

# Big Data Analytics for Stock Investment Behavior Dynamics

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*Abstract* - Stock exchange is a place which is full of challenges. The nature of investment in stocks is high risk. This is due to a “not so easy to predict” characteristics of the whole system. Supervising such activities can be a real challenge. The key issue is to understand the investment behavior. From huge amount of data available to analyze, use cases need to be determined. A concept of data analytics is then introduced. This is then further discussed and explained. Strange behaviors in the investment management of BPJS Ketenagakerjaan (National Labor Social Security Agency of Indonesia) is also spotted on.

*Index Terms* - Big data Analytics, Modelling Analysis, Policy, Risk Management, System Thinking.

## INTRODUCTION

As mandated by the law [1], the management of *BPJS Ketenagakerjaan* (National Labor Social Security Agency of Indonesia), is to manage a huge chunk of participatory collected fund. The investment of the fund must be managed prudently, as it needs to pass certain *Supreme Audit Board* scrutineering. On the other hand, it is *highly* expected to gain yields as high as possible. The margin of the investment yields shall be distributed well as social security benefits to the participants.

One of the permitted investment sectors is the *Indonesian Stock Exchange*. The agency may only invest in the LQ45 stock category [2]. This would obviously bring certain constraints in the investment policy making process. Such constraints shall be elaborated in 0.

In the previous work [3], the system dynamic model conceived showed a very important role of the management decision within the organization. This was mainly done to establish certain level of risk threshold in order to create a sense of control within the system. It was straightforwardly transparent that the management element had always been the most determining factor which drove the whole system dynamic.

The challenge for the management is now somewhat different. Instead of just dealing with the investment risks, the management needs to find a way to disentangle some inflexibility issues.

The *big data analytics* scheme [4] is used, and the results presented in this work are to be analyzed further, to identify the investment behavior of the management. Should it be understood, it may be used to optimize the investment return of the Agency.

## CONSTRAINTS

The *National Labor Social Security Agency* is governed directly under the President of Indonesia [1]. Hence, the management dutifully reports to the President.

As a government entity the Agency is bound to certain scrutiny to ensure a good governance is always applied. Mistakes and losses made by the management may lead to legal suits.

These are main elements that pull real constraints to the investment dynamic:

1. *Loss* may be the Nation's loss. This would lead to State legal charges.
2. *Cut Loss mechanism*, a common practice used in stock trading by dumping unwanted stocks to increase opportunities in gaining higher yields. Such practice is prohibited due to point 2900.
3. *LQ45 category*, only top 45 frequently traded stocks are allowed to be acquired.
4. *Realized Gain*, only realized gain that is allowed to be distributed as benefits to the social security members. This is due to a *cash basis* scheme for benefit distribution.
5. *Unrealized Loss*, this is not considered to be in the category of point 2900.
6. *Opportunity Loss*, this is not considered to be in the category of point 2900.
7. *Guaranteed Benefit*, Members must receive distributed benefit higher than standard average bank's fixed deposit interest annually.

Fortunately, the allowable stock investment portfolios only are at maximum 20 percent of the total managed fund. Thus, to guarantee point 2900, the yields can still be compensated from other type of allowable investment schemes.

The saying “*high risk – high return*” is unlikely to be applied in this case, especially with the above constraints remain. However, points 2 and 5 above may still be debatable. These are due to different perspectives in interpreting existing State regulations, especially *The State Finance Law* [5]. Furthermore, the management needs to rectify certain regulations accordingly to put the two aforementioned issues (points 2 and 5) negligible.

The 7 constraints above are directly restricting the optimization of the investment. Complex compromises

between investment common practices and compliances to the above constraints must be done accordingly. This kind of situation can be shown through the *data analytics*.

## RISKS

Certain identified risks were found in the investment practices within the Agency. They are as follows:

