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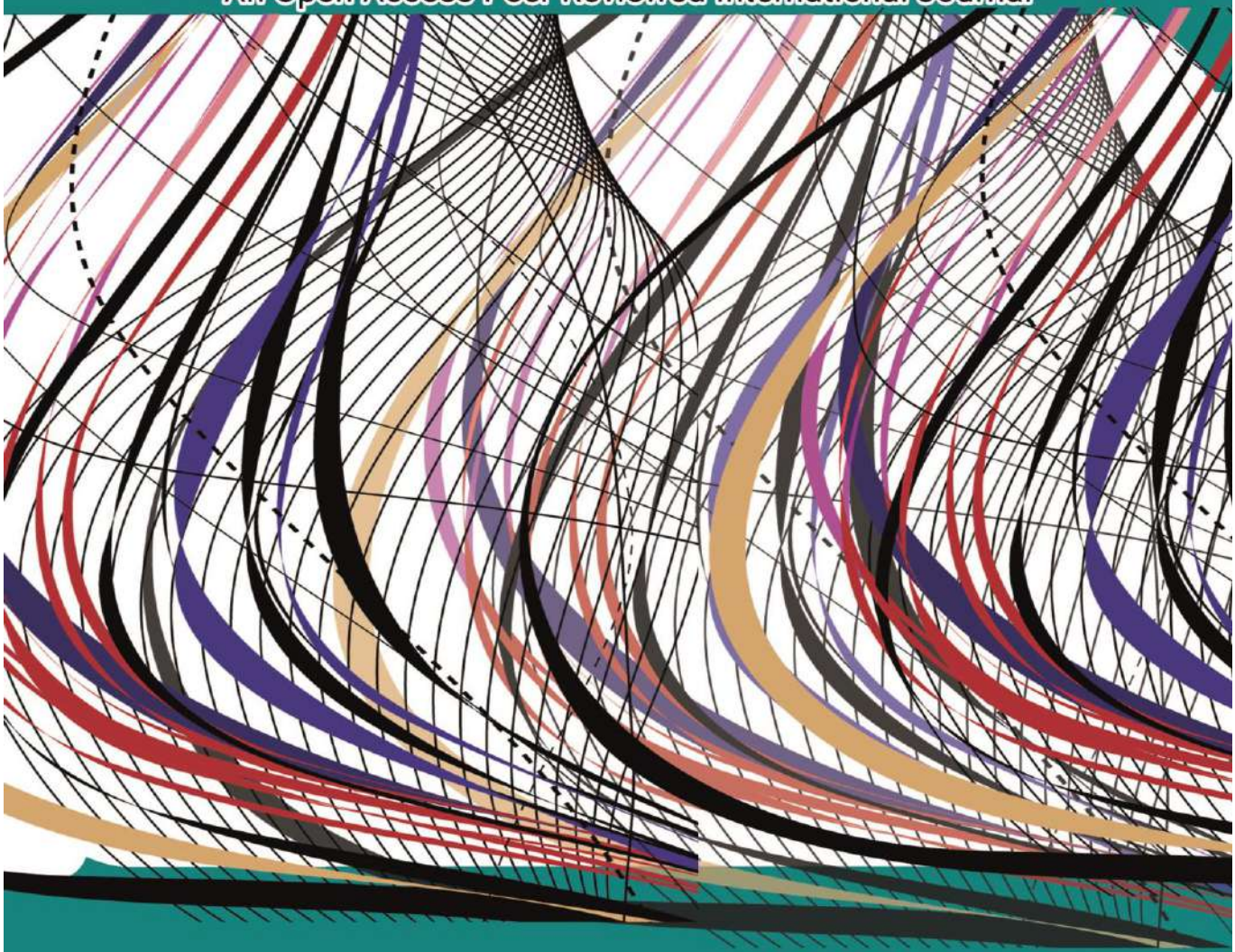

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FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-3: Mar, 2020 of **"International Journal of Advanced Engineering, Management and Science (IJAEMS) (ISSN: 2354-1311)" ,** an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers.

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Dr. Dinh Tran Ngoc Huy
Editor-in-Chief
Date: Apr, 2020

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Sensor-less DC-Voltage Control for Grid-Connected Inverters

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Abstract— *Three-phase grid-connected inverters using solar energy are applied very popular with large capacity. These inverters usually have input power sources in the direct current (DC) that varies according to the weather conditions. The DC voltage often needs to boost up the higher voltage level to be in accordance with the output voltage of inverters. Then, the output voltage of the DC/DC boost converter is in the form of DC voltage. In order to measure this DC value in the two-stage inverters, the existing methods usually use isolated voltage sensors. This paper presents a strategy for estimating the DC voltage value of inverters without using sensors in order to reduce cost and volume for inverters. The proposed method contributes to decreasing the price of inverters while ensuring the power quality of inverter outputs. The simulated results on MATLAB/Simulink have validated the performance of the presented solution.*

Keywords— ***Current harmonics, DC voltage controllers, grid-connected inverters, sensor-less DC-link voltage.***

I. INTRODUCTION

Renewable energies such as wind powers and solar powers are increasingly used due to its sustainability and environment. Because of the heavy dependence on weather conditions, these renewable energy sources have an unstable characteristic. Therefore, in order to become the high-quality, efficient power sources, these energies need to be connected to the grid through power semiconductor grid-connected inverters [1]–[3]. In operation, grid-connected inverters must meet the required power quality standards [4], [5]. Due to the output of the solar panels or the wind turbine generators is usually in form of direct-current (DC) and its capacity and voltage change according to weather conditions. Therefore, two-stage or single-stage grid-connected inverters with maximum power point detection function often have to use a DC voltage sensor to control this DC-link voltage value [6], [7]. The use of Hall sensors to isolate DC voltage for ensuring the safety of control circuits has increased the cost and space of the device.

The study of removing this sensor will contribute to reducing space and hardware, which will reduce device costs. However, this makes it difficult to control the quality of the output power, since the output current harmonics depend on the DC voltage value. Therefore, the accurate estimation of the DC voltage value without using the sensor has become a challenge. The control of DC-link voltage in grid-connected inverters plays an important role in system stability [8]–[10]. There have been solutions recommended to solve this problem. The work published in [11] introduced a control method without DC voltage sensor by estimating this value. However, this method has only applied for three-phase rectifiers. The method in [12] using the output current and the grid voltage to detect the DC-link voltage is only used for inverters with the fixed DC voltage. Another work in [13] has proposed a diagram without voltage sensor and removed the voltage control loop. However, the authors of this work have used neural networks to replace for the voltage control loop and only applied for the single-phase grid-connected inverters. This makes it difficult for large-scale inverter applications. The technique without DC voltage sensor in [14] has used the grid voltage to estimate the reference DC voltage. This may be inappropriate when the grid voltage changes and lead to the change of the estimated DC voltage. Meanwhile, the output voltage of DC-DC converter is still fixed.

