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Proof of Data Weigher Analysis (DWA) and Its Application to Dynamic Meta Data Weigher

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Abstract *– Data Weigher Analysis (DWA) addresses the persistent problem of objectively quantifying whether the values in a data set lean more heavily toward the left or right side, a challenge that becomes increasingly complex in irregular or large-scale data sets. Motivated by the need for a simple yet rigorous quantitative framework, this study compares two DWA techniques—the data weighting method and the data mean difference method—designed to compute balance points in a sequence. The data weighting method assigns balanced linear weights to left and right subsets, whereas the data mean difference method calculates first- and second-order mean differences to capture asymmetry in data distribution. We provide a theoretical proof of equivalence between these two formulations, showing that the mean difference approach produces the same linear weighting as the original data weighting scheme. Building on this theoretical result, we introduce a sliding-window algorithm to operationalize DWA on large, dynamic data streams, allowing automated detection of local imbalances in real time. Empirically, we validate our approach on real-world metadata and trade datasets, comparing it against baseline descriptive statistics to assess efficiency and precision. Quantitative findings show that the mean difference method reduces computation processes without loss of accuracy compared with manual weighting. Overall, this work contributes to a unified theoretical foundation, a lightweight algorithmic implementation, and evidence of practical benefits for using DWA in decision-making contexts such as questionnaire analysis, market dynamics, and trade flow monitoring.*

Keywords*: Data Weigher Analysis; Trading; Quantitative research; Average Data; Meta Data*

I. INTRODUCTION

Data Weigher Analysis is a quantitative measurement method that uses data weighting to determine whether a data group is heavier than the left or right data. Data Weigher Analysis (DWA) is a quantitative method capable of analysing meta-data to determine the tendency of data weight to the left or right. A simple explanation of data weighing in data set analysis, for example, there is a data set 2, 1, 6, 9, 8 (Krantz 2006). Then, the middle value of the data set sequence is the third sequence, namely at number 6. The sequence of numbers in the middle can be considered an equilibrium point, so the data set on the right will be easily known to be greater than the data on the left. This can be interpreted as the collection of numbers on the right side (9, 8) being heavier than on the left side (2, 1). However, providing a direct analysis will be easier if the data becomes more prominent and irregular (McQuarrie 2003). A specific method is needed to explain quantitatively, one of which can use this DWA method. In conducting DWA, data collection can be done with two methods, namely, the first with the data weighting method and the second with the data mean difference method. The data weighting method uses balanced linear weights between the left and right data.

In contrast, the data mean method uses a new technique: the difference between the first and second order averages. The average data is the first level, the average value that has been generally, namely the total data amount divided by the amount of data. While the second level data mean is the first level of the data set divided by the total number of second level data.

In this study, it can be proven mathematically that the two methods are the same. After being proven mathematically, the first and second data mean difference methods will produce linear data weighting in weighing the data (Salas 2007). The benefits of DWA include helping make decisions more objectively and quickly; for example, it can be applied to questionnaire analysis (Raghavendra et al. 2021) or trade. Because there is no need to find the data weight value, the practical application of DWA in using effective and efficient metadata is the data mean difference method (Stewart 2012).

II. METHODS

3.1 Proof of Similarity of Multi-Level Mean Difference Method with Data Weighting Method

The calculation of the two DWA methods, namely the data weighting method with multi-level average differences, will have the same final value. Below, it will be proven that linear data weighting in weighing data can come from the multi-level average difference of the data. First, it is necessary to explain the definition of the multi-level or higher-order average, namely the first and second levels of the data set.

2.1.1 High Order Average (HOA)

The average value of data is the total sum of the data values divided by the total number of data. Meanwhile, the Higher Order Average (HOA) is a more general form of the first-order average of the known data (Goenawan 2021). It is more general because the first-order or data average is included in the HOA section. So, the definition of the higher-order average of data is the total sum of the data divided by the total number of data levels (Goenawan 2022). The meaning of the notation D_i is a data collection whose order is based on a time series so that the first and second-order HOA formulas can be formulated as below. First, the formula for calculating the first-order average with D_i is a data collection of t is

$$\overline{D(t)}^{(1)} = \frac{\sum_{i=1}^{t} D_i}{t} \tag{1}$$

Second, the formula for calculating the second order mean in stages with D_i is a data set of $t.(t+1)/2$.

$$\overline{D(t)}^{(2)} = \frac{\sum_{j=1}^{t}\sum_{i=1}^{j} D_i}{\left(\frac{t\cdot(t+1)}{2}\right)} \tag{2}$$

The DWA calculation formula using the first and second order average difference method can be formulated as follows:

$$K_2^1(t) = \overline{D(t)}^{(1)} - \overline{D(t)}^{(2)} \tag{3}$$

Next, it will be proven mathematically that the formula for the difference between the averages of data one and two will produce linear data weighting when used to perform data weighing analysis. First, it is necessary to know the definition of adding discrete data in a first-order tier with the amount of data as large as t.

$$\sum_{i=1}^{t} D_i = D_1 + D_2 + \cdots + D_t \tag{4}$$

Then the definition of the addition of second-order discrete data with the amount of data is $t.(t+1)/2$ (Goenawan 2020 and 2023).

$$\sum_{j=1}^{t}\sum_{i=1}^{j} D_i = D_1 + (D_1 + D_2) + (D_1 + D_2 + D_3) + \cdots + (D_1 + D_2 + D_3 + \cdots + D_t) \tag{5}$$

If in eq.(5) the same discrete data is added together it will become:

$$\sum_{j=1}^{t}\sum_{i=1}^{j} D_i = t.D_1 + (t-1).D_2 + \cdots + 1.D_t \tag{6}$$

Then the $K_2^1(t)$ operation is performed, namely the difference between the average of the first and second order data, $\overline{D(t)}^{(1)} - \overline{D(t)}^{(2)}$

$$\frac{\begin{matrix} 1/t \\ 1/(t\cdot(t+1)/2) \end{matrix} \begin{bmatrix} 1 & 1 & 1\ . & \cdots & 1 \\ t & t-1 & t-2. & \cdots & 1 \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix}}{} \quad (7)$$

