



**Lampiran 1. Data Nilai Tukar Rupiah Terhadap Euro Tanggal 1 November 2024 - 27 Maret 2025**

| t  | Tanggal          | Aktual (Rp) | t  | Tanggal          | Aktual (Rp) |
|----|------------------|-------------|----|------------------|-------------|
| 1  | 01 November 2024 | 17142,48    | 50 | 15 Januari 2025  | 16763,16    |
| 2  | 04 November 2024 | 17174,77    | 51 | 16 Januari 2025  | 16894,17    |
| 3  | 05 November 2024 | 17241,76    | 52 | 17 Januari 2025  | 16950,39    |
| 4  | 06 November 2024 | 17253,44    | 53 | 20 Januari 2025  | 16923,83    |
| 5  | 07 November 2024 | 17089,26    | 54 | 21 Januari 2025  | 16977,09    |
| 6  | 08 November 2024 | 17039,02    | 55 | 22 Januari 2025  | 17026,48    |
| 7  | 11 November 2024 | 16977,8     | 56 | 23 Januari 2025  | 17084,67    |
| 8  | 12 November 2024 | 16844,09    | 57 | 24 Januari 2025  | 17013,31    |
| 9  | 13 November 2024 | 16853,15    | 58 | 30 Januari 2025  | 17033,18    |
| 10 | 14 November 2024 | 16818,91    | 59 | 31 Januari 2025  | 17033,13    |
| 11 | 15 November 2024 | 16832,93    | 60 | 03 Februari 2025 | 17057,5     |
| 12 | 18 November 2024 | 16856,83    | 61 | 04 Februari 2025 | 16908,96    |
| 13 | 19 November 2024 | 16800,05    | 62 | 05 Februari 2025 | 16959,97    |
| 14 | 20 November 2024 | 16815,41    | 63 | 06 Februari 2025 | 17051,68    |
| 15 | 21 November 2024 | 16860,06    | 64 | 07 Februari 2025 | 17036,93    |
| 16 | 22 November 2024 | 16882,08    | 65 | 10 Februari 2025 | 17048,13    |
| 17 | 25 November 2024 | 16769,3     | 66 | 11 Februari 2025 | 16947,71    |
| 18 | 26 November 2024 | 16662,36    | 67 | 12 Februari 2025 | 16962,34    |
| 19 | 28 November 2024 | 16771,71    | 68 | 13 Februari 2025 | 17064,18    |
| 20 | 29 November 2024 | 16804,26    | 69 | 14 Februari 2025 | 17147,46    |
| 21 | 02 Desember 2024 | 16861,12    | 70 | 17 Februari 2025 | 17129,1     |
| 22 | 03 Desember 2024 | 16788,54    | 71 | 18 Februari 2025 | 17077,43    |
| 23 | 04 Desember 2024 | 16829,63    | 72 | 19 Februari 2025 | 17115,32    |
| 24 | 05 Desember 2024 | 16854,66    | 73 | 20 Februari 2025 | 17183,46    |
| 25 | 06 Desember 2024 | 16827,53    | 74 | 21 Februari 2025 | 17135,31    |
| 26 | 09 Desember 2024 | 16858,98    | 75 | 24 Februari 2025 | 17189,11    |
| 27 | 10 Desember 2024 | 16840,94    | 76 | 25 Februari 2025 | 17190,63    |
| 28 | 11 Desember 2024 | 16829,21    | 77 | 26 Februari 2025 | 17160,07    |
| 29 | 12 Desember 2024 | 16769,36    | 78 | 27 Februari 2025 | 17285,8     |
| 30 | 13 Desember 2024 | 16850,06    | 79 | 28 Februari 2025 | 17300,83    |
| 31 | 16 Desember 2024 | 16806,01    | 80 | 03 Maret 2025    | 17322,53    |
| 32 | 17 Desember 2024 | 16915,31    | 81 | 04 Maret 2025    | 17262,02    |
| 33 | 18 Desember 2024 | 16933,54    | 82 | 05 Maret 2025    | 17339,91    |
| 34 | 19 Desember 2024 | 16986,29    | 83 | 06 Maret 2025    | 17563,42    |
| 35 | 20 Desember 2024 | 17006,18    | 84 | 07 Maret 2025    | 17708,31    |
| 36 | 23 Desember 2024 | 16979,24    | 85 | 10 Maret 2025    | 17780,35    |
| 37 | 24 Desember 2024 | 16910,5     | 86 | 11 Maret 2025    | 17757,98    |
| 38 | 27 Desember 2024 | 16925,94    | 87 | 12 Maret 2025    | 17983,38    |
| 39 | 30 Desember 2024 | 17023,1     | 88 | 13 Maret 2025    | 18028,39    |
| 40 | 31 Desember 2024 | 16936,38    | 89 | 14 Maret 2025    | 17939,92    |
| 41 | 02 Januari 2025  | 16908,4     | 90 | 17 Maret 2025    | 17857,77    |
| 42 | 03 Januari 2025  | 16911,13    | 91 | 18 Maret 2025    | 17904,52    |

**Lampiran 1. (Lanjutan)**

| <b>t</b> | <b>Tanggal</b>  | <b>Aktual<br/>(Rp)</b> | <b>t</b> | <b>Tanggal</b> | <b>Aktual<br/>(Rp)</b> |
|----------|-----------------|------------------------|----------|----------------|------------------------|
| 43       | 06 Januari 2025 | 16757,69               | 92       | 19 Maret 2025  | 18059,89               |
| 44       | 07 Januari 2025 | 16811,01               | 93       | 20 Maret 2025  | 18093,97               |
| 45       | 08 Januari 2025 | 16924,21               | 94       | 21 Maret 2025  | 18020,98               |
| 46       | 09 Januari 2025 | 16824,19               | 95       | 24 Maret 2025  | 17976,52               |
| 47       | 10 Januari 2025 | 16795,71               | 96       | 25 Maret 2025  | 18040,23               |
| 48       | 13 Januari 2025 | 16759,96               | 97       | 26 Maret 2025  | 18021,47               |
| 49       | 14 Januari 2025 | 16715,84               | 98       | 27 Maret 2025  | 17982,94               |



**Lampiran 2. Hasil Fuzzyfikasi Data Nilai Tukar Rupiah Terhadap Euro**

| <b>t</b> | <b>Aktual (Rp)</b> | <b>Fuzzy</b> | <b>t</b> | <b>Aktual (Rp)</b> | <b>Fuzzy</b> |
|----------|--------------------|--------------|----------|--------------------|--------------|
| 1        | 17142,48           | A3           | 50       | 16763,16           | A1           |
| 2        | 17174,77           | A3           | 51       | 16894,17           | A1           |
| 3        | 17241,76           | A4           | 52       | 16950,39           | A2           |
| 4        | 17253,44           | A4           | 53       | 16923,83           | A2           |
| 5        | 17089,26           | A3           | 54       | 16977,09           | A2           |
| 6        | 17039,02           | A3           | 55       | 17026,48           | A2           |
| 7        | 16977,8            | A2           | 56       | 17084,67           | A3           |
| 8        | 16844,09           | A2           | 57       | 17013,31           | A3           |
| 9        | 16853,15           | A2           | 58       | 17033,18           | A2           |
| 10       | 16818,91           | A1           | 59       | 17033,13           | A3           |
| 11       | 16832,93           | A1           | 60       | 17057,5            | A3           |
| 12       | 16856,83           | A2           | 61       | 16908,96           | A3           |
| 13       | 16800,05           | A1           | 62       | 16959,97           | A2           |
| 14       | 16815,41           | A1           | 63       | 17051,68           | A2           |
| 15       | 16860,06           | A2           | 64       | 17036,93           | A3           |
| 16       | 16882,08           | A2           | 65       | 17048,13           | A3           |
| 17       | 16769,3            | A1           | 66       | 16947,71           | A3           |
| 18       | 16662,36           | A1           | 67       | 16962,34           | A2           |
| 19       | 16771,71           | A1           | 68       | 17064,18           | A2           |
| 20       | 16804,26           | A1           | 69       | 17147,46           | A3           |
| 21       | 16861,12           | A2           | 70       | 17129,1            | A3           |
| 22       | 16788,54           | A1           | 71       | 17077,43           | A3           |
| 23       | 16829,63           | A1           | 72       | 17115,32           | A3           |
| 24       | 16854,66           | A2           | 73       | 17183,46           | A3           |
| 25       | 16827,53           | A1           | 74       | 17135,31           | A3           |
| 26       | 16858,98           | A2           | 75       | 17189,11           | A3           |
| 27       | 16840,94           | A2           | 76       | 17190,63           | A3           |
| 28       | 16829,21           | A1           | 77       | 17160,07           | A3           |
| 29       | 16769,36           | A1           | 78       | 17285,8            | A3           |
| 30       | 16850,06           | A2           | 79       | 17300,83           | A4           |
| 31       | 16806,01           | A1           | 80       | 17322,53           | A4           |
| 32       | 16915,31           | A2           | 81       | 17262,02           | A4           |
| 33       | 16933,54           | A2           | 82       | 17339,91           | A4           |
| 34       | 16986,29           | A2           | 83       | 17563,42           | A4           |
| 35       | 17006,18           | A2           | 84       | 17708,31           | A6           |
| 36       | 16979,24           | A2           | 85       | 17780,35           | A6           |
| 37       | 16910,5            | A2           | 86       | 17757,98           | A7           |
| 38       | 16925,94           | A2           | 87       | 17983,38           | A7           |
| 39       | 17023,1            | A3           | 88       | 18028,39           | A8           |
| 40       | 16936,38           | A2           | 89       | 17939,92           | A8           |
| 41       | 16908,4            | A2           | 90       | 17857,77           | A8           |
| 42       | 16911,13           | A2           | 91       | 17904,52           | A7           |
| 43       | 16757,69           | A1           | 92       | 18059,89           | A7           |
| 44       | 16811,01           | A1           | 93       | 18093,97           | A8           |

**Lampiran 2. (Lanjutan)**

| <b>t</b> | <b>Aktual (Rp)</b> | <b>Fuzzy</b> | <b>t</b> | <b>Aktual (Rp)</b> | <b>Fuzzy</b> |
|----------|--------------------|--------------|----------|--------------------|--------------|
| 45       | 16924,21           | A2           | 94       | 18020,98           | A8           |
| 46       | 16824,19           | A1           | 95       | 17976,52           | A8           |
| 47       | 16795,71           | A1           | 96       | 18040,23           | A8           |
| 48       | 16759,96           | A1           | 97       | 18021,47           | A8           |
| 49       | 16715,84           | A3           | 98       | 17982,94           | A8           |



**Lampiran 3. Hasil Fuzzy Logical Relationship (FLR)**

| t  | Aktual<br>(Rp) | FLR |   |    | t  | Aktual<br>(Rp) | FLR |   |    |
|----|----------------|-----|---|----|----|----------------|-----|---|----|
| 1  | 17142,48       | A3  | → | A3 | 50 | 16763,16       | A1  | → | A2 |
| 2  | 17174,77       | A3  | → | A4 | 51 | 16894,17       | A2  | → | A2 |
| 3  | 17241,76       | A4  | → | A4 | 52 | 16950,39       | A2  | → | A2 |
| 4  | 17253,44       | A4  | → | A3 | 53 | 16923,83       | A2  | → | A2 |
| 5  | 17089,26       | A3  | → | A3 | 54 | 16977,09       | A2  | → | A3 |
| 6  | 17039,02       | A3  | → | A2 | 55 | 17026,48       | A3  | → | A3 |
| 7  | 16977,8        | A2  | → | A2 | 56 | 17084,67       | A3  | → | A2 |
| 8  | 16844,09       | A2  | → | A2 | 57 | 17013,31       | A2  | → | A3 |
| 9  | 16853,15       | A2  | → | A1 | 58 | 17033,18       | A3  | → | A3 |
| 10 | 16818,91       | A1  | → | A1 | 59 | 17033,13       | A3  | → | A3 |
| 11 | 16832,93       | A1  | → | A2 | 60 | 17057,5        | A3  | → | A2 |
| 12 | 16856,83       | A2  | → | A1 | 61 | 16908,96       | A2  | → | A2 |
| 13 | 16800,05       | A1  | → | A1 | 62 | 16959,97       | A2  | → | A3 |
| 14 | 16815,41       | A1  | → | A2 | 63 | 17051,68       | A3  | → | A3 |
| 15 | 16860,06       | A2  | → | A2 | 64 | 17036,93       | A3  | → | A3 |
| 16 | 16882,08       | A2  | → | A1 | 65 | 17048,13       | A3  | → | A2 |
| 17 | 16769,3        | A1  | → | A1 | 66 | 16947,71       | A2  | → | A2 |
| 18 | 16662,36       | A1  | → | A1 | 67 | 16962,34       | A2  | → | A3 |
| 19 | 16771,71       | A1  | → | A1 | 68 | 17064,18       | A3  | → | A3 |
| 20 | 16804,26       | A1  | → | A2 | 69 | 17147,46       | A3  | → | A3 |
| 21 | 16861,12       | A2  | → | A1 | 70 | 17129,1        | A3  | → | A3 |
| 22 | 16788,54       | A1  | → | A1 | 71 | 17077,43       | A3  | → | A3 |
| 23 | 16829,63       | A1  | → | A2 | 72 | 17115,32       | A3  | → | A3 |
| 24 | 16854,66       | A2  | → | A1 | 73 | 17183,46       | A3  | → | A3 |
| 25 | 16827,53       | A1  | → | A2 | 74 | 17135,31       | A3  | → | A3 |
| 26 | 16858,98       | A2  | → | A2 | 75 | 17189,11       | A3  | → | A3 |
| 27 | 16840,94       | A2  | → | A1 | 76 | 17190,63       | A3  | → | A3 |
| 28 | 16829,21       | A1  | → | A1 | 77 | 17160,07       | A3  | → | A4 |
| 29 | 16769,36       | A1  | → | A2 | 78 | 17285,8        | A4  | → | A4 |
| 30 | 16850,06       | A2  | → | A1 | 79 | 17300,83       | A4  | → | A4 |
| 31 | 16806,01       | A1  | → | A2 | 80 | 17322,53       | A4  | → | A4 |
| 32 | 16915,31       | A2  | → | A2 | 81 | 17262,02       | A4  | → | A4 |
| 33 | 16933,54       | A2  | → | A2 | 82 | 17339,91       | A4  | → | A6 |
| 34 | 16986,29       | A2  | → | A2 | 83 | 17563,42       | A6  | → | A6 |
| 35 | 17006,18       | A2  | → | A2 | 84 | 17708,31       | A6  | → | A7 |
| 36 | 16979,24       | A2  | → | A2 | 85 | 17780,35       | A7  | → | A7 |
| 37 | 16910,5        | A2  | → | A2 | 86 | 17757,98       | A7  | → | A8 |
| 38 | 16925,94       | A2  | → | A3 | 87 | 17983,38       | A8  | → | A8 |
| 39 | 17023,1        | A3  | → | A2 | 88 | 18028,39       | A8  | → | A8 |
| 40 | 16936,38       | A2  | → | A2 | 89 | 17939,92       | A8  | → | A7 |
| 41 | 16908,4        | A2  | → | A2 | 90 | 17857,77       | A7  | → | A7 |
| 42 | 16911,13       | A2  | → | A1 | 91 | 17904,52       | A7  | → | A8 |



