CHAPTER 5

IMPLEMENTATION AND TESTING

5.1 Implementation

This project is implemented using mysql,php(laravel), and javascript (vue js). This chapter will discuss about how the program works. On this program, the centroid is automatically determined by the system.

a) Selecting the Data

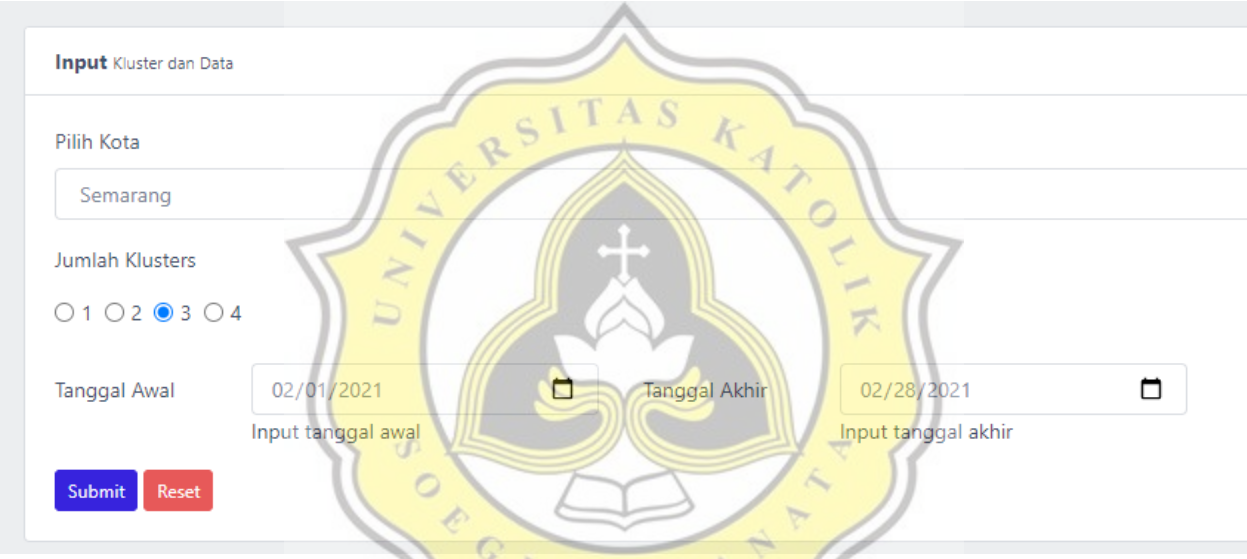


Figure 1.3. Input Form

```
1. public function loadData(Request $request)
2.     {
3.         DB::select('call spDeletealldata()');
4.         $kota = $request->input('kota');
5.         $bulan =$request->input('bulan');
6.         $tahun = $request->input('tahun');
7.         $tanggal_awal = $request->input('tanggalAwal');
8.         $tanggal_akhir = $request->input('tanggalAkhir');
9.
10.
11.
12.
13.          $centroid=DB::select('call
   generateCentroid("'.$kota.'","'.$tanggal_awal.'","'.$tanggal_akhir.'")'
   );
```

```
14.          $input=DB::select('insert into tblData
    (tanggal,TemperaturMinimum, TemperaturMaksimum, TemperaturRataRata,
    KelembapanRatarata, CurahHujan, PenyinaranMatahari,
    KecepatanAnginMaksimum, KecepatanAnginRataRata) ((select
    tanggal,TemperaturMinimum, TemperaturMaksimum, TemperaturRataRata,
    KelembapanRatarata, CurahHujan, PenyinaranMatahari,
    KecepatanAnginMaksimum, KecepatanAnginRataRata from tblMasterDataMaster
    where tanggal between "'.$tanggal_awal.'" and "'.$tanggal_akhir.'" and
    kota ="'.$kota.'"))');
15.          DB::select('call spIterasiK1((select varC1aAwal from
    tblCentroidAwal),(select varC1bAwal from tblCentroidAwal),(select
    varC1cAwal from tblCentroidAwal),(select varC1dAwal from
    tblCentroidAwal),(select varC1eAwal from tblCentroidAwal),(select
    varC1fAwal from tblCentroidAwal),(select varC1gAwal from
    tblCentroidAwal),(select varC1hAwal from tblCentroidAwal))');
16.          DB::select('call cekIterasiK1()');
17.          DB::select('call spWcssK1()');
18.
19.         DB::select('call spIterasiK2((select varC1aAwal from
    tblCentroidAwal),(select varC1bAwal from tblCentroidAwal),(select
    varC1cAwal from tblCentroidAwal),(select varC1dAwal from
    tblCentroidAwal),(select varC1eAwal from tblCentroidAwal),(select
    varC1fAwal from tblCentroidAwal),(select varC1gAwal from
    tblCentroidAwal),(select varC1hAwal from tblCentroidAwal),(select
    varC2aAwal from tblCentroidAwal),(select varC2bAwal from
    tblCentroidAwal),(select varC2cAwal from tblCentroidAwal),(select
    varC2dAwal from tblCentroidAwal),(select varC2eAwal from
    tblCentroidAwal),(select varC2fAwal from tblCentroidAwal),(select
    varC2gAwal from tblCentroidAwal),(select varC2hAwal from
    tblCentroidAwal))');
20.          DB::select('call cekIterasiK2()');
21.          DB::select('call spWcssK2()');
22.          DB::select('call spSilhouetteK2()');
23.
24.          DB::select('call spIterasiK3((select varC1aAwal from
    tblCentroidAwal),(select varC1bAwal from tblCentroidAwal),(select
    varC1cAwal from tblCentroidAwal),(select varC1dAwal from
    tblCentroidAwal),(select varC1eAwal from tblCentroidAwal),(select
    varC1fAwal from tblCentroidAwal),(select varC1gAwal from
    tblCentroidAwal),(select varC1hAwal from tblCentroidAwal),(select
    varC2aAwal from tblCentroidAwal),(select varC2bAwal from
    tblCentroidAwal),(select varC2cAwal from tblCentroidAwal),(select
    varC2dAwal from tblCentroidAwal),(select varC2eAwal from
    tblCentroidAwal),(select varC2fAwal from tblCentroidAwal),(select
    varC2gAwal from tblCentroidAwal),(select varC2hAwal from
    tblCentroidAwal),(select varC3aAwal from tblCentroidAwal),(select
    varC3bAwal from tblCentroidAwal),(select varC3cAwal from
    tblCentroidAwal),(select varC3dAwal from tblCentroidAwal),(select
    varC3eAwal from tblCentroidAwal),(select varC3fAwal from
    tblCentroidAwal),(select varC3gAwal from tblCentroidAwal),(select
    varC3hAwal from tblCentroidAwal))');
25.          DB::select('call cekIterasiK3()');
26.          DB::select('call spWcssK3()');
27.          DB::select('call spSilhouetteK3()');
```

```
28.
29.           DB::select('call spIterasiK4((select varC1aAwal from
   tblCentroidAwal),(select varC1bAwal from tblCentroidAwal),(select
   varC1cAwal from tblCentroidAwal),(select varC1dAwal from
   tblCentroidAwal),(select varC1eAwal from tblCentroidAwal),(select
   varC1fAwal from tblCentroidAwal),(select varC1gAwal from
   tblCentroidAwal),(select varC1hAwal from tblCentroidAwal),(select
   varC2aAwal from tblCentroidAwal),(select varC2bAwal from
   tblCentroidAwal),(select varC2cAwal from tblCentroidAwal),(select
   varC2dAwal from tblCentroidAwal),(select varC2eAwal from
   tblCentroidAwal),(select varC2fAwal from tblCentroidAwal),(select
   varC2gAwal from tblCentroidAwal),(select varC2hAwal from
   tblCentroidAwal),(select varC3aAwal from tblCentroidAwal),(select
   varC3bAwal from tblCentroidAwal),(select varC3cAwal from
   tblCentroidAwal),(select varC3dAwal from tblCentroidAwal),(select
   varC3eAwal from tblCentroidAwal),(select varC3fAwal from
   tblCentroidAwal),(select varC3gAwal from tblCentroidAwal),(select
   varC3hAwal from tblCentroidAwal),(select varC4aAwal from
   tblCentroidAwal),(select varC4bAwal from tblCentroidAwal),(select
   varC4cAwal from tblCentroidAwal),(select varC4dAwal from
   tblCentroidAwal),(select varC4eAwal from tblCentroidAwal),(select
   varC4fAwal from tblCentroidAwal),(select varC4gAwal from
   tblCentroidAwal),(select varC4hAwal from tblCentroidAwal))');
30.          DB::select('call cekIterasiK4()');
31.          DB::select('call spwcss()');
32.          DB::select('call spSilhouetteK4()');
33.
34.           DB::select('call spIterasiK5((select varC1aAwal from
   tblCentroidAwal),(select varC1bAwal from tblCentroidAwal),(select
   varC1cAwal from tblCentroidAwal),(select varC1dAwal from
   tblCentroidAwal),(select varC1eAwal from tblCentroidAwal),(select
   varC1fAwal from tblCentroidAwal),(select varC1gAwal from
   tblCentroidAwal),(select varC1hAwal from tblCentroidAwal),(select
   varC2aAwal from tblCentroidAwal),(select varC2bAwal from
   tblCentroidAwal),(select varC2cAwal from tblCentroidAwal),(select
   varC2dAwal from tblCentroidAwal),(select varC2eAwal from
   tblCentroidAwal),(select varC2fAwal from tblCentroidAwal),(select
   varC2gAwal from tblCentroidAwal),(select varC2hAwal from
   tblCentroidAwal),(select varC3aAwal from tblCentroidAwal),(select
   varC3bAwal from tblCentroidAwal),(select varC3cAwal from
   tblCentroidAwal),(select varC3dAwal from tblCentroidAwal),(select
   varC3eAwal from tblCentroidAwal),(select varC3fAwal from
   tblCentroidAwal),(select varC3gAwal from tblCentroidAwal),(select
   varC3hAwal from tblCentroidAwal),(select varC4aAwal from
   tblCentroidAwal),(select varC4bAwal from tblCentroidAwal),(select
   varC4cAwal from tblCentroidAwal),(select varC4dAwal from
   tblCentroidAwal),(select varC4eAwal from tblCentroidAwal),(select
   varC4fAwal from tblCentroidAwal),(select varC4gAwal from
   tblCentroidAwal),(select varC4hAwal from tblCentroidAwal),(select
   varC5aAwal from tblCentroidAwal),(select varC5bAwal from
   tblCentroidAwal),(select varC5cAwal from tblCentroidAwal),(select
   varC5dAwal from tblCentroidAwal),(select varC5eAwal from
   tblCentroidAwal),(select varC5fAwal from tblCentroidAwal),(select
   varC5gAwal from tblCentroidAwal),(select varC5hAwal from
   tblCentroidAwal))');
```

```
35.          DB::select('call cekIterasiK5()');
36.          DB::select('call spWcssK5()');
37.          DB::select('call spSilhouetteK5()');
38.
39.          return response([
40.              'success' => true,
41.              'message' => 'Display data',
42.              'data' => $input
43.          ], 200);
44.
45.      }
```

The code above shows the process of select a specific city and date range from the tblData. After selecting the city data and the selected date range,First the program will generate the centroid automatically as shown in line 13, and then the data will be processed by calling the procedure on mysql which can be seen in line 15 to 37. Incoming data will be processed into 5 clusters, because these 5 clusters are needed to determine the elbow and silhouette coefficient methods.