This paper proposes a method for controlling the DC-link voltage without using a voltage sensor to reduce device cost and space regardless of the voltage drop of the converter. The value of the reference current for the inverter is estimated based on the voltage at the maximum power point of the solar modules. Section 2 in the paper introduces a method for controlling three-phase grid-

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connected photovoltaic inverters using the DC voltage sensor. The details of the proposed strategy without the DC voltage sensor are presented in Section 3. The simulation results are showed and discussed in Section 4. The conclusions in Section 5 show the performance of the proposed technique compared with that of the method using the sensor.

II. CONTROL OF DC-LINK VOLTAGE

The structure of a two-stage grid-connected inverter system using solar energy is shown in Fig. 1. The block of MPPT is responsible for detecting the maximum power point using the INC algorithm [15]. The outputs of this block are a PWM pulse for the DC/DC boost converter and a maximum power P_{MPPT} of the solar modules. The value of P_{MPPT} is used for calculating the reference current I_{d_ref}, that determines the amount of active power injected into the grid.

In Fig. 1, the phase-locked loop (PLL) functions to detect the magnitude V_{max}, frequency f, and angle θ of the grid voltage. This helps the inverter synchronize with the power network while it generates powers into the grid.

The control principle diagram of an inverter system is shown in Fig. 2. In the normal operation conditions, the inverter does not need to generate the reactive power Q into the grid. Thus, the reference reactive current I_{q_ref} is zero. The reference DC-link voltage V_{ref} is defined by the modulation index and the voltage magnitude as (1).

$$V_{ref} = \frac{2*V_{max}}{m} \quad (1)$$

Where m is the modulation index, and V_{max} is the voltage magnitude of the grid.

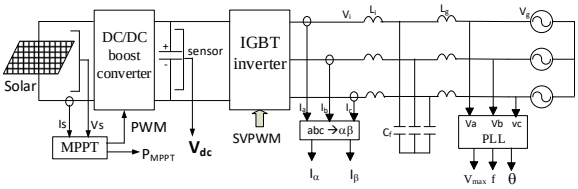

Fig. 1: Principle diagram of grid-connected photovoltaic inverter system

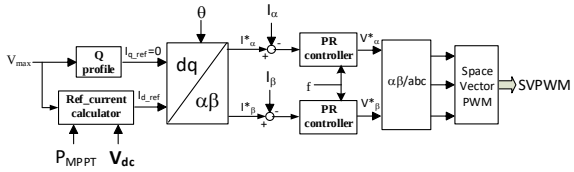

Fig. 2: Control diagram of grid-connected inverter

The reference current calculation block of $I_{d\text{-}ref}$ is shown in Fig. 3 and calculated as (2). This current will define the active power injected into the grid.

$$I_{d\_ref} = \frac{P_{MPPT}}{V_{max}} + \Delta I_{d\_ref} \quad (2)$$

Where $\Delta I_{d\text{-}ref}$ depends on the DC-link voltage regulation via a PI controller.

$$\Delta I_{d\_ref} = (V_{dc} - V_{ref}) * \left(K_{p-PI} + \frac{K_{i-PI}}{s} \right) = error * \left(K_{p-PI} + \frac{K_{i-PI}}{s} \right) \quad (3)$$

Where the error is the difference between the reference DC voltage value and the one measured by the sensor. Thus, it always needs a DC-link voltage sensor in order to calculate the reference current for the inverter.

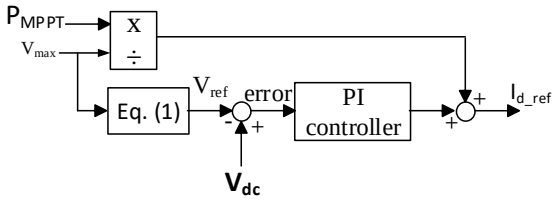

Fig. 3: Reference current calculation block when using voltage sensor

The DC/DC boost converter is shown in Fig. 4 and used to boost from the panel voltage V_s up to the reference DC-link voltage V_{dc}.

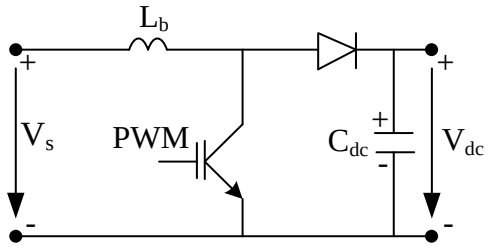

Fig. 4: Boost converter principle diagram

III. THE PROPOSED STRATEGY

As mentioned above, there is always a sensor to measure DC-link voltage of the inverter. In the proposed technique, the DC-link voltage value is estimated by using the outputs of the MPPT block.

Basing on the blocks MPPT and DC/DC boost converter, the DC-link voltage value is estimated as (4).

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$$V_{dc-estimated} = \frac{V_{solar}}{1 - D_{PWM}} \quad (4)$$

Where the voltage V_{solar} and the duty D_{PWM} are the voltage value and the pulse-width-modulation of the solar panels at the maximum power point, respectively. The estimation principle diagram is also described in Fig. 5. Where $V_{dc\text{-}estimated}$ is the estimated DC-link voltage value. This method has not been affected by the voltage drop of the boost devices.

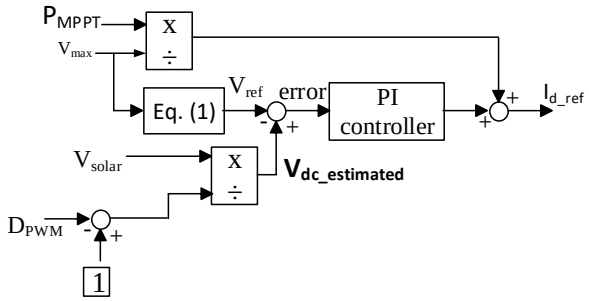

Fig. 5: The proposed reference current calculation.