**Lampiran 3. (Lanjutan)**

| t  | Aktual<br>(Rp) | FLR | t | Aktual<br>(Rp) | FLR | t        | Aktual<br>(Rp) | FLR | t  |
|----|----------------|-----|---|----------------|-----|----------|----------------|-----|----|
| 43 | 16757,69       | A1  | → | A1             | 92  | 18059,89 | A8             | →   | A8 |
| 44 | 16811,01       | A1  | → | A2             | 93  | 18093,97 | A8             | →   | A8 |
| 45 | 16924,21       | A2  | → | A1             | 94  | 18020,98 | A8             | →   | A8 |
| 46 | 16824,19       | A1  | → | A1             | 95  | 17976,52 | A8             | →   | A8 |
| 47 | 16795,71       | A1  | → | A1             | 96  | 18040,23 | A8             | →   | A8 |
| 48 | 16759,96       | A1  | → | A1             | 97  | 18021,47 | A8             | →   | A8 |
| 49 | 16715,84       | A1  | → | A1             | 98  | 17982,94 | A8             | →   | *  |



**Lampiran 4. Hasil Prediksi Awal  $F(t)$  Markov Chain**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> | <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> |
|----------|--------------------|--------------------------|----------|--------------------|--------------------------|
| 1        | 17142,48           | *                        | 50       | 16763,16           | 16832,94                 |
| 2        | 17174,77           | 17109,03                 | 51       | 16894,17           | 16807,73                 |
| 3        | 17241,76           | 17131,49                 | 52       | 16950,39           | 16834,77                 |
| 4        | 17253,44           | 17280,68                 | 53       | 16923,83           | 16887,35                 |
| 5        | 17089,26           | 17289,02                 | 54       | 16977,09           | 16918,18                 |
| 6        | 17039,02           | 17072,01                 | 55       | 17026,48           | 16903,62                 |
| 7        | 16977,8            | 17037,06                 | 56       | 17084,67           | 16932,83                 |
| 8        | 16844,09           | 16933,21                 | 57       | 17013,31           | 17028,34                 |
| 9        | 16853,15           | 16859,89                 | 58       | 17033,18           | 17068,82                 |
| 10       | 16818,91           | 16864,86                 | 59       | 17033,13           | 16952,69                 |
| 11       | 16832,93           | 16866,62                 | 60       | 17057,5            | 17033,00                 |
| 12       | 16856,83           | 16874,64                 | 61       | 16908,96           | 17032,96                 |
| 13       | 16800,05           | 16866,88                 | 62       | 16959,97           | 17049,92                 |
| 14       | 16815,41           | 16855,85                 | 63       | 17051,68           | 16895,46                 |
| 15       | 16860,06           | 16864,62                 | 64       | 17036,93           | 16923,44                 |
| 16       | 16882,08           | 16868,65                 | 65       | 17048,13           | 17045,87                 |
| 17       | 16769,3            | 16880,72                 | 66       | 16947,71           | 17035,61                 |
| 18       | 16662,36           | 16838,28                 | 67       | 16962,34           | 17043,40                 |
| 19       | 16771,71           | 16777,17                 | 68       | 17064,18           | 16916,71                 |
| 20       | 16804,26           | 16839,65                 | 69       | 17147,46           | 16924,74                 |
| 21       | 16861,12           | 16858,25                 | 70       | 17129,1            | 17054,56                 |
| 22       | 16788,54           | 16869,23                 | 71       | 17077,43           | 17112,50                 |
| 23       | 16829,63           | 16849,27                 | 72       | 17115,32           | 17099,72                 |
| 24       | 16854,66           | 16872,75                 | 73       | 17183,46           | 17063,78                 |
| 25       | 16827,53           | 16865,69                 | 74       | 17135,31           | 17090,14                 |
| 26       | 16858,98           | 16871,55                 | 75       | 17189,11           | 17137,54                 |
| 27       | 16840,94           | 16868,06                 | 76       | 17190,63           | 17104,04                 |
| 28       | 16829,21           | 16858,16                 | 77       | 17160,07           | 17141,47                 |
| 29       | 16769,36           | 16872,51                 | 78       | 17285,8            | 17142,53                 |
| 30       | 16850,06           | 16838,31                 | 79       | 17300,83           | 17121,27                 |
| 31       | 16806,01           | 16863,16                 | 80       | 17322,53           | 17312,13                 |
| 32       | 16915,31           | 16859,25                 | 81       | 17262,02           | 17322,87                 |
| 33       | 16933,54           | 16898,95                 | 82       | 17339,91           | 17338,37                 |
| 34       | 16986,29           | 16908,94                 | 83       | 17563,42           | 17295,15                 |
| 35       | 17006,18           | 16937,87                 | 84       | 17708,31           | 17350,78                 |
| 36       | 16979,24           | 16948,78                 | 85       | 17780,35           | 17694,55                 |
| 37       | 16910,5            | 16934,00                 | 86       | 17757,98           | 17766,99                 |
| 38       | 16925,94           | 16896,31                 | 87       | 17983,38           | 17892,56                 |
| 39       | 17023,1            | 16904,78                 | 88       | 18028,39           | 17881,38                 |
| 40       | 16936,38           | 17025,99                 | 89       | 17939,92           | 17965,86                 |
| 41       | 16908,4            | 16910,50                 | 90       | 17857,77           | 18005,87                 |
| 42       | 16911,13           | 16895,16                 | 91       | 17904,52           | 17927,23                 |
| 43       | 16757,69           | 16896,65                 | 92       | 18059,89           | 17931,27                 |
| 44       | 16811,01           | 16831,64                 | 93       | 18093,97           | 17954,65                 |



**Lampiran 4. (Lanjutan)**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> | <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> |
|----------|--------------------|--------------------------|----------|--------------------|--------------------------|
| 45       | 16924,21           | 16862,11                 | 94       | 18020,98           | 18064,16                 |
| 46       | 16824,19           | 16903,83                 | 95       | 17976,52           | 17999,28                 |
| 47       | 16795,71           | 16869,64                 | 96       | 18040,23           | 17959,76                 |
| 48       | 16759,96           | 16853,37                 | 97       | 18021,47           | 18016,39                 |
| 49       | 16715,84           | 16832,94                 | 98       | 17982,94           | 17999,72                 |



**Lampiran 5. Hasil Perhitungan  $D_t$  Markov Chain**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> | <b><math>D_{t1}</math></b> | <b><math>D_{t2}</math></b> |
|----------|--------------------|--------------------------|----------------------------|----------------------------|
| 1        | 17142,48           | *                        | *                          | *                          |
| 2        | 17174,77           | 17109,03                 | 0                          | 0                          |
| 3        | 17241,76           | 17131,49                 | 89,54                      | 89,54                      |
| 4        | 17253,44           | 17280,68                 | 0                          | 0                          |
| 5        | 17089,26           | 17289,02                 | -89,54                     | -89,54                     |
| 6        | 17039,02           | 17072,01                 | 0                          | 0                          |
| 7        | 16977,8            | 17037,06                 | -89,54                     | -89,54                     |
| 8        | 16844,09           | 16933,21                 | 0                          | 0                          |
| 9        | 16853,15           | 16859,89                 | 0                          | 0                          |
| 10       | 16818,91           | 16864,86                 | -89,54                     | -89,54                     |
| 11       | 16832,93           | 16866,62                 | 0                          | 0                          |
| 12       | 16856,83           | 16874,64                 | 89,54                      | 89,54                      |
| 13       | 16800,05           | 16866,88                 | -89,54                     | -89,54                     |
| 14       | 16815,41           | 16855,85                 | 0                          | 0                          |
| 15       | 16860,06           | 16864,62                 | 89,54                      | 89,54                      |
| 16       | 16882,08           | 16868,65                 | 0                          | 0                          |
| 17       | 16769,3            | 16880,72                 | -89,54                     | -89,54                     |
| 18       | 16662,36           | 16838,28                 | 0                          | 0                          |
| 19       | 16771,71           | 16777,17                 | 0                          | 0                          |
| 20       | 16804,26           | 16839,65                 | 0                          | 0                          |
| 21       | 16861,12           | 16858,25                 | 89,54                      | 89,54                      |
| 22       | 16788,54           | 16869,23                 | -89,54                     | -89,54                     |
| 23       | 16829,63           | 16849,27                 | 0                          | 0                          |
| 24       | 16854,66           | 16872,75                 | 89,54                      | 89,54                      |
| 25       | 16827,53           | 16865,69                 | -89,54                     | -89,54                     |
| 26       | 16858,98           | 16871,55                 | 89,54                      | 89,54                      |
| 27       | 16840,94           | 16868,06                 | 0                          | 0                          |
| 28       | 16829,21           | 16858,16                 | -89,54                     | -89,54                     |
| 29       | 16769,36           | 16872,51                 | 0                          | 0                          |
| 30       | 16850,06           | 16838,31                 | 89,54                      | 89,54                      |
| 31       | 16806,01           | 16863,16                 | -89,54                     | -89,54                     |
| 32       | 16915,31           | 16859,25                 | 89,54                      | 89,54                      |
| 33       | 16933,54           | 16898,95                 | 0                          | 0                          |
| 34       | 16986,29           | 16908,94                 | 0                          | 0                          |
| 35       | 17006,18           | 16937,87                 | 0                          | 0                          |
| 36       | 16979,24           | 16948,78                 | 0                          | 0                          |
| 37       | 16910,5            | 16934,00                 | 0                          | 0                          |
| 38       | 16925,94           | 16896,31                 | 0                          | 0                          |
| 39       | 17023,1            | 16904,78                 | 89,54                      | 89,54                      |
| 40       | 16936,38           | 17025,99                 | -89,54                     | -89,54                     |
| 41       | 16908,4            | 16910,50                 | 0                          | 0                          |
| 42       | 16911,13           | 16895,16                 | 0                          | 0                          |
| 43       | 16757,69           | 16896,65                 | -89,54                     | -89,54                     |
| 44       | 16811,01           | 16831,64                 | 0                          | 0                          |

## Lampiran 5. (Lanjutan)

| t  | Aktual (Rp) | $F(t)$   | $D_{t1}$ | $D_{t2}$ |
|----|-------------|----------|----------|----------|
| 45 | 16924,21    | 16862,11 | 89,54    | 89,54    |
| 46 | 16824,19    | 16903,83 | -89,54   | -89,54   |
| 47 | 16795,71    | 16869,64 | 0        | 0        |
| 48 | 16759,96    | 16853,37 | 0        | 0        |
| 49 | 16715,84    | 16832,94 | 0        | 0        |
| 50 | 16763,16    | 16807,73 | 0        | 0        |
| 51 | 16894,17    | 16834,77 | 89,54    | 89,54    |
| 52 | 16950,39    | 16887,35 | 0        | 0        |
| 53 | 16923,83    | 16918,18 | 0        | 0        |
| 54 | 16977,09    | 16903,62 | 0        | 0        |
| 55 | 17026,48    | 16932,83 | 89,54    | 89,54    |
| 56 | 17084,67    | 17028,34 | 0        | 0        |
| 57 | 17013,31    | 17068,82 | -89,54   | -89,54   |
| 58 | 17033,18    | 16952,69 | 89,54    | 89,54    |
| 59 | 17033,13    | 17033,00 | 0        | 0        |
| 60 | 17057,5     | 17032,96 | 0        | 0        |
| 61 | 16908,96    | 17049,92 | -89,54   | -89,54   |
| 62 | 16959,97    | 16895,46 | 0        | 0        |
| 63 | 17051,68    | 16923,44 | 89,54    | 89,54    |
| 64 | 17036,93    | 17045,87 | 0        | 0        |
| 65 | 17048,13    | 17035,61 | 0        | 0        |
| 66 | 16947,71    | 17043,40 | -89,54   | -89,54   |
| 67 | 16962,34    | 16916,71 | 0        | 0        |
| 68 | 17064,18    | 16924,74 | 89,54    | 89,54    |
| 69 | 17147,46    | 17054,56 | 0,00     | 0,00     |
| 70 | 17129,1     | 17112,50 | 0,00     | 0,00     |
| 71 | 17077,43    | 17099,72 | 0        | 0        |
| 72 | 17115,32    | 17063,78 | 0        | 0        |
| 73 | 17183,46    | 17090,14 | 0        | 0        |
| 74 | 17135,31    | 17137,54 | 0        | 0        |
| 75 | 17189,11    | 17104,04 | 0        | 0        |
| 76 | 17190,63    | 17141,47 | 0        | 0        |
| 77 | 17160,07    | 17142,53 | 0        | 0        |
| 78 | 17285,8     | 17082,34 | 89,54    | 89,54    |
| 79 | 17300,83    | 17312,13 | 0        | 0        |
| 80 | 17322,53    | 17322,87 | 0        | 0        |
| 81 | 17262,02    | 17338,37 | 0        | 0        |
| 82 | 17339,91    | 17295,15 | 0        | 0        |
| 83 | 17563,42    | 17350,78 | 89,54    | 179,09   |
| 84 | 17708,31    | 17605,01 | 0        | 0        |
| 85 | 17780,35    | 17677,45 | 89,54    | 89,54    |
| 86 | 17757,98    | 17892,56 | 0        | 0        |
| 87 | 17983,38    | 17881,38 | 89,54    | 89,54    |
| 88 | 18028,39    | 17965,86 | 0        | 0        |

**Lampiran 5. (Lanjutan)**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> | <b><math>D_{t1}</math></b> | <b><math>D_{t2}</math></b> |
|----------|--------------------|--------------------------|----------------------------|----------------------------|
| 89       | 17939,92           | 18005,87                 | 0                          | 0                          |
| 90       | 17857,77           | 17927,23                 | -89,54                     | -89,54                     |
| 91       | 17904,52           | 17931,27                 | 0                          | 0                          |
| 92       | 18059,89           | 17954,65                 | 89,54                      | 89,54                      |
| 93       | 18093,97           | 18033,87                 | 0                          | 0                          |
| 94       | 18020,98           | 18064,16                 | 0                          | 0                          |
| 95       | 17976,52           | 17999,28                 | 0                          | 0                          |
| 96       | 18040,23           | 17959,76                 | 0                          | 0                          |
| 97       | 18021,47           | 18016,39                 | 0                          | 0                          |
| 98       | 17982,94           | 17999,72                 | 0                          | 0                          |