2) Initialize the first iteration

```
46.  declare cHitung cursor for
47.   select        tanggal,        TemperaturMinimum,TemperaturMaksimum,
   TemperaturRataRata, KelembapanRatarata, CurahHujan, PenyinaranMatahari,
   KecepatanAnginMaksimum, KecepatanAnginRataRata  from tblIterasiK2;
48.
49.
50.      select count(*) into varTotal from tblIterasiK2;
51.      open cHitung;
52.      while i<>varTotal do
53.       fetch   cHitung   into   varTanggal,   varTempMin,   varTempMaks,
   varTempRata,  varKelembapanRata,  varCurahHujan,  varPenyinaranMatahari,
   varKecepatanAnginMaks, varKecepatanAnginRata;
54.            set vJarakC1 = jarakEuclidian(
55.              c11,
56.              c12,
57.              c13,
58.              c14,
59.              c15,
60.              c16,
61.              c17,
62.              c18,
63.              varTempMin,
64.              varTempMaks,
65.              varTempRata,
66.              varKelembapanRata,
67.              varCurahHujan,
68.              varPenyinaranMatahari,
69.              varKecepatanAnginMaks,
70.              varKecepatanAnginRata
71.            );
72.            -- select vJarakC1;
```

```
            set vJarakC2 = jarakEuclidian(
              c21,
              c22,
              c23,
              c24,
              c25,
              c26,
              c27,
              c28,
              varTempMin,
              varTempMaks,
              varTempRata,
              varKelembapanRata,
              varCurahHujan,
              varPenyinaranMatahari,
              varKecepatanAnginMaks,
              varKecepatanAnginRata
            );
                update tblIterasiK2 set jarakC1 = vJarakC1 where
   tanggal=varTanggal;
                update tblIterasiK2 set jarakC2 = vJarakC2 where
   tanggal=varTanggal;
             if(vJarakC1<vJarakC2) then
                update tblIterasiK2 set kelas = 'C1' where
   tanggal=varTanggal;
             else
                update tblIterasiK2 set kelas = 'C2' where
   tanggal=varTanggal;
             end if;
             set i=i+1;
        end while;
       close cHitung;

create function jarakEuclidian(
    var1 double,
    var2 double,
    var3 double,
    var4 double,
    var5 double,
    var6 double,
    var7 double,
    var8 double,
    ca double,
    cb double,
    cc double,
    cd double,
    ce double,
    cf double,
    cg double,
    ch double
    )
  RETURNS double
  BEGIN
   declare vJarak double;
```

```
123.    set vJarak= SQRT(POW((var1 - ca),2) + POW((var2-cb),2) + POW((var3-
   cc),2)  +  POW((var4-cd),2)  +  POW((var5-ce),2)  +  POW((var6-cf),2)  +
   POW((var7-cg),2) + POW((var8-ch),2));
124.     RETURN(vJarak);
125.   end
```

the code above is the code in the procedure spIterasiK2 . To initialize the process of first iteration, the cursor on line 46 is needed to calculate the distance of data sets to centroid. Line 50 will be used to store the number of data sets that will be used for the loop cursor process in retrieving data per data. Line 51 the cHitung cursor is opened and then on line 52 the looping process to retrieving data per data is begin. Fetching process of data is shown on line 53 and will be stored in every variable that has been declared. The next step is to calculate each data points to every centroid, line 54-71 code will count each data point to Centroid 1, and line 73 – 90 will count each data point to Centroid 2, Line 102 – 125 shows the formula to calculate the datapoints to each centroid. The result from the function will be stored in a variable. After the calculation process on Distance Centroid 1 and Centroid 2, the result is updated to set a column on tblIterasiK2, that is jarakC1 and jarakC2, the process is shown on line 91 and 92, after the distance of Centroid 1 and Centroid 2 is inserted to table, the next process is to determine the closest cluster from each data point as shown in line 93-97, the process is repeated until the end of data

3) Calculate the Next Iteration until stops

```
126.  declare curr1 cursor for
127.        select tanggal, TemperaturMinimum, TemperaturMaksimum,
     TemperaturRataRata, KelembapanRatarata, CurahHujan,
     PenyinaranMatahari, KecepatanAnginMaksimum,
     KecepatanAnginRataRata, jarakC1, jarakC2, kelas from
     tblIterasiK2;
128.
129.     select count(*) into varTotal from tblIterasiK2;
130.
131.     loopIterasi: WHILE (counterCount <> 1) do
132.       open curr1;
133.       while i<>varTotal do
134.        fetch curr1 into varTanggal, varTempMin,
                  varTempMaks, varTempRata, varKelembapanRata,
                  varCurahHujan, varPenyinaranMatahari,
                  varKecepatanAnginMaks, varKecepatanAnginRata,
                        vJarakC1, vJarakC2, varKelas;
135.
136.        insert into tblsimpanTemporaryK2 values (varTanggal,
   varTempMin, varTempMaks, varTempRata, varKelembapanRata, varCurahHujan,
   varPenyinaranMatahari, varKecepatanAnginMaks, varKecepatanAnginRata,
   vJarakC1, vJarakC2, varKelas);
137.         set i=i+1;
138.       end while;
139.       close curr1;
140.       set i=0;
141.
142.       select hitungC1BaruK2('TemperaturMinimum') into @c1a;
143.       select hitungC1BaruK2('TemperaturMaksimum') into @c1b;
144.       select hitungC1BaruK2('TemperaturRataRata') into @c1c;
145.       select hitungC1BaruK2('KelembapanRatarata') into @c1d;
146.       select hitungC1BaruK2('CurahHujan') into @c1e;
147.       select hitungC1BaruK2('PenyinaranMatahari') into @c1f;
148.       select hitungC1BaruK2('KecepatanAnginMaksimum') into
            @c1g;
149.       select hitungC1BaruK2('KecepatanAnginRataRata') into
            @c1i;
150.
151.       select hitungC2BaruK2('TemperaturMinimum') into @c2a;
152.       select hitungC2BaruK2('TemperaturMaksimum') into @c2b;
153.       select hitungC2BaruK2('TemperaturRataRata') into @c2c;
154.       select hitungC2BaruK2('KelembapanRatarata') into @c2d;
155.       select hitungC2BaruK2('CurahHujan') into @c2e;
156.       select hitungC2BaruK2('PenyinaranMatahari') into @c2f;
157.       select hitungC2BaruK2('KecepatanAnginMaksimum') into
            @c2g;
158.       select hitungC2BaruK2('KecepatanAnginRataRata') into
            @c2i;
159.
160.
161.
162.       call spIterasiK2(@c1a, @c1b, @c1c, @c1d, @c1e, @c1f, @c1g, @c1i,
   @c2a, @c2b, @c2c, @c2d, @c2e, @c2f, @c2g, @c2i);
```

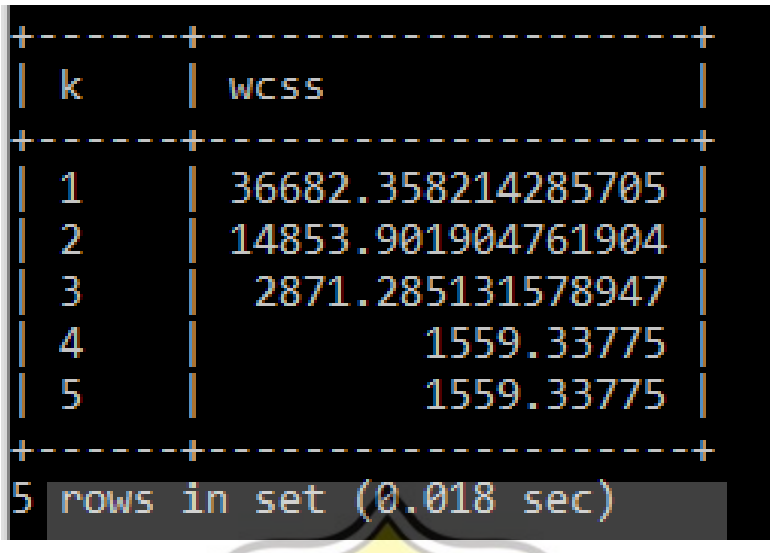
```
163.
164.       select group_concat(kelas) into varIterasiSesudah from
     tblIterasiK2;
165.       select group_concat(kelas) into varIterasiSebelum from
     tblsimpanTemporaryK2;
166.
167.       set countIterasi = countIterasi + 1;
168.       if (varIterasiSebelum = varIterasiSesudah) then
169.         LEAVE loopIterasi;
170.       end if;
171.       delete from tblsimpanTemporaryK2;
172.
173.     end while loopIterasi;
174.
175.     update tblCountIterasi
176.       set jumlahIterasi = countIterasi
177.     where kluster = 2;
178.
179.     insert into tblSimpanCentroidK2 (kelas,
    TemperaturMinimum,TemperaturMaksimum, TemperaturRataRata,
    KelembapanRatarata, CurahHujan, PenyinaranMatahari,
    KecepatanAnginMaksimum, KecepatanAnginRataRata) values
180.     ('C1',@c1a, @c1b, @c1c, @c1d, @c1e, @c1f, @c1g, @c1i),
181.     ('C2',@c2a, @c2b, @c2c, @c2d, @c2e, @c2f, @c2g, @c2i);
```

The next step is to automatically iterate until the centroid does not change, line 131 will begin the while infinite process, line 132 – 140 is the process to save the current iteration process to another backup table. This table is used later to check the previous iteration and the curent iteration process if the centroid has change or not. The calculation proces to the next centroid iteration is shown in line 142-158, After the new centroid is calculated, the next step is to call the iteration procedurer with the new centroid parameters as shown in line 162, after the calculation process on the new iteration, the next step is to compare the current centroid or cluster result from current iteration and previous iteration, if the centroid or cluster result has the same value, the iteration is stoped, the comparison process is shown in line 164-170. If the iteration still continue, the next step is to delete the backup table that contains the previous iteration as shown in line 171, to save the amount of iteration, the count iteration result will be stored on tblCountIterasi, the process shown in line 175-177. After that, the next process is to save the current final centroid into tblSimpanCentroidK2 as shown in line 179-181

4) Calculate the WCSS

```
delimiter //
create procedure spWcssK2()
BEGIN
  declare vSum double default 0;
  declare vJarakC1S double;
  declare vJarakC2S double;
  declare varTotal double;
  declare varSquare double;
  declare varSumC1 double default 0;
  declare varSumC2 double default 0;
  declare varKelas1 varchar(5);
  declare varKelas2 varchar(5);
  declare varWcss double default 0;
  declare i int default 0;

  declare curr1 cursor for
    select jarakC1,kelas from tblIterasiK2;

  declare curr2 cursor for
    select jarakC2,kelas from tblIterasiK2;

  select count(*) into varTotal from tblIterasiK2;

  open curr1;
  open curr2;
  while (i <> varTotal) do
    fetch curr1 into vJarakC1S,varKelas1;
    fetch curr2 into vJarakC2S,varKelas2;
    if (varKelas1='C1') THEN
      set varSumC1 = varSumC1 + POWER(vJarakC1S,2);
    end if;
    if (varKelas2='C2') THEN
      set varSumC2 = varSumC2 + POWER(vJarakC2S,2);
    end if;
    set i = i+1;
  end while;
  close curr1;
  close curr2;
  set varWcss = varSumC1 + varSUmC2;
  update tblWcss
  set wcss = varwcss
  where k = '2';
end //
delimiter ;
```

Figure 1.4. WCSS result



k	wcss
1	36682.358214285705
2	14853.901904761904
3	2871.285131578947
4	1559.33775
5	1559.33775

5 rows in set (0.018 sec)