IV. SIMULATION RESULTS

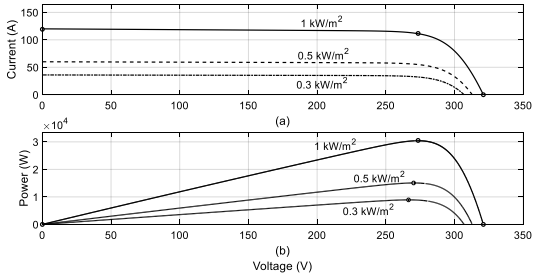

Fig. 6: V-A and V-W curves of the solar panels

The system model of this paper has used 90 solar panels from SUNPOWER, SPR-305E-WHT-D. Each panel has a peak power 305.226 Wp. All panels are 20 parallel-connected strings and each string consists of 5 series-connected panels. The total power of the system is 30.522kWp. The solar panel characteristics of the system in Fig. 6 show the voltage at the maximum power point about 270VDC. Then, the converter in Fig. 4 boosts this voltage value up to about 730VDC by the duty D_{PWM}.

In order to be appropriate to actual changes of irradiance conditions, there are 3 intervals of time selected in the same condition of 25°C to test 3 different irradiance levels, respectively. In the first interval of time, 0-0.4s, irradiance level is 1000W/m^2 (1pu). In the second interval, 0.4-0.7s, the irradiance is 500W/m^2 (0.5pu), and 300W/m^2 (0.3pu) is the irradiance level for the last interval 0.7-1s. The system parameters are showed in Table 1.

Table 1: System parameters

Description	Symbol	Value
Total peak power of solar panels	Solar	30.522 Wp
Grid voltage	V_g	3x380 V
Grid frequency	f	50 Hz
DC capacitor	C_{dc}	1000 µF
Filter inductor	L_i	7.5 mH
Filter capacitor	C_f	7.5 µF
Modulation index	m	0.8
DC voltage regulator coefficients	K_p-PI K_i-PI	0.2 2.5
Current controller coefficients	K_p-PR K_i-PR	110.37 304.2
DC/DC booster switching frequency	PWM	2 kHz
Inverter switching frequency	SVPWM	5 kHz

4.1. THE METHOD OF USING VOLTAGE SENSOR

The simulation results of the method using sensor are showed in Figs. 7-13. The output current waveforms in Ampere and total harmonic distortion (THD) are shown in Figs. 11-13 and measured at the moments 0.38s, 0.68s, and 0.98s, respectively.

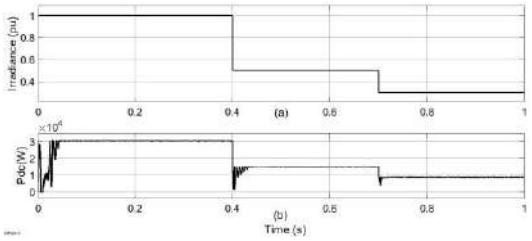

Fig. 7: Maximum power levels of the solar panels for three different irradiances

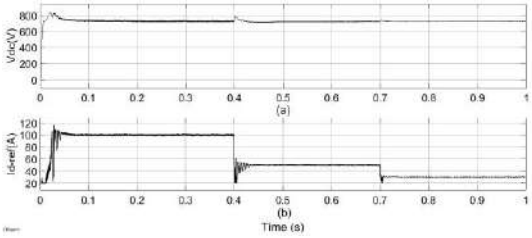

Fig. 8: DC-link voltage and reference current $I_{\_dref}$

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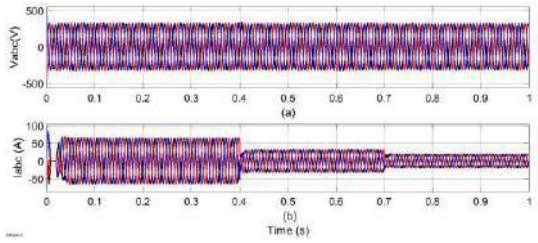

Fig. 9: Output three-phase voltages and currents

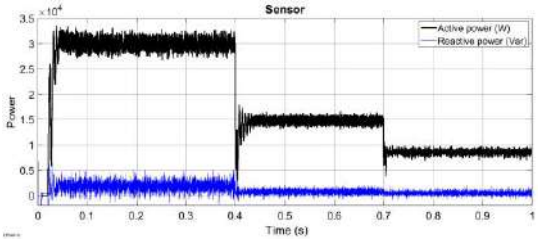

Fig. 10: Active and reactive powers

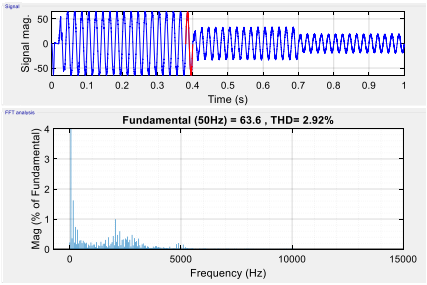

Fig. 11: Current THD of phase A measured in the first interval

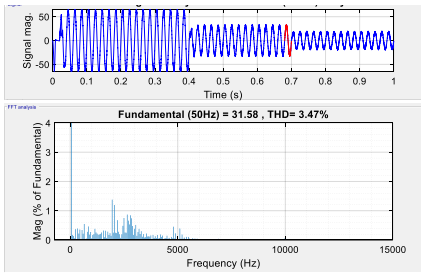

Fig. 12: Current THD of phase A in the second interval

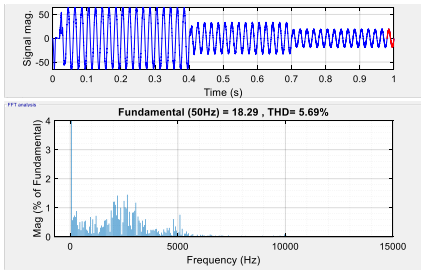

Fig. 13: Current THD of phase A in the final interval

4.2. THE PROPOSED METHOD

The simulation results of the proposed method are shown in Figs. 14-21.