*Lampiran 6. Hasil Akhir Prediksi  $F'(t)$  dari FTS Markov Chain*

| t  | Aktual<br>(Rp) | $F(t)$   | $F'(t)$  | t  | Aktual<br>(Rp) | $F(t)$   | $F'(t)$  |
|----|----------------|----------|----------|----|----------------|----------|----------|
| 1  | 17142,48       | *        | *        | 50 | 16763,16       | 16807,73 | 16807,73 |
| 2  | 17174,77       | 17109,03 | 17109,03 | 51 | 16894,17       | 16834,77 | 17013,86 |
| 3  | 17241,76       | 17131,49 | 17310,58 | 52 | 16950,39       | 16887,35 | 16887,35 |
| 4  | 17253,44       | 17280,68 | 17280,68 | 53 | 16923,83       | 16918,18 | 16918,18 |
| 5  | 17089,26       | 17289,02 | 17109,93 | 54 | 16977,09       | 16903,62 | 16903,62 |
| 6  | 17039,02       | 17072,01 | 17072,01 | 55 | 17026,48       | 16932,83 | 17111,91 |
| 7  | 16977,8        | 17037,06 | 16857,97 | 56 | 17084,67       | 17028,34 | 17028,34 |
| 8  | 16844,09       | 16933,21 | 16933,21 | 57 | 17013,31       | 17068,82 | 16889,73 |
| 9  | 16853,15       | 16859,89 | 16859,89 | 58 | 17033,18       | 16952,69 | 17131,78 |
| 10 | 16818,91       | 16864,86 | 16685,77 | 59 | 17033,13       | 17033,00 | 17033,00 |
| 11 | 16832,93       | 16866,62 | 16866,62 | 60 | 17057,5        | 17032,96 | 17032,96 |
| 12 | 16856,83       | 16874,64 | 17053,72 | 61 | 16908,96       | 17049,92 | 16870,83 |
| 13 | 16800,05       | 16866,88 | 16687,79 | 62 | 16959,97       | 16895,46 | 16895,46 |
| 14 | 16815,41       | 16855,85 | 16855,85 | 63 | 17051,68       | 16923,44 | 17102,53 |
| 15 | 16860,06       | 16864,62 | 17043,71 | 64 | 17036,93       | 17045,87 | 17045,87 |
| 16 | 16882,08       | 16868,65 | 16868,65 | 65 | 17048,13       | 17035,61 | 17035,61 |
| 17 | 16769,3        | 16880,72 | 16701,63 | 66 | 16947,71       | 17043,40 | 16864,31 |
| 18 | 16662,36       | 16838,28 | 16838,28 | 67 | 16962,34       | 16916,71 | 16916,71 |
| 19 | 16771,71       | 16777,17 | 16777,17 | 68 | 17064,18       | 16924,74 | 17103,83 |
| 20 | 16804,26       | 16839,65 | 16839,65 | 69 | 17147,46       | 17054,56 | 17054,56 |
| 21 | 16861,12       | 16858,25 | 17037,34 | 70 | 17129,1        | 17112,50 | 17112,50 |
| 22 | 16788,54       | 16869,23 | 16690,14 | 71 | 17077,43       | 17099,72 | 17099,72 |
| 23 | 16829,63       | 16849,27 | 16849,27 | 72 | 17115,32       | 17063,78 | 17063,78 |
| 24 | 16854,66       | 16872,75 | 17051,84 | 73 | 17183,46       | 17090,14 | 17090,14 |
| 25 | 16827,53       | 16865,69 | 16686,60 | 74 | 17135,31       | 17137,54 | 17137,54 |
| 26 | 16858,98       | 16871,55 | 17050,64 | 75 | 17189,11       | 17104,04 | 17104,04 |
| 27 | 16840,94       | 16868,06 | 16868,06 | 76 | 17190,63       | 17141,47 | 17141,47 |
| 28 | 16829,21       | 16858,16 | 16679,07 | 77 | 17160,07       | 17142,53 | 17142,53 |
| 29 | 16769,36       | 16872,51 | 16872,51 | 78 | 17285,8        | 17082,34 | 17300,35 |
| 30 | 16850,06       | 16838,31 | 17017,40 | 79 | 17300,83       | 17312,13 | 17312,13 |
| 31 | 16806,01       | 16863,16 | 16684,07 | 80 | 17322,53       | 17322,87 | 17322,87 |
| 32 | 16915,31       | 16859,25 | 17038,34 | 81 | 17262,02       | 17338,37 | 17338,37 |
| 33 | 16933,54       | 16898,95 | 16898,95 | 82 | 17339,91       | 17295,15 | 17295,15 |
| 34 | 16986,29       | 16908,94 | 16908,94 | 83 | 17563,42       | 17350,78 | 17619,42 |
| 35 | 17006,18       | 16937,87 | 16937,87 | 84 | 17708,31       | 17605,01 | 17694,55 |
| 36 | 16979,24       | 16948,78 | 16948,78 | 85 | 17780,35       | 17677,45 | 17946,08 |
| 37 | 16910,5        | 16934,00 | 16934,00 | 86 | 17757,98       | 17892,56 | 17892,56 |
| 38 | 16925,94       | 16896,31 | 16896,31 | 87 | 17983,38       | 17881,38 | 18060,47 |
| 39 | 17023,1        | 16904,78 | 17083,86 | 88 | 18028,39       | 17965,86 | 17965,86 |
| 40 | 16936,38       | 17025,99 | 16846,90 | 89 | 17939,92       | 18005,87 | 18005,87 |
| 41 | 16908,4        | 16910,50 | 16910,50 | 90 | 17857,77       | 17927,23 | 17748,14 |
| 42 | 16911,13       | 16895,16 | 16895,16 | 91 | 17904,52       | 17931,27 | 17931,27 |
| 43 | 16757,69       | 16896,65 | 16717,56 | 92 | 18059,89       | 17954,65 | 18133,74 |



**Lampiran 6. (Lanjutan)**

| t  | Aktual<br>(Rp) | $F(t)$   | $F'(t)$  | t  | Aktual<br>(Rp) | $F(t)$   | $F'(t)$  |
|----|----------------|----------|----------|----|----------------|----------|----------|
| 44 | 16811,01       | 16811,01 | 16831,64 | 93 | 18093,97       | 18033,87 | 18033,87 |
| 45 | 16924,21       | 16862,11 | 17041,20 | 94 | 18020,98       | 18064,16 | 18064,16 |
| 46 | 16824,19       | 16903,83 | 16724,74 | 95 | 17976,52       | 17999,28 | 17999,28 |
| 47 | 16795,71       | 16869,64 | 16869,64 | 96 | 18040,23       | 17959,76 | 17959,76 |
| 48 | 16759,96       | 16853,37 | 16853,37 | 97 | 18021,47       | 18016,39 | 18016,39 |
| 49 | 16715,84       | 16832,94 | 16832,94 | 98 | 17982,94       | 17999,72 | 17999,72 |



**Lampiran 7. Hasil Perhitungan dari  $D_z$ ,  $X_i$ ,  $XX_i$ ,  $Y_i$  dan  $YY_i$**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>D_z</math></b> | <b><math>X_i</math></b> | <b><math>XX_i</math></b> | <b><math>Y_i</math></b> | <b><math>YY_i</math></b> |
|----------|--------------------|-------------------------|-------------------------|--------------------------|-------------------------|--------------------------|
| 1        | 17142,48           | *                       | *                       | *                        | *                       | *                        |
| 2        | 17174,77           | *                       | *                       | *                        | *                       | *                        |
| 3        | 17241,76           | *                       | *                       | *                        | *                       | *                        |
| 4        | 17253,44           | 55,31                   | 17308,75                | 17198,13                 | 17281,10                | 17225,79                 |
| 5        | 17089,26           | 152,50                  | 17241,76                | 16936,76                 | 17165,51                | 17013,01                 |
| 6        | 17039,02           | 113,94                  | 17152,96                | 16925,08                 | 17095,99                | 16982,05                 |
| 7        | 16977,8            | 10,98                   | 16988,78                | 16966,82                 | 16983,29                | 16972,31                 |
| 8        | 16844,09           | 72,49                   | 16916,58                | 16771,60                 | 16880,34                | 16807,85                 |
| 9        | 16853,15           | 124,65                  | 16977,80                | 16728,50                 | 16915,48                | 16790,83                 |
| 10       | 16818,91           | 25,18                   | 16844,09                | 16793,73                 | 16831,50                | 16806,32                 |
| 11       | 16832,93           | 20,22                   | 16853,15                | 16812,71                 | 16843,04                | 16822,82                 |
| 12       | 16856,83           | 9,88                    | 16866,71                | 16846,95                 | 16861,77                | 16851,89                 |
| 13       | 16800,05           | 32,88                   | 16832,93                | 16767,17                 | 16816,49                | 16783,61                 |
| 14       | 16815,41           | 41,42                   | 16856,83                | 16773,99                 | 16836,12                | 16794,70                 |
| 15       | 16860,06           | 29,29                   | 16889,35                | 16830,77                 | 16874,71                | 16845,42                 |
| 16       | 16882,08           | 22,63                   | 16904,71                | 16859,45                 | 16893,40                | 16870,77                 |
| 17       | 16769,3            | 90,76                   | 16860,06                | 16678,54                 | 16814,68                | 16723,92                 |
| 18       | 16662,36           | 5,84                    | 16668,20                | 16656,52                 | 16665,28                | 16659,44                 |
| 19       | 16771,71           | 2,41                    | 16774,12                | 16769,30                 | 16772,92                | 16770,51                 |
| 20       | 16804,26           | 76,80                   | 16881,06                | 16727,46                 | 16842,66                | 16765,86                 |
| 21       | 16861,12           | 24,31                   | 16885,43                | 16836,81                 | 16873,28                | 16848,97                 |
| 22       | 16788,54           | 15,72                   | 16804,26                | 16772,82                 | 16796,40                | 16780,68                 |
| 23       | 16829,63           | 31,49                   | 16861,12                | 16798,14                 | 16845,38                | 16813,89                 |
| 24       | 16854,66           | 16,06                   | 16870,72                | 16838,60                 | 16862,69                | 16846,63                 |
| 25       | 16827,53           | 2,10                    | 16829,63                | 16825,43                 | 16828,58                | 16826,48                 |
| 26       | 16858,98           | 4,32                    | 16863,30                | 16854,66                 | 16861,14                | 16856,82                 |
| 27       | 16840,94           | 13,41                   | 16854,35                | 16827,53                 | 16847,65                | 16834,24                 |
| 28       | 16829,21           | 6,31                    | 16835,52                | 16822,90                 | 16832,37                | 16826,06                 |
| 29       | 16769,36           | 48,12                   | 16817,48                | 16721,24                 | 16793,42                | 16745,30                 |
| 30       | 16850,06           | 20,85                   | 16870,91                | 16829,21                 | 16860,49                | 16839,64                 |
| 31       | 16806,01           | 36,65                   | 16842,66                | 16769,36                 | 16824,34                | 16787,69                 |
| 32       | 16915,31           | 65,25                   | 16980,56                | 16850,06                 | 16947,94                | 16882,69                 |
| 33       | 16933,54           | 91,07                   | 17024,61                | 16842,47                 | 16979,08                | 16888,01                 |
| 34       | 16986,29           | 34,52                   | 17020,81                | 16951,77                 | 17003,55                | 16969,03                 |
| 35       | 17006,18           | 32,86                   | 17039,04                | 16973,32                 | 17022,61                | 16989,75                 |
| 36       | 16979,24           | 7,05                    | 16986,29                | 16972,19                 | 16982,77                | 16975,72                 |
| 37       | 16910,5            | 41,80                   | 16952,30                | 16868,70                 | 16931,40                | 16889,60                 |
| 38       | 16925,94           | 53,30                   | 16979,24                | 16872,64                 | 16952,59                | 16899,29                 |
| 39       | 17023,1            | 81,72                   | 17104,82                | 16941,38                 | 17063,96                | 16982,24                 |
| 40       | 16936,38           | 10,44                   | 16946,82                | 16925,94                 | 16941,60                | 16931,16                 |
| 41       | 16908,4            | 58,74                   | 16967,14                | 16849,66                 | 16937,77                | 16879,03                 |
| 42       | 16911,13           | 25,25                   | 16936,38                | 16885,88                 | 16923,76                | 16898,51                 |
| 43       | 16757,69           | 150,71                  | 16908,40                | 16606,98                 | 16833,05                | 16682,34                 |
| 44       | 16811,01           | 100,12                  | 16911,13                | 16710,89                 | 16861,07                | 16760,95                 |