After that, the denominator is made the same as $t.(t+1)$ so that eq.(7) can be rewritten as:

$$\frac{\begin{matrix} 1/(t\cdot(t+1)) \\ 1/(t\cdot(t+1)) \end{matrix} \begin{bmatrix} t+1 & t+1 & t+1\ . & \cdots & t+1 \\ 2\cdot t & 2\cdot(t-1) & 2\cdot(t-2). & \cdots & 2 \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix}}{} \quad (8)$$

If the two are subtracted from each other, the result is:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \begin{bmatrix} -t+1 & -t+3 & -t+5 & \cdots & -t+(2\cdot t-1) \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix} \quad (9)$$

If t is even then:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \begin{bmatrix} -t+1 & -t+3 & \cdots & -1 & 1 & 3 & \cdots & t-1 \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix} \quad (10)$$

Meanwhile, if t is odd then:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \begin{bmatrix} -t+1 & -t+3 & \cdots & 0 & 2 & 4 & \cdots & t-1 \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix} \quad (11)$$

From eq.(11) it can be rewritten as:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \begin{bmatrix} -t+1 & -t+3 & -t+5 & \cdots & -t+(2\cdot t-1) \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix} \quad (12)$$

When written in summation notation eq.(12) becomes:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \cdot \sum_{i=1}^{t} D_i \cdot (-t-1+2\cdot i) \quad (13)$$

If t is even then:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \cdot \left[\sum_{i=1}^{\frac{t}{2}} D_i \cdot (-t-1+2\cdot i) + \sum_{i=\frac{t}{2}+1}^{t} D_i \cdot (-t-1+2\cdot i) \right] \quad (14)$$

and in the first term of eq.(14) the negative sign is removed from the sum notation to become:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)} \cdot \left[-\sum_{i=1}^{\frac{t}{2}} D_i \cdot (t+1-2\cdot i) + \sum_{i=\frac{t}{2}+1}^{t} D_i \cdot (-t-1+2\cdot i) \right] \quad (15)$$

At linear data weight values and an even number of data, if $K_2^1(\mathrm{t}) = 0$, then the right data set is the same size or "equal in weight" as the left data set without any data being used as an equilibrium point so that the trend direction of the data is horizontal with an angle of zero degrees.

If t is even and $K_2^1 > 0$ then there is an inequality relationship:

$$\sum_{i=\frac{t}{2}+1}^{t} D_i \cdot (-t-1+2\cdot i) > \sum_{i=1}^{t/2} D_i \cdot (t+1-2\cdot i) \quad (16)$$

In the inequality of eq.(16) it can be rewritten in matrix form as:

$$\begin{bmatrix} t-1 & t-3 & t-5 & \cdots & 1 \end{bmatrix} \cdot \begin{bmatrix} D_t \\ D_{t-1} \\ D_{t-2} \\ \vdots \\ D_{\frac{t}{2}+1} \end{bmatrix} > \begin{bmatrix} t-1 & t-3 & t-5 & \cdots & 1 \end{bmatrix} \cdot \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_{t/2} \end{bmatrix} \quad (17)$$

At linear data weight values and an even number of data, if $K_2^1(\mathrm{t}) > 0$, then the right data set is larger or "heavier" than the left data without any data being used as an equilibrium point so that the trend direction of the data is upwards with a positive angle.

Meanwhile, if t is even and $K_2^1 < 0$ then there is an inequality relationship:

$$\sum_{i=\frac{t}{2}+1}^{t} D_i \cdot (-t-1+2\cdot i) < \sum_{i=1}^{t/2} D_i \cdot (t+1-2\cdot i) \quad (18)$$

In the inequality of eq.(18) it can be rewritten in matrix form as:

$$\begin{bmatrix} t-1 & t-3 & t-5 & \cdots & 1 \end{bmatrix} \cdot \begin{bmatrix} D_t \\ D_{t-1} \\ D_{t-2} \\ \vdots \\ D_{\frac{t}{2}+1} \end{bmatrix} < \begin{bmatrix} t-1 & t-3 & t-5 & \cdots & 1 \end{bmatrix} \cdot \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_{t/2} \end{bmatrix} \quad (19)$$

At the linear data weight value and even number of data, if $K_2^1(\mathrm{t}) < 0$, then the right data set is smaller or "lighter" than the left data without any data being used as an equilibrium point so that the trend direction of the data is downward with a negative angle.

Furthermore, in the same way, for *t* with an even value from the previous equation, namely, eq. (12) and (13) if *t* has an odd value, then the formula for the difference in the first and second order averages is

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)}\cdot\left[\sum_{i=1}^{\frac{t-1}{2}} D_i\cdot(-t-1+2\cdot i) + D_{\frac{t+1}{2}}\cdot 0 + \sum_{i=\frac{t+3}{2}}^{t} D_i\cdot(-t-1+2\cdot i)\right] \quad (20)$$

And as in the first term of eq.(15), the negative sign is removed from the sum notation to become:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)}\cdot\left[-\sum_{i=1}^{\frac{t-1}{2}} D_i\cdot(t+1-2\cdot i) + \sum_{i=\frac{t+3}{2}}^{t} D_i\cdot(-t-1+2\cdot i)\right] \quad (21)$$

At the linear data weight value and an odd number of data, if $K_2^1(\mathrm{t}) = 0$, then the right data set is the same size or "equal weight" as the left data with the data sequence in the middle, which is used as the equilibrium point so that the trend direction of the data is horizontal with an angle of zero degrees.

