The 2018 GEI distribution is presented in Figure 2. The lowest GEI provinces of which GEI is less than 65 are PAPUA BARAT, KEP. BANGKA BELITUNG, KALIMANTAN TIMUR, NUSA TENGGARA BARAT, LAMPUNG, BALI, and KALIMANTAN BARAT. BANGKA BELITUNG is consists of two islands BANGKA and BELITUNG and was in 2000 separated from SUMATRA SELATAN.

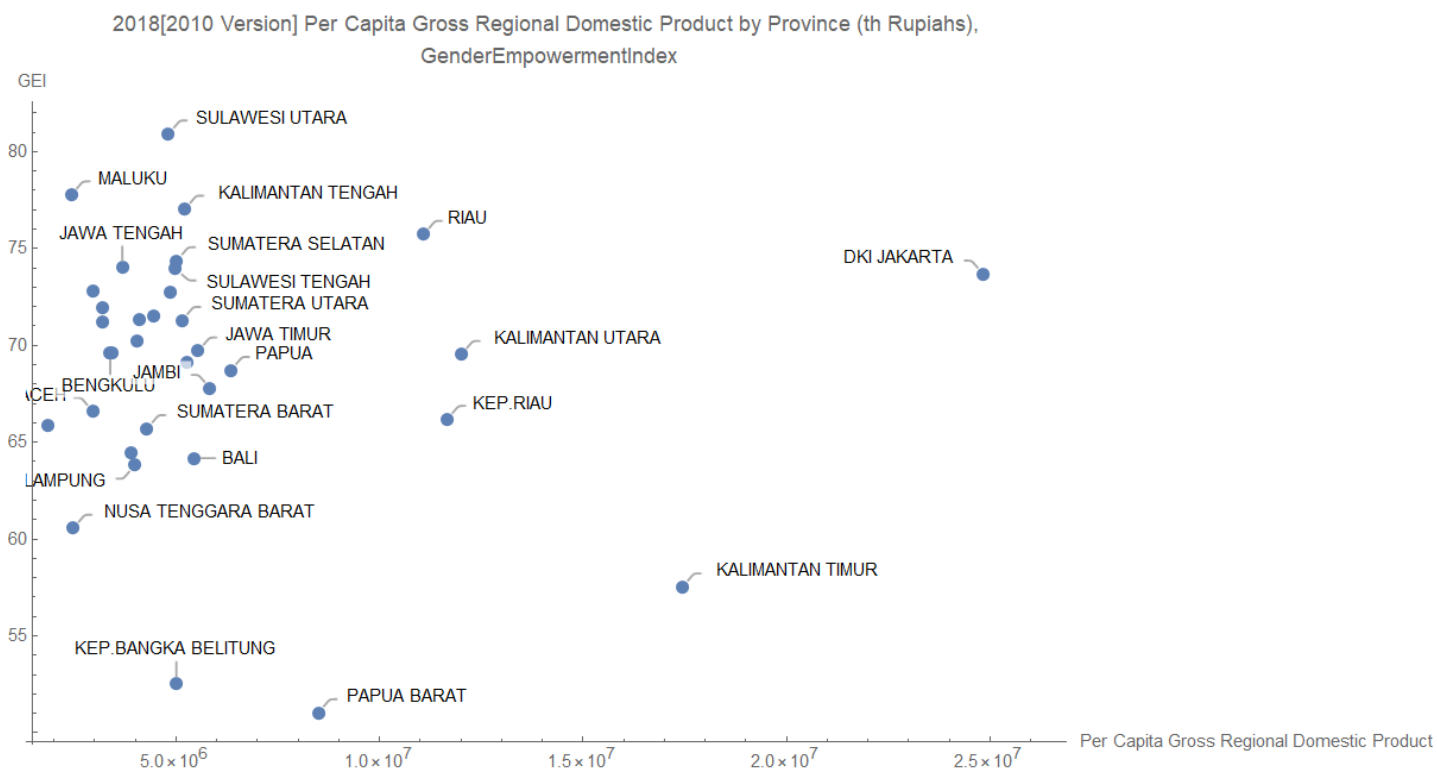


Figure 3. The relationship between per capita Gross Regional Domestic Product and GEI.

First we thought about the relationship with GEI and the GDP. Then, the relationship between per capita Gross Regional Domestic Product (GRDP) and GEI is shown in Figure 3. As shown in Figure 3, the per capita GRDP of DKI JAKARTA is the largest value far from others. DKI JAKARTA is the capital city of Indonesia and the center of the economic center. The second largest per capita GRDP provinces are KALIMANTAN TIMUR and KALIMANTAN UTARA. Kalimantan's feature is that mineral resources such as gold and iron, and natural resources such as oil and gas are abundant, and mining is developing[1]. The fourth is KEP. RIAU. Island Batam is an island in KEP. RIAU and is located on the south side of Singapore. Owing to the geographical advantage, Batam has been developed as an export processing hub to Singapore. On June 29, 2007, the Indonesian government designated Batam Island as Free Trade Zoon. This encouraged global companies' investment.