## Lampiran 7. (Lanjutan)

| t  | Aktual (Rp) | $D_z$  | $X_i$    | $XX_i$   | $Y_i$    | $YY_i$   |
|----|-------------|--------|----------|----------|----------|----------|
| 45 | 16924,21    | 59,88  | 16984,09 | 16864,33 | 16954,15 | 16894,27 |
| 46 | 16824,19    | 13,18  | 16837,37 | 16811,01 | 16830,78 | 16817,60 |
| 47 | 16795,71    | 71,54  | 16867,25 | 16724,17 | 16831,48 | 16759,94 |
| 48 | 16759,96    | 7,27   | 16767,23 | 16752,69 | 16763,60 | 16756,33 |
| 49 | 16715,84    | 8,37   | 16724,21 | 16707,47 | 16720,03 | 16711,66 |
| 50 | 16763,16    | 3,20   | 16766,36 | 16759,96 | 16764,76 | 16761,56 |
| 51 | 16894,17    | 83,69  | 16977,86 | 16810,48 | 16936,02 | 16852,33 |
| 52 | 16950,39    | 74,79  | 17025,18 | 16875,60 | 16987,79 | 16913,00 |
| 53 | 16923,83    | 29,66  | 16953,49 | 16894,17 | 16938,66 | 16909,00 |
| 54 | 16977,09    | 26,70  | 17003,79 | 16950,39 | 16990,44 | 16963,74 |
| 55 | 17026,48    | 3,87   | 17030,35 | 17022,61 | 17028,42 | 17024,55 |
| 56 | 17084,67    | 8,80   | 17093,47 | 17075,87 | 17089,07 | 17080,27 |
| 57 | 17013,31    | 13,17  | 17026,48 | 17000,14 | 17019,90 | 17006,73 |
| 58 | 17033,18    | 51,49  | 17084,67 | 16981,69 | 17058,93 | 17007,44 |
| 59 | 17033,13    | 19,82  | 17052,95 | 17013,31 | 17043,04 | 17023,22 |
| 60 | 17057,5     | 24,32  | 17081,82 | 17033,18 | 17069,66 | 17045,34 |
| 61 | 16908,96    | 124,17 | 17033,13 | 16784,79 | 16971,05 | 16846,88 |
| 62 | 16959,97    | 97,53  | 17057,50 | 16862,44 | 17008,74 | 16911,21 |
| 63 | 17051,68    | 40,70  | 17092,38 | 17010,98 | 17072,03 | 17031,33 |
| 64 | 17036,93    | 76,96  | 17113,89 | 16959,97 | 17075,41 | 16998,45 |
| 65 | 17048,13    | 3,55   | 17051,68 | 17044,58 | 17049,91 | 17046,36 |
| 66 | 16947,71    | 89,22  | 17036,93 | 16858,49 | 16992,32 | 16903,10 |
| 67 | 16962,34    | 85,79  | 17048,13 | 16876,55 | 17005,24 | 16919,45 |
| 68 | 17064,18    | 87,21  | 17151,39 | 16976,97 | 17107,79 | 17020,58 |
| 69 | 17147,46    | 18,56  | 17166,02 | 17128,90 | 17156,74 | 17138,18 |
| 70 | 17129,1     | 64,92  | 17194,02 | 17064,18 | 17161,56 | 17096,64 |
| 71 | 17077,43    | 33,31  | 17110,74 | 17044,12 | 17094,09 | 17060,78 |
| 72 | 17115,32    | 13,78  | 17129,10 | 17101,54 | 17122,21 | 17108,43 |
| 73 | 17183,46    | 30,25  | 17213,71 | 17153,21 | 17198,59 | 17168,34 |
| 74 | 17135,31    | 19,99  | 17155,30 | 17115,32 | 17145,31 | 17125,32 |
| 75 | 17189,11    | 5,65   | 17194,76 | 17183,46 | 17191,94 | 17186,29 |
| 76 | 17190,63    | 52,28  | 17242,91 | 17138,35 | 17216,77 | 17164,49 |
| 77 | 17160,07    | 29,04  | 17189,11 | 17131,03 | 17174,59 | 17145,55 |
| 78 | 17285,8     | 95,17  | 17380,97 | 17190,63 | 17333,39 | 17238,22 |
| 79 | 17300,83    | 110,70 | 17411,53 | 17190,13 | 17356,18 | 17245,48 |
| 80 | 17322,53    | 6,67   | 17329,20 | 17315,86 | 17325,87 | 17319,20 |
| 81 | 17262,02    | 38,81  | 17300,83 | 17223,21 | 17281,43 | 17242,62 |
| 82 | 17339,91    | 17,38  | 17357,29 | 17322,53 | 17348,60 | 17331,22 |
| 83 | 17563,42    | 145,62 | 17709,04 | 17417,80 | 17636,23 | 17490,61 |
| 84 | 17708,31    | 78,62  | 17786,93 | 17629,69 | 17747,62 | 17669,00 |
| 85 | 17780,35    | 72,85  | 17853,20 | 17707,50 | 17816,78 | 17743,93 |
| 86 | 17757,98    | 49,67  | 17807,65 | 17708,31 | 17782,82 | 17733,15 |
| 87 | 17983,38    | 203,03 | 18186,41 | 17780,35 | 18084,90 | 17881,87 |
| 88 | 18028,39    | 180,39 | 18208,78 | 17848,00 | 18118,59 | 17938,20 |

**Lampiran 7. (Lanjutan)**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>D_z</math></b> | <b><math>X_i</math></b> | <b><math>XX_i</math></b> | <b><math>Y_i</math></b> | <b><math>YY_i</math></b> |
|----------|--------------------|-------------------------|-------------------------|--------------------------|-------------------------|--------------------------|
| 89       | 17939,92           | 43,46                   | 17983,38                | 17896,46                 | 17961,65                | 17918,19                 |
| 90       | 17857,77           | 6,32                    | 17864,09                | 17851,45                 | 17860,93                | 17854,61                 |
| 91       | 17904,52           | 35,40                   | 17939,92                | 17869,12                 | 17922,22                | 17886,82                 |
| 92       | 18059,89           | 108,62                  | 18168,51                | 17951,27                 | 18114,20                | 18005,58                 |
| 93       | 18093,97           | 121,29                  | 18215,26                | 17972,68                 | 18154,62                | 18033,33                 |
| 94       | 18020,98           | 38,91                   | 18059,89                | 17982,07                 | 18040,44                | 18001,53                 |
| 95       | 17976,52           | 28,53                   | 18005,05                | 17947,99                 | 17990,79                | 17962,26                 |
| 96       | 18040,23           | 19,25                   | 18059,48                | 18020,98                 | 18049,86                | 18030,61                 |
| 97       | 18021,47           | 44,95                   | 18066,42                | 17976,52                 | 18043,95                | 17999,00                 |
| 98       | 17982,94           | 19,77                   | 18002,71                | 17963,17                 | 17992,83                | 17973,06                 |



**Lampiran 8. Hasil Prediksi Fuzzy Times Series Singh**

| t  | Aktual (Rp) | $F(t)$   | t  | Aktual (Rp) | $F(t)$   |
|----|-------------|----------|----|-------------|----------|
| 1  | 17142,48    | *        | 50 | 16763,16    | 16706,38 |
| 2  | 17174,77    | *        | 51 | 16894,17    | 16885,47 |
| 3  | 17241,76    | *        | 52 | 16950,39    | 16885,47 |
| 4  | 17253,44    | 17243,65 | 53 | 16923,83    | 16885,47 |
| 5  | 17089,26    | 17064,56 | 54 | 16977,09    | 16885,47 |
| 6  | 17039,02    | 17064,56 | 55 | 17026,48    | 17064,56 |
| 7  | 16977,8     | 16885,47 | 56 | 17084,67    | 17064,56 |
| 8  | 16844,09    | 16885,47 | 57 | 17013,31    | 17064,56 |
| 9  | 16853,15    | 16885,47 | 58 | 17033,18    | 17064,56 |
| 10 | 16818,91    | 16706,38 | 59 | 17033,13    | 17064,56 |
| 11 | 16832,93    | 16706,38 | 60 | 17057,5     | 17064,56 |
| 12 | 16856,83    | 16885,47 | 61 | 16908,96    | 16885,47 |
| 13 | 16800,05    | 16706,38 | 62 | 16959,97    | 16885,47 |
| 14 | 16815,41    | 16706,38 | 63 | 17051,68    | 17064,56 |
| 15 | 16860,06    | 16885,47 | 64 | 17036,93    | 17064,56 |
| 16 | 16882,08    | 16885,47 | 65 | 17048,13    | 17064,56 |
| 17 | 16769,3     | 16885,47 | 66 | 16947,71    | 16885,47 |
| 18 | 16662,36    | 16706,38 | 67 | 16962,34    | 16885,47 |
| 19 | 16771,71    | 16706,38 | 68 | 17064,18    | 17064,56 |
| 20 | 16804,26    | 16885,47 | 69 | 17147,46    | 17064,56 |
| 21 | 16861,12    | 16885,47 | 70 | 17129,1     | 17064,56 |
| 22 | 16788,54    | 16706,38 | 71 | 17077,43    | 17064,56 |
| 23 | 16829,63    | 16885,47 | 72 | 17115,32    | 17064,56 |
| 24 | 16854,66    | 16885,47 | 73 | 17183,46    | 17064,56 |
| 25 | 16827,53    | 16706,38 | 74 | 17135,31    | 17064,56 |
| 26 | 16858,98    | 16885,47 | 75 | 17189,11    | 17064,56 |
| 27 | 16840,94    | 16885,47 | 76 | 17190,63    | 17243,65 |
| 28 | 16829,21    | 16706,38 | 77 | 17160,07    | 17064,56 |
| 29 | 16769,36    | 16706,38 | 78 | 17285,8     | 17243,65 |
| 30 | 16850,06    | 16885,47 | 79 | 17300,83    | 17243,65 |
| 31 | 16806,01    | 16706,38 | 80 | 17322,53    | 17243,65 |
| 32 | 16915,31    | 16885,47 | 81 | 17262,02    | 17243,65 |
| 33 | 16933,54    | 16885,47 | 82 | 17339,91    | 17243,65 |
| 34 | 16986,29    | 16885,47 | 83 | 17563,42    | 17601,83 |
| 35 | 17006,18    | 17064,56 | 84 | 17708,31    | 17780,91 |
| 36 | 16979,24    | 16885,47 | 85 | 17780,35    | 17780,91 |
| 37 | 16910,5     | 16885,47 | 86 | 17757,98    | 17780,91 |
| 38 | 16925,94    | 16885,47 | 87 | 17983,38    | 17960,00 |
| 39 | 17023,1     | 17064,56 | 88 | 18028,39    | 17960,00 |
| 40 | 16936,38    | 16885,47 | 89 | 17939,92    | 17960,00 |
| 41 | 16908,4     | 16885,47 | 90 | 17857,77    | 17780,91 |
| 42 | 16911,13    | 16885,47 | 91 | 17904,52    | 17780,91 |
| 43 | 16757,69    | 16706,38 | 92 | 18059,89    | 17960,00 |
| 44 | 16811,01    | 16885,47 | 93 | 18093,97    | 17960,00 |



**Lampiran 8. (Lanjutan)**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> | <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> |
|----------|--------------------|--------------------------|----------|--------------------|--------------------------|
| 45       | 16924,21           | 16885,47                 | 94       | 18020,98           | 17960,00                 |
| 46       | 16824,19           | 16706,38                 | 95       | 17976,52           | 17960,00                 |
| 47       | 16795,71           | 16706,38                 | 96       | 18040,23           | 17960,00                 |
| 48       | 16759,96           | 16706,38                 | 97       | 18021,47           | 17960,00                 |
| 49       | 16715,84           | 16706,38                 | 98       | 17982,94           | 17960,00                 |



**Lampiran 9. Hasil Prediksi Fuzzy Times Series Chen**

| t  | Aktual (Rp) | F(t)     | t  | Aktual (Rp) | F(t)     |
|----|-------------|----------|----|-------------|----------|
| 1  | 17142,48    | *        | 50 | 16763,16    | 16840,70 |
| 2  | 17174,77    | 17109,33 | 51 | 16894,17    | 16840,70 |
| 3  | 17241,76    | 17109,33 | 52 | 16950,39    | 16930,24 |
| 4  | 17253,44    | 17348,12 | 53 | 16923,83    | 16930,24 |
| 5  | 17089,26    | 17348,12 | 54 | 16977,09    | 16930,24 |
| 6  | 17039,02    | 17109,33 | 55 | 17026,48    | 16930,24 |
| 7  | 16977,8     | 17109,33 | 56 | 17084,67    | 17109,33 |
| 8  | 16844,09    | 16930,24 | 57 | 17013,31    | 17109,33 |
| 9  | 16853,15    | 16930,24 | 58 | 17033,18    | 16930,24 |
| 10 | 16818,91    | 16930,24 | 59 | 17033,13    | 17109,33 |
| 11 | 16832,93    | 16840,70 | 60 | 17057,5     | 17109,33 |
| 12 | 16856,83    | 16840,70 | 61 | 16908,96    | 17109,33 |
| 13 | 16800,05    | 16930,24 | 62 | 16959,97    | 16930,24 |
| 14 | 16815,41    | 16840,70 | 63 | 17051,68    | 16930,24 |
| 15 | 16860,06    | 16840,70 | 64 | 17036,93    | 17109,33 |
| 16 | 16882,08    | 16930,24 | 65 | 17048,13    | 17109,33 |
| 17 | 16769,3     | 16930,24 | 66 | 16947,71    | 17109,33 |
| 18 | 16662,36    | 16840,70 | 67 | 16962,34    | 16930,24 |
| 19 | 16771,71    | 16840,70 | 68 | 17064,18    | 16930,24 |
| 20 | 16804,26    | 16840,70 | 69 | 17147,46    | 17109,33 |
| 21 | 16861,12    | 16840,70 | 70 | 17129,1     | 17109,33 |
| 22 | 16788,54    | 16930,24 | 71 | 17077,43    | 17109,33 |
| 23 | 16829,63    | 16840,70 | 72 | 17115,32    | 17109,33 |
| 24 | 16854,66    | 16840,70 | 73 | 17183,46    | 17109,33 |
| 25 | 16827,53    | 16930,24 | 74 | 17135,31    | 17109,33 |
| 26 | 16858,98    | 16840,70 | 75 | 17189,11    | 17109,33 |
| 27 | 16840,94    | 16930,24 | 76 | 17190,63    | 17109,33 |
| 28 | 16829,21    | 16930,24 | 77 | 17160,07    | 17109,33 |
| 29 | 16769,36    | 16840,70 | 78 | 17285,8     | 17109,33 |
| 30 | 16850,06    | 16840,70 | 79 | 17300,83    | 17348,12 |
| 31 | 16806,01    | 16930,24 | 80 | 17322,53    | 17348,12 |
| 32 | 16915,31    | 16840,70 | 81 | 17262,02    | 17348,12 |
| 33 | 16933,54    | 16930,24 | 82 | 17339,91    | 17348,12 |
| 34 | 16986,29    | 16930,24 | 83 | 17563,42    | 17348,12 |
| 35 | 17006,18    | 16930,24 | 84 | 17708,31    | 17736,14 |
| 36 | 16979,24    | 16930,24 | 85 | 17780,35    | 17736,14 |
| 37 | 16910,5     | 16930,24 | 86 | 17757,98    | 17915,23 |
| 38 | 16925,94    | 16930,24 | 87 | 17983,38    | 17915,23 |
| 39 | 17023,1     | 16930,24 | 88 | 18028,39    | 17915,23 |
| 40 | 16936,38    | 17109,33 | 89 | 17939,92    | 17915,23 |
| 41 | 16908,4     | 16930,24 | 90 | 17857,77    | 17915,23 |
| 42 | 16911,13    | 16930,24 | 91 | 17904,52    | 17915,23 |
| 43 | 16757,69    | 16930,24 | 92 | 18059,89    | 17915,23 |

**Lampiran 9. (Lanjutan)**

| <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> | <b>t</b> | <b>Aktual (Rp)</b> | <b><math>F(t)</math></b> |
|----------|--------------------|--------------------------|----------|--------------------|--------------------------|
| 44       | 16811,01           | 16840,70                 | 93       | 18093,97           | 17915,23                 |
| 45       | 16924,21           | 16840,70                 | 94       | 18020,98           | 17915,23                 |
| 46       | 16824,19           | 16930,24                 | 95       | 17976,52           | 17915,23                 |
| 47       | 16795,71           | 16840,70                 | 96       | 18040,23           | 17915,23                 |
| 48       | 16759,96           | 16840,70                 | 97       | 18021,47           | 17915,23                 |
| 49       | 16715,84           | 16840,70                 | 98       | 17982,94           | 17915,23                 |