After the iteration process has ended, the calculation process of wcss is begin. To calculate wcss, the amount of distance from datasets to its cluster's centroid is needed, the process to take the distance is shown in line 207-220. The process on line 208 and 209 is to fetch the current datasets distance to its centroid, after that the calculation of wcss is performed by selecting the amount of all sum of square distance between datasets to its centroid as shown in line 210-215. On line 220 the next process is to count the total sum of the sum of square from all datasets to its centroid, after that the amount of wcss is stored into tblWcss as shown in line 221-223

5) Calculate the silhouette coefficient

```
226. while (i<>varTotal) do
227.     fetch curr1 into varTanggal, varTempMin, varTempMaks,
         varTempRata, varKelembapanRata, varCurahHujan,
         varPenyinaranMatahari, varKecepatanAnginMaks,
         varKecepatanAnginRata, varKelas;
228.     set j=0;
229.     set k=0;
230.     set varSumai = 0;
231.     set varSumbi = 0;
232.     set varTotalSesamaCluster = 0;
233.     set varTotalClusterTerdekat = 0;
234.     if (varKelas = 'C2') then
235.       set varCterdekat = vJarakTerdekatC2;
236.     elseif (varKelas = 'C1') then
237.       set varCterdekat = vJarakTerdekatC1;
238.     end if;
239.     open curr5;
240.     open curr6;
```

```
241.     -- looping menghitung data a(i) dan b(i) pada tiap data point
242.       while (j<>varTotal) do
243.         -- menghitung a(i)
244.         fetch curr5 into varTanggal2, varTempMin2,
                varTempMaks2, varTempRata2, varKelembapanRata2,
                varCurahHujan2, varPenyinaranMatahari2,
                        varKecepatanAnginMaks2, varKecepatanAnginRata2,
                        varKelas2;
245.
246.         if (varTanggal <> varTanggal2) then
247.           if(varKelas = varKelas2) then
248.             set varSumai = varSumai + jarakEuclidian(
249.                         varTempMin, varTempMaks,
                                varTempRata,varKelembapanRata,

    varCurahHujan,varPenyinaranMatahari,
                varKecepatanAnginMaks,
                                varKecepatanAnginRata,
250.                        varTempMin2, varTempMaks2,
                            varTempRata2, varKelembapanRata2,
                            varCurahHujan2,
                                varPenyinaranMatahari2,
                                varKecepatanAnginMaks2,
                                varKecepatanAnginRata2);
251.
252.             set varTotalSesamaCluster =
                            varTotalSesamaCluster + 1;
253.
254.           -- menghitung b(i)
255.
256.           elseif(varKelas <> varKelas2 && varKelas2 =
                            varCterdekat ) then
257.             while ( k <> varTotal) do
258.               fetch curr6 into varTanggal3, varTempMin3,
                            varTempMaks3, varTempRata3,
                                varKelembapanRata3, varCurahHujan3,
                                varPenyinaranMatahari3,
                                        varKecepatanAnginMaks3,
                                                varKecepatanAnginRata3,
   varKelas3;
259.
260.                 if (varKelas3 = varCterdekat ) then
261.                   set varTotalClusterTerdekat =
                                varTotalClusterTerdekat + 1;
262.                 end if;
263.               set k = k+1;
264.             end while;
265.             set varSumbi = varSumbi + jarakEuclidian(
266.                                 varTempMin, varTempMaks,
                                        varTempRata,
                                                varKelembapanRata,
                                                        varCurahHujan,

    varPenyinaranMatahari,
```

```
                    varKecepatanAnginMaks,
                                varKecepatanAnginRata,
267.                                    varTempMin2, varTempMaks2,
                                        varTempRata2,
                                        varKelembapanRata2,
                                        varCurahHujan2,
                                                varPenyinaranMatahari2,
                                                varKecepatanAnginMaks2,
                                                varKecepatanAnginRata2);
268.            end if;
269.
270.          end if;
271.
272.          set j=j+1;
273.        end while;
274.        close curr5;
275.        close curr6;
276.        set varSumai = varSumai / varTotalSesamaCluster;
277.        set varSumbi = varSumbi / varTotalClusterTerdekat;
278.        if (varSumai is NULL or '') then
279.          set varSumai = 0;
280.          set varTotalSesamaCluster = 0;
281.        end if;
282.        if (varSumbi is NULL or '') then
283.          set varSumbi = 0;
284.          set varTotalClusterTerdekat = 0;
285.        end if;
286.        set varSilhouetteCoefficient = (varSumbi -
            varSumai)/greatest(varSumbi,varSumai);
287.        set varSilhouetteScore = varSilhouetteScore +
            varSilhouetteCoefficient;
288.        set i=i+1;
289.    end while;
290.    close curr1;
291.    set varSilhouetteScore = varSilhouetteScore / varTotal;
292.    update tblSilhouette
293.    set silhouetteScore = varSilhouetteScore
294.    where kluster = 2;
```

To calculate the silhouette coefficient, the final result of iteration is needed, the first process is to loop on each datapoints to calculate the a(i) and b(i), line 226 shows the begining of iteration process on each datapoints, line 227 is used to store each datapoints to variables, the process on line 234 is to set the nearest distance cluster where the data points belongs to, the process to calculate the amount of other data point in the same cluster (calculate a(i)) is shown on line 244-251, line 246 is used to skip the calculation distance of current datapoint, so it will only count the other data points distance. The process on line 247 is to select the datapoints in the same cluster.

The calculation process to count the datapoint distance to other datapoints on nearest cluster (b(i)) is shown on line 255-266, the selection process of the nearest datapoints cluster is on line 255, after that the amount of other datapoints on nearest cluster is stored on a variable as shown in line 260-261, line 264 is used to calculate the distance of datapoints to all nearest datapoint on its cluster. After that, to count the actual amount of a(i) and b(i) is shown in line 274 and 275, line 276 is used to set the value of a(i) to 0 if there is no datapoints on the same cluster . Line 280 is used to set the value of a(i) to 0 if there is no datapoints on other closest cluster. After the value of a(i) and b(i) has ben calculated, the next step is to calculate the silhouette coefficient, the process is shown on line 284, on line 285 is used to contain the sum of each data point silhouette coefficient's . after that, the process on line 289 is to generate the final silhouette score by average the amount of total silhouette coefficient on each cluster. The silhouette score then will be stored on tblSilhouette as shown in line 286-288.

Figure 1.5. Silhouette Score Result

```
+---------+--------------------+
| kluster | silhouetteScore    |
+---------+--------------------+
|       2 | 0.6573616667814182 |
|       3 | 0.6959204743684351 |
|       4 | 0.5678700788000952 |
|       5 | 0.5321557930858095 |
+---------+--------------------+
4 rows in set (0.002 sec)
```

5.2 Testing

To input the data, users need to enter the city, the amount of targeted clusters, and the date range to specity the range of weather data date to be processed.

1) Testing the weather data on semarang city from 1 – 28 February 2021 and pick the amount of k = 4

Figure 1.6. Input Form

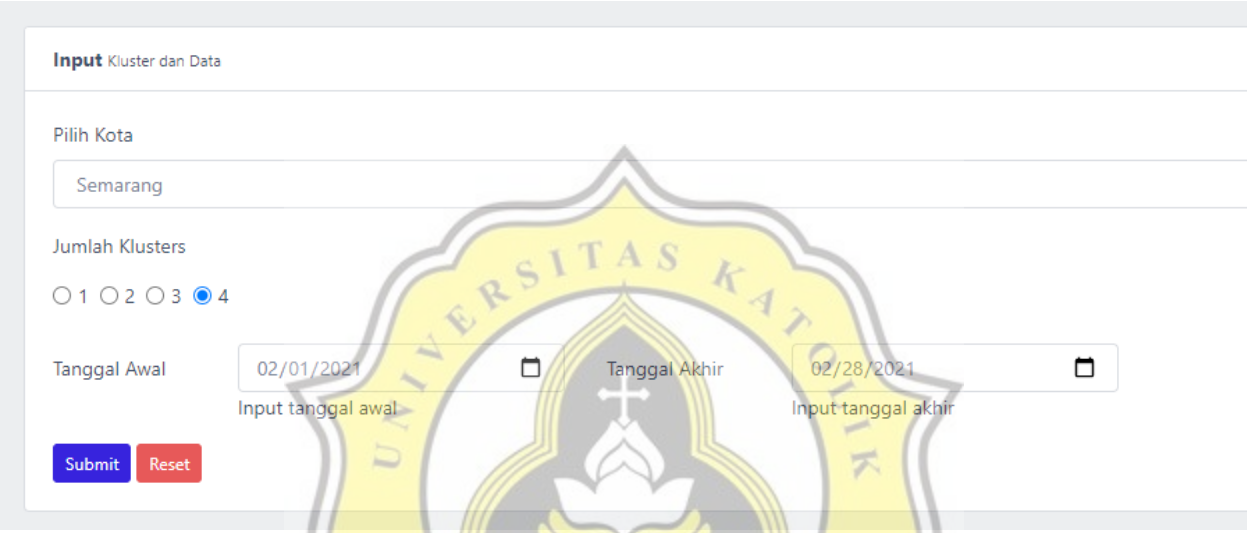


Table 1.31 : The amount of initial Centroids

No	Temp Min	Temp Max	Avg Temp	Humidity Avg	Rainfall	Sunshine	Max Wind Velocity	Avg Wind velocity
1	23.8	30.2	26.8	90	12.7	4.7	9	4
2	24.6	30	27	90	6.7	6.2	7	4

The first test will run the data from semarang city from 1 February 2021 to 28 Februari 2021, and the result can be seen as follows