If *t* is odd and $K_2^1(t) > 0$, then there is an inequality relationship:

$$\sum_{i=\frac{t+3}{2}}^{t} D_i\cdot(-t-1+2\cdot i) > \sum_{i=1}^{\frac{t-1}{2}} D_i\cdot(t+1-2\cdot i) \quad (22)$$

In the inequality of eq.(22) it can be rewritten in matrix form as:

$$[t-1 \quad t-3 \quad t-5 \quad \cdots \quad 2]\cdot\begin{bmatrix} D_t \\ D_{t-1} \\ D_{t-2} \\ \vdots \\ D_{\frac{t+3}{2}} \end{bmatrix} > [t-1 \quad t-3 \quad t-5 \quad \cdots \quad 2]\cdot\begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_{\frac{t-1}{2}} \end{bmatrix} \quad (23)$$

For linear data weight values and odd amounts of data, if $K_2^1(\mathrm{t}) > 0$ then the right data set is larger or "heavier" than the left data, with the data sequence in the middle being used as the equilibrium point, so that the direction of the trend is data is upward at a positive angle. If *t* is odd and $K_2^1(t) < 0$, then there is an inequality relationship:

$$\sum_{i=\frac{t+3}{2}}^{t} D_i\cdot(-t-1+2\cdot i) < \sum_{i=1}^{\frac{t-1}{2}} D_i\cdot(t+1-2\cdot i) \quad (24)$$

In the inequality of eq.(24) it can be rewritten in matrix form as:

$$[t-1 \quad t-3 \quad t-5 \quad \cdots \quad 2]\cdot\begin{bmatrix} D_t \\ D_{t-1} \\ D_{t-2} \\ \vdots \\ D_{\frac{t+3}{2}} \end{bmatrix} < [t-1 \quad t-3 \quad t-5 \quad \cdots \quad 2]\cdot\begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_{\frac{t-1}{2}} \end{bmatrix} \quad (25)$$

At linear data weight value and odd data amount, if $K_2^1(\mathrm{t}) < 0$, then the right data set is smaller or "lighter" than the left data with the data sequence in the middle used as the equilibrium point so that the trend direction of the data is downward with a negative angle. So the distribution of DWA data weight $K_2^1(t)$ is the distribution of DWA data $K_2^1(t)$ divided by the amount of data in the second level data sum *t*.(*t*+1)/2, so that eq.(13) can be rewritten as:

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)/2}\cdot\sum_{i=1}^{t} D_i\cdot\frac{(-t-1+2\cdot i)}{2} \quad (26)$$

Or from the eq.(26) in matrix form is

$$K_2^1(\mathrm{t}) = \frac{1}{t\cdot(t+1)/2}\left[\frac{-t+1}{2} \quad \frac{-t+3}{2} \quad \frac{-t+5}{2} \quad \cdots \quad \frac{t-1}{2}\right]\begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix} \quad (27)$$

Finally, from the numerator of the eq.(27), it can be seen that the DWA data distribution value has been proven to have a linear data weight (Goenawan 2021), which can be seen in Table 1. In trade, the *t* variable is the amount of data (column 2), whereas in quantitative questionnaires, the *t* variable is the number of scales (column 3).

Table 1. Distribution of DWA Data Weights

No.	t	Distribution of DWA Data Weights $K_2^1(t)$
1	2	-0,5 +0,5
2	3	-1 0 +1
3	4	-1,5 -0,5 +0,5 +1,5
4	5	-2 -1 0 +1 +2
5	6	-2,5 -1,5 -0,5 +0,5 +1,5 +2,5
6	7	-3 -2 -1 0 +1 +2 +3
7	8	-3,5 -2,5 -1,5 -0,5 +0,5 +1,5 +2,5 +3,5
8	9	-4 -3 -2 -1 0 +1 +2 +3 +4

3.2 Empirical DWA Weight Search

This empirical DWA weight search can quickly determine the linear weight of data weighing analysis that can be utilized in questionnaire analysis. Below, in tables 2 and 3, data weight values are generated from the formula eq.(3), and the difference in the first and second order averages with t data has been mathematically proven by eq.(27).

$$K_2^1(t) = \overline{D(t)}^{(1)} - \overline{D(t)}^{(2)} \tag{28}$$

Description of notation:

p_1 and p_2 are the number patterns of the amount of data on the average of first and second order data.

P_1 and P_2 are the number patterns of the amount of data on the average of first and second order data after being multiplied by the sum of second order data (55) and one (10).

b is the linear weight derived from the difference between the values of P_1 and P_2 and is still divided by the sum of the amount of first-order data (10).

Table 2 contains the calculation process for finding the pattern of linear weight values of DWA data in a set of ten (10) data.

Table 2. Finding the DWA weight value in a data set of 10

No.	p_1	p_2	P_1	P_2	P_1-P_2	b
1	1	10	55	100	-45	**-4,5**
2	1	9	55	90	-35	**-3,5**
3	1	8	55	80	-25	**-2,5**
4	1	7	55	70	-15	**-1,5**
5	1	6	55	60	-5	**-0,5**
6	1	5	55	50	5	**0,5**
7	1	4	55	40	15	**1,5**
8	1	3	55	30	25	**2,5**
9	1	2	55	20	35	**3,5**
10	1	1	55	10	45	**4,5**
amount	10	55				

Meanwhile, table 3 contains the calculation process for finding the linear weight value pattern for DWA data in a set of eleven (11) data.

Table 3. Finding the DWA weight value in a data set of 11

No.	p_1	p_2	P_1	P_2	P_1-P_2	b
1	1	11	66	121	-55	**-5**
2	1	10	66	110	-44	**-4**
3	1	9	66	99	-33	**-3**
4	1	8	66	88	-22	**-2**
5	1	7	66	77	-11	**-1**
6	1	6	66	66	0	**0**
7	1	5	66	55	11	**1**
8	1	4	66	44	22	**2**
9	1	3	66	33	33	**3**
10	1	2	66	22	44	**4**
11	1	1	66	11	55	**5**
amount	11	66				

III. RESULTS AND DISCUSSION

3.1 Dynamic Meta Data Scales for Trading Application

3.1.1 Sideways Data Case

Data Weighing Analysis (DWA) application for trading can be done dynamically. This study uses an example of stock price data x for one month, then later the data will be weighed dynamically every 15, 17, and 20 days for 30 days, where the results are in the form of a calculation table and sideways graph simulation.

Table 4. Example of closing stock price data x for one month

Day	Price (IDR)	Day	Price (IDR)
1	1420	16	1850
2	1550	17	1960
3	1780	18	1730
4	1490	19	1620
5	1350	20	1750
6	1220	21	1920
7	1360	22	2040
8	1590	23	1680
9	1680	24	1340
10	1380	25	1390
11	1150	26	1880
12	1180	27	2010
13	1440	28	2060
14	1370	29	2010
15	1790	30	1970

Table 4 above contains the closing price of stock x in one month or 30 days, which can be used to create a graph of the closing price value of stock x with the trading transaction time at that time, as seen in Figure 1.