**Lampiran 10. Perhitungan Tingkat Akurasi dari FTS Markov Chain**

| t  | Aktual<br>(Rp) | $F'(t)$  | Error   | $(Error)^2$ | Error  | Error /Xt |
|----|----------------|----------|---------|-------------|--------|-----------|
| 1  | 17109,03       | *        | *       | *           | *      | *         |
| 2  | 17310,58       | 17109,03 | 65,74   | 4321,48     | 65,74  | 0,00383   |
| 3  | 17280,68       | 17310,58 | -68,82  | 4736,66     | 68,82  | 0,00399   |
| 4  | 17109,93       | 17280,68 | -27,24  | 741,78      | 27,24  | 0,00158   |
| 5  | 17072,01       | 17109,93 | -20,67  | 427,24      | 20,67  | 0,00121   |
| 6  | 16857,97       | 17072,01 | -32,99  | 1088,30     | 32,99  | 0,00194   |
| 7  | 16933,21       | 16857,97 | 119,83  | 14358,96    | 119,83 | 0,00706   |
| 8  | 16859,89       | 16933,21 | -89,12  | 7943,17     | 89,12  | 0,00529   |
| 9  | 16685,77       | 16859,89 | -6,74   | 45,42       | 6,74   | 0,00040   |
| 10 | 16866,62       | 16685,77 | 133,14  | 17726,45    | 133,14 | 0,00792   |
| 11 | 17053,72       | 16866,62 | -33,69  | 1135,30     | 33,69  | 0,00200   |
| 12 | 16687,79       | 17053,72 | -196,89 | 38767,39    | 196,89 | 0,01168   |
| 13 | 16855,85       | 17045,96 | 112,26  | 12602,91    | 112,26 | 0,00668   |
| 14 | 17043,71       | 16855,85 | -40,44  | 1635,16     | 40,44  | 0,00240   |
| 15 | 16868,65       | 17043,71 | -183,65 | 33728,40    | 183,65 | 0,01089   |
| 16 | 16701,63       | 16868,65 | 13,43   | 180,44      | 13,43  | 0,00080   |
| 17 | 16838,28       | 16701,63 | 67,67   | 4578,67     | 67,67  | 0,00404   |
| 18 | 16777,17       | 16838,28 | -175,92 | 30946,31    | 175,92 | 0,01056   |
| 19 | 16839,65       | 16777,17 | -5,46   | 29,78       | 5,46   | 0,00033   |
| 20 | 17037,34       | 16839,65 | -35,39  | 1252,65     | 35,39  | 0,00211   |
| 21 | 16690,14       | 17037,34 | -176,22 | 31054,02    | 176,22 | 0,01045   |
| 22 | 16849,27       | 16690,14 | 98,40   | 9682,58     | 98,40  | 0,00586   |
| 23 | 17051,84       | 16849,27 | -19,64  | 385,73      | 19,64  | 0,00117   |
| 24 | 16686,60       | 17051,84 | -197,18 | 38879,42    | 197,18 | 0,01170   |
| 25 | 17050,64       | 16686,60 | 140,93  | 19862,02    | 140,93 | 0,00838   |
| 26 | 16868,06       | 17050,64 | -191,66 | 36733,04    | 191,66 | 0,01137   |
| 27 | 16679,07       | 16868,06 | -27,12  | 735,23      | 27,12  | 0,00161   |
| 28 | 16872,51       | 16679,07 | 150,14  | 22540,98    | 150,14 | 0,00892   |
| 29 | 17017,40       | 16872,51 | -103,15 | 10639,90    | 103,15 | 0,00615   |
| 30 | 16684,07       | 17017,40 | -167,34 | 28002,23    | 167,34 | 0,00993   |
| 31 | 17038,34       | 16684,07 | 121,94  | 14868,20    | 121,94 | 0,00726   |
| 32 | 16898,95       | 17038,34 | -123,03 | 15136,75    | 123,03 | 0,00727   |
| 33 | 16908,94       | 16898,95 | 34,59   | 1196,76     | 34,59  | 0,00204   |
| 34 | 16937,87       | 16908,94 | 77,35   | 5982,58     | 77,35  | 0,00455   |
| 35 | 16948,78       | 16937,87 | 68,31   | 4666,22     | 68,31  | 0,00402   |
| 36 | 16934,00       | 16948,78 | 30,46   | 927,95      | 30,46  | 0,00179   |
| 37 | 16896,31       | 16934,00 | -23,50  | 552,45      | 23,50  | 0,00139   |
| 38 | 17083,86       | 16896,31 | 29,63   | 878,05      | 29,63  | 0,00175   |
| 39 | 16846,90       | 17083,86 | -60,76  | 3692,25     | 60,76  | 0,00357   |
| 40 | 16910,50       | 16846,90 | 89,48   | 8007,33     | 89,48  | 0,00528   |
| 41 | 16895,16       | 16910,50 | -2,10   | 4,41        | 2,10   | 0,00012   |
| 42 | 16717,56       | 16895,16 | 15,97   | 255,16      | 15,97  | 0,00094   |
| 43 | 17109,03       | 16717,56 | 40,13   | 1610,04     | 40,13  | 0,00239   |

## Lampiran 10. (Lanjutan)

| t  | Aktual<br>(Rp) | $F'(t)$  | Error   | $(Error)^2$ | Error  | Error /Xt |
|----|----------------|----------|---------|-------------|--------|-----------|
| 44 | 16811,01       | 16831,64 | -20,63  | 425,65      | 20,63  | 0,00123   |
| 45 | 16924,21       | 17041,20 | -116,99 | 13686,35    | 116,99 | 0,00691   |
| 46 | 16824,19       | 16724,74 | 99,45   | 9890,77     | 99,45  | 0,00591   |
| 47 | 16795,71       | 16869,64 | -73,93  | 5465,84     | 73,93  | 0,00440   |
| 48 | 16759,96       | 16853,37 | -93,41  | 8724,88     | 93,41  | 0,00557   |
| 49 | 16715,84       | 16832,94 | -117,10 | 13712,05    | 117,10 | 0,00701   |
| 50 | 16763,16       | 16807,73 | -44,57  | 1986,22     | 44,57  | 0,00266   |
| 51 | 16894,17       | 17013,86 | -119,69 | 14324,69    | 119,69 | 0,00708   |
| 52 | 16950,39       | 16887,35 | 63,04   | 3973,68     | 63,04  | 0,00372   |
| 53 | 16923,83       | 16918,18 | 5,65    | 31,89       | 5,65   | 0,00033   |
| 54 | 16977,09       | 16903,62 | 73,47   | 5398,13     | 73,47  | 0,00433   |
| 55 | 17026,48       | 17111,91 | -85,43  | 7298,95     | 85,43  | 0,00502   |
| 56 | 17084,67       | 17028,34 | 56,33   | 3173,48     | 56,33  | 0,00330   |
| 57 | 17013,31       | 16889,73 | 123,58  | 15272,60    | 123,58 | 0,00726   |
| 58 | 17033,18       | 17131,78 | -98,60  | 9721,26     | 98,60  | 0,00579   |
| 59 | 17033,13       | 17033,00 | 0,13    | 0,02        | 0,13   | 0,00001   |
| 60 | 17057,5        | 17032,96 | 24,54   | 602,09      | 24,54  | 0,00144   |
| 61 | 16908,96       | 16870,83 | 38,13   | 1454,14     | 38,13  | 0,00226   |
| 62 | 16959,97       | 16895,46 | 64,51   | 4161,09     | 64,51  | 0,00380   |
| 63 | 17051,68       | 17102,53 | -50,85  | 2585,26     | 50,85  | 0,00298   |
| 64 | 17036,93       | 17045,87 | -8,94   | 79,87       | 8,94   | 0,00052   |
| 65 | 17048,13       | 17035,61 | 12,52   | 156,85      | 12,52  | 0,00073   |
| 66 | 16947,71       | 16864,31 | 83,40   | 6955,81     | 83,40  | 0,00492   |
| 67 | 16962,34       | 16916,71 | 45,63   | 2081,78     | 45,63  | 0,00269   |
| 68 | 17064,18       | 17103,83 | -39,65  | 1571,74     | 39,65  | 0,00232   |
| 69 | 17147,46       | 17054,56 | 92,90   | 8629,95     | 92,90  | 0,00542   |
| 70 | 17129,1        | 17112,50 | 16,60   | 275,68      | 16,60  | 0,00097   |
| 71 | 17077,43       | 17099,72 | -22,29  | 497,03      | 22,29  | 0,00131   |
| 72 | 17115,32       | 17063,78 | 51,54   | 2656,39     | 51,54  | 0,00301   |
| 73 | 17183,46       | 17090,14 | 93,32   | 8708,97     | 93,32  | 0,00543   |
| 74 | 17135,31       | 17137,54 | -2,23   | 4,97        | 2,23   | 0,00013   |
| 75 | 17189,11       | 17104,04 | 85,07   | 7236,19     | 85,07  | 0,00495   |
| 76 | 17190,63       | 17141,47 | 49,16   | 2416,68     | 49,16  | 0,00286   |
| 77 | 17160,07       | 17142,53 | 17,54   | 307,73      | 17,54  | 0,00102   |
| 78 | 17285,8        | 17300,35 | -14,55  | 211,85      | 14,55  | 0,00084   |
| 79 | 17300,83       | 17312,13 | -11,30  | 127,75      | 11,30  | 0,00065   |
| 80 | 17322,53       | 17322,87 | -0,34   | 0,11        | 0,34   | 0,00002   |
| 81 | 17262,02       | 17338,37 | -76,35  | 5829,10     | 76,35  | 0,00442   |
| 82 | 17339,91       | 17295,15 | 44,76   | 2003,71     | 44,76  | 0,00258   |
| 83 | 17563,42       | 17619,42 | -56,00  | 3135,55     | 56,00  | 0,00319   |
| 84 | 17708,31       | 17694,55 | 13,76   | 189,36      | 13,76  | 0,00078   |
| 85 | 17780,35       | 17946,08 | -165,73 | 27467,37    | 165,73 | 0,00932   |
| 86 | 17757,98       | 17892,56 | -134,58 | 18112,53    | 134,58 | 0,00758   |



## Lampiran 10. (Lanjutan)

| t            | Aktual<br>(Rp) | $F'(t)$  | Error  | $(Error)^2$ | Error   | Error /Xt |
|--------------|----------------|----------|--------|-------------|---------|-----------|
| 87           | 18060,47       | 18060,47 | -77,09 | 5942,34     | 77,09   | 0,00429   |
| 88           | 17965,86       | 17965,86 | 62,53  | 3910,18     | 62,53   | 0,00347   |
| 89           | 18005,87       | 18005,87 | -65,95 | 4349,06     | 65,95   | 0,00368   |
| 90           | 17748,14       | 17748,14 | 109,63 | 12019,03    | 109,63  | 0,00614   |
| 91           | 17931,27       | 17931,27 | -26,75 | 715,71      | 26,75   | 0,00149   |
| 92           | 18133,74       | 18133,74 | -73,85 | 5453,31     | 73,85   | 0,00409   |
| 93           | 18033,87       | 18033,87 | 60,10  | 3612,32     | 60,10   | 0,00332   |
| 94           | 18064,16       | 18064,16 | -43,18 | 1864,58     | 43,18   | 0,00240   |
| 95           | 17999,28       | 17999,28 | -22,76 | 518,05      | 22,76   | 0,00127   |
| 96           | 17959,76       | 17959,76 | 80,47  | 6475,30     | 80,47   | 0,00446   |
| 97           | 18016,39       | 18016,39 | 5,08   | 25,79       | 5,08    | 0,00028   |
| 98           | 17999,72       | 17999,72 | -16,78 | 281,44      | 16,78   | 0,00093   |
| <b>Total</b> |                |          |        | 698252,91   | 6570,48 | 0,38511   |

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{X_t - F_t}{X_t} \right| \times 100$$

$$= \frac{1}{98} \times 0,38511 = 0,39$$



**Lampiran 11. Perhitungan Tingkat Akurasi dari FTS Singh**

| t  | Aktual<br>(Rp) | $F'(t)$  | Error   | $(Error)^2$ | Error  | Error /Xt |
|----|----------------|----------|---------|-------------|--------|-----------|
| 1  | 17142,48       | *        | *       | *           | *      | *         |
| 2  | 17174,77       | *        | *       | *           | *      | *         |
| 3  | 17241,76       | *        | *       | *           | *      | *         |
| 4  | 17253,44       | 17243,65 | 9,79    | 95,87       | 9,79   | 0,00057   |
| 5  | 17089,26       | 17064,56 | 24,70   | 610,11      | 24,70  | 0,00145   |
| 6  | 17039,02       | 17064,56 | -25,54  | 652,28      | 25,54  | 0,00150   |
| 7  | 16977,8        | 16885,47 | 92,33   | 8524,66     | 92,33  | 0,00544   |
| 8  | 16844,09       | 16885,47 | -41,38  | 1712,38     | 41,38  | 0,00246   |
| 9  | 16853,15       | 16885,47 | -32,32  | 1044,64     | 32,32  | 0,00192   |
| 10 | 16818,91       | 16706,38 | 112,53  | 12662,51    | 112,53 | 0,00669   |
| 11 | 16832,93       | 16706,38 | 126,55  | 16014,35    | 126,55 | 0,00752   |
| 12 | 16856,83       | 16885,47 | -28,64  | 820,30      | 28,64  | 0,00170   |
| 13 | 16800,05       | 16706,38 | 93,67   | 8773,66     | 93,67  | 0,00558   |
| 14 | 16815,41       | 16706,38 | 109,03  | 11887,06    | 109,03 | 0,00648   |
| 15 | 16860,06       | 16885,47 | -25,41  | 645,72      | 25,41  | 0,00151   |
| 16 | 16882,08       | 16885,47 | -3,39   | 11,50       | 3,39   | 0,00020   |
| 17 | 16769,3        | 16885,47 | -116,17 | 13495,69    | 116,17 | 0,00693   |
| 18 | 16662,36       | 16706,38 | -44,02  | 1937,95     | 44,02  | 0,00264   |
| 19 | 16771,71       | 16706,38 | 65,33   | 4267,72     | 65,33  | 0,00390   |
| 20 | 16804,26       | 16885,47 | -81,21  | 6595,22     | 81,21  | 0,00483   |
| 21 | 16861,12       | 16885,47 | -24,35  | 592,97      | 24,35  | 0,00144   |
| 22 | 16788,54       | 16706,38 | 82,16   | 6749,91     | 82,16  | 0,00489   |
| 23 | 16829,63       | 16885,47 | -55,84  | 3118,21     | 55,84  | 0,00332   |
| 24 | 16854,66       | 16885,47 | -30,81  | 949,31      | 30,81  | 0,00183   |
| 25 | 16827,53       | 16706,38 | 121,15  | 14676,79    | 121,15 | 0,00720   |
| 26 | 16858,98       | 16885,47 | -26,49  | 701,77      | 26,49  | 0,00157   |
| 27 | 16840,94       | 16885,47 | -44,53  | 1983,00     | 44,53  | 0,00264   |
| 28 | 16829,21       | 16706,38 | 122,83  | 15086,67    | 122,83 | 0,00730   |
| 29 | 16769,36       | 16706,38 | 62,98   | 3966,20     | 62,98  | 0,00376   |
| 30 | 16850,06       | 16885,47 | -35,41  | 1253,93     | 35,41  | 0,00210   |
| 31 | 16806,01       | 16706,38 | 99,63   | 9925,70     | 99,63  | 0,00593   |
| 32 | 16915,31       | 16885,47 | 29,84   | 890,37      | 29,84  | 0,00176   |
| 33 | 16933,54       | 16885,47 | 48,07   | 2310,63     | 48,07  | 0,00284   |
| 34 | 16986,29       | 16885,47 | 100,82  | 10164,48    | 100,82 | 0,00594   |
| 35 | 17006,18       | 17064,56 | -58,38  | 3408,19     | 58,38  | 0,00343   |
| 36 | 16979,24       | 16885,47 | 93,77   | 8792,64     | 93,77  | 0,00552   |
| 37 | 16910,5        | 16885,47 | 25,03   | 626,45      | 25,03  | 0,00148   |
| 38 | 16925,94       | 16885,47 | 40,47   | 1637,75     | 40,47  | 0,00239   |
| 39 | 17023,1        | 17064,56 | -41,46  | 1718,91     | 41,46  | 0,00244   |
| 40 | 16936,38       | 16885,47 | 50,91   | 2591,73     | 50,91  | 0,00301   |
| 41 | 16908,4        | 16885,47 | 22,93   | 525,74      | 22,93  | 0,00136   |
| 42 | 16911,13       | 16885,47 | 25,66   | 658,39      | 25,66  | 0,00152   |
| 43 | 16757,69       | 16706,38 | 51,31   | 2632,49     | 51,31  | 0,00306   |