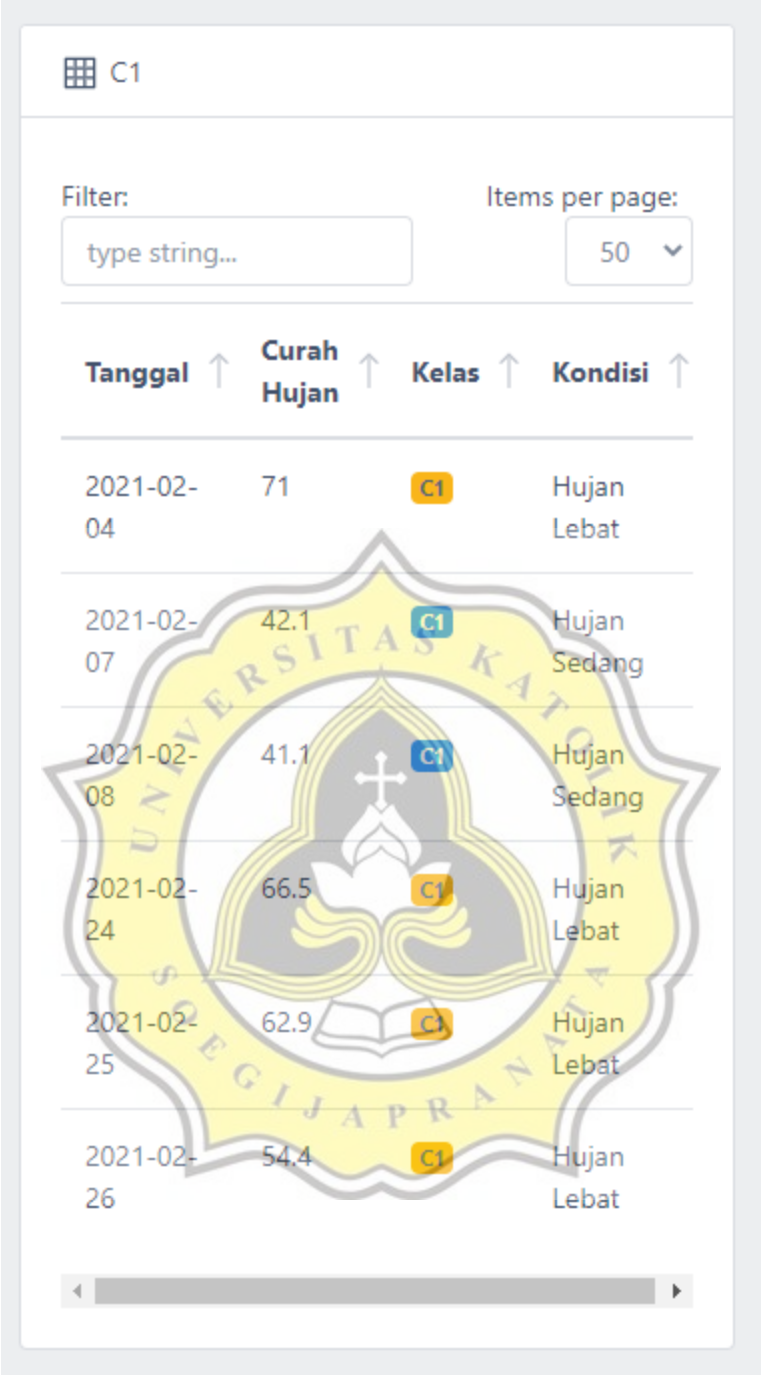


Figure 1.7. The Result from C1 on K=4

From the calculation result, in C1 contains about days that have heavy and moderate rainfall. The lowest rainfall in C1 is on 2021-02-08 with 41.1mm and the highest rainfall is on 2021-02-04 with 71mm

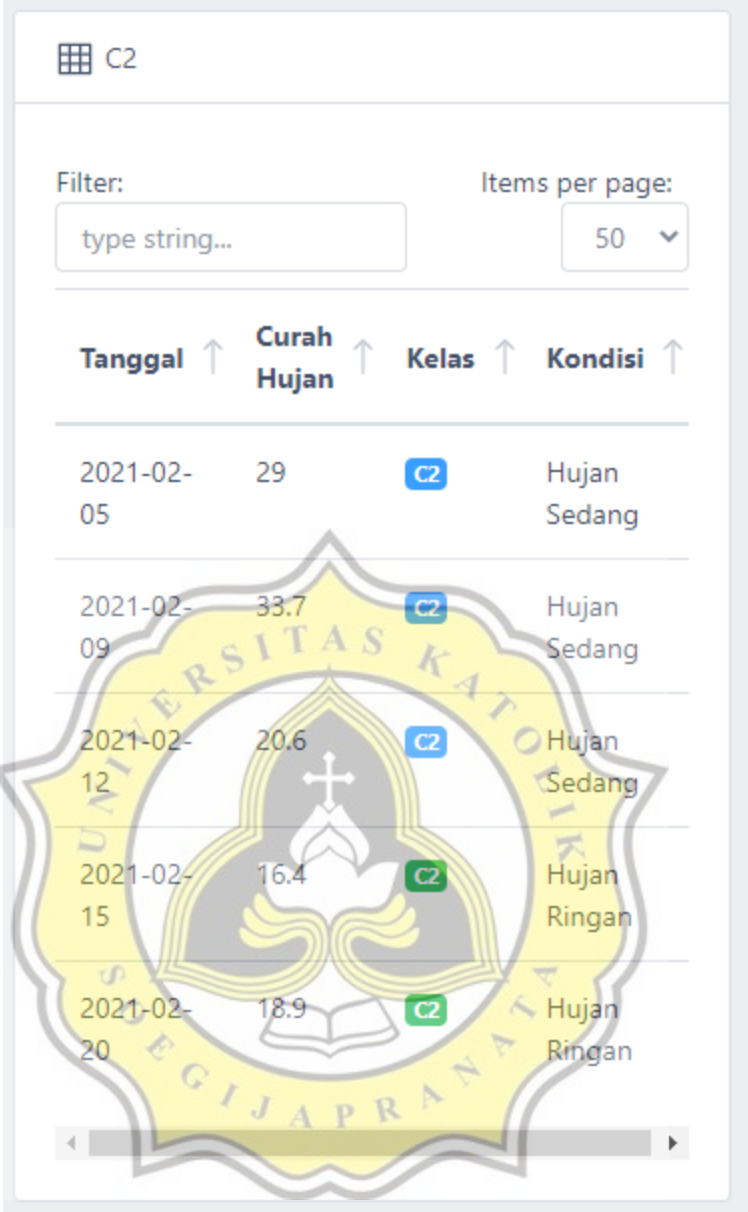


Figure 1.8. The result from C2 on K=4

From the calculation result, in C2 contains about days that have light and moderate rainfall. The lowest rainfall in C2 is on 2021-02-15 with 16.4mm and the highest rainfall is on 2021-02-09 with 33.7mm

Figure 1.9. The result from C3 on K=4

From the calculation result, in C3 contains about days that have light rainfall and cloudy weather. The lowest rainfall in C3 is on 2021-02-14 and 2021-02-18 with 0mm and the highest rainfall is on 2021-02-01 with 12.7mm

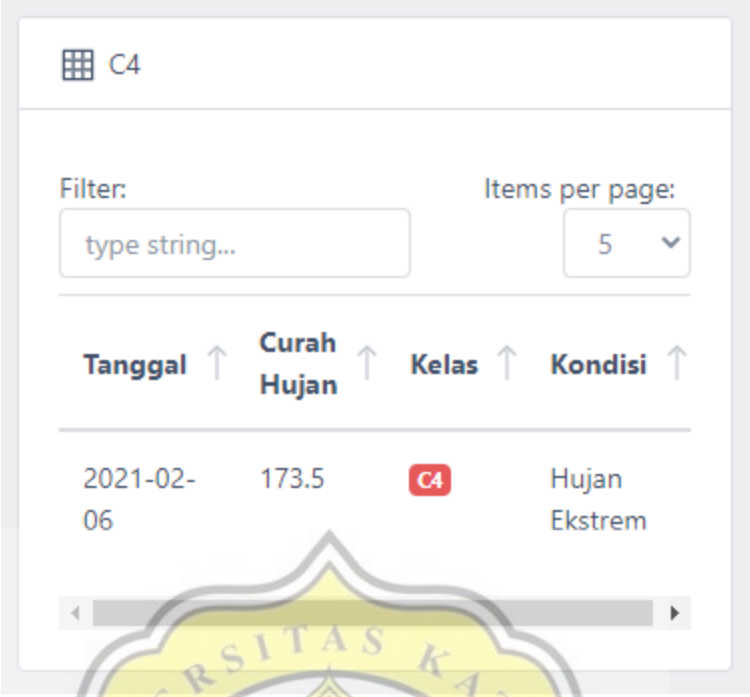


Figure 1.10. The result from C=4 on K=4

From the calculation result, in C4 contains about days that have extreme rainfall with the amount of 173.5 mm

Table 1.32 : Conclusion Result on K=4

Clusters	**Min Rainfall(mm)**	**Max Rainfall**	**Information**
C1	41.1mm	71mm	Heavy
C2	16.4mm	33.7mm	Moderate
C3	0mm	12.7mm	Cloudy-Light
C4	173.5mm	173.5mm	Extreme

The clustering process on K=4 draw conclusions that the people of semarang city needs to be aware for flooding with the date which is in Clusters 4, because on C4 has the extreme rainfall with 173.5mm. Cluster 1 does not have a large flood potential as in Cluster 4. Clusters 2 and 3 are arguably the safest, because they don't have days with heavy-extreme rainfall

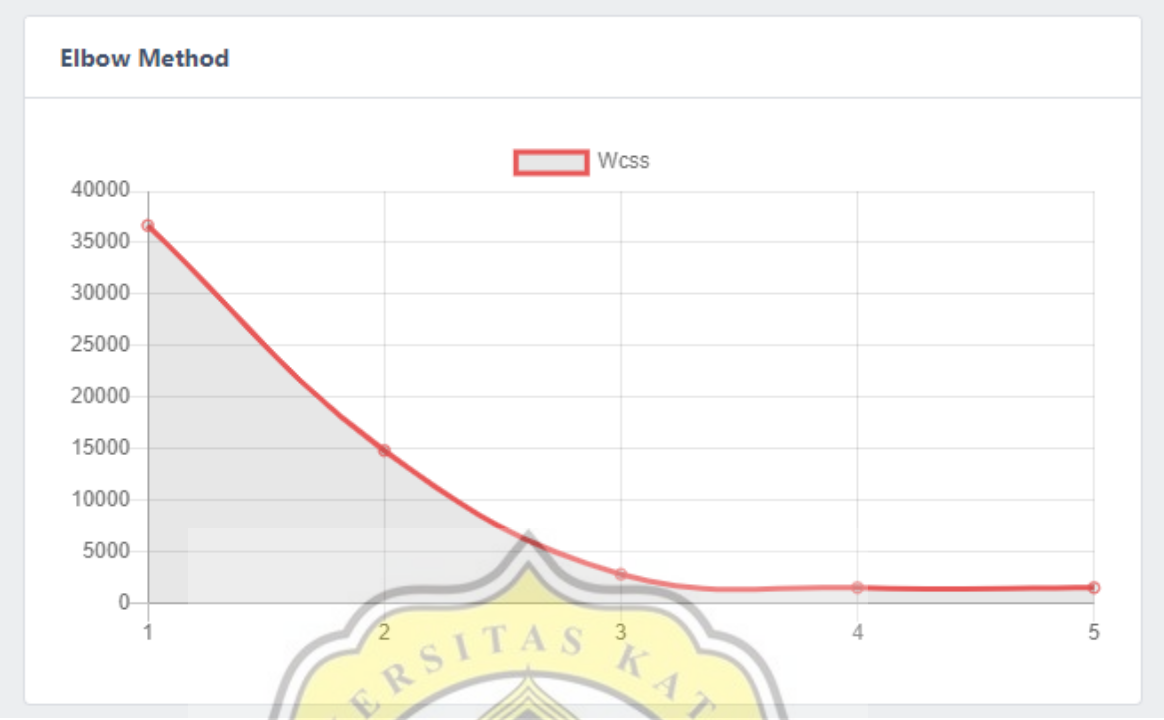


Figure 1.11. Elbow method result for Semarang 1-28 February 2021

Table 1.33 : WCSS result on Semarang 1-28 February 2021

K	WCSS
1	36682.358214285705
2	14853.901904761904
3	2871.285131578947
4	1559.33775
5	1559.33775

The Elbow Method calculation for semarang on 1-28 February 2021 shows that the optimal number of clusters is on K=3. The graph start to form an elbow on K=3

Figure 1.12. The graph of Silhouette score for Semarang on 1-28 February 2021

Table 1.34 : Silhouette Score on Semarang 1-28 February 2021

K	Silhouette Score
2	0.6573616667814182
3	0.6959204743684351
4	0.5678700788000952
5	0.5321557930858095