1. *High market dependency due to Stock rigidity*, the yields from stock investment is hugely dependent upon market situation. This is due to the number of stocks acquired keeps increasing proportionally to the increasing premium based fund collected. In addition, the allowable stocks acquired are only in the LQ45 category [6]. The situation causes *stock rigidity* where stocks to be acquired and sold become *rigidly* transactional and directly influencing the stock prices.
2. *Opaque yield information, unrealized loss* in point 5 and 6 of 0 creates *illusion* of real portfolios' value. This is due to the situation is not yet considered a loss. The method used in this case is YoI (Yield on Investment). Using the formula:  $Yield = \frac{Net\ Realized\ Return}{Principal\ Amount}$ , taken from [7]. This obviously does not cover the *unrealized* information.
3. *Non-risk-based management decision*, the investment decision is merely based on a risk management process, since there is a significant lag of data being processed through the risk management division. This data lagging situation cannot be used as a preemptive action to the investment decision. It is, however, considered to be a post risk analytic process. Hence, none can be mitigated.
4. *Internal moral hazard*, unrecorded investment placement process starting from offering up to placement decision. The situation causes the placement process to be *unsupervised*.
5. *Mediocre investment performance*, none of the personnel in the investment directorate holds a globally recognized certificates in investment management (e.g., CFA).
6. *Double exposure*, LQ45 stocks are also managed in the mutual fund investment portfolio. This situation has increased the risks exposed in similar stock portfolio.
7. *Membership premium laundering scheme*, the cash basis scheme for benefit distribution has pushed the *realized gain* to be done without considering the real return. The fresh fund from premium collection is then placed in a higher price stock. The situation is called *a membership premium laundering scheme*.
8. *Implicit stock cornering scheme*, when 7 is further analyzed, then it may also be considered to be an *illegal stock cornering activity*.
9. *Off market stock deal*, the stock investment is also exposed to illegal deals, where personnel involved may get an advantage by buying or selling stocks in a block sale not from the market.

## SENSORS

Any systems may be monitored by applying certain conditions to the system itself that produce feedbacks. Feedbacks can be looked at by applying sensors to the element of concerns [3].

## DATA

### I. Assumptions

Assumptions used in this work, are all related to authorities given to the agency based on the Law of The Republic of Indonesia No. 24 Year 2011 regarding Social Security Agencies (BPJS) [8] and its subsidiaries. The scope beyond such authorities shall not be included into the *data analytic* conceived. However, the *data analytic* is designed to be as broad as possible to cover all corresponding detailed dynamics.

The real challenge is to mitigate the aforementioned risks in 0. The adaptation of this mitigation process shall not be included into the *data analytics* in this current work. However, sensors and thresholds are used similar to [3] as use cases in the *data analytics*. It should be expected to show *investment behavior* based on the existing constraints in 0.

The philosophy behind this work is based on the mathematical logic in understanding the stock investment behavior. Some common investment senses are also used in the *analytic* considerations. None of the known method from stock trading strategies is applied.

### II. Type and Period

The data used in the *analytics* was stock trading data performed by the Agency from January 2016 to September 2020. Such data was derived from the Agency's internal information system. Stock prices during that same stretch was obtained from the *Indonesian Stock Exchange*. The latter data was used as the stock price confirmation references.

### III. Parameter

The *investment behavior* is defined as the way of the investment activities are performed under the aforementioned constraints.

Use cases are as follows:

1. Check all the possible risks 0 are relevant and mitigated during the transactions.
2. Transactions against trends.
3. Gains or losses.
4. Unrealized gains or unrealized losses.

### IV. Losses and Gains

The Agency utilizes a performance measurement method in the form of *realized YoI* (Yield on Investment) [7]. "*Realized*" means calculating the measurement on *income* (interest, coupons, dividends) and *profit* from selling divided by *disbursing investment*.

$$YoI = \frac{Net\ Realized\ Return}{Principle\ Amount}$$

There are 2 (two) weaknesses in the measurement method of *realized YoI*, namely:

1. In this method, the potential losses are not spotted on in assessing the performance. This will burden young (newly coming) participants or the future Agency administrators. Thus, it is necessary to calculate performance that includes *unrealized* calculations. Such calculations involve *potential losses*.

2. In addition to the performance measurement that involves *unrealized* aspects, the Agency also needs to measure *risk-based investment performance measurements*. Hence, this can show whether the results of their performance are the result of *their investment skills*, and **not** the results of *high risk taking* (they are the impact of the effect of *high risk-high return greed*). If it is due to high risk taking, this is considered to be *perilous*. It will further lead to a large *potential loss* when the investment slope is negative.

There are 3 methods commonly used in *risk-based portfolio performance measurement* [9], they are:

1. Sharpe Ratio (excess return divided by Standard Deviation)
2. Treynor Ratio (excess return divided by beta)
3. Jensen's Alpha (alpha divided by beta)

## V. Data Analytics

The data derived were in *csv* format [10].

The data analytic process was done with the following scheme as shown in Figure 1.