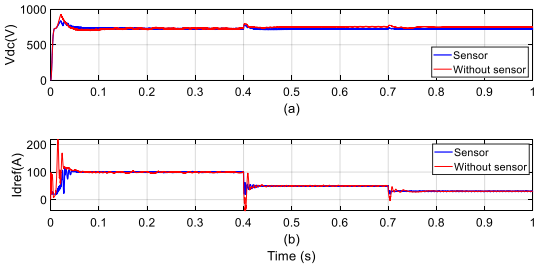

Fig. 14: Responses of the estimated DC voltage and reference current

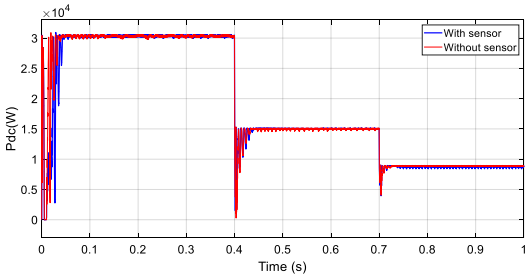

Fig. 15: DC side power responses

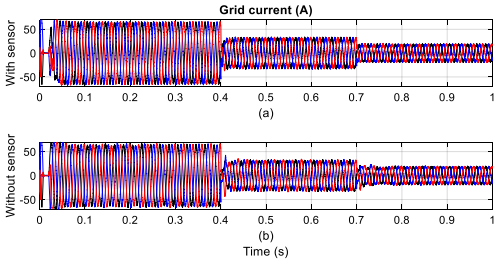

Fig. 16: Inverter output currents

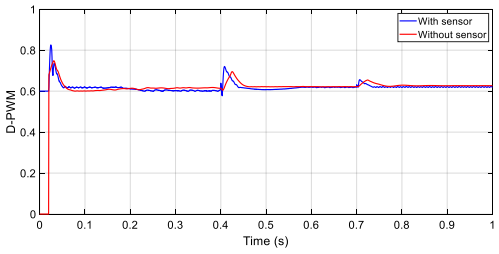

Fig. 17: D_{PWM} responses of the simulation cases

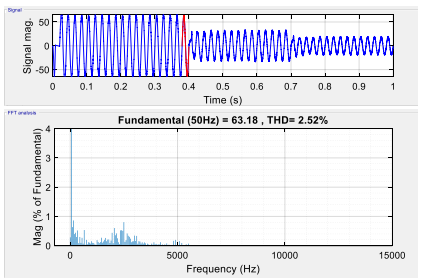

Fig. 18: Current THD of phase A in the first interval

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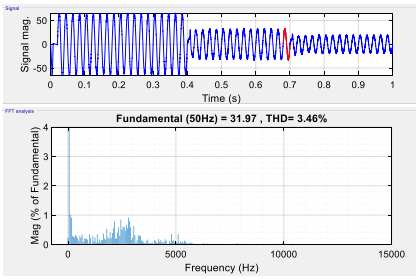

Fig. 19: Current THD of phase A in the second interval

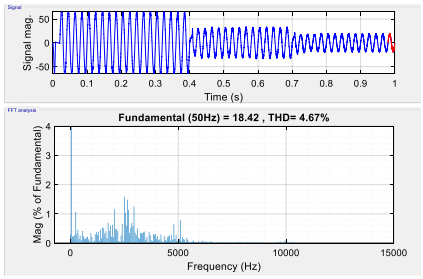

Fig. 20: Current THD of phase A in the final interval

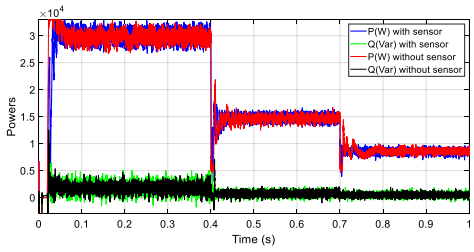

Fig. 21: Active power responses injected into the grid

4.3. DISCUSSIONS

The results in Figs. 7-13 showed the overshoot and steady-state error of the DC voltage for the method using voltage sensor are relatively small. However, the output current THD is higher than that of the proposed method causes the output power responses in Fig. 10 to have the higher steady-state errors in Fig. 21. The current THD values of the method using sensor in Figs. 11-13 are measured at the final sinewave period in the intervals of time, respectively. The current THD results for the 2 cases are also showed in Table 2.

Table 2: Fundamental grid current magnitudes and total harmonic distortions

Intervals		0-0.4s	0.4-0.7s	0.7-1s
Sensor	Ip (A)	63.6	31.58	18.29
	THD (%)	**2.92**	**3.47**	**5.69**
Proposed	Ip (A)	63.18	31.97	18.42
	THD (%)	**2.52**	**3.46**	**4.67**

Although the steady state error and the overshoot of DC-link voltage for the proposed method in Fig. 14(a) are slightly higher than those of the method using sensor and make the reference current in Fig. 14(b) and the DC power in Fig. 15 be also slightly higher, these do not cause over-current for the inverter in Fig. 16(b).

The DC-link voltage responses for the two cases are also showed in Fig. 14(a). The voltage value of the proposed method is the signal in the red. This value is slightly higher than that of the method using sensor. Because its duty D_{PWM} in Fig. 17 is also a bit higher than that of the method using sensor. This also makes the current magnitude injected into the grid a bit higher than that of the method using sensor. As a result, the current harmonics of the proposed method are slightly lower than that of the method using sensor. The current waveforms (unit of Ampere) and THD (%) of the phase A are shown in Figs. 18-20 using the FFT of Matlab/Simulink. These values are slightly lower than those of the method using sensor in Figs. 11-13 and shown in Table 2. The lower current harmonics of the proposed method also contribute to reducing the steady state error of the active power injected into the grid in Fig. 21. In the interval of 0.7s-1s, the actual voltage value is bit higher than the estimated one due to the voltage loss of the filter. However, the power quality of the proposed method is also similar to that of the method using sensor.

V. CONCLUSION

This paper has proposed a method for estimating the DC-link voltage of the grid-connected inverters to remove the DC voltage sensor. The estimation is based on the DC maximum power and the PWM duty of the DC/DC booster regardless of the voltage drop on the converter devices. The simulation results showed the power quality of the proposed method is similar to that of the method using sensor. This has validated the performance of the proposed method. The study of reducing hardware space and device costs for grid-connected inverters also helps the manufacturers increase the competition.

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Formulation and Production of Arc Welding Electrode Coated with Mill Scale Based Flux Locally Sourced from Ajaokuta Steel Company Limited in Nigeria

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Abstract**—** *This research is targeted at locally produced iron (Fe) based arc welding electrodes, using mill scales from Ajaokuta Steel Company Limited (ASCL). Mill scale was collected, prepared into pulverized form and analyzed using X-ray fluorescence spectrometer machine. The result of the analysis showed predominantly (more than 96%) iron, which is an important constituent of iron oxide electrode coatings. The flux compositions were generated using Hadamard multivariate chemical model, by which fifteen different flux compositions were formulated within given trial ranges of the constituent flux elements. Three of the flux compositions formulated were used for the coatings of the electrodes. The percentage compositions of the three different fluxes were A(X1=40%, X2=25%, X3=15%, X4=8%, X5=5%, X6=3%, X7=4%), B(X1=43%, X2=25%, X3=10%, X4=10%, X5=5%, X6=3%, X7=4%) and C(X1=44%, X2=30%, X3=10%, X4=8%, X5=3%, X6=3%, X7=2%). Where X1=mill scales, X2=sodium silicate, X3=calcium carbonate, X4=manganese dioxide, X5=silica, X6=calcium fluoride and X7=feldspar. The elemental composition of the mill scale, using the modern XRF machine shows that Fe, Ti and Mn were found to be major constituent elements, with Fe constituting more than 96% of the total contents. Other elements such as P, Cu, Ni and Cr were found to be present in traces. Also the elemental compositions of the steel core wire used for the research was found to be within the specification of mild steel, according to ASTM standard which states the percentage of carbon for mild steel as 0.05 – 0.25%, Manganese not to be more than 1.65% while Silicon should not be more than 0.6%*