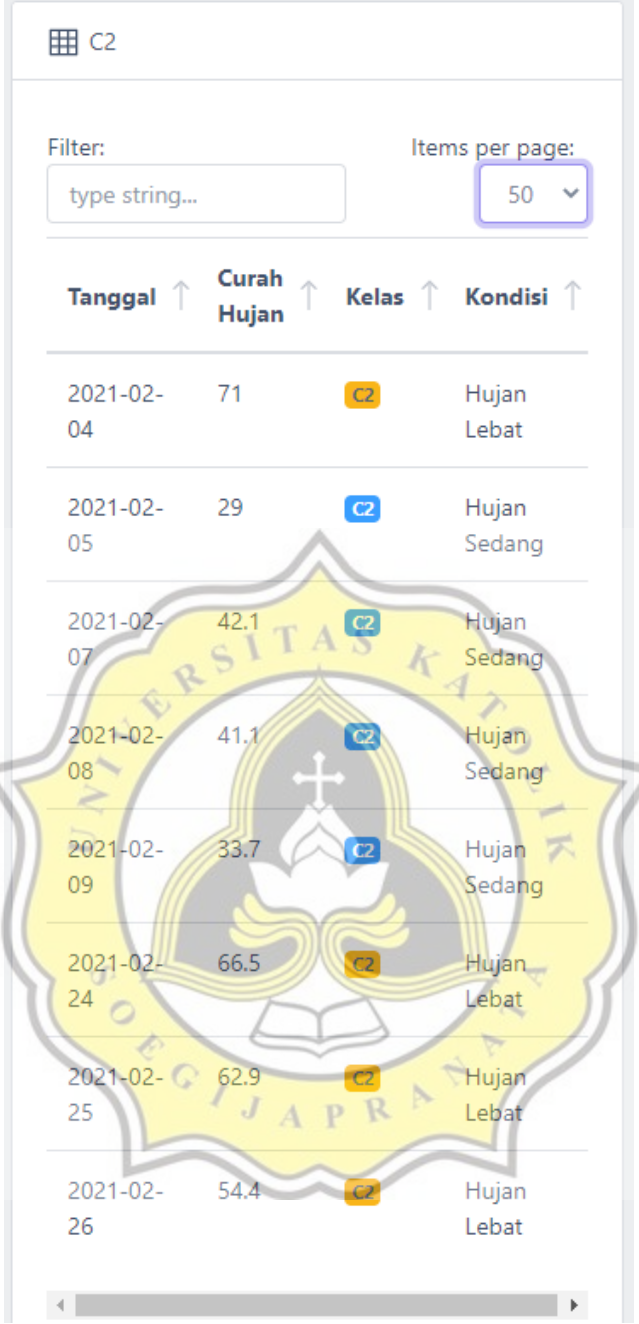
The Silhouette Coefficient calculation for semarang on 1-28 February 2021 shows that the optimal number of clusters is on K=3. The highest of Silhouette Score is on K=3 with the amount of 0.6959204743684351

2) Testing the weather data on Semarang city from 1 – 28 February 2021 and pick the recommended clusters from elbow method and silhouette score (K=3)

Both Elbow Method and Silhouette Coefficient shows that the optimal clusters for datasets on Semarang from 1 – 28 February is 3. Below is the result for the calculation on K=3

Figure 1.13. The result of C=1 at K=3

From the calculation result, in C1 contains about days that have Extreme rainfall with the amount of 173.5mm on 6 February 2021



C2

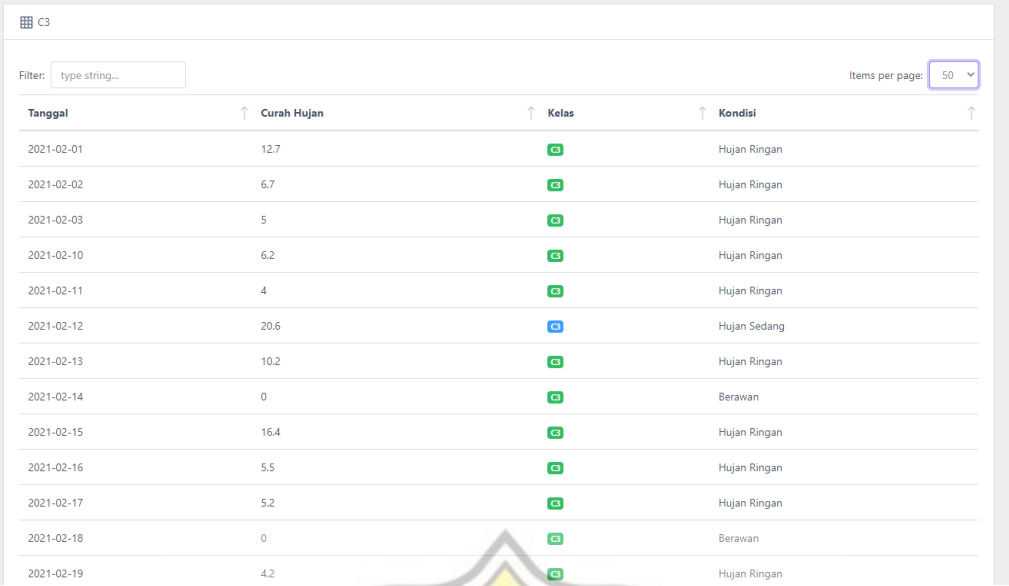
Filter: type string...

Items per page: 50

Tanggal	Curah Hujan	Kelas	Kondisi
2021-02-04	71	C2	Hujan Lebat
2021-02-05	29	C2	Hujan Sedang
2021-02-07	42.1	C2	Hujan Sedang
2021-02-08	41.1	C2	Hujan Sedang
2021-02-09	33.7	C2	Hujan Sedang
2021-02-24	66.5	C2	Hujan Lebat
2021-02-25	62.9	C2	Hujan Lebat
2021-02-26	54.4	C2	Hujan Lebat

Figure 1.14. The result of C=2 at K=3

From the calculation result, in C2 contains about days that have moderate and heavy rainfall. The lowest rainfall in C2 is on 2021-02-05 with 29mm and the highest rainfall is on 2021-02-04 with 71mm



C3

Filter: type string... Items per page: 50

Tanggal	Curah Hujan	Kelas	Kondisi
2021-02-01	12.7	C3	Hujan Ringan
2021-02-02	6.7	C3	Hujan Ringan
2021-02-03	5	C3	Hujan Ringan
2021-02-10	6.2	C3	Hujan Ringan
2021-02-11	4	C3	Hujan Ringan
2021-02-12	20.6	C3	Hujan Sedang
2021-02-13	10.2	C3	Hujan Ringan
2021-02-14	0	C3	Berawan
2021-02-15	16.4	C3	Hujan Ringan
2021-02-16	5.5	C3	Hujan Ringan
2021-02-17	5.2	C3	Hujan Ringan
2021-02-18	0	C3	Berawan
2021-02-19	4.2	C3	Hujan Ringan

Figure 1.15. The Result of C=3 at K=3

From the calculation result in C3, almost all the dates in Cluster3 contain about the days with cloudy and light rainfall, only 1 day, namely on February 12, 2021 which is classified as moderate rainfall. With the minimum rainfall on C3 is 0mm and maximum is 20.6mm

Table 1.35 : Conclusion result on semarang from 1-28 February 2021

Clusters	**Min Rainfall(mm)**	**Max Rainfall**	**Information**
C1	173.5mm	173.5mm	Extreme
C2	29mm	71mm	Moderate-Heavy
C3	0mm	20.6mm	Cloudy-Light

The clustering process on K=3 draw conclusions that the people of semarang city needs to be aware for flooding with the date which is in Clusters 1, because on C1 has the extreme rainfall with 173.5mm. Cluster 2 does not have a large flood potential as in Cluster 1. Clusters 3 are arguably the safest date, because all the dates on C3 dominated by dates with cloudy-light rainfall, only 1 dates have moderate rainfall that is on 12 February 2021

3) Analyzing the result from K=3 and K=4 on Semarang 1-28 February2021

Precision Recall/Confusion Matrix is used to determine the accuracy of each K=3 and K=4

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN}$$

TP = True Positive

TN = True Negative

FP = False Positive

FP = False Negative

Table 1.36 : Accuracy Result from K=3 on Semarang 1-28 February 2021

Class	**TP**	**FP**	**FN**	**TN**	**Accuracy**
C1 (Extreme Rainfall)	1	0	0	27	100 %
C2 (Moderate-Heavy)	8	0	1	19	96.4285714 %
C3 (Cloudy-Light)	18	1	0	9	96.4285714 %
Average					97.6190476 %

Table 1.37 : Accuracy Result from K=4 on Semarang 1-28 February 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Heavy)	4	2	0	22	92.8571429 %
C2 (Moderate)	3	2	2	21	85.7142857 %
C3 (Cloudy-Light)	16	0	2	10	92.8571429 %
C4(Extreme)	1	0	0	27	100 %
Average					92.8571429 %

From the classification result on K=3 and K=4, can be concluded that dividing clusters into 3 is more effective because in cluster 3 the classification of rainfall data is more accurate, the result from precision recall/confusion matrix shows that K=3 has 97.6190476 % accuracy while at K=4 has an accuracy of 92.8571429 % This proves that the results of selecting the optimal cluster based on the results of the elbow method and the silhouette coefficient method are successful

4)Another analysis with elbow method and silhouette coefficient

Figure 1.16. The elbow method on Cilacap 1-30 April 2021

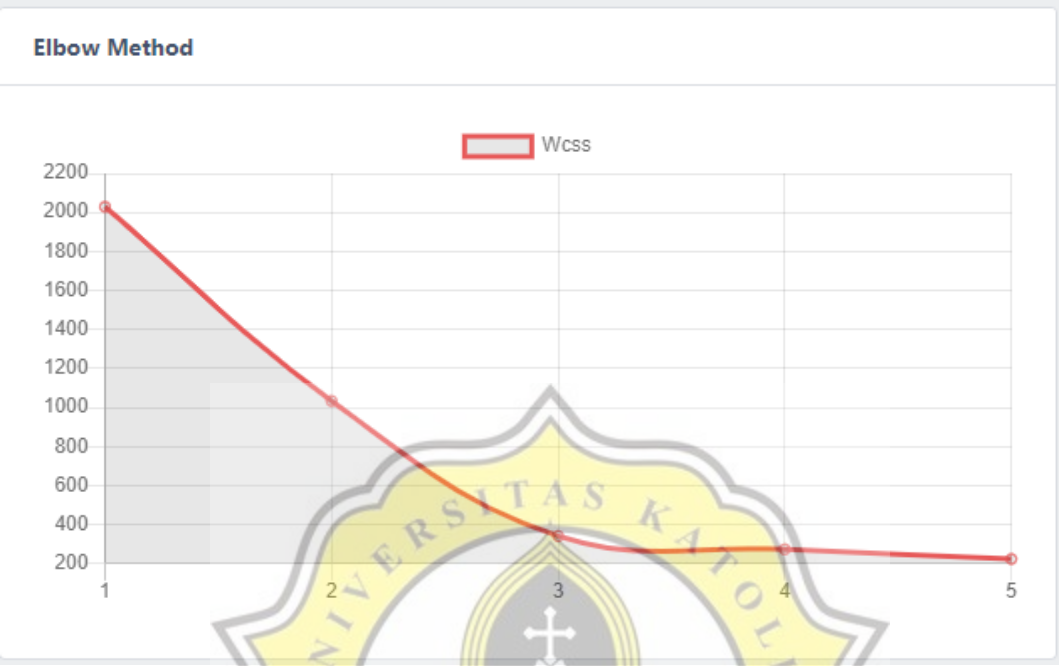
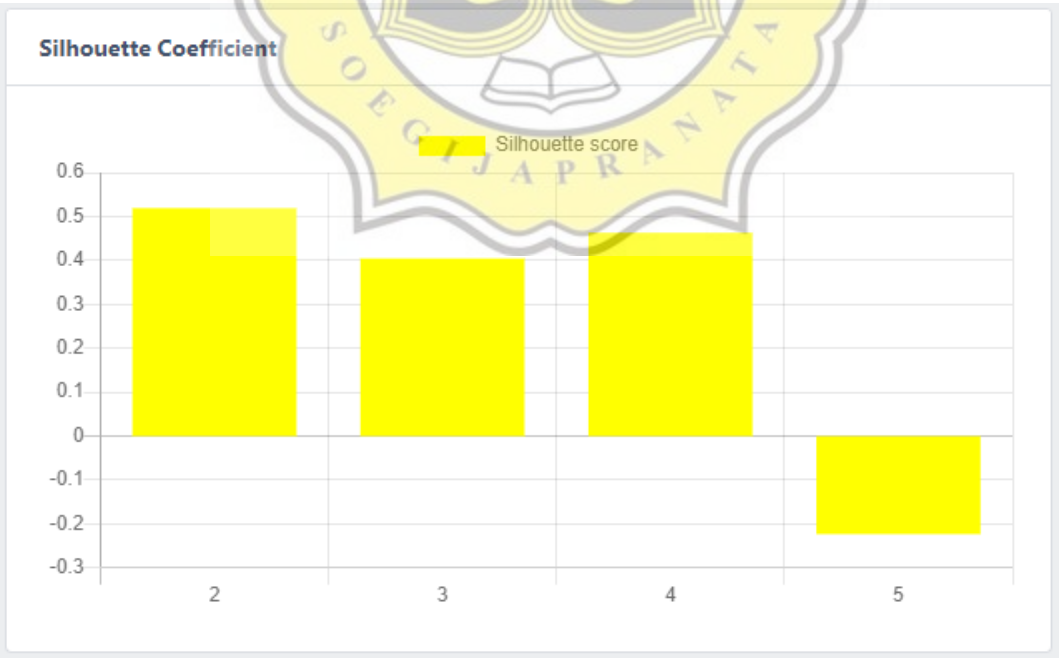