### 2.1 Revenue Contribution of Women (Percent)

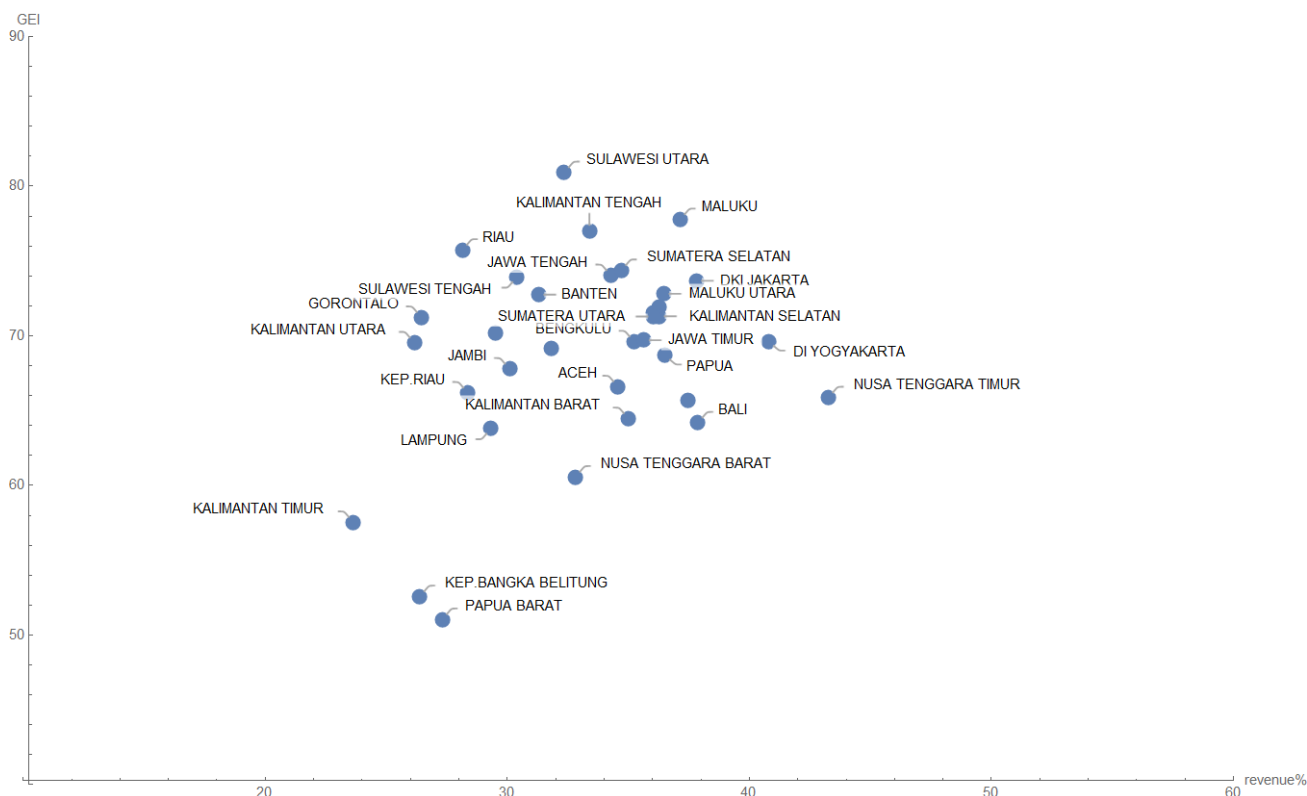


Figure 4. Relationship between the revenue(%) and GEI. The correlation coefficient is 0.33.

In the section, we shall focus on the variable titled “revenue contribution of women (%)”. The variable is one of GEI variables. The value becomes 100%, added together with the men’s revenue (%). We found that women’s revenue(%) is lower than 50% in every province. Figure 4 illustrates the relationship between the revenue(%) and the GEI. Although the revenue(%) is one of variables for GEI, the correlation coefficient with GEI was 0.33 which shows low correlation.

The highest of the revenue(%) are (1)NUSA TENGGARA TIMUR, (2)DI YOGYAKARTA, (3)BALI, (4)DKI JAKARTA, and (5)SUMATERA BARAT. A common feature of the top four provinces is that the ratio of the third industries is high in the GDP ratio. For example, the third industry includes retail sales, hotels, and restaurants. Although it is not proved, the high ratio of the third industry may increase the women revenue(%).

### 2.2 Women as Professionals (Percent)

The second variable is Women as Professionals (Percent). The variable is also one forming the GEI. The relationship is shown in Figure 5.