Keywords**— Arc welding, Electrodes, Flux, Iron, Mill Scale.**

I. INTRODUCTION

Arc welding electrodes play an important role in most engineering firm such as fabrication industries. Electrodes are usually coated with chemical constituents known as flux, which melts along with the core wire during welding, to protect the welded joint from oxidation. In some situations, alloying elements could be introduced into the welding through fluxes to improve some of the properties of the parent metals. The importance of flux in electrode cannot be overemphasized, as it shielded the welding pool from atmospheric oxygen or nitrogen, which is detrimental to the strength and chemical/physical properties of the welded joints.

In this work, mill scales from Ajaokuta Steel Company Limited (ASCL) was used to formulate flux along with other constituents. Hadarmart multivariate matrix was adopted in formulating the percentage weight composition of each constituent in the flux for producing electrodes.

II. MATERIALS AND METHODS

MATERIALS

The following materials were used in the production of the Electrodes: Mild steel wire (3mm diameter), Mill scales, Sodium silicate, Calcium carbonate, Manganese dioxide, Silica, Calcium fluoride, Feldspar, weighing balance, sieve (75 microns aperture), oven, wooden mould and spatula.

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METHODS

In this research, the Hadamard multivariate analysis was adopted. The model as shown in Table 2.1 was used to generate different flux compositions. The proposed chemical composition range for the coating flux of the locally produced electrode is shown in Table 2.2. These ranges for the flux formulation process were chosen base on trial.

Table 2.1: Hadamard matrix layout for formulation of the flux (Source: Achebo and Ibhadode, 2008)

Trial	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**X_7**
1	+	-	-	+	+	-	+
2	+	+	-	-	-	+	+
3	+	+	+	+	-	-	-
4	-	+	+	-	+	-	+
5	+	-	+	-	+	+	-
6	-	+	-	+	+	+	-
7	-	-	+	+	-	+	+
8	-	-	-	-	-	-	-

This is a standard table adapted in formulating flux compositions. As each of the constituent is confined between a trial range of upper and lower value as revealed in table 2.2, when filling the matrix table, the lower range was entered on the negative column while the upper range was entered on the positive column.

Table 2.2: Proposed chemical composition ranges for flux coatings of the locally produced welding electrode

Constituent elements	Composition ranges (%)
Mill scales	40≤X1≤50
Sodium silicate	25≤X2≤30
Calcium carbonate	10≤X3≤15
Manganese dioxide	8≤X4≤10
Silica	3≤X5≤5
Calcium fluoride	3≤X6≤5
Feldspar	2 ≤X7≤4

where X1= Mill scales, X2= Sodium silicate, X3= Calcium carbonate, X4= Manganese dioxide, X5= Silica, X6= Calcium fluoride and X7= Feldspar.

These ranges were chosen base on trial for the formulation of the flux for this research. During the formulation, the lower values were entered on the negative boxes and the higher values on the positive boxes in table 2.1.

FLUX COMPOSITION FORMULATION PROCEDURE

Tables 2.3-2.9 show the steps involved in arriving at the flux compositions. The composition ranges in Table 2.2 were used for these steps. The matrices of variables X1, X2, X3, X4, X5, X6, X7 were extracted from the Hadamard matrix layout Table 1.1 and the composition ranges in Table 2.2 were used to fill the matrices of the extracted variables bearing in mind that by standard, the positive (+) signifies high value and negative (-) signifies a low value of the composition ranges. In this case X1 is being considered first in the formulation process as mill scales constitute highest percentage. The other variables X2-X7 were filled and X1 was left blank in table 2.3. The condition of this formulation process required that each composition or trial must add up to hundred percent by weight. To make a complete composition therefore, the variables X2-X7 were added up and the remaining value to sum it up to hundred percent by weight were entered in the X1 column. If the value fell within the range set for variable X1 as specified in Table 2.2, it was entered in the column X1, but if the value was above or below the range, it was skipped because it was not within the trial range. This procedure was repeated for X2, X3, X4, X5, X6 and X7 as shown from Table 2.4 to Table 2.9 All formulated flux compositions generated from the procedure is tabulated in Table 2.10 and Table 2.11 shows the three (3) compositions range selected for this research based on the differences in percentage values of the mill scale and other constituents.

Table 2.3: Mill scales, 40-50% of flux composition ranges by weight

Trial	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**X_7**
1	43	25	10	10	5	3	4
2	40	30	10	8	3	5	4
3	_	30	15	10	3	3	2
4	_	30	15	8	5	3	4
5	40	25	15	8	5	5	2
6	_	30	10	10	5	5	2
7	_	25	15	10	3	5	4
8	44	30	10	8	3	3	2

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Table 2.4: Sodium silicate, 25-30% of flux composition ranges by weight

Trial	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	50	_	10	10	5	3	4
2	50	_	10	8	3	5	4
3	50	_	15	10	3	3	2
4	40	25	15	8	5	3	4
5	50	_	15	8	5	5	2
6	40	28	10	10	5	5	2
7	40	_	15	10	3	5	4
8	40	_	10	8	3	3	2

Table 2.5: Calcium carbonate, 10-15% of flux composition ranges by weight

Trial	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	50	25	_	10	5	3	4
2	50	30	_	8	3	5	4
3	50	30	_	10	3	3	2
4	40	30	10	8	5	3	4
5	50	25	_	8	5	5	2
6	40	30	_	10	5	5	2
7	40	25	13	10	3	5	4
8	40	30	14	8	3	3	2

Table 2.6: Manganese dioxide, 8-10% of flux composition ranges by weight

Trial	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	50	25	10	_	5	3	4
2	50	30	10	_	3	5	4
3	50	30	15	_	3	3	2
4	40	30	15	_	5	3	4
5	50	25	15	_	5	5	2
6	40	30	10	8	5	5	2
7	40	25	15	8	3	5	4
8	40	30	10	_	3	3	2