Figure 1.17. Silhouette Coefficient Graph on Cilacap 1-30 April 2021



It is possible that the graph shown by the elbow and silhouette coefficient methods shows a different amount of optimal clusters. The data above is taken on Cilacap 1-30 April 2021. The optimal number of clusters on Elbow method is 3 but on Sillhouette Coefficient method, the optimal number of cluster is 2. Below is the result for the both classification using K=2 , and K=3.

Table 1.38 : Conclusion result on Cilacap from 1-30 April 2021 (K=2)

Clusters	**Min Rainfall(mm)**	**Max Rainfall**	**Information**
C1	12,4mm	42.9mm	Moderate
C2	0mm	7.7mm	Cloudy-Light Rain

Table 1.39 : Conclusion result on Cilacap from 1-30 April 2021 (K=3)

Clusters	**Min Rainfall(mm)**	**Max Rainfall**	**Information**
C1	42.9mm	42.9mm	Moderate
C2	3,4mm	25.3mm	Light Rain
C3	0	5.8mm	Cloudy

Table 1.40 : Accuracy result from K=2 on Cilacap 1-30 April 20212

Class	**TP**	**FP**	**FN**	**TN**	**Accuracy**
C1 (Moderate)	17	0	3	1	85.7142857 %
C2 (Cloudy-Light)	1	3	0	17	85.7142857 %
Average					85.7142857 %

Table 1.41 : Accuracy result from K=3 on Cilacap 1-30 April 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Moderate)	1	0	0	20	100 %
C2 (Light)	9	0	8	4	61.9047619 %
C3 (Cloudy)	3	8	0	10	61.9047619 %
Average					74.6031746 %

The accuracy calculation above has been determined, and the result is K=2 has 85.7142857 % accuracy while K=3 has 74.6031746 %. This accuracy result proves that, the data on Cilacap 1-30 April 2021 has high accuracy on K=2 rather than K=3, on this case Silhouette Coefficient method performs better than Elbow method

5)Testing cilacap data with other random centroid

Table 1.42 : Starting Centroid

Date	Temp Min	Temp Max	Avg Temp	Humidity Avg	Rainfall	Sunshine	Max Wind Velocity	Avg Wind velocity
2021-04-16	24.7	31.6	27.9	81	0.4	6.6	4	2
2021-04-05	24	31.9	27.6	86	42.9	7.3	3	1

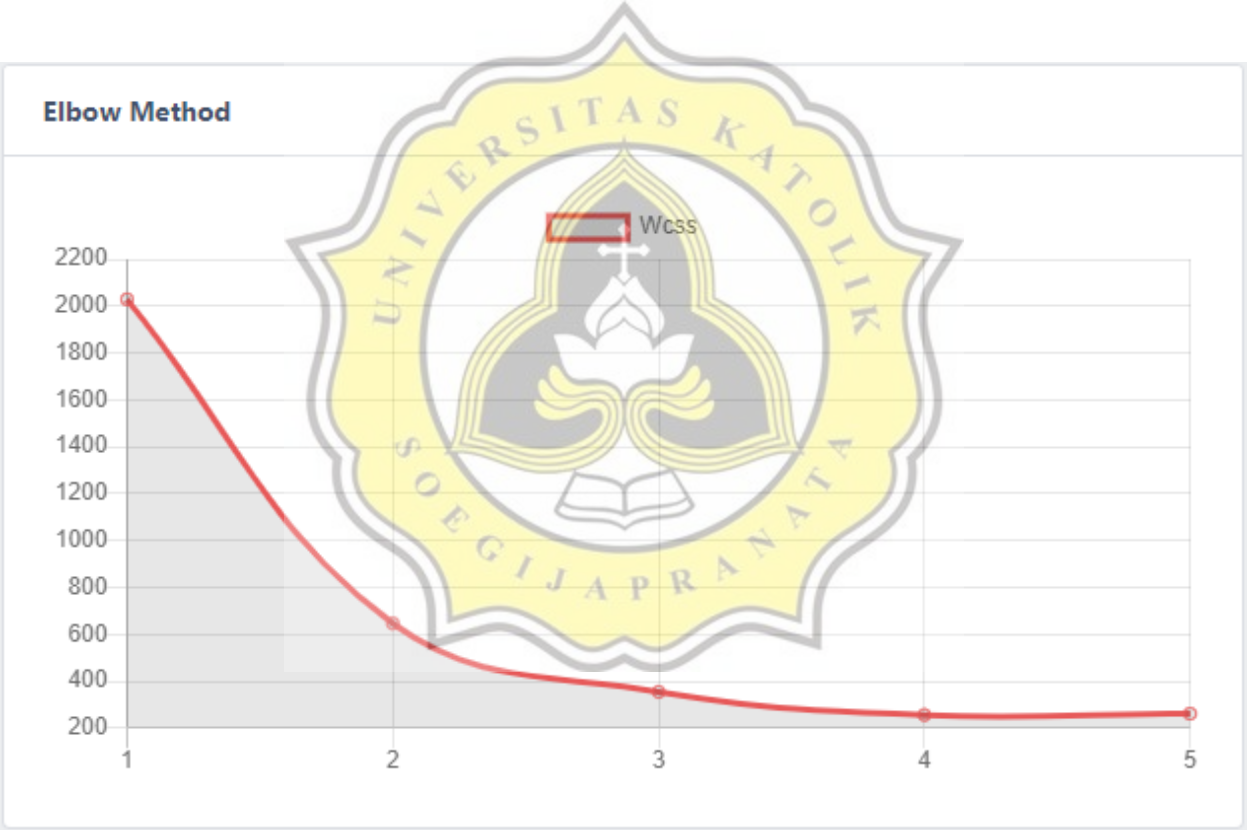


Table 1.43 : Elbow Method Result on Cilacap 1-30 April when using table 5.10 Centroid

Figure 1.18. Silhouette Coefficient Result on Cilacap 1-30 April when using table 1.42 Centroid

Because K-means always determine the centroid randomly, Therefore, the results obtained will also produce different results, although sometimes they do not have very significant differences. the results of the elbow method and the silhouette method are very dependent on the resulting clustering results, when processing new data with the new centroid, it is possible that the calculation results from the elbow method and the silhouette method are also different from the previous ones. The results of the most significant difference in the use of centroids are in cilacap city 1-30 april, when using the randomed centroid on table 5.10 above,the elbow method and silhouette coefficient have the same result eventhough the calculation process before, both elbow and silhouette coefficient method produce different number of optimal clusters

Table 1.44 : Conclusion result on Cilacap from 1-30 April 2021 (K=2) when using table 1.42 Centroids

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	0mm	15.3mm	Cloudy-Light Rain
C2	42.9mm	42.9mm	Moderate

Table 1.45 : Accuracy result Cilacap 1-30 April 2021 when using table 1.42 Centroids

Class	TP	FP	FN	TN	Accuracy
C1 (Cloudy-Light Rain)	20	0	0	1	100 %
C2 (Moderate)	1	0	0	20	100%
Average					100 %

Table 1.46 : Conclusion result on Cilacap from 1-30 April 2021 (K=3) when using table 1.42 Centroids

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	42.9mm	42.9mm	Moderate
C2	0mm	5.8mm	Cloudy
C3	7mm	15.3mm	Light Rain

Table 1.47 : Accuracy result Cilacap 1-30 April 2021 (K=3) when using table 5.10 Centroids

Class	**TP**	**FP**	**FN**	**TN**	**Accuracy**
C1 (Light Rain)	7	0	10	4	52.3809524%
C2 (Cloudy)	3	10	0	8	52.3809524%
C3 (Moderate)	1	0	0	20	100%
Average					68.2539683 %

6) Final Test Result from another cities

Figure 1.19. Elbow Method on Semarang 1 January 2021 - 31 May 2021

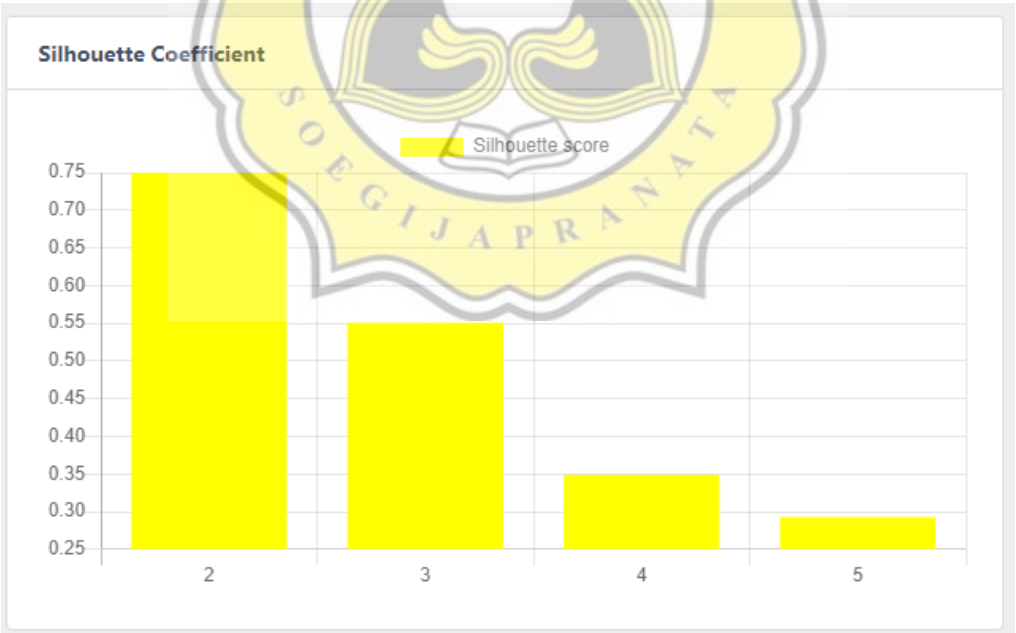


Figure 1.20. Silhouette Coefficient on Semarang 1 January 2021 - 31 May 2021

Table 1.48 : Result on Semarang 1 January 2021- 31 May 2021 using the optimal number of Kluster = 2