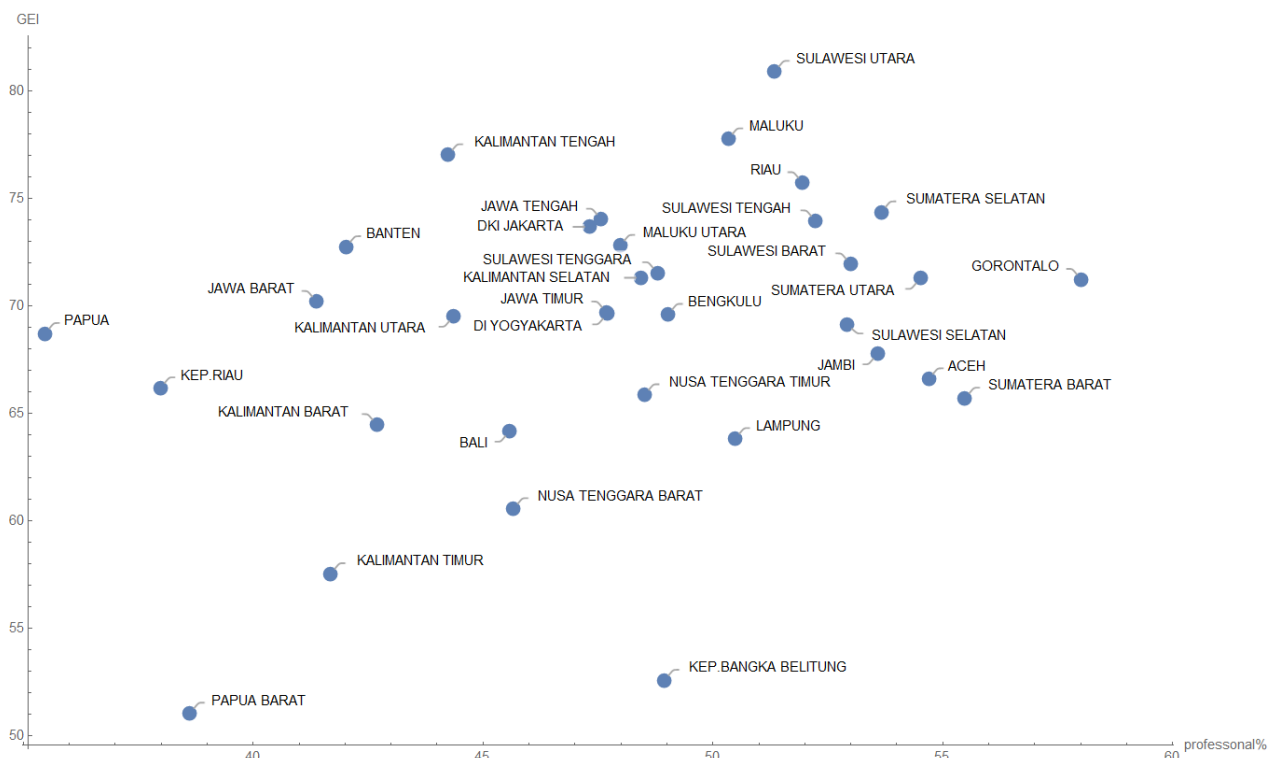


Figure 5. Relationship between the professional(%) and GEI.

The correlation coefficient is 0.33 which is the same value as the Figure 4. The highest of the professional (%) among the women are (1) GORONTALO, (2) SUMATERA BARAT, (3) ACEH, (4) SUMATERA UTARA, (5) SUMATERA SELATAN, and (6) JAMBI. Only GORONTALO is located in SULAWESI. Among top six, almost all the provinces are located in SUMATERA. We can call that as the highest professional (%) cluster in SUMATERA.

The lowest provinces are (1) PAPIA, (2) KEP. RIAU, (3) PAPIA BARAT, and (4) JAWA BARAT.

### 2.3 Involvement of Women in Parliament (Percent)

The third variable is the Involvement of Women in Parliament (Percent). The parliament(%) is also one of variables forming the GEI. The relationship between the parliament and GEI shows the linearity with the high correlation coefficient 0.88 (See Figure 6). We think that the parliament(%) is the most reliable index among the three variables, because that is a formal one and they can count that correctly.

The highest valued provinces are (1) SULAWESI UTARA, (2) GORONTALO, (3) RIAU, (4) MALUKU, (5) KALIMANTAN TENGAH, and (6) SULAWESI TENGAH. The lowest ones are (1) KEP. BANGKA BELITUNG, (2) PAPIA BARAT, (3) BALI, (4) NUSA TENGGARA BARAT, (5) KALIMANTAN BARAT, (5) NUSA TENGGARA TIMUR, and (5) SUMATERA BARAT (The last three has the same value). The interesting thing we found that there are clusters of the highest province group and the lowest province groups. The highest cluster is located around SULAWESI TENGAH (See Figure 7). The cluster size is four provinces. The lowest cluster is located around NUSA TENGGARA (See Figure 8). The cluster size is three provinces. Considering the linearity with the GEI values, we can say that the clusters have the same tendency about the GEI. It is interesting that we can find the geometrical clusters like this concerning the gender empowerment.