Table 2.7: Silica, 3-5% of flux composition ranges by weight

Trial	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	50	25	10	10	_	3	4
2	50	30	10	8	_	5	4
3	50	30	15	10	_	3	2
4	40	30	15	8	_	3	4
5	50	25	15	8	_	5	2
6	40	30	10	10	3	5	2
7	40	25	15	10	_	5	4
8	40	30	10	8	_	3	2

Table 2.8: Calcium fluoride, 3-5% of flux composition ranges by weight

Trial	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	50	25	10	10	5	_	4
2	50	30	10	8	3	_	4
3	50	30	15	10	3	_	2
4	40	30	15	8	5	_	4
5	50	25	15	8	5	_	2
6	40	30	10	10	5	3	2
7	40	25	15	10	3	3	4
8	40	30	10	8	3	_	2

Table 2.9: Feldspar, 2-4% of flux composition ranges by weight

Trial	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	50	25	10	10	5	3	_
2	50	30	10	8	3	5	_
3	50	30	15	10	3	3	_
4	40	30	15	8	5	3	_
5	50	25	15	8	5	5	_
6	40	30	10	10	5	5	_
7	40	25	15	10	3	5	2
8	40	30	10	8	3	3	_

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Table 2.10: Some formulated sample flux compositions in (%) weight

S/N	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	40	30	10	8	3	5	4
2	40	25	15	8	5	5	2
3	40	25	15	8	5	3	4
4	40	30	10	8	5	3	4
5	40	30	10	8	5	5	2
6	40	30	10	10	3	5	2
7	40	30	10	10	5	3	2
8	40	25	15	10	3	5	2
9	40	25	15	10	3	3	4
10	40	25	15	8	3	5	4
11	40	25	13	10	3	5	4
12	40	30	14	8	3	3	2
13	40	28	10	10	5	5	2
14	43	25	10	10	5	3	4
15	44	30	10	8	3	3	2

Table 2.11: Flux compositions (%) used in production of sample electrodes

S/N	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	40	25	15	8	5	3	4
2	43	25	10	10	5	3	4
3	44	30	10	8	3	3	2

PRODUCTION PROCESS OF THE ELECTRODES

Each of the formulating minerals, mill scales, calcium carbonate, manganese dioxide, silica, calcium fluoride and feldspar were sieved with a 75µm aperture sieve so as to ensure uniformity of particle size for effecting coating onto the core wire. Thereafter, the minerals were weighed in proportions indicated in Table 2.11 and mixed thoroughly for about 15 minutes until a homogenous mixture was obtained. A measured quantity of sodium silicate was added to the homogenous dry compound and thoroughly mixed for another 5 minutes until a thick paste was formed. The 3mm mild steel core wire was thoroughly polished using silicon carbide grit paper to remove rust and impurities. The thick paste was then deposited on the groove of the mould which was of same size as the electrode to be produced. A core wire was then dipped in the paste in the groove. The core wire was left in the paste for 5 minutes to enable sticking of about 2mm of the paste to the core wire. The core wire coated with the flux paste was then removed from the groove and a spatula was used to smoothen the coatings, to achieve a better finishing surface of the electrode. The electrodes were left in the atmosphere (at room temperature) for 5 minutes for curing. Hence, the electrode formed was dried at a well regulated temperature of 600C in an oven for an hour. The drying process was done so as to eliminate the moisture content of the electrode coating, and while drying the electrodes in the oven, adequate care was taken not to overheat it to prevent cracking of the coating. After an hour the electrodes were removed from the oven.

III. RESULT AND DISCUSSION

RESULTS

The results obtained from each test conducted during the investigation are presented in tables. Table 3.1(i) present the percentage chemical composition of the mill scale as obtained from the XRF analysis. Similarly, Table 3.1(ii) shows the percentage chemical composition of the core wire and the mild steel plate as received.

Table 3.1(i): Percentage Chemical Composition of the Mill Scales Using XRF Analysis

Element	O	P	Ti	Cr	Mn	Fe	Ni	Cu	As	Sn
Composition (%)	0.00 62	0.0 054	1.3 208	0.09 86	1.18 26	96.9 362	0.0 692	0.3 23	0.0 083	0. 0 3 9 9

Table 3.1(ii): Percentage Chemical Composition of the Mild Steel Core Wire

Element	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Fe %
Core wire	0.12 0	0.04 0	0.54 1	-	0.05 1	0.03 0	0.01 6	88.0 65

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DISCUSSIONS

The elemental composition of the mill scale, using the modern XRF machine was presented in Table 3.1(i). It could be observed that Fe, Ti and Mn were found to be major constituent elements, with Fe constituting more than 96% of the total contents. Ferrite (Fe) being the major constituent in high iron oxide electrode covering (Davies, 2008), suggests that mill scales obtained from ASCL can be used in electrode production. Other elements such as P, Cu, Ni and Cr were found to be present in traces. Table 3.1(ii) also presented the elemental compositions of the steel core wire used for the research. It was found to be within the specification of mild steel, according to ASTM standard which states the percentage of carbon for mild steel as 0.05 – 0.25%, Manganese not to be more than 1.65% while Silicon should not be more than 0.6%.

IV. CONCLUSION

In this research, iron based arc welding electrodes were produced using mill scales (an industrial waste). The analyzed mill scales from ASCL showed the presence of predominantly iron. Iron oxide is one of the important constituents of covering on high iron oxide electrode coatings. Therefore, mill scales from ASCL can be used in the production of iron oxide electrodes for welding.

V. RECOMMENDATION

Mechanized production process, such as extrusion, should be adopted so as to have electrodes with smooth appearance, and to increase efficiency and productivity.

Future research should be carried out on the performance evaluation of the electrodes produced from mill Scale based flux sourced from Ajaokuta Steel Company Limited in Nigeria. The produced electrodes thus should be used to weld and its welded part be tested for some mechanical properties such as tensile strength, hardness strength and microstructural analysis to ascertain its use for industrial applications.