## Lampiran 11. (Lanjutan)

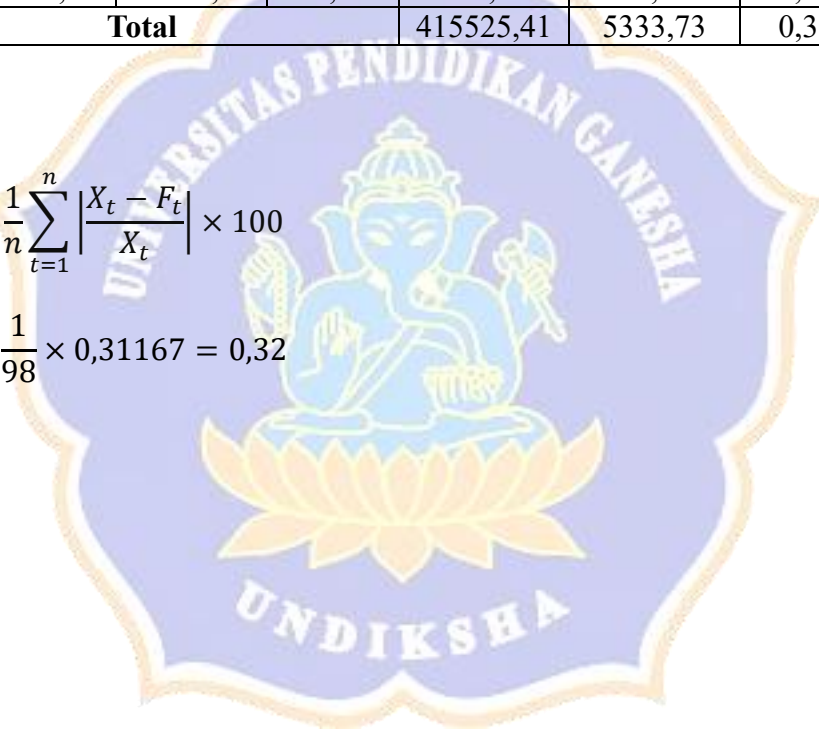
| t  | Aktual<br>(Rp) | $F'(t)$  | Error  | $(Error)^2$ | Error  | Error /Xt |
|----|----------------|----------|--------|-------------|--------|-----------|
| 44 | 16811,01       | 16885,47 | -74,46 | 5544,43     | 74,46  | 0,00443   |
| 45 | 16924,21       | 16885,47 | 38,74  | 1500,71     | 38,74  | 0,00229   |
| 46 | 16824,19       | 16706,38 | 117,81 | 13878,68    | 117,81 | 0,00700   |
| 47 | 16795,71       | 16706,38 | 89,33  | 7979,46     | 89,33  | 0,00532   |
| 48 | 16759,96       | 16706,38 | 53,58  | 2870,58     | 53,58  | 0,00320   |
| 49 | 16715,84       | 16706,38 | 9,46   | 89,45       | 9,46   | 0,00057   |
| 50 | 16763,16       | 16706,38 | 56,78  | 3223,72     | 56,78  | 0,00339   |
| 51 | 16894,17       | 16885,47 | 8,70   | 75,67       | 8,70   | 0,00051   |
| 52 | 16950,39       | 16885,47 | 64,92  | 4214,48     | 64,92  | 0,00383   |
| 53 | 16923,83       | 16885,47 | 38,36  | 1471,42     | 38,36  | 0,00227   |
| 54 | 16977,09       | 16885,47 | 91,62  | 8394,05     | 91,62  | 0,00540   |
| 55 | 17026,48       | 17064,56 | -38,08 | 1450,06     | 38,08  | 0,00224   |
| 56 | 17084,67       | 17064,56 | 20,11  | 404,42      | 20,11  | 0,00118   |
| 57 | 17013,31       | 17064,56 | -51,25 | 2626,53     | 51,25  | 0,00301   |
| 58 | 17033,18       | 17064,56 | -31,38 | 984,68      | 31,38  | 0,00184   |
| 59 | 17033,13       | 17064,56 | -31,43 | 987,83      | 31,43  | 0,00185   |
| 60 | 17057,5        | 17064,56 | -7,06  | 49,84       | 7,06   | 0,00041   |
| 61 | 16908,96       | 16885,47 | 23,49  | 551,74      | 23,49  | 0,00139   |
| 62 | 16959,97       | 16885,47 | 74,50  | 5550,11     | 74,50  | 0,00439   |
| 63 | 17051,68       | 17064,56 | -12,88 | 165,89      | 12,88  | 0,00076   |
| 64 | 17036,93       | 17064,56 | -27,63 | 763,40      | 27,63  | 0,00162   |
| 65 | 17048,13       | 17064,56 | -16,43 | 269,93      | 16,43  | 0,00096   |
| 66 | 16947,71       | 16885,47 | 62,24  | 3873,70     | 62,24  | 0,00367   |
| 67 | 16962,34       | 16885,47 | 76,87  | 5908,85     | 76,87  | 0,00453   |
| 68 | 17064,18       | 17064,56 | -0,38  | 0,14        | 0,38   | 0,00002   |
| 69 | 17147,46       | 17064,56 | 82,90  | 6872,46     | 82,90  | 0,00483   |
| 70 | 17129,1        | 17064,56 | 64,54  | 4165,45     | 64,54  | 0,00377   |
| 71 | 17077,43       | 17064,56 | 12,87  | 165,64      | 12,87  | 0,00075   |
| 72 | 17115,32       | 17064,56 | 50,76  | 2576,61     | 50,76  | 0,00297   |
| 73 | 17183,46       | 17064,56 | 118,90 | 14137,28    | 118,90 | 0,00692   |
| 74 | 17135,31       | 17064,56 | 70,75  | 5005,61     | 70,75  | 0,00413   |
| 75 | 17189,11       | 17064,56 | 124,55 | 15512,78    | 124,55 | 0,00725   |
| 76 | 17190,63       | 17243,65 | -53,02 | 2810,95     | 53,02  | 0,00308   |
| 77 | 17160,07       | 17064,56 | 95,51  | 9122,22     | 95,51  | 0,00557   |
| 78 | 17285,8        | 17243,65 | 42,15  | 1776,75     | 42,15  | 0,00244   |
| 79 | 17300,83       | 17243,65 | 57,18  | 3269,73     | 57,18  | 0,00331   |
| 80 | 17322,53       | 17243,65 | 78,88  | 6222,30     | 78,88  | 0,00455   |
| 81 | 17262,02       | 17243,65 | 18,37  | 337,51      | 18,37  | 0,00106   |
| 82 | 17339,91       | 17243,65 | 96,26  | 9266,29     | 96,26  | 0,00555   |
| 83 | 17563,42       | 17601,83 | -38,41 | 1475,02     | 38,41  | 0,00219   |
| 84 | 17708,31       | 17780,91 | -72,60 | 5271,44     | 72,60  | 0,00410   |
| 85 | 17780,35       | 17780,91 | -0,56  | 0,32        | 0,56   | 0,00003   |
| 86 | 17757,98       | 17780,91 | -22,93 | 526,00      | 22,93  | 0,00129   |

## Lampiran 11. (Lanjutan)

| t            | Aktual<br>(Rp) | $F(t)$   | Error  | $(Error)^2$ | Error   | $\frac{ Error }{X_t}$ |
|--------------|----------------|----------|--------|-------------|---------|-----------------------|
| 87           | 17983,38       | 17960,00 | 23,38  | 546,46      | 23,38   | 0,00130               |
| 88           | 18028,39       | 17960,00 | 68,39  | 4676,72     | 68,39   | 0,00379               |
| 89           | 17939,92       | 17960,00 | -20,08 | 403,34      | 20,08   | 0,00112               |
| 90           | 17857,77       | 17780,91 | 76,86  | 5906,74     | 76,86   | 0,00430               |
| 91           | 17904,52       | 17780,91 | 123,61 | 15278,27    | 123,61  | 0,00690               |
| 92           | 18059,89       | 17960,00 | 99,89  | 9977,33     | 99,89   | 0,00553               |
| 93           | 18093,97       | 17960,00 | 133,97 | 17947,04    | 133,97  | 0,00740               |
| 94           | 18020,98       | 17960,00 | 60,98  | 3718,14     | 60,98   | 0,00338               |
| 95           | 17976,52       | 17960,00 | 16,52  | 272,80      | 16,52   | 0,00092               |
| 96           | 18040,23       | 17960,00 | 80,23  | 6436,30     | 80,23   | 0,00445               |
| 97           | 18021,47       | 17960,00 | 61,47  | 3778,14     | 61,47   | 0,00341               |
| 98           | 17982,94       | 17960,00 | 22,94  | 526,09      | 22,94   | 0,00128               |
| <b>Total</b> |                |          |        | 415525,41   | 5333,73 | 0,31167               |

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{X_t - F_t}{X_t} \right| \times 100$$

$$= \frac{1}{98} \times 0,31167 = 0,32$$



**Lampiran 12. Perhitungan Tingkat Akurasi dari FTS Chen**

| t  | Aktual<br>(Rp) | $F'(t)$  | Error   | $(Error)^2$ | Error  | Error /Xt |
|----|----------------|----------|---------|-------------|--------|-----------|
| 1  | 17142,48       | *        | *       | *           | *      | *         |
| 2  | 17174,77       | 17109,33 | 65,44   | 4282,15     | 65,44  | 0,00381   |
| 3  | 17241,76       | 17109,33 | 132,43  | 17537,21    | 132,43 | 0,00768   |
| 4  | 17253,44       | 17348,12 | -94,68  | 8963,71     | 94,68  | 0,00549   |
| 5  | 17089,26       | 17348,12 | -258,86 | 67006,88    | 258,86 | 0,01515   |
| 6  | 17039,02       | 17109,33 | -70,31  | 4943,76     | 70,31  | 0,00413   |
| 7  | 16977,8        | 17109,33 | -131,53 | 17300,63    | 131,53 | 0,00775   |
| 8  | 16844,09       | 16930,24 | -86,15  | 7422,36     | 86,15  | 0,00511   |
| 9  | 16853,15       | 16930,24 | -77,09  | 5943,35     | 77,09  | 0,00457   |
| 10 | 16818,91       | 16930,24 | -111,33 | 12395,06    | 111,33 | 0,00662   |
| 11 | 16832,93       | 16840,70 | -7,77   | 60,35       | 7,77   | 0,00046   |
| 12 | 16856,83       | 16840,70 | 16,13   | 260,22      | 16,13  | 0,00096   |
| 13 | 16800,05       | 16930,24 | -130,19 | 16950,25    | 130,19 | 0,00775   |
| 14 | 16815,41       | 16840,70 | -25,29  | 639,52      | 25,29  | 0,00150   |
| 15 | 16860,06       | 16840,70 | 19,36   | 374,86      | 19,36  | 0,00115   |
| 16 | 16882,08       | 16930,24 | -48,16  | 2319,69     | 48,16  | 0,00285   |
| 17 | 16769,3        | 16930,24 | -160,94 | 25902,69    | 160,94 | 0,00960   |
| 18 | 16662,36       | 16840,70 | -178,34 | 31804,71    | 178,34 | 0,01070   |
| 19 | 16771,71       | 16840,70 | -68,99  | 4759,45     | 68,99  | 0,00411   |
| 20 | 16804,26       | 16840,70 | -36,44  | 1327,78     | 36,44  | 0,00217   |
| 21 | 16861,12       | 16840,70 | 20,42   | 417,03      | 20,42  | 0,00121   |
| 22 | 16788,54       | 16930,24 | -141,70 | 20079,78    | 141,70 | 0,00844   |
| 23 | 16829,63       | 16840,70 | -11,07  | 122,52      | 11,07  | 0,00066   |
| 24 | 16854,66       | 16840,70 | 13,96   | 194,92      | 13,96  | 0,00083   |
| 25 | 16827,53       | 16930,24 | -102,71 | 10549,99    | 102,71 | 0,00610   |
| 26 | 16858,98       | 16840,70 | 18,28   | 334,20      | 18,28  | 0,00108   |
| 27 | 16840,94       | 16930,24 | -89,30  | 7975,05     | 89,30  | 0,00530   |
| 28 | 16829,21       | 16930,24 | -101,03 | 10207,69    | 101,03 | 0,00600   |
| 29 | 16769,36       | 16840,70 | -71,34  | 5089,22     | 71,34  | 0,00425   |
| 30 | 16850,06       | 16840,70 | 9,36    | 87,63       | 9,36   | 0,00056   |
| 31 | 16806,01       | 16930,24 | -124,23 | 15433,87    | 124,23 | 0,00739   |
| 32 | 16915,31       | 16840,70 | 74,61   | 5566,84     | 74,61  | 0,00441   |
| 33 | 16933,54       | 16930,24 | 3,30    | 10,87       | 3,30   | 0,00019   |
| 34 | 16986,29       | 16930,24 | 56,05   | 3141,25     | 56,05  | 0,00330   |
| 35 | 17006,18       | 16930,24 | 75,94   | 5766,41     | 75,94  | 0,00447   |
| 36 | 16979,24       | 16930,24 | 49,00   | 2400,69     | 49,00  | 0,00289   |
| 37 | 16910,5        | 16930,24 | -19,74  | 389,79      | 19,74  | 0,00117   |
| 38 | 16925,94       | 16930,24 | -4,30   | 18,52       | 4,30   | 0,00025   |
| 39 | 17023,1        | 16930,24 | 92,86   | 8622,40     | 92,86  | 0,00545   |
| 40 | 16936,38       | 17109,33 | -172,95 | 29912,35    | 172,95 | 0,01021   |
| 41 | 16908,4        | 16930,24 | -21,84  | 477,12      | 21,84  | 0,00129   |
| 42 | 16911,13       | 16930,24 | -19,11  | 365,31      | 19,11  | 0,00113   |
| 43 | 16757,69       | 16930,24 | -172,55 | 29774,58    | 172,55 | 0,01030   |