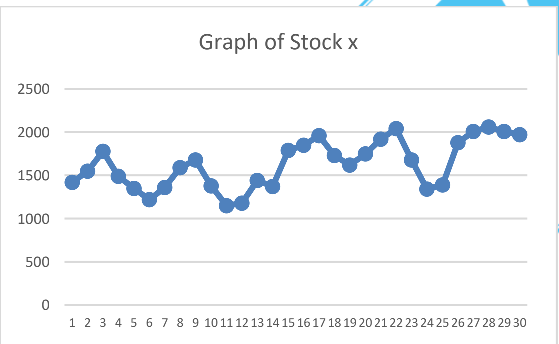

Figure 1. Graph of stock x data for one month

For example, Table 4 shows real electronic trading data on stock price changes for 30 days. The data is weighed using DWA dynamically every 15 days using the formula eq.(3) which is the difference between the average data (HOA 1) and the average data level two (HOA 2) with data as much as t, which will be weighed at the equilibrium point s which is on day h and u is the end of the day on the right side of the scale, so if the data set is "heavy" on the right, then:

$$K_2^1(t(s;h;u)) > 0 \tag{29}$$

Meanwhile, if the data set is "left heavy" then:

$$K_2^1(t(s;h;u)) < 0. \tag{30}$$

After the calculation is carried out, a data scale analysis can be produced, shown in Figure 2, namely the DWA graph per 15 days for 30 days.

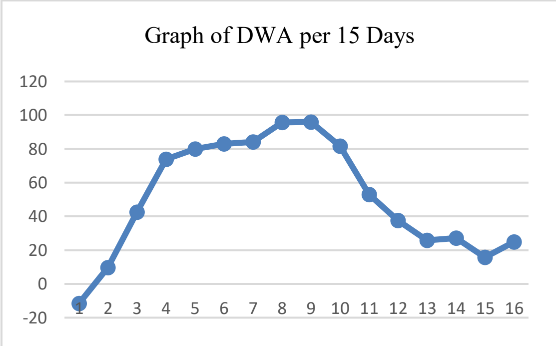

Figure 2. DWA graph of stock x per 15 days for one month

From the DWA analysis, if the data set is weighed on day 8 as the equilibrium point, the abscissa variable no.1, with 7 days to the right and left, the negative results indicate that the data set on days 1 to 7 has "heavier" data than days 9 to 15. Furthermore, for the data set weighed on days 9 and 10, the abscissa variables no.2 and 3, the DWA results are positive, meaning that the set of 7 data on the right side of the equilibrium point is "heavier" than the set of 7 data on the left side. Then other information is the scale value $K_2^1(15(2;9;16)) < K_2^1(15(3;10;17))$, meaning that although both tend to be "heavy" to the right, the set of 7 data on the right side on day 10 (abscissa no.3) is "heavier" than day 9 (abscissa no.2) when the DWA scale is carried out.

On the other hand, for the data set weighed on days 18 and 19, abscissa variables no.11 and 12, the DWA results are positive, meaning that the set of 7 data on the right side of the equilibrium point is still "heavier" than the set of 7 data on the left side. However, other information on the weight value $K_2^1(15(11;18;25)) > K_2^1(15(12;19;26))$ means that although both tend to be "heavy" to the right, the set of 7 data on the right side on day 19 (abscissa no.12) is "lighter" than day 18 (abscissa no.11) when DWA weighing is carried out.

Because DWA is dynamic, a data weight analysis can also be produced, which will be found in Figure 3, namely the DWA graph for 17 days for 30 days.

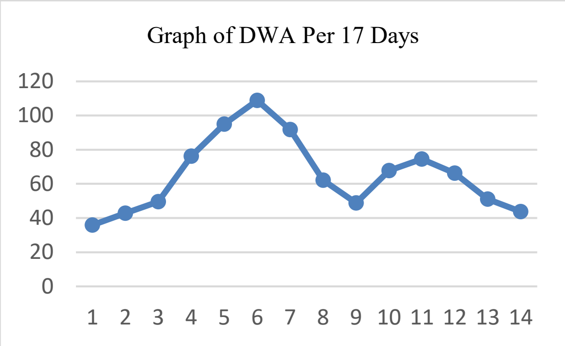

Figure 3. DWA graph of stock x per 17 days for one month

From the DWA analysis of Figure 3 above, if the data set is weighed on day 9 as the equilibrium point, the abscissa variable no.1, with 8 days to the right and left, the positive results indicate that the data set on days 1 to 8 has "lighter" data than days 10 to 17. Furthermore, for the data set weighed on days 12 and 13, the abscissa variables no.4 and 5, the DWA results are positive, meaning that the set of 8 data on the right side of the equilibrium point is "heavier" than the set of 8 data on the left side. Then other information is the scale value $K_2^1(17(4;12;20)) < K_2^1(17(5;13;21))$, meaning that although both tend to be "heavy" to the right, the set of 8 data on the right side on day 13 (abscissa no.5) is "heavier" than day 12 (abscissa no.4).

On the other hand, for the data set weighed on days 19 and 20, abscissa variables no.11 and 12, the DWA results are positive, meaning that the set of 8 data on the right side of the equilibrium point is still "heavier" than the set of 8 data on the left side. However, other information on the weight value $K_2^1(17(11;19;27)) > K_2^1(17(12;20;28))$ means that although both tend to be "heavy" to the right, the set of 8 data on the right side on day 19 (abscissa no.11) is "heavier" than the left side on day 20 (abscissa no.12) when DWA weighing is carried out. Furthermore, with the same data set in Table 5, data weighing will also be carried out every 20 days for 30 days, where the DWA results are in Figure 4.