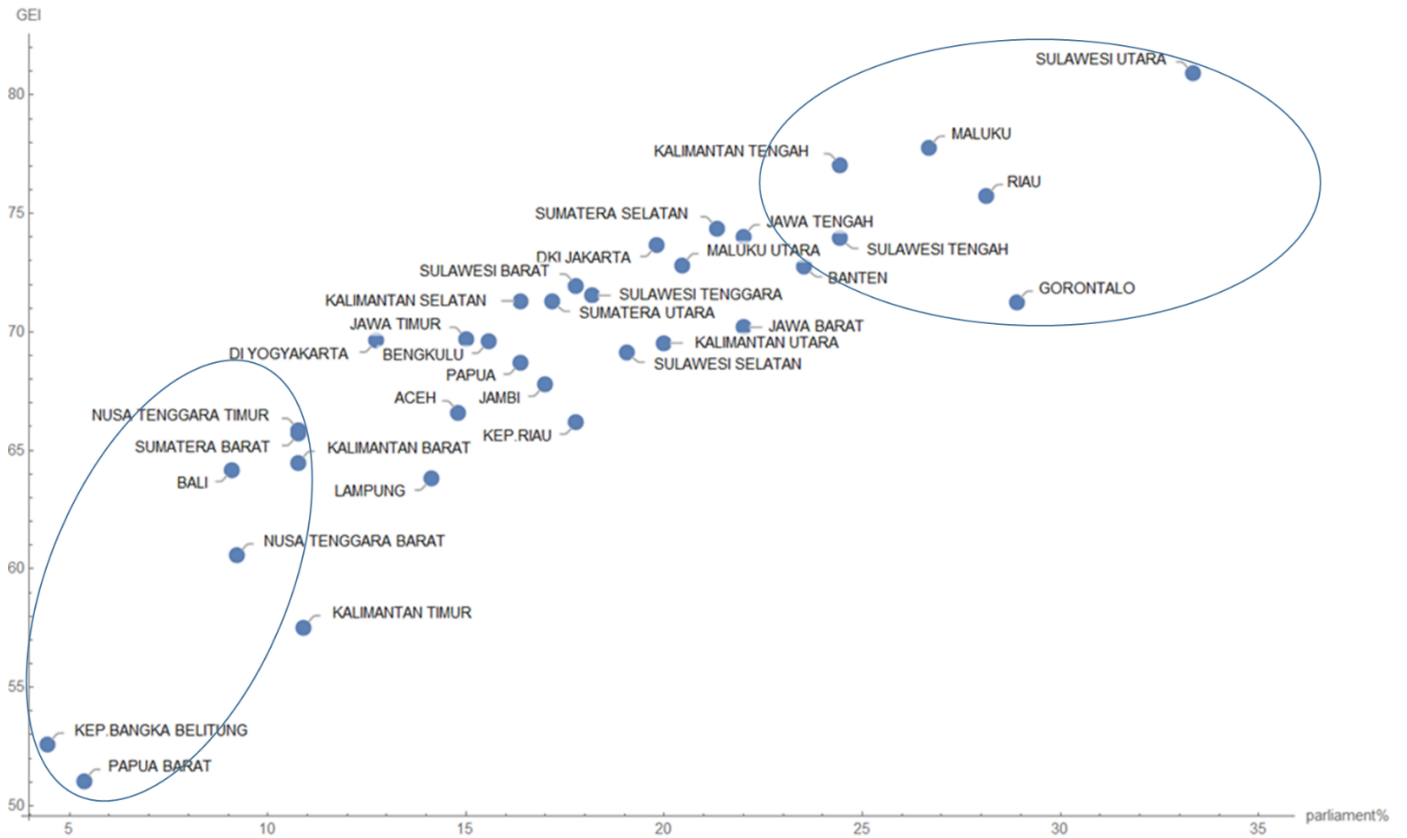


Figure 6: Relationship between the parliament(%) and GEI.

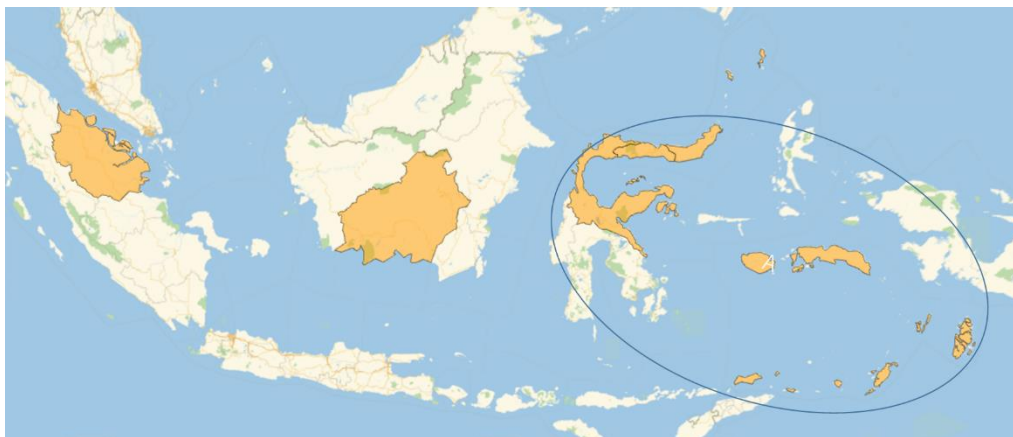


Figure 7. Top 6 of Parliament (%) provinces.



Figure 8. The lowest top 7 of parliament (%) provinces.

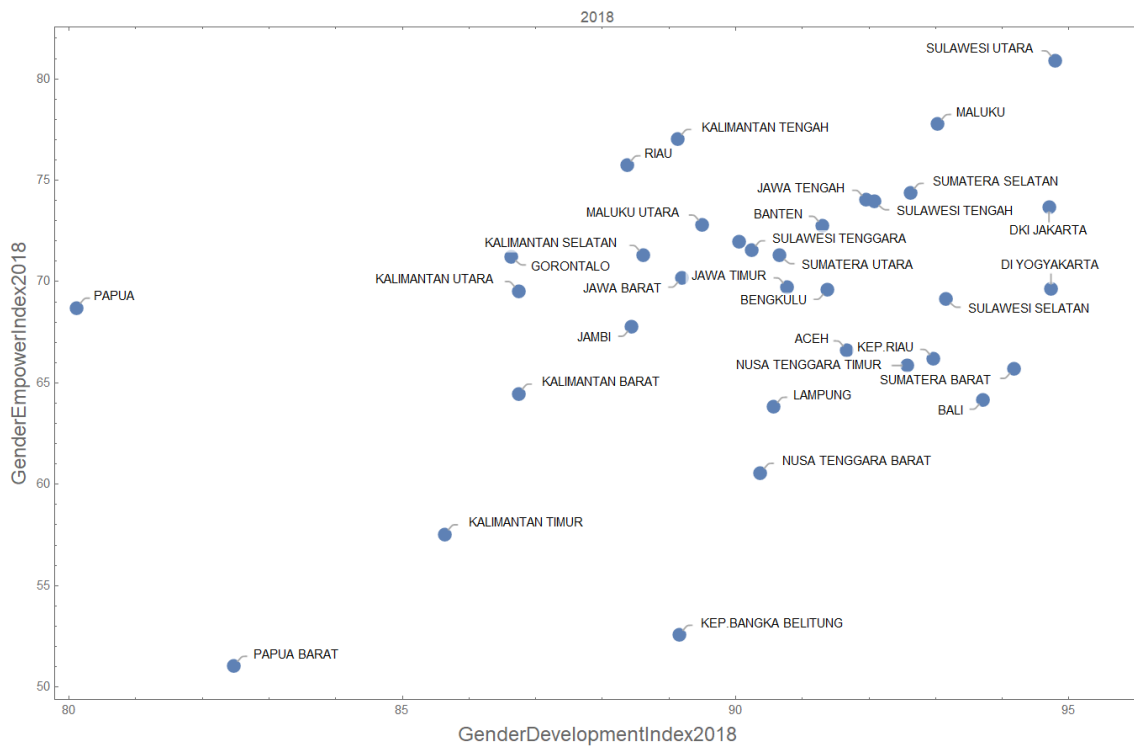


Figure 9. The relationship between GDI and GEI in 2018.