## Lampiran 12. (Lanjutan)

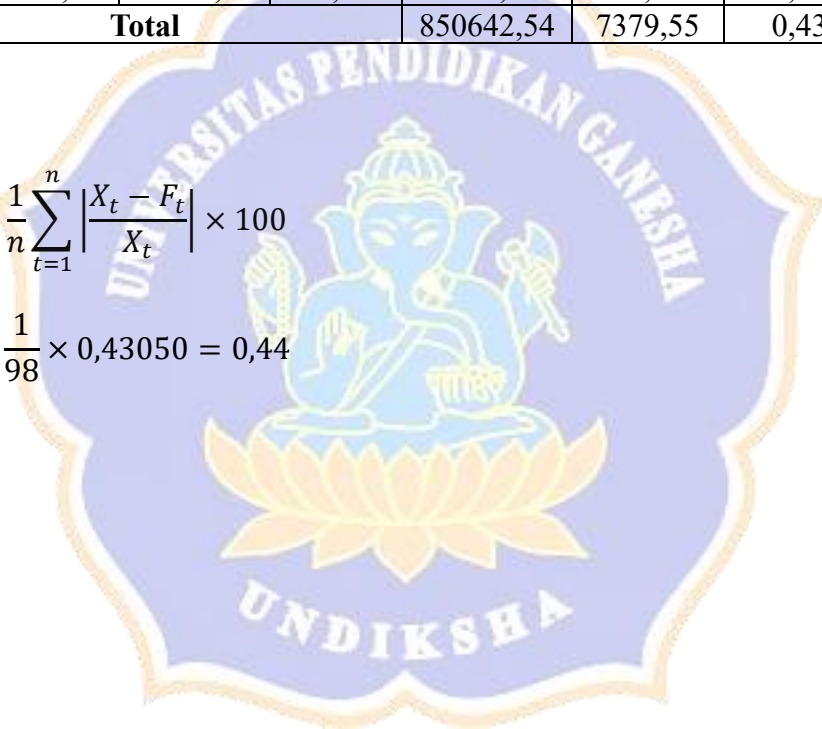
| t  | Aktual<br>(Rp) | $F'(t)$  | Error   | $(Error)^2$ | Error  | Error /Xt |
|----|----------------|----------|---------|-------------|--------|-----------|
| 44 | 16811,01       | 16840,70 | -29,69  | 881,42      | 29,69  | 0,00177   |
| 45 | 16924,21       | 16840,70 | 83,51   | 6974,13     | 83,51  | 0,00493   |
| 46 | 16824,19       | 16930,24 | -106,05 | 11247,27    | 106,05 | 0,00630   |
| 47 | 16795,71       | 16840,70 | -44,99  | 2023,99     | 44,99  | 0,00268   |
| 48 | 16759,96       | 16840,70 | -80,74  | 6518,75     | 80,74  | 0,00482   |
| 49 | 16715,84       | 16840,70 | -124,86 | 15589,71    | 124,86 | 0,00747   |
| 50 | 16763,16       | 16840,70 | -77,54  | 6012,26     | 77,54  | 0,00463   |
| 51 | 16894,17       | 16840,70 | 53,47   | 2859,17     | 53,47  | 0,00317   |
| 52 | 16950,39       | 16930,24 | 20,15   | 405,90      | 20,15  | 0,00119   |
| 53 | 16923,83       | 16930,24 | -6,41   | 41,13       | 6,41   | 0,00038   |
| 54 | 16977,09       | 16930,24 | 46,85   | 2194,63     | 46,85  | 0,00276   |
| 55 | 17026,48       | 16930,24 | 96,24   | 9261,54     | 96,24  | 0,00565   |
| 56 | 17084,67       | 17109,33 | -24,66  | 608,21      | 24,66  | 0,00144   |
| 57 | 17013,31       | 17109,33 | -96,02  | 9220,20     | 96,02  | 0,00564   |
| 58 | 17033,18       | 16930,24 | 102,94  | 10596,00    | 102,94 | 0,00604   |
| 59 | 17033,13       | 17109,33 | -76,20  | 5806,73     | 76,20  | 0,00447   |
| 60 | 17057,5        | 17109,33 | -51,83  | 2686,54     | 51,83  | 0,00304   |
| 61 | 16908,96       | 17109,33 | -200,37 | 40148,89    | 200,37 | 0,01185   |
| 62 | 16959,97       | 16930,24 | 29,73   | 883,69      | 29,73  | 0,00175   |
| 63 | 17051,68       | 16930,24 | 121,44  | 14746,91    | 121,44 | 0,00712   |
| 64 | 17036,93       | 17109,33 | -72,40  | 5242,03     | 72,40  | 0,00425   |
| 65 | 17048,13       | 17109,33 | -61,20  | 3745,67     | 61,20  | 0,00359   |
| 66 | 16947,71       | 17109,33 | -161,62 | 26121,63    | 161,62 | 0,00954   |
| 67 | 16962,34       | 16930,24 | 32,10   | 1030,21     | 32,10  | 0,00189   |
| 68 | 17064,18       | 16930,24 | 133,94  | 17939,09    | 133,94 | 0,00785   |
| 69 | 17147,46       | 17109,33 | 38,13   | 1453,75     | 38,13  | 0,00222   |
| 70 | 17129,1        | 17109,33 | 19,77   | 390,78      | 19,77  | 0,00115   |
| 71 | 17077,43       | 17109,33 | -31,90  | 1017,73     | 31,90  | 0,00187   |
| 72 | 17115,32       | 17109,33 | 5,99    | 35,86       | 5,99   | 0,00035   |
| 73 | 17183,46       | 17109,33 | 74,13   | 5494,98     | 74,13  | 0,00431   |
| 74 | 17135,31       | 17109,33 | 25,98   | 674,86      | 25,98  | 0,00152   |
| 75 | 17189,11       | 17109,33 | 79,78   | 6364,55     | 79,78  | 0,00464   |
| 76 | 17190,63       | 17109,33 | 81,30   | 6609,39     | 81,30  | 0,00473   |
| 77 | 17160,07       | 17109,33 | 50,74   | 2574,36     | 50,74  | 0,00296   |
| 78 | 17285,8        | 17109,33 | 176,47  | 31141,00    | 176,47 | 0,01021   |
| 79 | 17300,83       | 17348,12 | -47,29  | 2236,05     | 47,29  | 0,00273   |
| 80 | 17322,53       | 17348,12 | -25,59  | 654,69      | 25,59  | 0,00148   |
| 81 | 17262,02       | 17348,12 | -86,10  | 7412,67     | 86,10  | 0,00499   |
| 82 | 17339,91       | 17348,12 | -8,21   | 67,35       | 8,21   | 0,00047   |
| 83 | 17563,42       | 17348,12 | 215,30  | 46355,44    | 215,30 | 0,01226   |
| 84 | 17708,31       | 17736,14 | -27,83  | 774,65      | 27,83  | 0,00157   |
| 85 | 17780,35       | 17736,14 | 44,21   | 1954,30     | 44,21  | 0,00249   |
| 86 | 17757,98       | 17915,23 | -157,25 | 24727,96    | 157,25 | 0,00886   |

## Lampiran 12. (Lanjutan)

| t            | Aktual<br>(Rp) | $F(t)$   | Error  | $(Error)^2$ | $ Error $ | $ Error /X_t$ |
|--------------|----------------|----------|--------|-------------|-----------|---------------|
| 87           | 17983,38       | 17915,23 | 68,15  | 4644,25     | 68,15     | 0,00379       |
| 88           | 18028,39       | 17915,23 | 113,16 | 12804,90    | 113,16    | 0,00628       |
| 89           | 17939,92       | 17915,23 | 24,69  | 609,53      | 24,69     | 0,00138       |
| 90           | 17857,77       | 17915,23 | -57,46 | 3301,80     | 57,46     | 0,00322       |
| 91           | 17904,52       | 17915,23 | -10,71 | 114,73      | 10,71     | 0,00060       |
| 92           | 18059,89       | 17915,23 | 144,66 | 20926,15    | 144,66    | 0,00801       |
| 93           | 18093,97       | 17915,23 | 178,74 | 31947,54    | 178,74    | 0,00988       |
| 94           | 18020,98       | 17915,23 | 105,75 | 11182,80    | 105,75    | 0,00587       |
| 95           | 17976,52       | 17915,23 | 61,29  | 3756,31     | 61,29     | 0,00341       |
| 96           | 18040,23       | 17915,23 | 125,00 | 15624,69    | 125,00    | 0,00693       |
| 97           | 18021,47       | 17915,23 | 106,24 | 11286,67    | 106,24    | 0,00590       |
| 98           | 17982,94       | 17915,23 | 67,71  | 4584,47     | 67,71     | 0,00377       |
| <b>Total</b> |                |          |        | 850642,54   | 7379,55   | 0,43050       |

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{X_t - F_t}{X_t} \right| \times 100$$

$$= \frac{1}{98} \times 0,43050 = 0,44$$



**Lampiran 13. Coding Pemrograman Phyton untuk Pengolahan Data**

```
# Import library yang diperlukan
import pandas as pd
import numpy as np
import plotly.graph_objects as go
from fractions import Fraction
from collections import Counter
from plotly.subplots import make_subplots
from sklearn.metrics import mean_absolute_error, mean_squared_error

# Membaca file Excel
df = pd.read_excel('datanilai_tukar.xlsx')

# Langkah 1 menentukan himpunan semesta U
# Menghitung D_min dan D_max
D_min = df['nilai_tukar'].min()
D_max = df['nilai_tukar'].max()

# Menentukan D_1 dan D_2
D_1 = 0.75 # Example value, adjust as needed
D_2 = 0.35 # Example value, adjust as needed

# Menampilkan D_min, D_max, D_1, D2
print("D_min:", D_min)
print("D_max:", D_max)
print("D_1:", D_1)
print("D_2:", D_2)

# Menghitung himpunan semesta U
U = [D_min - D_1, D_max + D_2]
print("Universe U:", U)
```

**Lampiran 13. Lanjutan**

```

# Langkah 2 Membagi himpunan semesta U menjadi n interval yang sama
menggunakan aturan Sturges
# Hitung jumlah data
N = len(df)
# Menghitung jumlah interval (n) menggunakan aturan Sturges
n = int(np.ceil(1 + 3.322 * np.log10(N)))
print("interval(n):", n)
# Menghitung panjang interval (l)
l = (U[1] - U[0]) / n
print(f"Panjang interval (l): {l:.2f}")
# Membuat list interval dan nilai tengah
intervals = []
midpoints = {}
for i in range(n):
    interval_start = U[0] + i * l
    interval_end = U[0] + (i + 1) * l
    intervals.append([interval_start, interval_end])
    midpoint = (interval_start + interval_end) / 2
    state_name = f"A_{i+1}"
    midpoints[state_name] = midpoint
# Menampilkan interval dan nilai tengah
print("\nDAFTAR INTERVAL & NILAI TENGAH:")
for i, (interval, state_name) in enumerate(zip(intervals, midpoints)):
    print(f"{state_name} = [{interval[0]:.2f}, {interval[1]:.2f}], m_{i+1} = {midpoints[state_name]:.2f}")

```

```

# Langkah 3
# Menentukan himpunan-himpunan Fuzzy
membership_matrix = np.zeros((n, n))
for i in range(n):
    for j in range(n):
        if i == j:
            membership_matrix[i, j] = 1
        elif j == i - 1 or j == i + 1:
            membership_matrix[i, j] = 0.5
        else:
            membership_matrix[i, j] = 0
# Menampilkan matriks derajat keanggotaan
print("Membership Matrix:")
print(membership_matrix)
# Menampilkan himpunan-himpunan Fuzzy
Fuzzy_sets = []
for i in range(n):
    Fuzzy_set = []
    for j in range(membership_matrix.shape[1]):
        val = membership_matrix[i, j]
        if val > 0:
            val = int(val) if val.is_integer() else round(float(val), 2)
            Fuzzy_set.append((f'A_{j+1}', val))
    Fuzzy_sets.append(Fuzzy_set)
# Menampilkan himpunan-himpunan Fuzzy
print("HIMPUNAN-HIMPUNAN FUZZY:")
for i, Fuzzy_set in enumerate(Fuzzy_sets):
    formatted_set = ", ".join([f'({nama}, {nilai})' for nama, nilai in
                                Fuzzy_set])
    print(f'A_{i+1} = [{formatted_set}]")

```

### Lampiran 13. Lanjutan



```

# Fuzzifikasi data historis
    flrg_dict[lhs].append(rhs)
# Menampilkan FLRG
    for lhs, rhs_list in flrg_dict.items():
        print(f'{lhs} -> {' , '.join(rhs_list)}')
# Buat list urutan A_1 sampai A_8
    ordered_states = [f'A_{i}' for i in range(1, 9)]
# Menampilkan FLRG terurut dan disertai frekuensi
    for lhs in ordered_states:
        if lhs in flrg_dict:
            count_rhs = Counter(flrg_dict[lhs])
            rhs_with_counts = [f'{rhs}({count_rhs[rhs]})' for rhs in
sorted(count_rhs.keys(), key=lambda x: int(x.split('_')[1]))]
            print(f'{lhs} -> {' , '.join(rhs_with_counts)}')
        else:
            print(f'{lhs} -> -')

```

**Lampiran 14. Coding Pemrograman Phyto untuk Pengolahan Data *Fuzzy Times Series Markov Chain***

```

# Langkah 6 Prediksi Awal
# Hitung matriks probabilitas transisi R dalam bentuk pecahan
transition_counts = {}
for lhs in ordered_states:
    transition_counts[lhs] = {rhs: 0 for rhs in ordered_states}
    if lhs in flrg_dict:
        for rhs in flrg_dict[lhs]:
            transition_counts[lhs][rhs] += 1
# Hitung probabilitas
transition_matrix = {}
for lhs in ordered_states:
    counts = transition_counts[lhs]
    total = sum(counts.values())
    if total == 0:
        transition_matrix[lhs] = {rhs: Fraction(0, 1) for rhs in ordered_states}
    else:
        transition_matrix[lhs] = {rhs: Fraction(count, total) for rhs, count in
            counts.items()}
# Tampilkan hasil
print("Transition Matrix:")
for lhs in ordered_states:
    baris = ', '.join([f'{rhs}: {transition_matrix[lhs][rhs]}' for rhs in
        ordered_states])
    print(f'{lhs}: {baris}')
#Prediksi Awal
prediksi_ft = [None]
for i in range(1, len(df)):
    prev_Fuzzy = df.loc[i-1, 'Fuzzy'] # Fuzzy sebelumnya
    prev_actual = df.loc[i-1, 'nilai_tukar'] # Nilai aktual sebelumnya
    if prev_Fuzzy in transition_matrix:

```

#### Lampiran 14. Lanjutan

```

probs = transition_matrix[prev_Fuzzy]
nonzero_probs = {state: prob for state, prob in probs.items() if prob > 0}
if len(nonzero_probs) == 1 and list(nonzero_probs.values())[0] == 1:
    # One-to-one case
    target_state = list(nonzero_probs.keys())[0]
    Ft = midpoints[target_state]
else:
    # One-to-many case
    Ft = 0
    for state, prob in nonzero_probs.items():
        if state == prev_Fuzzy:
            # Gunakan nilai aktual sebelumnya jika transisi ke dirinya sendiri
            Ft += prev_actual * prob
        else:
            Ft += midpoints[state] * prob
    else:
        Ft = None # Tidak ada prediksi jika tidak ditemukan di matriks
    prediksi_ft.append(Ft)

# Menambahkan kolom hasil prediksi ke DataFrame
df['prediksi_awal'] = prediksi_ft
# Menampilkan hasil akhir
print(df[['nilai_tukar', 'Fuzzy', 'prediksi_awal']])

#Langkah 7 Nilai Kecenderungan Prediksi
# Panjang interval (l), dihitung dari selisih salah satu interval
l = intervals[0][1] - intervals[0][0]
D_t1 = [None]
D_t2 = [None]

```

#### Lampiran 14. Lanjutan

```

for i in range(1, len(df)):
    prev_Fuzzy = df.loc[i - 1, 'Fuzzy']
    current_Fuzzy = df.loc[i, 'Fuzzy']

# Ambil indeks numerik dari Fuzzy A_i -> ambil angka setelah "_"
    i_idx = int(prev_Fuzzy.split('_')[1])
    j_idx = int(current_Fuzzy.split('_')[1])

# Hitung D_t1
    if i_idx < j_idx:
        d1 = 1 / 2
    elif i_idx > j_idx:
        d1 = -1 / 2
    else:
        d1 = 0
    D_t1.append(d1)

# Hitung D_t2
    if i_idx == j_idx:
        d2 = 0
    elif i_idx < j_idx:
        s = j_idx - i_idx
        d2 = (1 / 2) * s
    else:
        v = i_idx - j_idx
        d2 = -(1 / 2) * v
    D_t2.append(d2)

# Tambahkan ke DataFrame
    df['D_t1'] = D_t1
    df['D_t2'] = D_t2

```

#### Lampiran 14. Lanjutan

```

# Tampilkan hasil akhir
print(df[['Fuzzy', 'D_t1', 'D_t2']])

# Langkah 8 Prediksi Akhir
prediksi_akhir = [None] # Baris pertama tidak bisa dihitung
for i in range(1, len(df)):
    Fuzzy_prev = df.loc[i - 1, 'Fuzzy'] # A_i
    Fuzzy_now = df.loc[i, 'Fuzzy']      # A_(i+1)
    Ft = df.loc[i, 'prediksi_awal']
    Dt1 = df.loc[i, 'D_t1']
    Dt2 = df.loc[i, 'D_t2']
    if Fuzzy_prev in transition_matrix:
        flrg = transition_matrix[Fuzzy_prev]

# Cek apakah transisinya one-to-many
if len([prob for prob in flrg.values() if prob > 0]) > 1:
    # Cek apakah Fuzzy_now bisa diakses dari Fuzzy_prev
    accessible = Fuzzy_now in flrg and flrg[Fuzzy_now] > 0
    if accessible:
        if Fuzzy_prev in flrg and flrg[Fuzzy_prev] > 0:
            # Berkomunikasi
            F_akhir = Ft + Dt1 + Dt2
        else:
            # Tidak berkomunikasi
            F_akhir = Ft + Dt2
    else:
# Jika tidak accessible
        F_akhir = Ft + Dt1 + Dt2 # Atau sesuaikan ± tergantung arah
        pergerakan
    else:
        # One-to-one: prediksi akhir sama dengan prediksi awal

```

#### Lampiran 14. Lanjutan



```
F_akhir = Ft
else:
    F_akhir = None # Tidak ada prediksi jika state tidak ada di
transition_matrix
    prediksi_akhir.append(F_akhir)
# Tambahkan ke DataFrame
df['prediksi_akhir'] = prediksi_akhir
# Tampilkan hasil akhir
print(df[['nilai_tukar', 'Fuzzy', 'prediksi_awal', 'D_t1', 'D_t2', 'prediksi_akhir']])
```



**Lampiran 15. Coding Pemrograman Phytom untuk Pengolahan Data *Fuzzy Times Series Singh***

```
#Langkah 6 Prediksi Akhir
# List untuk menyimpan hasil
Dz_list = [None, None, None]
X_list = [None, None, None]
XX_list = [None, None, None]
Y_list = [None, None, None]
YY_list = [None, None, None]

# Perhitungan mulai dari data ke-4 (index ke-3)
for i in range(3, len(df)):
    E_i = df['nilai_tukar'][i]
    E_1 = df['nilai_tukar'][i - 1]
    E_2 = df['nilai_tukar'][i - 2]

    Dz = abs(abs(E_i - E_1) - abs(E_1 - E_2))
    X = E_i + Dz
    XX = E_i - Dz
    Y = E_i + Dz / 2
    YY = E_i - Dz / 2

    Dz_list.append(Dz)
    X_list.append(X)
    XX_list.append(XX)
    Y_list.append(Y)
    YY_list.append(YY)

# Tambahkan hasil ke dalam DataFrame
df['D_z'] = Dz_list
df['X_i'] = X_list
```

### Lampiran 15. Lanjutan

```

df['XX_i'] = XX_list
df['Y_i'] = Y_list
df['YY_i'] = YY_list

# Tampilkan hasil
print(df[['nilai_tukar', 'D_z', 'X_i', 'XX_i', 'Y_i', 'YY_i']])
final_predictions = [None, None, None]

# Ambil panjang interval L (diasumsikan semua sama, jadi ambil dari interval pertama)
L_value = intervals[0][1] - intervals[0][0]

# Fungsi bantu: menentukan state dari suatu nilai
def get_state_from_value(value):
    for i, (start, end) in enumerate(intervals):
        if start <= value <= end:
            return f'A_{i+1}"
    return None

# Hitung prediksi akhir dari data ke-4
for i in range(3, len(df)):
    E_i = df['nilai_tukar'][i]
    Y = df['Y_i'][i]
    YY = df['YY_i'][i]
    X = df['X_i'][i]
    XX = df['XX_i'][i]
    found = False
    # Cek Y_i dan YY_i
    for check in [Y, YY]:
        state = get_state_from_value(check)

```

### Lampiran 15. Lanjutan

```

if state is not None:
    M = midpoints[state]
    F_j = M - (0.25 * L_value)
    final_predictions.append(F_j)
    found = True
    break

# Cek X_i dan XX_i jika belum ketemu
if not found:
    for check in [X, XX]:
        state = get_state_from_value(check)
        if state is not None:
            M = midpoints[state]
            F_j = M + (0.25 * L_value)
            final_predictions.append(F_j)
            found = True
            break
    if not found:
        state = get_state_from_value(E_i)
        if state is not None:
            F_j = midpoints[state]
            final_predictions.append(F_j)
        else:
            final_predictions.append(None)

# Tambahkan ke DataFrame
df['prediksi_akhir'] = final_predictions

# Tampilkan hasil
print(df[['nilai_tukar', 'prediksi_akhir']])

```

## Lampiran 16. Coding Pemrograman Phyton untuk Pengolahan Data *Fuzzy Times Series Chen*

Langkah 6 Prediksi Akhir

```

forecast_values = {}
ordered_states = [f'A_{i}' for i in range(1, 9)]
for lhs in ordered_states:
    if lhs in flrg_dict and flrg_dict[lhs]: # pastikan LHS punya relasi
        # Ambil RHS dan urutkan berdasar angka
        rhs_sorted = sorted(flrg_dict[lhs], key=lambda x: int(x.split('_')[1]))
        # Hilangkan duplikat sambil mempertahankan urutan
        rhs_unique = list(dict.fromkeys(rhs_sorted))
        # Ambil nilai tengah dari RHS
        midpoint_values = [midpoints[rhs] for rhs in rhs_unique]
        # Hitung rata-rata sebagai nilai prediksi
        forecast = sum(midpoint_values) / len(midpoint_values)
        forecast_values[lhs] = forecast
    else:
        forecast_values[lhs] = None # tidak bisa diramal

# Tampilkan hasil prediksi
print("\nNILAI PREDIKSI UNTUK SETIAP STATE:")
for state in ordered_states:
    if forecast_values[state] is not None:
        print(f'{state} => {forecast_values[state]:.2f}')
    else:
        print(f'{state} => -')

prediksi_list = [None] # indeks 0 tidak diprediksi

```



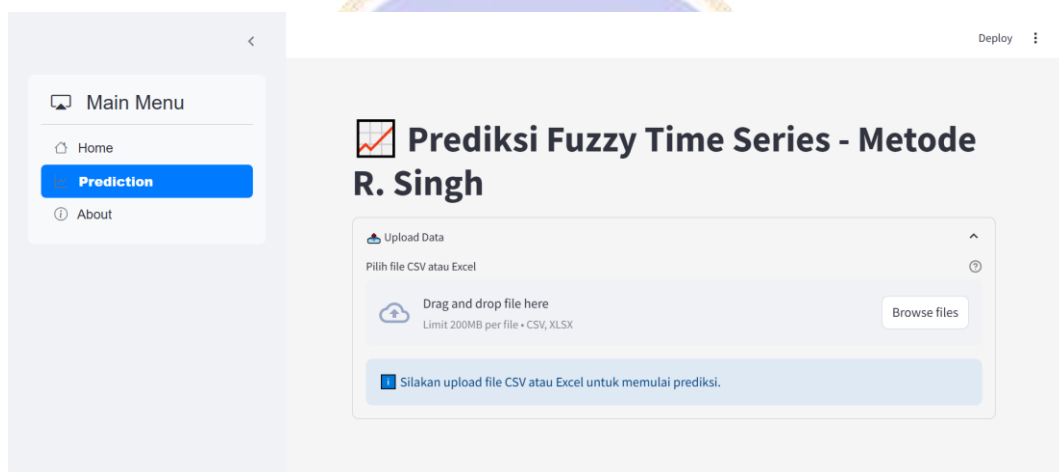
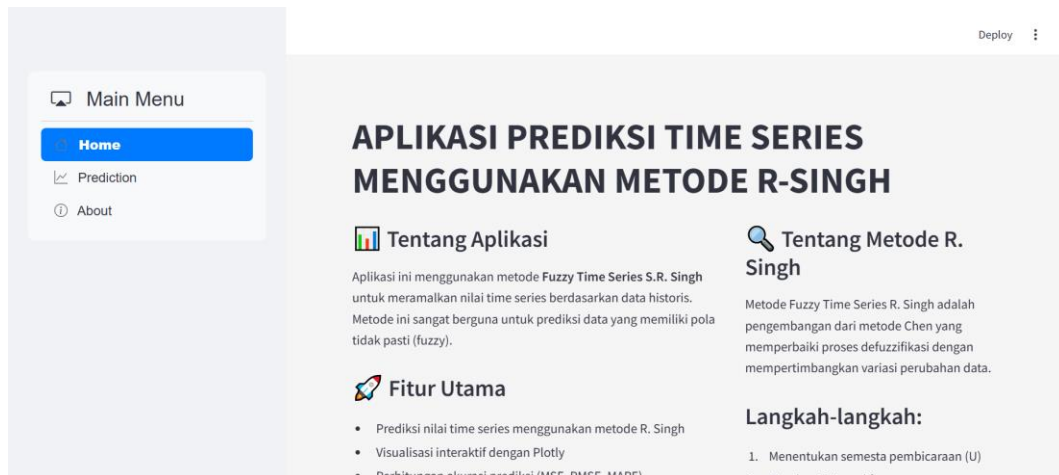
## Lampiran 16. Lanjutan

```

keterangan_list = ["-"] # indeks 0 tidak diprediksi
for t in range(1, len(df)):
    prev_state = df.loc[t-1, 'Fuzzy'] # gunakan Fuzzy dari data ke-(t-1)
    if prev_state in flrg_dict:
        rhs_states = flrg_dict[prev_state]
        if not rhs_states: # Aturan 1: FLRG kosong
            prediksi = midpoints[prev_state]
            detail = f"Aturan 1: {prev_state} → ∅ ⇒ Prediksi = m_i = {prediksi:.2f}"
        else:
            rhs_unique = list(dict.fromkeys(rhs_states))
            if len(rhs_unique) == 1: # Aturan 2
                rhs = rhs_unique[0]
                prediksi = midpoints[rhs]
                detail = f"Aturan 2: {prev_state} → {rhs} ⇒ Prediksi = m_j = {prediksi:.2f}"
            else: # Aturan 3
                midpoint_values = [midpoints[r] for r in rhs_unique]
                prediksi = sum(midpoint_values) / len(midpoint_values)
                detail = f"Aturan 3: {prev_state} → {' '.join(rhs_unique)}"
        else:
            prediksi = None
            detail = f"{prev_state} tidak ditemukan dalam FLRG"
        prediksi_list.append(prediksi)
        keterangan_list.append(detail)
# Tambahkan ke DataFrame
df['prediksi'] = prediksi_list
df['keterangan_prediksi'] = keterangan_list
print(df[['nilai_tukar', 'Fuzzy', 'prediksi']])

```

### Lampiran 17. Tampilan Aplikasi Prediksi Fuzzy Times Serie Singh



## RIWAYAT HIDUP



Desak Made Dwi Yuniastri, lahir di Desa Pelapuan, Kecamatan Busungbiu, Kabupaten Buleleng pada tahun 2002. Penulis lahir dari pasangan suami istri yakni Dewa Made Winjana dan Ketut Dariasih. Penulis berkebangsaan Indonesia dan beragama Hindu. Saat ini penulis bertempat tinggal di Desa Pelapuan, Kecamatan Busungbiu, Kabupaten Buleleng, Bali. Penulis mengawali pendidikan di jenjang Taman Kanak-Kanak lulus pada tahun 2009,

kemudian melanjutkan pendidikan dasar di SD Negeri 1 Pelapuan dan lulus pada tahun 2015. Selanjutnya, penulis menempuh pendidikan menengah pertama di SMP Negeri 1 Busungbiu dan lulus pada tahun 2018. Pendidikan menengah atas dilanjutkan di SMK Negeri 3 Singaraja dan lulus pada tahun 2021. Pada tahun 2021, penulis melanjutkan pendidikan pada jenjang Strata 1 Program Studi Matematika, Jurusan Matematika, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Ganesha. Pada akhir studi di tahun 2025, penulis telah menyelesaikan skripsi dengan judul “Perbandingan Akurasi Metode *Fuzzy Time Series* Model *Markov Chain*, *Singh*, dan *Chen* dalam Memprediksi Nilai Tukar Rupiah terhadap Euro” Selanjutnya, penulis berstatus sebagai mahasiswa aktif Program Studi S1 Matematika di Universitas Pendidikan Ganesha.