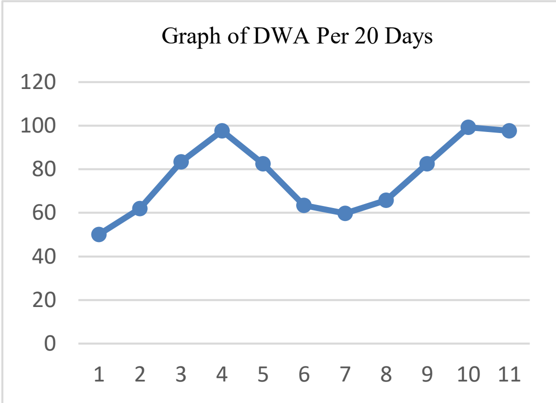

Figure 4. DWA graph of stock x per 20 days for one month

From the DWA analysis of Figure 4 above, if the data set is weighed strictly between days 10 and 11 as the equilibrium point, the abscissa variable no. 1, with 10 days to the right and left, the positive results indicate that the data set on days 11 to 20 has "heavier" data than days 1 to 10. Furthermore, for the data set weighed between days 13 and 14 (13|14) and 14 and 15 (14|15), the abscissa variables no. 4 and 5, the DWA results are positive, meaning that the set of 10 data on the right side of the equilibrium point is "heavier" than the set of 10 data on the left side. Then other information is the scale value $K_2^1(20(4;13|14;23)) > K_2^1(20(5;14|15;24))$ meaning that even though both tend to be "heavy" to the right, the set of 10 data on the right side on day 13|14 (abscissa no.4) is "heavier" than day 14|15 (abscissa no.5).

On the other hand, for the data set weighed on days 17|18 and 18|19, abscissa variables no.8 and 9, the DWA results are positive, meaning that the set of 10 data on the right side of the equilibrium point is still "heavier" than the set of 10 data on the left side. However, other information on the $K_2^1(20(8;17|18;27)) < K_2^1(20(9;18|19;28))$ (20(9;18|19;28)) balance value means that even though both tend to be "heavy" to the right, the collection of 10 data on the right side on day 18|19 (abscissa no.9) has a "heavier" $K_2^1(20(8))$ value than day 17|18 (abscissa no.8) $K_2^1(20(8))$ when DWA balance is carried out. The graph trend is towards an increase in the $K_2^1(20)$ value.

For the data balance analysis to be more complete using dynamic DWA, the three dynamic DWA graphs above can be combined to obtain a more objective and accurate trading data analysis, as seen in Figure 5.

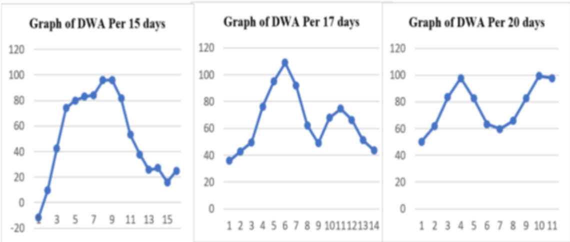

Figure 5. DWA graph of stock x per 15, 17 and 20 days for one month

From the DWA analysis of Figure 5 above, which consists of 3 DWA graphs per 15, 17, and 20 days, if the data set of Figure 1 is weighed on days 10 and 11, which in figure 5 are respectively at the value and position of K_2^1 (15(3;10;17)), $K_2^1(15(3;10;17))$, $K_2^1(17(2;10;18))$, $K_2^1(20(1;10|11;20))$ and $K_2^1(15(4;11;18))$, $K_2^1(17(3;11;19))$, $K_2^1(20(2;11|12;21))$ then by using DWA it can be analyzed that the three graphs show a sideways position in an uptrend so that the signal can be interpreted as buy information.

3.1.2 Non Sideways Data Case - Uptrend

Data Weighing Analysis (DWA) application for trading can be done dynamically. This study uses an example of uptrend stock price data y for one month. Later, the data will be weighed dynamically every 15, 17, and 20 days for 30 days, where the results will be in the form of a calculation table and a simulation of an uptrend graph, not sideways.

Table 5. Example of closing stock price data y for one month

Day	Price (IDR)	Day	Price (IDR)
1	1420	16	2150
2	1550	17	2750
3	1780	18	3250
4	1490	19	3300
5	1350	20	3550
6	1220	21	3740
7	1360	22	3360
8	1590	23	3680
9	1850	24	3750
10	1980	25	3860
11	2250	26	3820
12	2400	27	3530
13	2350	28	3910
14	2650	29	4150
15	2300	30	4130

Table 5 above contains the closing price of stock y in one month or 30 days, which can be used to create a graph of the closing price value of stock y with the trading transaction time at that time, as seen in Figure 6.

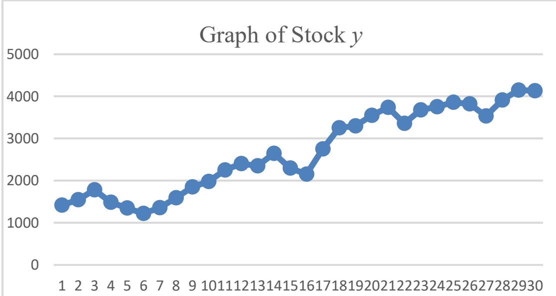

Figure 6. Graph of stock y data for one month

After the calculation is carried out, a data scale analysis can be produced, shown in Figure 7, namely the DWA graph per 15 days for 30 days.

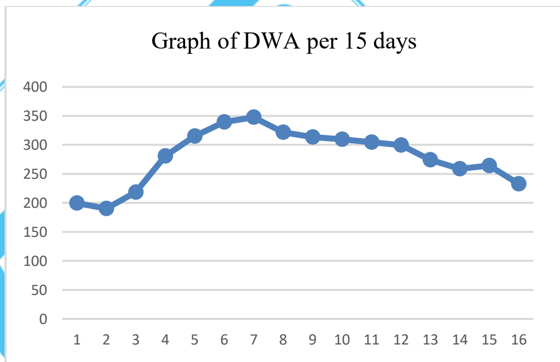

Figure 7. DWA graph of stock y per 15 days for one month

From the DWA analysis of Figure 7, if the data set is weighed on day 8 as the equilibrium point, the abscissa variable no.1, with 7 days to the right and left, the positive results indicate that the data set on days 1 to 7 has "lighter" data than the data on days 9 to 15. Furthermore, for the data set weighed on days 9 and 10, the abscissa variables no.2 and 3, the DWA results are positive, meaning that the set of 7 data on the right side of the equilibrium point is actually "heavier" than the set of 7 data on the left side. Then other information is the scale value $K_2^1(15(2;9;16)) < K_2^1(15(3;10;17))$, meaning that although both tend to be "heavy" to the right, the set of 7 data on the right side on day 10 (abscissa no.3) is "heavier" than day 9 (abscissa no.2) when the DWA scale is carried out. On the other hand, for the data set weighed on days 19 and 20, abscissa variables no.12 and 13, the DWA results are positive, meaning that the set of 7 data on the right side of the equilibrium point is still "heavier" than the set of 7 data on the left side. However, other information on the weight value $K_2^1(15(12;19;26)) > K_2^1(15(13;20;27))$ means that although both tend to be right-handed, the set of 7 data on the right side on day 20 (abscissa no.13) is "lighter" than day 19 (abscissa no.12) when DWA weighing is carried out. Because DWA is dynamic, a data weight analysis can also be produced, which will be found in Figure 8: the DWA graph per 17 days for 30 days.