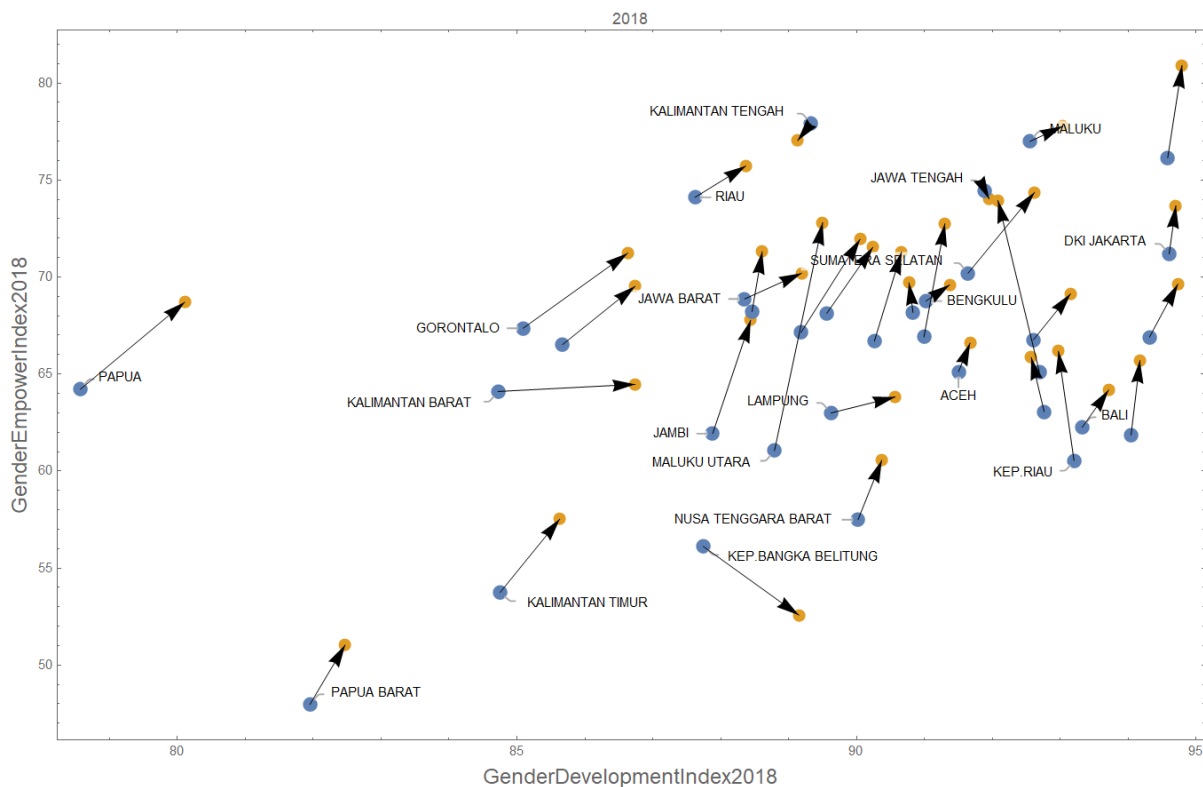


Figure 10. The time series change from 2014 to 2018 between GDI and GEI.

#### 4. Time Series Data Change of Gender Empowerment Index

In the section, we shall analyze the time series change of GEI. The comparison of one in 2014 and 2018. Compared with the data in 2014, we shall find which province showed a remarkable progress. The analysis method we use is the shape analysis method [7-11]. When we try to measure the time change as shown in Figure 10, in the traditional ways, we did not have the objective measurement. The shape analysis method can offer us the objective measurement; the relative movement in the whole can be made a numerical expression without subjectivity.

The shape analysis can divide the time series changes to the following two parts:

- (1) Affine transformation (Linear transformation) which describes the whole trend, and
- (2) Non-Affine transformation (Non-linear transformation) which describes the individual data's specific movement. We have analyzed the Indonesia statistics data and other economic data using the shape analysis [12-18]. We have also conducted real deformation data analysis apart from the economics data[19].

In the shape analysis, first, the location of each data (in our case, a province) is standardized in advance. We call a set of the standardized location "a pre-shape". In our case, the pre-shape in 2014 and the pre-shape in 2018 are made; the pre-shape is consist of 34 points (provinces). When we compare the shape deformation in Figure 10 with one in Figure 11, we can perceive the slight differences. The standardized shape can correctly describe the relative deformation among the whole data, compared to the raw data description in Figure 10. We would like to find which province had the large changes compared to the others in Figure 11. The remarkable growth is shown in MULUKU UTARA, SULAWESI TENGAH, and GORONTALO. The large decline is shown in KEP BENGKA BELITUNG, KALIMANTAN BARAT, KALIMANTAN TENGAH, JAWA TENGAH.