APPENDIX

Plate I: Materials used for the production of electrodes

Plate II: Weighing balance at the Civil Engineering Lab (FUT, Minna)

Plate III: Oven used for curing of the produced electrodes at Civil Engineering Lab. (FUT, Minna)

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Plate IV: Mild steel core dipped in the mill scale paste in the mould groove

Plate V: Produced welding electrodes prior to curing in the oven

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Generation time, D and Z - values of *pseudomonas fluorescens* under different temperature, water activity and pH conditions

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Abstract— *The aim of this study is to observe and assess the performance of Psychrotrophic Gram-negative bacteria, namely Pseudomonas fluorescens, which pose a significant spoilage problem in food, under different temperature, water activity (aw) and pH conditions. Noting that at aw 0.6 and 0.75 irrespective of temperature or pH and at temperatures 60^0 and 100^0C irrespective of water activity or pH no survival was recorded. The D-value (Decimal reduction time) at 4^0, 25^0, 37^0 and 42^0C differ significantly, with the one at 37^0C was significantly the highest and that at 42^0C was significantly the lowest. The optimum conditions were found to be at pH=6, aw=0.97 and temperature=37^0C showing the significantly lowest generation time (7.69 min). At pH=6, aw=0.97 and temperatures of 4^0 and 25^0C we have significantly different generation times of 46.75 and 10.9 min respectively. Concerning the z-value it was calculated at pH=4 (high acid food), pH=6 (low acid food) and pH=8 (alkaline food), at aw 0.82, 0.93 and 0.97 and from consequent D-values at temperatures 4^0, 25^0, 37^0 and 42^0C and was shown to be 25.31±3.68. Outside of the optimum conditions, Pseudomonas fluorescens died at different rates. Within all pH-values, D-values at 42^0C were significantly the lowest when compared to those at 4^0, 25^0 and 37^0C among the different aw-values. Thus changing only one factor, either storage temperature, pH or aw out of the optimum neighborhood will lead to the reduction of this bacteria, although at different rates.*

Keywords— ***D-Value, Z-Value, low acid food, high acid food, Alkaline food, Generation time, Water activity.***

I. INTRODUCTON

Pseudomonas fluorescens encompasses a group of common, nonpathogenic saprophytes that colonize soil, water and plant surface environments [1]. Pseudomonas has high genetic diversity and poor nutritional needs allowing them to survive in different environments [2]. These characteristics allow them to survive on utensils equipment used in dairy production chain, as milking machines, pipelines, and bulk tanks. These bacteria are among the most common bacteria causing spoilage of food mainly dairy products. It is famous by its ability to cause post pasteurization contamination, and to cause spoilage of food even at low temperature [3]. There are mainly three essential enzymes found in the bacteria involved in spoilage of food mainly, lipases, proteases, and lecithenases. For example, in milk the degradation of casein by proteases will lead to gelation of milk, or when lipases degrade the fat present on the milk into free fatty acids will cause rancidity and bitterness of milk. Pseudomonas grow at pH range of 5.6-7.1 [5], temperature range of 4^0-42^0C, and aw of 0.97 [6].

Pseudomonas are psychrotrophic bacteria, they have the ability to survive in a temperature range of 0^0 - 40^0C [7]. Studies showed that the growth of bacteria is strongly related to the culturing temperature; its maximum growth is found to be at the optimal temperature specific for each bacterium. Concerning *pseudomonas fluorescens*, on its optimal temperature 37^0C, so many important metabolic enzymes are fully active, such as lipases and proteases, and there rate changes with temperature [8]. Psychrotrophs are the most common to cause spoilage at refrigerating

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temperature [9] with Pseudomonas spp being the most common bacteria within them [10].

Goncalves et al, in another study also showed that the pH will decrease the concentration of bacteria when acidity increased, or when it decreases to a value more than the optimal range that a bacteria can tolerate [5]. Water activity is this unbounded water; it is the ratio between vapor pressure of distilled water under identical conditions. Water activity affects bacterial growth and concentration at different levels. However, at water activity below 0.85 no bacteria can grow [11]. Furthermore, moist heat is more effective than dry-heat.

To study the heat resistance of microorganisms we need to study D-values at a reference and different temperatures, and the z-value, the temperature dependence of the thermal inactivation rate. The z-value is an indicator of the microbial inactivation rate based on different temperature dependence. Z-value is the temperature units needed to change microbial inactivation rate by a factor of 10. Z-value is also used to express the degradative reactions dependence on temperature during processing and storage [12].

Thus investigating the thermal resistant of bacteria will shed a light on the potential degradation of the food by the studied microbiota. In this study, these factors would guide us to develop a protection policy against the degradation of food during storage by *Pseudomonas fluorescens* in high and low acid food and alkaline food under different temperatures and water activities. In addition, each prevented degradation would lead to the reduction of waste of food and eventually having positive impact on the environment. Noting that losing one gr of beef, for example, means losing the CO_2 needed to produce them, which accounts to 13.3Kg. This is similar to burning 6 liters of petrol [13].

II. MATERIALS AND METHODS

2.1. Bacteria and media

In our study, *pseudomonas fluorescens* was collected from the Lab for Microbiology and Public Health, Faculty of Public Health, Lebanese University in Lebanon, Tripoli. The code of the strain was CMUL 014.

As for the growth-broth, the HIMEDIA Nutrient Broth M002, which complies as per ISO 17025:2005 whose company is situated in Mumbai-India was chosen. It is used for general cultivation of less fastidious microorganisms and can be enriched with blood or other biological fluids.

2.1.1. Developing Medias with different water activities

The different water activities of the media was achieved by dissolving the nutrient broth in distilled water at different rations.

For water activity 0.60: 35g nutrient broth was dissolved in 10 ml distilled water.

For water activity 0.75: 35g nutrient broth was dissolved in 15ml distilled water

For water activity 0.82: 30g nutrient broth was dissolved in 50ml distilled water

For water activity 0.93: 30g nutrient broth was dissolved in 50m distilled water

For water activity 0.97: 0.65g nutrient broth was dissolved in 50ml distilled water

The water activities were validated using the PAWKIT water activity meter and measuring them in triplicates.

2.1.2. Adjustment of pH

The Medias produced were adjusted to different pH values by the addition of (70%) HCl and (1N) NaOH.

For acidic pH (4 and 6), 70% HCl is added until reaching the needed pH.

For basic pH (8), (1N) NaOH is added until reaching the designated pH.

2.2. Equipment used to measure Physico-chemical properties

Brix Value: Brix Value was measured using Portable hand held RFM700 refractometer (Bellingham and Stanley LTD. United Kingdom).

Weight determination: Weight was measured using Portable electronic balance Model 727 was used to measure the weight with an accuracy of ±1 gr (Jata Hogar).

pH: Microcomputer based pH /conductivity /TDS /salinity and temperature pocket meter Model pH/EC80 was used to measure the pH (Jenco VisionP).

Ash content: Ash was determined using the AOAC 942.05 method.

Volume Determination: 10mL glass graduated cylinder, with sub gradations of 0.1mL (Graduated cylinder, tall form, BLAUBRAND®, class A, Boro 3.3, DE-M).

Caloric Value: Bomb calorimeter IKA C200 was used (KA®-Werke GmbH & Co. KG)

Water activity: It was determined using Pawkit water activity meter. Samples were flattened to cover the bottom of the cup and then water activity was measured at room temperature [14].