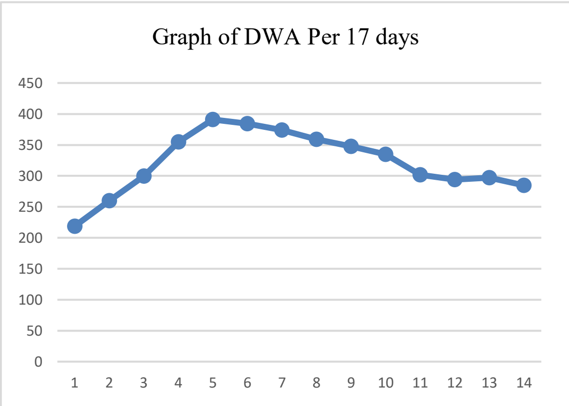

Figure 8. DWA graph of stock y per 17 days for one month

From the DWA analysis of Figure 8 above, if the data set is weighed on day 9 as the equilibrium point, the abscissa variable no.1, with 8 days to the right and left, the positive results indicate that the data set on days 1 to 8 has "lighter" data than days 10 to 17. Furthermore, for the data set weighed on days 12 and 13, the abscissa variables no.4 and 5, the DWA results are positive, meaning that the set of 8 data on the right side of the equilibrium point is "heavier" than the set of 8 data on the left side. Then other information is the scale value $K_2^1(17(4;12;19)) < K_2^1(17(5;13;20))$, meaning that even though both tend to be "heavy" to the right, the set of 8 data on the right side on day 13 (abscissa no.5) is "heavier" than day 12 (abscissa no.4). On the other hand, for the data set weighed on days 19 and 20, abscissa variables no.11 and 12, the DWA results are positive, meaning that the set of 8 data on the right side of the equilibrium point is still "heavier" than the set of 8 data on the left side. However, other information on the weight value $K_2^1(17(11;19;27)) \approx K_2^1(17(12;20;28))$ means that even though both tend to be "heavy" to the right, the set of 8 data on the right side on day 19 (abscissa no.11) weights $K_2^1(17)$ almost the same on day 20 (abscissa no.12) when DWA weighing is carried out. The graph trend is towards equilibrium with the difference in linear weight of the set of 8 data on the right and left sides or equilibrium value $K_2^1(17)$ with a difference that is not too significant when DWA weighing is carried out. Furthermore, with the same data set, table 6 will also carry out data weighing every 20 days for 30 days, where the DWA results are shown in Figure 9.

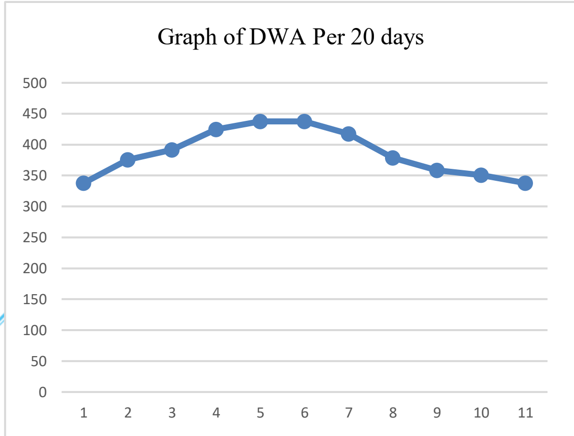

Figure 9. DWA graph of stock y per 20 days for one month

From the DWA analysis of Figure 9 above, if the data set is weighed strictly between days 10 and 11 as the equilibrium point, the abscissa variable no.1, with 10 days to the right and left, the positive results indicate that the data set on days 11 to 20 has "heavier" data than days 1 to 10. Furthermore, for the data set weighed between days 13 and 14 (13|14) and 14 and 15 (14|15), the abscissa variables no.4 and 5, the DWA results are positive, meaning that the set of 10 data on the right side of the equilibrium point is "heavier" than the set of 10 data on the left side. Then other information is the scale value $K_2^1(20(4;13|14;23)) < K_2^1(20(5;14|15;24))$ meaning that even though both tend to be "heavy" to the right, the set of 10 data on the right side on day 13|14 (abscissa no.4) is "lighter" than day 14|15 (abscissa no.5). On the other hand, for the data set weighed on days 17|18 and 18|19, abscissa variables no.8 and 9, the DWA results are positive, meaning that the set of 10 data on the right side of the equilibrium point is still "heavier" than the set of 10 data on the left side. However, other information on the $K_2^1(20(8;17|18;27)) > K_2^1(20(9;18|19;28))$balance value means that even though both tend to be "heavy" to the right, the collection of 10 data on the right side on day 18|19 (abscissa no.9) has a "lighter" $K_2^1(20)$ value than day 17|18 (abscissa no.8) when DWA is weighed. For the data weight analysis to be more complete using dynamic DWA, the three dynamic DWA graphs above can be combined to obtain a more objective and accurate trading data analysis, as seen in Figure 10.