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	33.7mm	173.5mm	Moderate-Heavy-Extreme
C2	0mm	30.4mm	Cloudy-Light

Table 1.49 : Accuracy result from K=2 on Semarang 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Moderate-Heavy-Extreme)	131	7	0	13	95.3642384 %
C2 (Cloudy-Light)	131	7	0	13	95.3642384 %
Average					95.3642384 %

Table 1.50 : Result on Semarang 1 January 2021- 31 May 2021 when Kluster = 3

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	54.4mm	173.5mm	Heavy-Extreme
C2	0mm	13.5mm	Cloudy
C3	13.4mm	48mm	Light-Moderate

Table 1.51 : Accuracy result from K=3 on Semarang 1 January - 31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Heavy-Extreme)	7	0	0	144	100 %
C2 (Cloudy)	71	51	0	29	66.2251656 %
C3 (Light-Moderate)	22	0	51	78	66.2251656 %
Average					77.4834437 %

Table 1.52 : Result on Semarang 1 January 2021- 31 May 2021 when Kluster = 4

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	54.4mm	173.5mm	Heavy-Extreme
C2	0mm	6.3mm	Cloudy
C3	16.4mm	48mm	Moderate
C4	0mm	15.3mm	Light

Table 1.53 : Accuracy result from K=4 on Semarang 1 January - 31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Heavy-Extreme)	7	0	0	144	100 %
C2 (Cloudy)	31	5	40	75	70.1986755 %
C3 (Moderate)	13	7	0	131	95.3642384 %
C4 (Light)	48	40	12	51	65.5629139 %
Average					82.781457 %

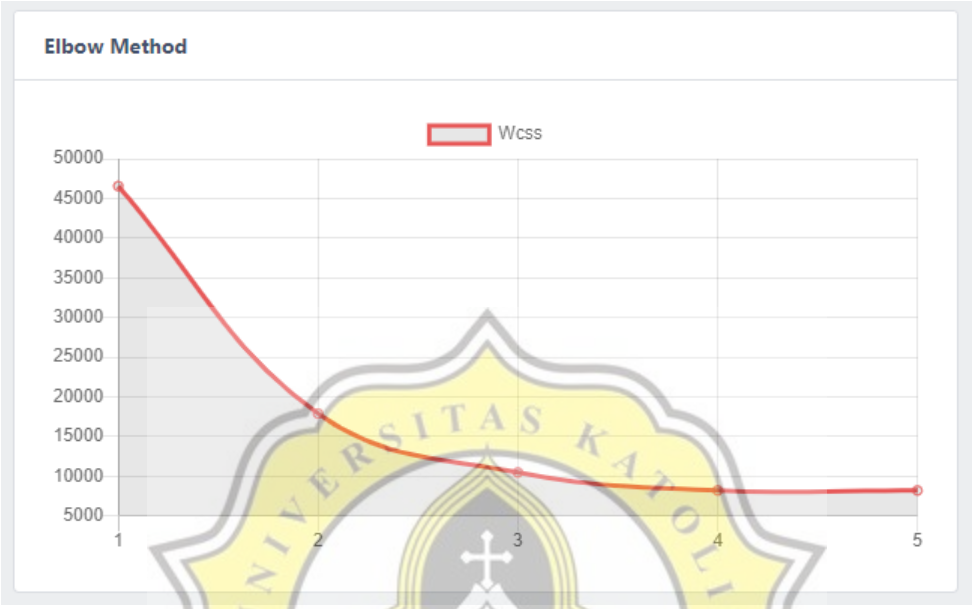


Table 1.54 : Elbow Method on Tegal 1 January 2021 - 31 May 2021

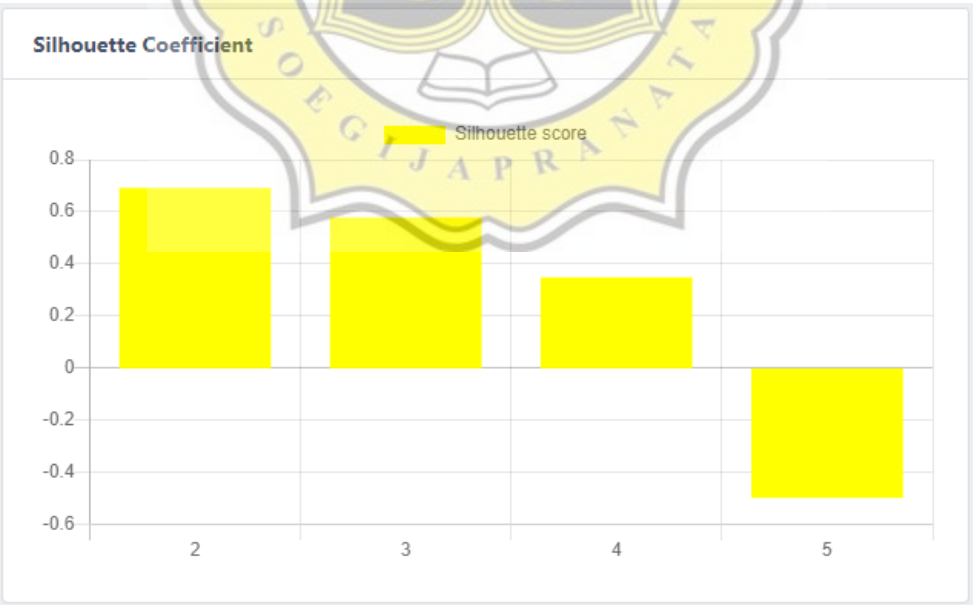


Table 1.55 : Silhouette Coefficient on Tegal 1 January 2021 - 31 May 2021

Table 1.56 : Result on Tegal 1 January 2021- 31 May 2021 using the optimal number of Kluster 2

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	29mm	112.3mm	Moderate-Heavy-Very Heavy
C2	0mm	24mm	Cloudy-Light

Table 1.57 : Accuracy result from K=2 on Tegal 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Moderate-Heavy-Very Heavy)	16	0	8	111	94.0740741%
C2 (Cloudy-Light)	111	8	0	16	94.0740741%
Average					94.0740741 %

Table 1.58 : Result on Tegal 1 January 2021- 31 May 2021 using Kluster = 3

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	57.5mm	112.3mm	Heavy-Very Heavy
C2	14mm	47.8mm	Light-Moderate
C3	0mm	11.5mm	Cloudy

Table 1.59 : Accuracy result from K=3 on Tegal 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Heavy-Very Heavy)	5	0	0	130	100%
C2 (Light-Moderate)	28	0	52	55	61.4814815%
C3 (Cloudy)	50	52	0	33	61.4814815%
Average					74.3209877 %

Table 1.60 : Result on Tegal 1 January 2021- 31 May 2021 using Kluster = 4

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	57.5mm	112.3mm	Heavy-Very Heavy
C2	17.2mm	47.8mm	Moderate
C3	0mm	16.8mm	Light
C4	0mm	9.2mm	Cloudy

Table 1.61 : Accuracy result from K=4 on Tegal 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Heavy-Very Heavy)	5	0	0	130	100%
C2 (Moderate)	19	4	0	112	97.037037%
C3 (Light)	47	11	12	65	82.962963 %
C4(Cloudy)	41	8	11	75	85.9259259 %
Average					91.4814815 %

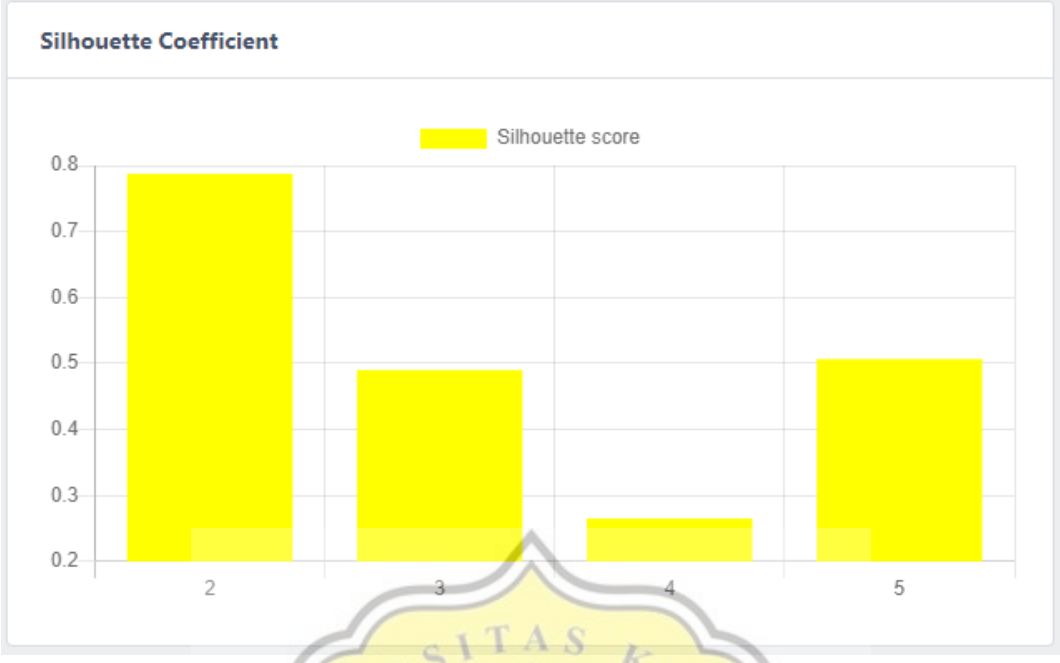


Table 1.62 : Silhouette Coefficient on Cilacap 1 January 2021 - 31 May 2021

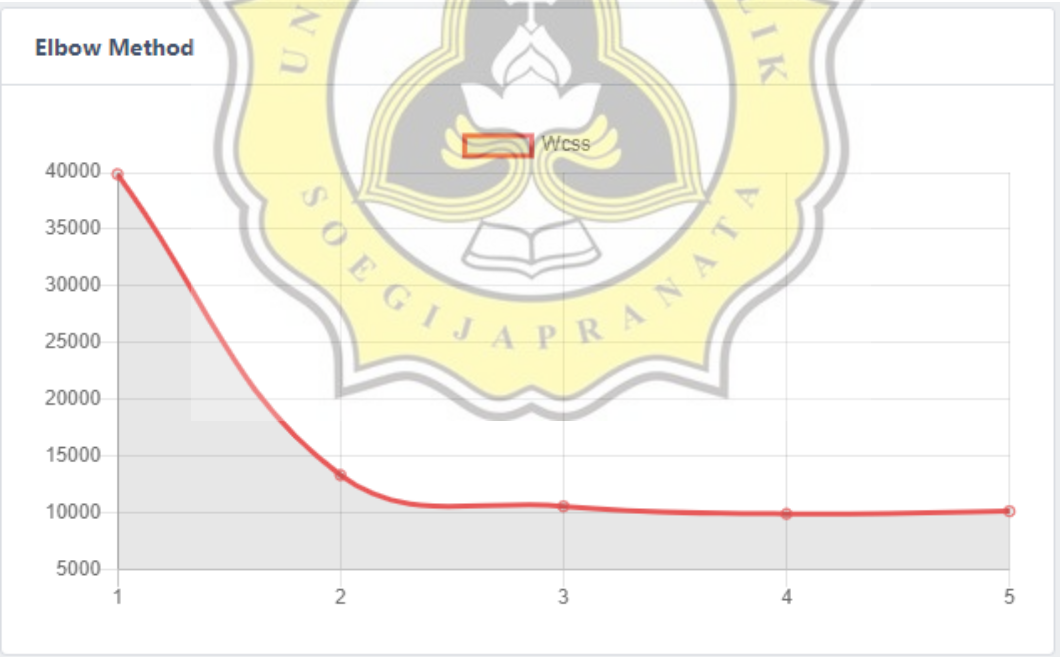


Table 1.63 : Elbow Method on Cilacap 1 January 2021 - 31 May 2021

Table 1.64 : Result on Cilacap 1 January 2021- 31 May 2021 using the optimal number of Kluster = 2