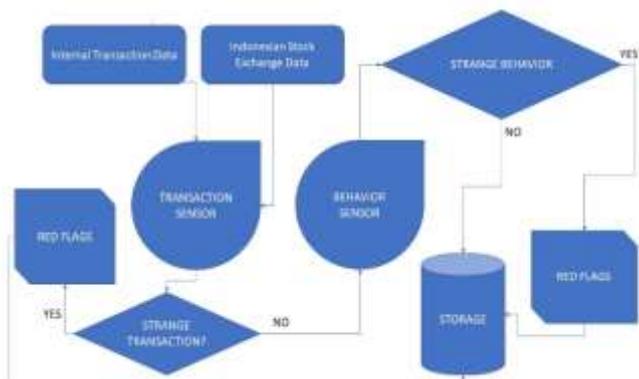


Figure 1. Data Analytic Flow

KNIME [11] was used as the analytical tool in this work.

## VI. Incomplete Data

Since the data used was restricted from January 2016 to September 2020, the initial outlays of some stocks purchased data were not available. These were stocks purchased prior to January 2016. Hence, the realized gain/loss sensor could not be determined precisely. However, it could be assumed that it had to suffice the constraint 0 number 4. Thus, such conditions would be treated as passing the sensor. Although, they can be notified as red flags at the same time.

## RESULTS

### I. Losses

According to the published data of the Agency in 2016-2019 (Program Management Report), it can be seen that YoI is always positive, i.e., 9.4% (2015), 9.4% (2016), 8.2% (2017), 7.3% (2019), and is higher than the average counter rate of the Government Banks.

According to the portfolio data, shown in Figure 2 below, from 2017 to Feb 2020, the unrealized loss of total assets increased sharply.

No.	Data Investment	2015		2016		2017		2018		2019		Feb 2020 (YTD)	
		Rp	%										
1	Time Deposit	47,760.17	22.2%	51,339.63	22.0%	59,529.21	22.2%	44,283.62	22.2%	46,864.49	20.9%	43,847.21	9.7%
2	Bond	95,940.37	40.6%	181,221.34	81.7%	185,238.71	58.7%	234,628.33	58.8%	230,773.37	80.2%	271,764.50	84.5%
3	Stock	44,006.33	18.8%	47,448.18	20.2%	40,250.15	19.0%	47,662.81	28.5%	41,246.63	19.1%	70,761.58	36.8%
4	Mutual Fund	20,891.00	8.0%	23,262.80	7.8%	26,679.44	9.1%	26,862.43	9.9%	40,216.69	12.7%	35,426.31	8.4%
5	Property	1,775.70	0.9%	1,774.36	0.7%	1,811.71	0.6%	1,866.49	0.5%	1,879.24	0.4%	1,884.72	0.4%
6	Direct Investment	151.46	0.1%	157.46	0.1%	482.35	0.1%	406.72	0.2%	450.74	0.1%	411.37	0.1%
<b>Total</b>		<b>208,858.22</b>	<b>100.0%</b>	<b>281,223.75</b>	<b>100.0%</b>	<b>317,281.34</b>	<b>100.0%</b>	<b>984,813.21</b>	<b>100.0%</b>	<b>431,672.38</b>	<b>100.0%</b>	<b>421,997.71</b>	<b>100.0%</b>
Investment Return		17,693.84	8.0%	21,744.43	9.42%	16,715.53	9.40%	17,277.36	8.28%	19,257.30	7.54%	1,694.72	1.28%
YoI Indonesia Consumer Price Index		-14.53%		7.69%		8.50%		-3.47%		-14.20%		-14.47%	
Unrealized Loss (Total Asset)		11,174.63	5.35%	11,139.36	3.96%	11,093.46	3.50%	11,246.31	1.14%	11,832.14	2.74%	11,113.76	2.63%
Unrealized Loss / Total Asset		4.00%		4.00%		3.50%		3.21%		3.21%		2.63%	
BHC FY		4.50	11.1%	3.76	10.3%	4.55	20.0%	6.18	3.1%	4.29	1.1%	5.62	13.4%

Figure 2. Unrealized Loss 2015-2020

*Unrealized loss* does not appear anywhere in YoI measurements. YoI is always positive at high enough level, despite the fact that there is a large *potential loss*. This was predicted already above in 0.

From this information, it can be concluded that the performance measurement does not show the risks involved. There is no calculated risk (*volatility, standard deviation, or beta*) in the YoI formula.

The comparison between YoI of total assets with the average counter rate of government banks is not objectively fair. This is because the government bank deposits' risk is very low.