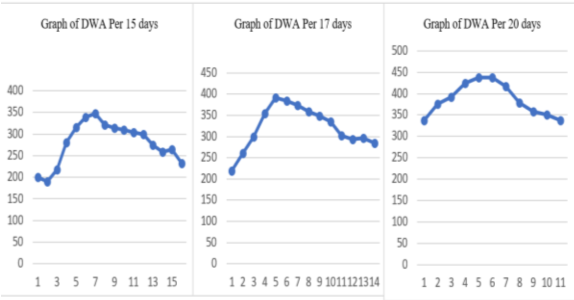

Figure 10. DWA graph of stock y per 15, 17 and 20 days for one month

From the DWA analysis of Figure 10 above, which consists of 3 DWA graphs per 15, 17, and 20 days, if the data set of Figure 6 is weighed on days 11 and 12, which in Figure 10 are respectively at the value and position of $K_2^1(15(4;11;18))$, $K_2^1(17(3;11;19))$, $K_2^1(20(2;13|14;23))$ and $K_2^1(15(5;12;19))$, $K_2^1(17(4;12;20))$, $K_2^1(20(3;14|15;24))$ then by using DWA, the three graphs can be analyzed to show an uptrend position so that the signal provides strong buy information.

3.1.3 Non-Sideways Data Case - Downtrend

Data Weigher Analysis (DWA) application for trading can be done dynamically. This study uses an example of a downtrend stock price data z for one month. Later, the data will be weighed dynamically every 15, 17, and 20 days for 30 days, where the results are in the form of a calculation table and a downtrend graph simulation, not sideways.

Table 6. Example of stock price data z for one month

Day	Price (IDR)	Day	Price (IDR)
1	5420	16	2750
2	5550	17	3260
3	4780	18	3450
4	4490	19	2920
5	4350	20	3150
6	4220	21	2740
7	4360	22	2360
8	3590	23	1880
9	3850	24	1750
10	3280	25	1860
11	3250	26	1520
12	2850	27	1230
13	2350	28	1810
14	2650	29	1550
15	2950	30	1130

Table 6 above contains the closing price of stock z in one month or 30 days, which can be used to create a graph of the closing price value of stock z with the trading transaction time at that time, as seen in Figure 11.

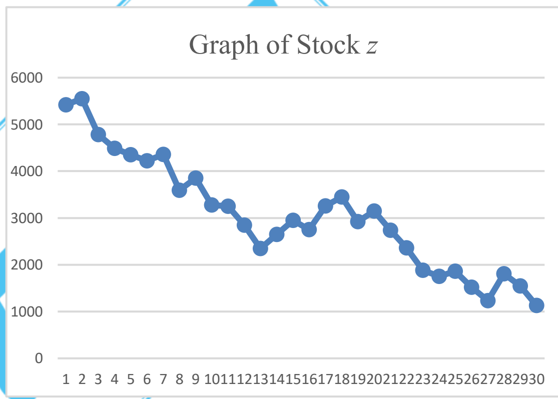

Figure 11. Graph of stock z data for one month

After the calculation is carried out, a data scale analysis can be produced, shown in Figure 7, namely the DWA graph per 15 days for 30 days.

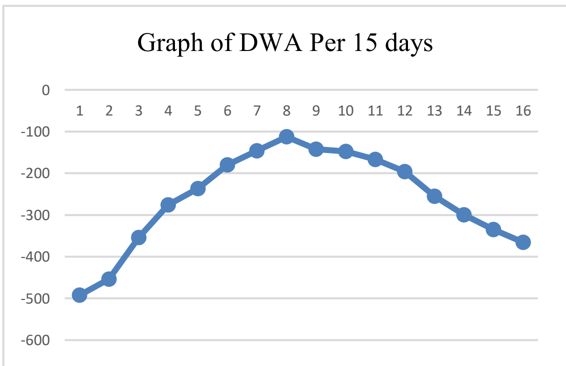

Figure 12. DWA graph of stock z per 15 days for one month

From the DWA analysis of Figure 12, if the data set is weighed on day 8 as the equilibrium point, the abscissa variable no.1, with 7 days to the right and left, the negative results indicate that the data set on days 1 to 7 has "heavier" data than the data on days 9 to 15. Furthermore, for the data set weighed on days 9 and 10, the abscissa variables no.2 and 3, the DWA results are negative, meaning that the set of 7 data on the right side of the equilibrium point is "lighter" than the set of 7 data on the left side. Then other information is the scale value $K_2^1(15(2;9;16)) < K_2^1(15(3;10;17))$, meaning that although both tend to be "heavy" to the left, the set of 7 data on the left side on day 10 (abscissa no.3) is "heavier" than day 9 (abscissa no.2) when the DWA scale is carried out. On the other hand, for the data set weighed on days 19 and 20, abscissa variables no. 12 and 13, the DWA results are negative, meaning that the set of 7 data on the right side of the equilibrium point is still "lighter" than the set of 7 data on the left side. However, other information on the weight value $K_2^1(15(12;19;26)) > K_2^1(15(13;20;27))$ means that although both tend to be "heavy" on the left, the set of 7 data on the left side on day 20 (abscissa no. 13) is "heavier" than day 19 (abscissa no. 12) when DWA weighing is carried out. Because DWA is dynamic, a data weight analysis can also be produced, which will be found in Figure 13, namely the DWA graph per 17 days for 30 days.

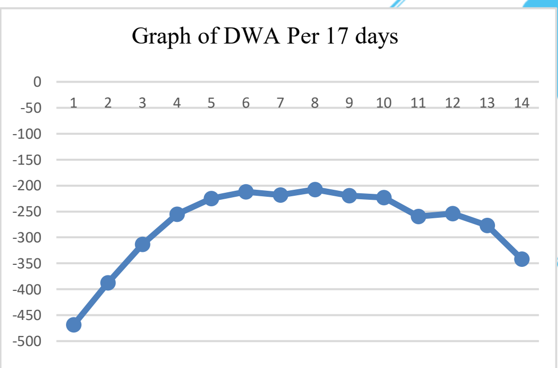

Figure 13. DWA graph of stock z per 17 days for one month

From the DWA analysis of Figure 13 above, if the data set is weighed on day 9 as the equilibrium point, the abscissa variable no.1, with 8 days to the right and left, the negative results indicate that the data set on days 1 to 8 has "heavier" data than days 10 to 17. Furthermore, for the data set weighed on days 12 and 13, the abscissa variables no.4 and 5, the DWA results are negative, meaning that the set of 8 data on the left side of the equilibrium point is "heavier" than the set of 8 data on the right side. Then other information is the scale value $K_2^1(17(4;12;19)) < K_2^1(17(5;13;20))$, meaning that even though both tend to be "heavy" to the left, the set of 8 data on the right side on day 13 (abscissa no.5) is "heavier" than day 12 (abscissa no.4). On the other hand, for the data set weighed on days 19 and 20, abscissa variables no.11 and 12, the DWA results are negative, meaning that the set of 8 data on the right side of the equilibrium point is still "lighter" than the set of 8 data on the left side. However, other information on the weight value $K_2^1(17(11;19;27)) \approx K_2^1(17(12;20;28))$ means that although both tend to be "heavy" on the left, the set of 8 data on the right side on day 19 (abscissa no.11) weights $K_2^1(17)$ almost the same on day 20 (abscissa no.12) when DWA weighing is carried out.