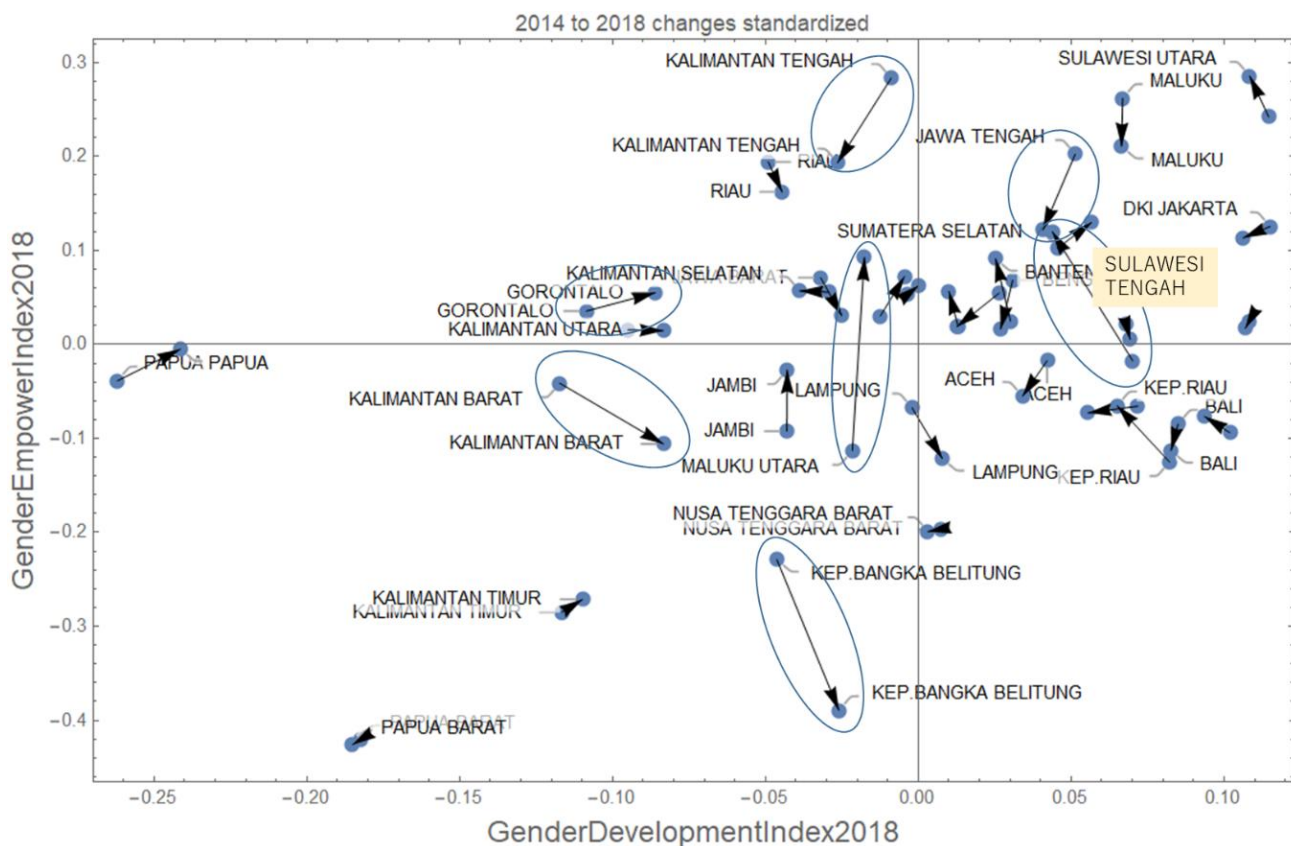


Figure 11. Standardized changes by the shape analysis of the relationship in Figure 10.

Then we shall divide the deformation in Figure 11 to the two parts they are the whole trend and the local movement. The results are shown in Figure 12 and 13 in which the orthogonal transformation grids are drawn.



There the location coordinates by the grids is not changed. The data (province) location expressed by the grids is not changed after the transformation; the skewed one is the grids, not the location. The result of the shape analysis illustrates how the space was distorted by the deformation. First, let's see the whole trend change shown in Figure 11. The grid size was reduced by the deformation in the y-axis, GEI. There is hardly change concerning the GHI direction.