### II. Investment Behavior

In this section, analytic result in a form of investment behavior is discussed. Some of strange investment conduct in stock investment are presented.



Figure 3. BBCA Stock Transactions 2016-2019

Figure 3 shows the behavior in the BBCA stock transactions. Logically, when the trend shows an incline tendency in the long run, the right strategy is to accumulate the stocks and sell them at the peak point position. In other words, selling is made when there is a reverse signal. This must be done based on a fundamental analysis and see whether the decline is due macroeconomic performance and/or by issuers. In addition, there should also be a signal from the aspect of technical analysis.

Strangely, as shown in Figure 3, BBCA stocks were in a long-term uptrend, but frequent buying and selling transactions during 2016-2019 stretch were done by the Investment

Directorate. An optimal yield out of this behavior would never be achieved.

Such strange behavior might be considered as risk 0 number 8. With more investigations and proof findings, the illegality of such behaviors could be determined.

Alternatively, it could be related to risk 0 number 7, since the Agency was forced to fulfill constraint 0 number 4. This kind of behavior may not be considered to be illegal. However, it could be considered to be ridiculously foolish. Furthermore, this behavior might lead to long term losses which were against constraint 0 number 1. This situation would finally end up in a *legal proceeding* anyway.

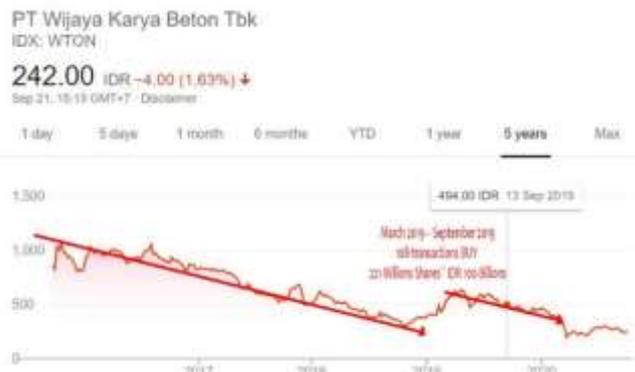


Figure 7 WTON Stock Transactions 2016-2019

Figure 4, Figure 5, Figure 6, Figure 7 and Figure 8 show similarly behaviors that are up *against the market*. Internally, the investment personnel call such action as “*averaging down*”. An *averaging down* scheme is commonly done to owned stocks (*in unrealized loss position*) that no longer have future prospects to incline. If such scheme is implemented for actively traded stocks, then it would be considered as “*digging your grave*” scenario. This is like collecting bad stocks. The *unrealized loss* would hit a high toll and would be difficult to recover. In the end the Agency would face an extreme problem to fulfill constraint 0 number 4. In such situation, the Agency would be accused to run a *Ponzi scheme* [12].



Figure 4 ADRO Stock Transactions 2016-2019

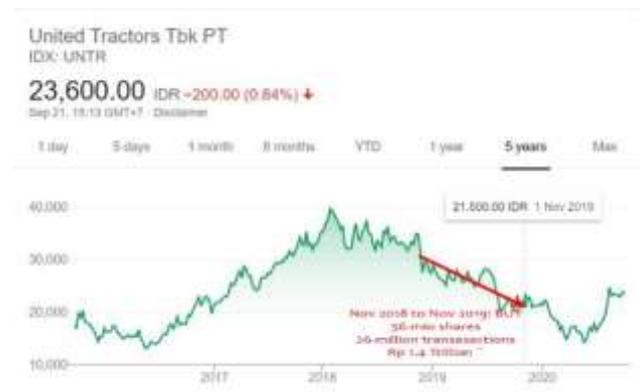


Figure 5 UNTR Stock Transactions 2016-2019



Figure 8 BBTN Stock Transactions 2016-2019



Figure 6 WSBP Stock Transactions 2016-2019

## ANALYSIS

The results obtained from the *Big Data Analytics* scheme were satisfactory. They provide tools to supervise stock investment activities. They can also be used as risk mitigation tools. Furthermore, they can be used as decision making tools. Especially if they can be embedded into a real time information system.

## RECOMMENDATIONS

The Agency needs to utilize *big data analytics* scheme to optimize its investment performance. The scheme also leads to more transparent investment practices and provide direct

accesses to risk mitigations. When applied in a real time information system, it will make investment decision making process more agile, strategic, and precise.

- Different type of use cases may be utilized accordingly to even further make the benefit of the analytics broader

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