Furthermore, with the same data set in Table 7, data weighing will also be carried out every 20 days for 30 days, where the DWA results are in Figure 14.

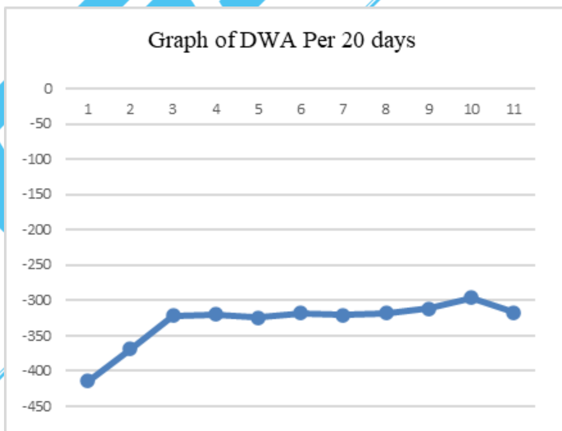

Figure 14. DWA graph of stock z per 20 days for one month

From the DWA analysis of Figure 14 above, if the data set is weighed strictly between days 10 and 11 as the equilibrium point, the abscissa variable no.1, with 10 days to the right and left, the negative results indicate that the data set on days 11 to 20 has "lighter" data than days 1 to 10. Furthermore, for the data set weighed between days 13 and 14 (13|14) and 14 and 15 (14|15), the abscissa variables no.4 and 5, the DWA results are negative, meaning that the set of 10 data on the right side of the equilibrium point is "lighter" than the set of 10 data on the left side. Then other information is the scale value $K_2^1(20(4;13|14;23)) \approx K_2^1(20(5;14|15;24))$ meaning both tend to be "heavy" left and the collection of 10 data on the right side on day 13|14 (abscissa no.4) is almost as "heavy" as day 14|15 (abscissa no.5). On the other hand, for the data collection weighed on days 17|18 and 18|19, abscissa variables no.8 and 9, the DWA results are negative meaning the collection of 10 data on the left side of the equilibrium point is still "heavier" than the collection of 10 data on the right side. However, other information on the $K_2^1(20(8;17|18;27)) < K_2^1(20(9;18|19;28))$ balance value means that even though both tend to be "heavy" on the left, the collection of 10 data on the right side on day 18|19 (abscissa no.9) has a "heavier" $K_2^1(20)$ value than day 17|18 (abscissa no.8) when DWA is weighed. For the data balance analysis to be more complete using dynamic DWA, the three dynamic DWA graphs above can be combined to obtain a more objective and accurate trading data analysis, as seen in Figure 15.

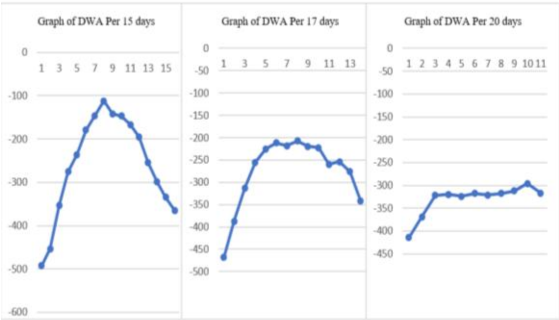

Figure 15. DWA graph of stock z per 15, 17 and 20 days for one month.

From the DWA analysis of figure 15 above which consists of 3 DWA graphs per 15, 17 and 20 days, if the data set of figure 11 is weighed on days 12 and 13, which in figure 15 respectively have negative values at positions $K_2^1(15(5;12;19))$, $K_2^1(17(4;12;20))$, $K_2^1(20(3;14|15;24))$ and $K_2^1(15(6;13;20))$, $K_2^1(17(5;13;21))$, $K_2^1(20(4;15|16;25))$ then by using DWA the three graphs can be analyzed to show a downtrend position so that the signal provides strong sell information. The benefits of DWA in recognizing Big Data graphic patterns in a series of buy and sell trading transactions, such as in currencies, stocks, and commodities are that within a certain period, the graphic data can go up or down. A new method can be used to analyze the graphic data pattern, namely Analysis through DWA. The DWA carried out is to weigh the weight value of the data reviewed from the middle value of the data set, whether it tends to be heavy to the right or to the left either statically or dynamically. With this Dynamic DWA information, the graphic analysis can be more complete to improve researchers/traders in concluding the Big Data trade.

IV. CONCLUSION

Data Weigher Analysis is a quantitative measurement method to determine the tendency of a data set, whether it is heavier to the left or right data, by using data weighting or a new method, namely the average of multilevel data. Data Weigher Analysis (DWA) can use two methods, namely the weighting method and the multilevel data average method, which are proven to be the same. The DWA calculation process using the multilevel data average method is more effective and efficient than the weighting method because it does not need to determine the weight value to calculate faster. Further applications of DWA can be used to weigh questionnaires and trade data sets, both static and dynamic. It is hoped that with this additional information, the analysis of DWA graphs in trade will give rise to a new branch of DWA science, namely Technical Analysis of Data Weighing (ATTD), which includes:

1. Manual ATTD, namely the modeling technique and recognition of graphic patterns carried out directly by humans,
2. Automatic ATTD, namely the modeling technique and extrapolation formula for trade data carried out by an automatic program.

Both branches of science above will be able to improve better for traders/researchers in making decisions. The novelty of this study is the measurement of dynamic DWA using the one and two-level mean difference method in weighing a set of dynamic data that produces a weighting value on the data along with its mathematical proof.

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