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	42.5mm	132.5mm	Moderate-Heavy-Very Heavy
C2	0mm	28.9mm	Cloudy-Light

Table 1.65 : Accuracy result from K=2 on Cilacap 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Moderate-Heavy-Very Heavy)	11	0	5	105	95.8677686%
C2 (Cloudy-Light)	105	5	0	11	95.8677686%
Average					95.8677686 %

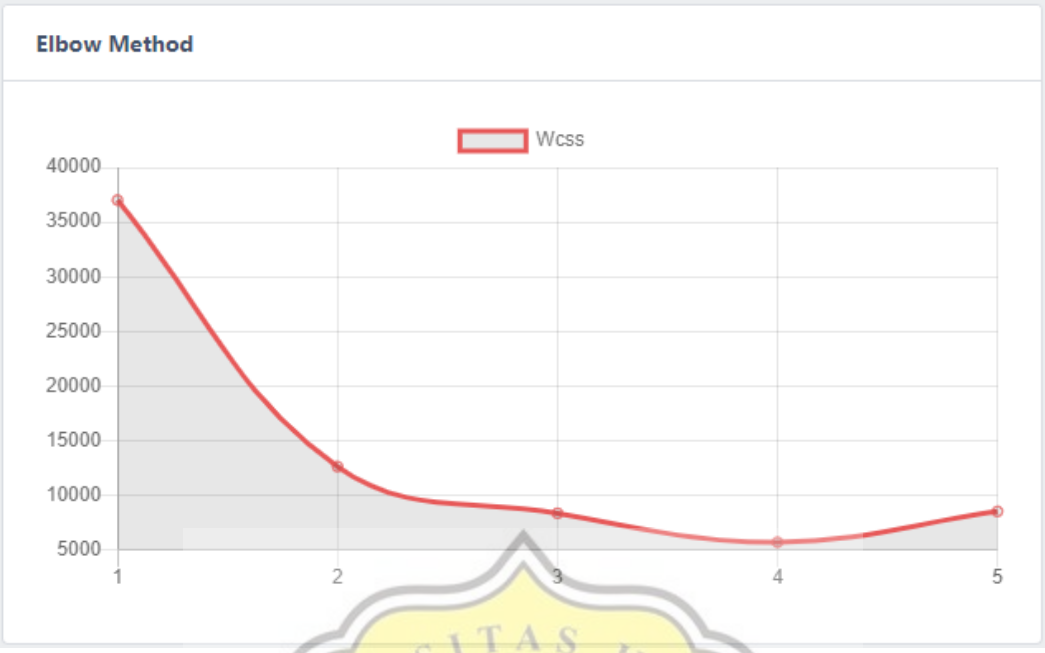


Table 1.66 : Elbow Method on Jakarta 1 January 2021 - 31 May 2021

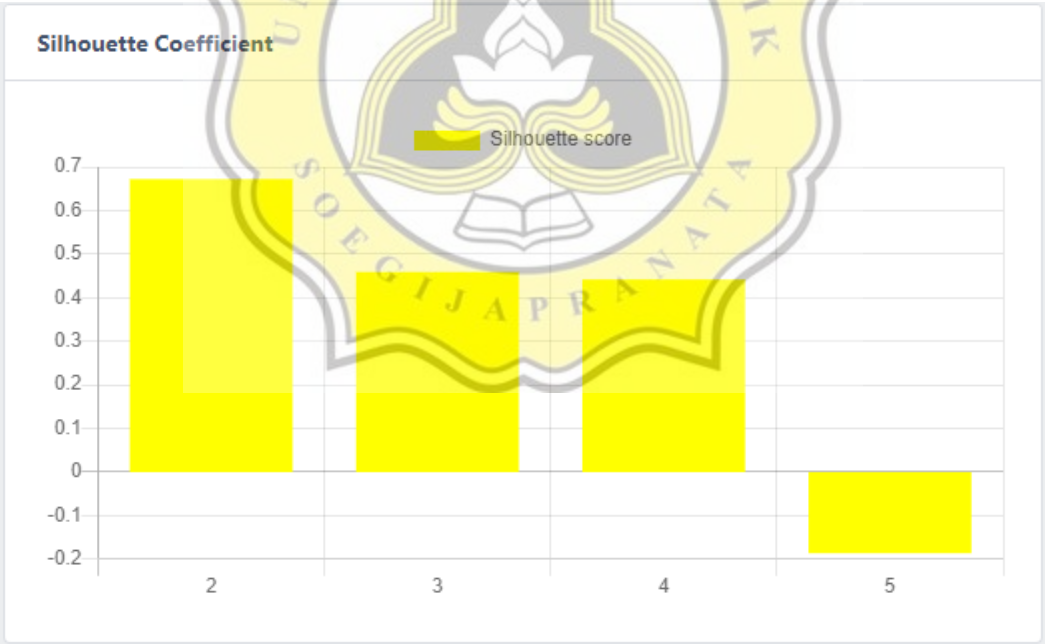


Table 1.67 : Silhouette Coefficient on Jakarta 1 January 2021 - 31 May 2021

Table 1.68 : Result on Jakarta 1 January 2021- 31 May 2021 using optimal Kluster = 2

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	0mm	22.3mm	Cloudy-Light
C2	26.2mm	91.6mm	Moderate-Heavy

Table 1.69 : Accuracy result from K=2 on Jakarta 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Cloudy-Light)	16	0	8	111	96.4912281%
C2 (Moderate-Heavy)	111	8	0	16	96.4912281%
Average					96.4912281 %

Table 1.70 : Result on Jakarta 1 January 2021- 31 May 2021 using Kluster = 3

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	0mm	1.6mm	Cloudy
C2	34.3mm	91.6mm	Moderate-Heavy
C3	8.2mm	30mm	Light

Table 1.71 : Accuracy result from K=3 on Jakarta 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Cloudy)	42	27	0	45	76.3157895%
C2 (Moderate-Heavy	23	8	27	56	92.9824561%
C3 (Light)	14	0	8	92	69.2982456%
Average					79.5321637 %

Table 1.72 : Result on Jakarta 1 January 2021- 31 May 2021 using Kluster = 4

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	0mm	8mm	Cloudy
C2	52.8mm	91.6mm	Heavy
C3	7mm	22.3mm	Light
C4	26.2mm	46.7mm	Moderate

Table 1.73 : Accuracy result from K=4 on Jakarta 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Cloudy)	42	25	0	47	78.0701754%
C2 (Heavy)	25	4	25	60	96.4912281%
C3 (Light)	13	0	4	97	74.5614035 %
C4(Moderate)	5	0	0	109	96.4912281 %
Average					91.4814815 %

Table 1.74 : Elbow Method on Bandung 1 January 2021 - 31 May 2021

Table 1.75 : Silhouette Coefficient on Bandung 1 January 2021 - 31 May 2021

Table 1.76 : Result on Bandung 1 January 2021- 31 May 2021 using optimal Kluster = 2

Clusters	**Min Rainfall(mm)**	**Max Rainfall**	**Information**
C1	0mm	15mm	Cloudy-Light
C2	17mm	76.8mm	Moderate-Heavy

Table 1.77 : Accuracy result from K=2 on Bandung 1 January -31 May 2021

Class	**TP**	**FP**	**FN**	**TN**	**Accuracy**
C1 (Cloudy-Light)	122	0	11	18	92.7152318%
C2 (Moderate-Heavy)	18	11	0	122	92.7152318%
Average					92.71523181 %

Table 1.78 : Result on Bandung 1 January 2021- 31 May 2021 using Kluster = 3

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	0mm	10mm	Cloudy
C2	17mm	76.8mm	Moderate-Heavy
C3	0mm	15mm	Light

Table 1.79 : Accuracy result from K=3 on Bandung 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Cloudy)	34	26	9	82	76.8211921%
C2 (Moderate-Heavy	18	11	0	122	92.7152318%
C3 (Light)	53	9	37	52	69.5364238 %
Average					79.6909492 %

Table 1.80 : Result on Bandung 1 January 2021- 31 May 2021 using Kluster = 4

Clusters	Min Rainfall(mm)	Max Rainfall	Information
C1	10mm	23.6mm	Moderate
C2	25.6mm	76.8mm	Heavy
C3	0mm	9.2mm	Light
C4	0mm	10mm	Cloudy

Table 1.81 : Accuracy result from K=4 on Bandung 1 January -31 May 2021

Class	TP	FP	FN	TN	Accuracy
C1 (Moderate)	3	21	13	114	77.4834437%
C2 (Heavy)	2	13	0	136	91.3907285%
C3 (Light)	41	9	49	52	61.589404%
C4(Cloudy)	34	28	9	80	75.4966887 %
Average					76.4900662%

7) Evaluation result

Based on the testing and analysis above, The elbow method and the silhouette method can be used in selecting a good optimal number of clusters, and both method mostly have the same results in determining the optimal number of clusters, it can be seen that the calculation of accuracy between using the optimal number of clusters is higher rather than not using the amount optimal number of cluster. This can be seen in the results of the clustering in Semarang on February 1 - 28, 2021, when using the amount of K = 4 produce the accuracy result 92.8571429 %, while when using the optimal number of cluster K=3 the accuracy result is higher (97.6190476 %). In the Cilacap city classification on April 1-30 2021, the elbow method and the silhouette coefficient method produce different optimal cluster results, but the accuracy obtained when using the optimal number of clusters from the silhouette coefficient (85.7142857 %) is higher than using the optimal cluster from the elbow method.(74.6031746 %), but when the data is processed with centroid on table 5.10, the elbow method and silhouette coefficient method produce the same amount of optimal number of clusters is 2. This shows that differences in the use of the initial centroid point can affect the results of the elbow method and the silhouette coefficient method

Table 1.82 : Final Result

City	Start Date	End Date	Elbow Method	Silhouette Score	K used	Accuracy
Semarang	1 February 2021	28 February 2021	3	3	4	92.8571429 %
					3	97.6190476 %
Cilacap	1 April 2021	30 April 2021	3	2	2	85.7142857 %
					3	74.6031746 %
Cilacap (different centroid)	1 April 2021	30 April 2021	2	2	2	100 %
					3	68.2539683 %
Semarang	1 January 2021	31 May 2021	2	2	2	95.3642384 %
					3	77.4834437 %
					4	82.781457 %
Tegal	1 January 2021	31 May 2021	2	2	2	94.0740741 %
					3	74.3209877 %
					4	91.4814815 %
Cilacap	1 January 2021	31 May 2021	2	2	2	95.8677686 %
Jakarta	1 January 2021	31 May 2021	2	2	2	96.4912281 %
					3	79.5321637 %
					4	91.4814815 %

Bandung	1 January 2021	31 May 2021	2	2	2	92.71523181%
					3	79.6909492 %
					4	76.4900662%