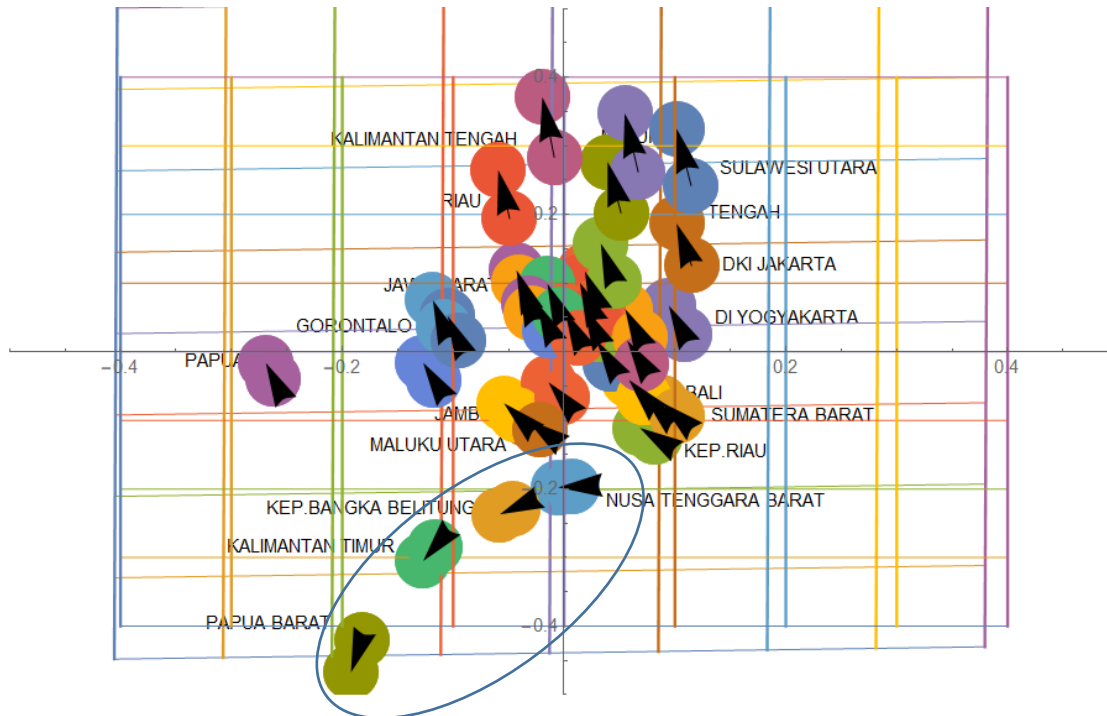


Figure 12. The whole trend by the time change from 2014 to 2018 between GDI and GEI.

Overall movement has shown no significant change in the four years. From the change of the grids, it can be seen that the change of GEI is larger, compared to GDI changes. It can also be seen that the changes in GEI is divided by  $GEI = -0.1$ , and the group  $2014GEI > -0.1$  province grew higher. On the other hand, the group  $2014GEI < -0.1$  province decreased. The movement is relative one compared with the other provinces. Some provinces are increased and other decreased.

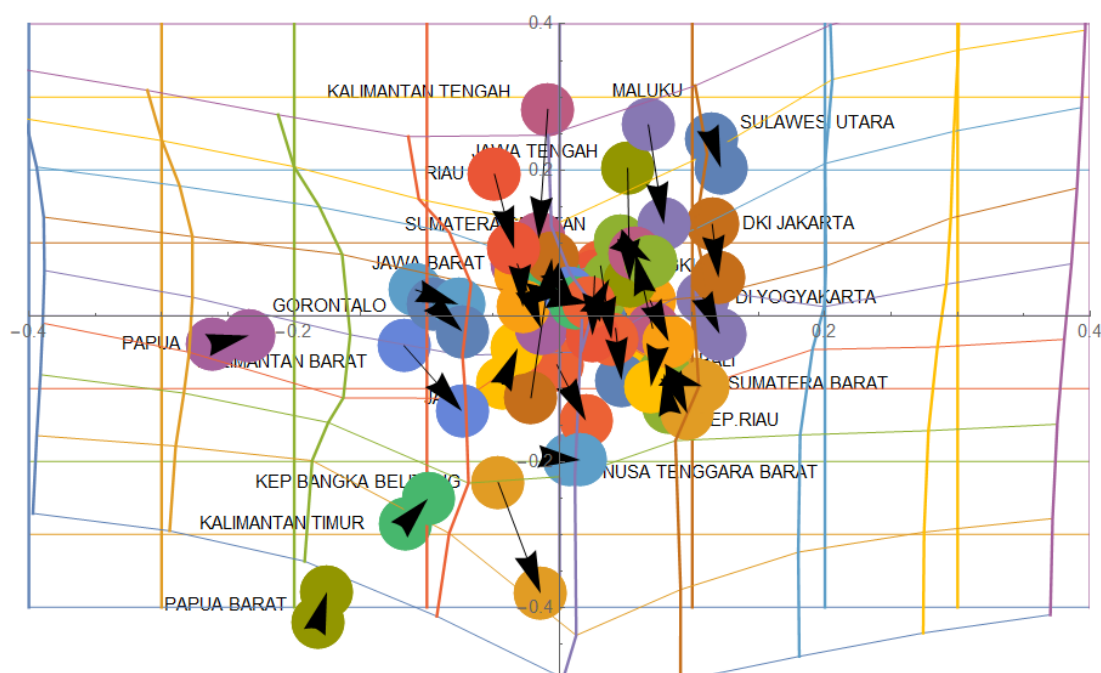


Figure 13. The individual province's local movement by the time change from 2014 to 2018 between GDI and GEI.

Then let's see the local change of the individual province, compared to the others. The result is shown in Figure 13. We cannot see the simple trend of the local changes there. Therefore, we extract the difference of each province as a vector (See Figure 14). As the above shown, the largest growth of GEI is seen in MALUKU UTARA. The second one is SULAWESI TENGAH. The x-axis scale is so small, compared to that of y-axis. Then, we can say that the significant change has happened only in GEI.

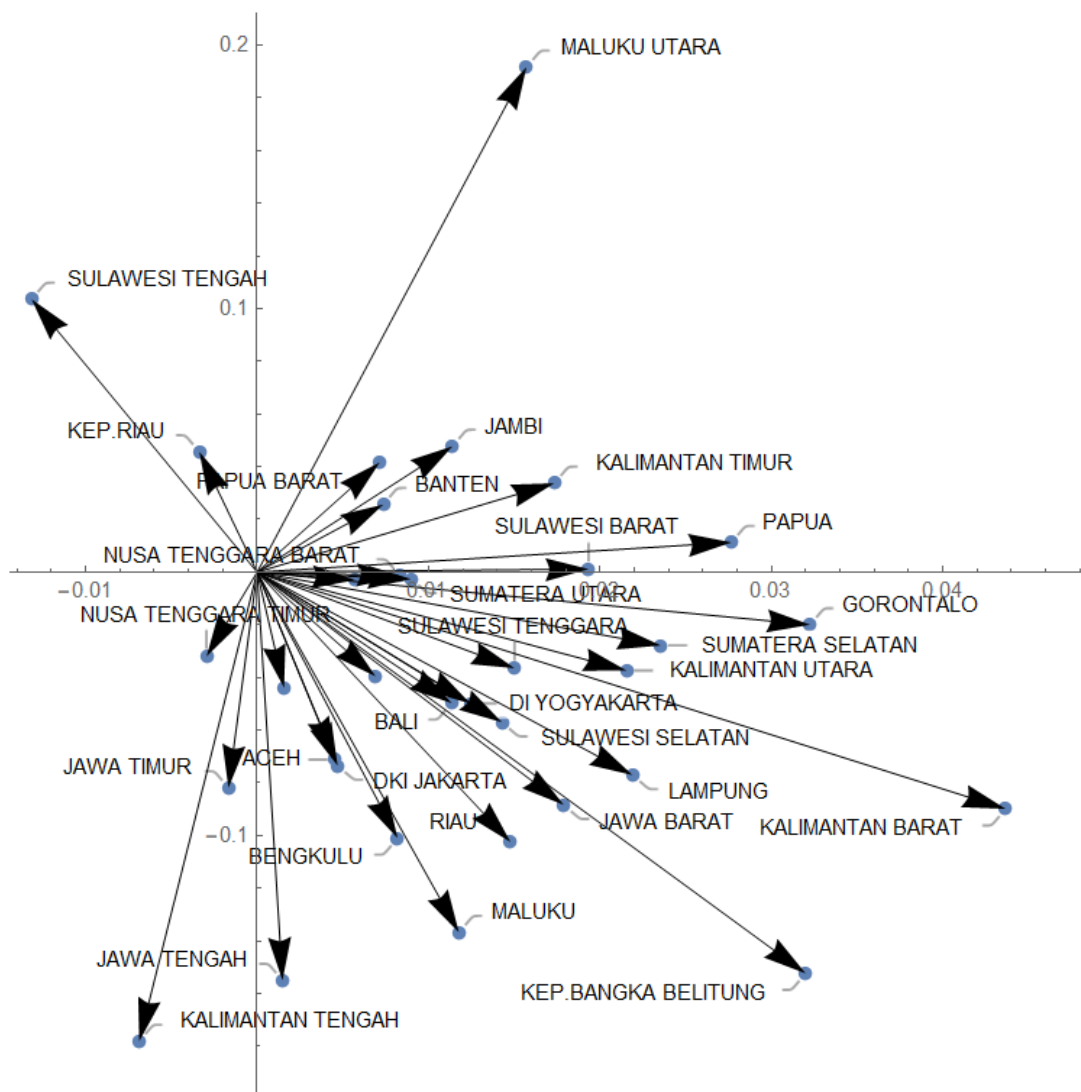


Figure 14. Just difference of the local movement in Figure 13.

The GEI locally decreased provinces are KALIMANTAN TENGAH, JAWA TENGAH, and KEP. BANGKA BELITUNG, and MALUKU. The relative decline on GEI of JAWA TENGAH is unexpected; The old city in JAWA TENGAH, Solo received the highest score in 2017 as a result of a resident satisfaction survey conducted by the Indonesian City Planning Association conducted in major cities [1] and Solo is also close to DI YOGYAKARTA. There is in JAWA TENGAH also the Borobudur Temple, which is registered as a World Cultural Heritage Site, and many tourists visit the shrine. Although it is our guess, since JAWA TENGAH is located between the capital city Jakarta and Surabaya, the second city, the economics in JAWA TENGAH may not have grown, compared to the economic growth of DKI JAKARTA and Surabaya. This economic performance may have also influenced the change in GEI. This will be a problem in the future study.

#### 4. Conclusions

We surveyed the Gender Empowerment in Indonesia by provinces. We found some interesting geometrical clusters. The first cluster is concerned on the women professional percentage. The highest of the professional (%) among the women are (1) GORONTALO, (2) SUMATERA BARAT, (3) ACEH, (4) SUMATERA UTARA, (5) SUMATERA SELATAN, and (6) JAMBI. Among the top six provinces, almost all the provinces are located in SUMATERA. We can call that as the highest professional (%) cluster in SUMATERA.

The second interesting geometrical clusters are concerned on Involvement of Women in Parliament (%). The highest valued provinces are (1) SULAWESI UTARA, (2) GORONTALO, (3) RIAU, (4) MALUKU, (5) KALIMANTAN TENGAH, and (6) SULAWESI TENGAH. The lowest ones are (1) KEP. BANGKA BELITUNG, (2) PAPUA BARAT, (3) BALI, (4) NUSA TENGGARA BARAT, (5) KALIMANTAN BARAT, (6) NUSA TENGGARA TIMUR, and (7) SUMATERA BARAT (The last three has the same value). There we found that there are geographical clusters of the highest province group and the lowest province groups. The highest cluster is located around SULAWESI TENGAH. The cluster size is four provinces. The lowest cluster is located around NUSA TENGGARA. The cluster size is three provinces. Because the correlation coefficient between the Gender Empowerment Index and the parliament (%) is high (0.88), we can say that the clusters have the same tendency about the GEI. It is interesting that we can find the geometrical clusters like this concerning the gender empowerment.

We have also investigated the time change of Gender Empowerment Index with Gender Development Index. The period is from 2014 to 2018. The method we used is the shape analysis. Using the shape analysis, we extracted from the deformation, the whole trend and the local movement of the individual province. Concerning the whole trend, we found that the lower GEI group decreased the GEI more in 2018. The difference between two groups is likely to grow more and more. Concerning the local movement, the GEI locally decreased provinces are KALIMANTAN TENGAH, JAWA TENGAH, and KEP. BANGKA BELITUNG, and MALUKU. The largest growth of GEI is seen in MALUKU UTARA. The second one is SULAWESI TENGAH.

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