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2.3. Formulas used for D and Z value and generation time

The microbial destruction rate is defined by D value (equation 1), which is the heating time at a given temperature required to reduce the surviving microbial population by 90% of its initial population [15].

Equation 1 D-Value: Decimal reduction rate.

$$D = \frac{t2 - t1}{\text{Log}(N1) - \text{Log}(N2)}$$

Where N1 and N2 represents the number of bacteria at a constant temperature measured at t1 and t2 (min) respectively.

The temperature sensitivity indicator is defined as Z (equation 2); a value represents a temperature range, which results in 10-fold change in D values [15].

Equation 2 Z-Value as temperature sensitivity indicator

$$Z = \frac{T2 - T1}{\text{Log}(D1) - \text{Log}(D2)}$$

Where D1 and D2 (**Eq.** 1) represents the decimal reduction value of bacteria at a measured at T1 and T2 (^{o}C) respectively.

Generation time (G) is the time needed for a single bacterium to double its number [16] [17] (**Eq.** 3&4).

Equation 3

$$\text{Generation time} = \frac{\text{Time interval}}{\text{Number of generations}}$$

Equation 4

$$\text{Number of generations} = \frac{\text{Log}N_1 - \text{Log}N_2}{\text{Log}(2)}$$

2.4. Procedure

After inoculating the *pseudomonas fluorescens* in the nutrient broth with different water activities, at different pH and incubated at different temperatures, the bacteria was enumerated using the plate count technique every 30 minutes up to 240 minutes (**Fig**. 1).

Please note that there was no growth at temperatures above 42^{0}C and water activity lower than 0.83. Thus, they will not be included in the statistical analysis.

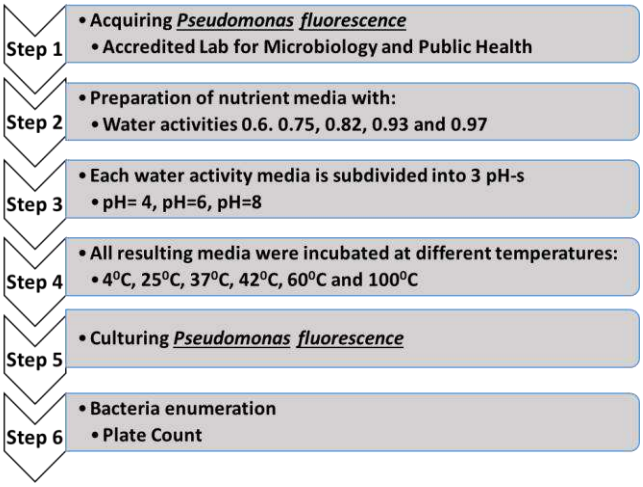

Fig.1 Summary of study flow

2.5. Statistical analysis

All tests and analysis were run in triplicates and averaged. General linear model performed via SPSS (statistical Package for the Social Sciences, version 17.0) was used to study the difference between D and z values at different temperatures, water activity and pH. To study the effect of each factor 2 were fixed and the third one was studied.

Furthermore, for GLM model was applied on generation time we only had growth at temperatures 4^{0}C, 25^{0}C and 37^{0}C, at pH=6 and aw=0.97.

III. RESULTS

3.1 Generation Time

The generation time is the time needed for one single bacterium to double itself [16]. Looking at the growth and death rate data across different temperatures within different water activities and at different pH, it was noticed that the growth of *Pseudomonas fluorescens* occurred only at an optimum pH=6 and aw=0.97 at temperatures 4^{0}, 25^{0} and 37^{0}C where the last temperature showed the significantly lowest generation time (7.69 min). At temperatures of 4^{0} and 25^{0}C we have significantly different generation times of 46.75 and 10.9 min with the first being significantly the longest and the second being in-between and significantly different from both (**Fig**. 2).

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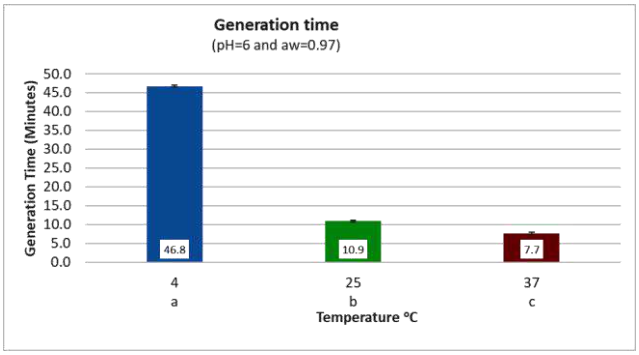

Fig.2: Generation Time at different temperature within pH=6 and aw=0.97

3.2 D-value

3.2.1 D-Values Within different pH at different temperatures and water activity

Within simulated high acid food (pH=4), and 0.82 water activity the temperature 4^0C showed the significantly highest D-value, and the D-value at 42^0C was significantly the lowest with those measured at 25^0C and 37^0C were in between. Within water activity 0.93, there was no significant difference between the different D-values at temperatures 4^0 and 25^0C, with the D-value at 42^0C was significantly the lowest and all were significantly lower than those measured at water activity of 0.82. Except at 37^0C, D-value was significantly the highest within 0.93 water activity at different temperatures and among different water activities. At water activity of 0.97, D-value at 42^0C was significantly the lowest followed by the D-value at 4^0, 25^0 and 37^0C being significantly the highest.

Table 1 D-Values within pH=4 (Simulated high Acid Food) at different water activities (aw) and temperatures

aw	0.82	0.93	0.92
At pH=4	Mean ± SE	Mean ± SE	Mean ± SE
4^0C	$53.60^{a\ 1}$ ±11.28	$13.23^{a\ 2}$ ±21.00	$20.62^{a\ 3}$ ±0.84
25^0C	$31.00^{ab\ 1}$ ±11.28	$14.13^{a\ 2}$ ±21.00	$24.23^{b\ 3}$ ±0.84
37^0C	$28.27^{ab\ 1}$ ±11.28	$264.0^{b\ 2}$ ±21.00	$27.27^{c\ 1}$ ±0.84
42^0C	$9.03^{b\ 1}$ ±11.28	$6.77^{c\ 2}$ ±21.00	$5.13^{d\ 3}$ ±0.84

- Among rows means with different letters are significantly different
- Among Columns: means with different numbers are significantly different

Within the simulated low acid food, at water activity of 0.82 and 0.93 the D-values followed the same pattern to that high acid food. Within the 0.97 and temperatures of 4^0, 25^0, 37^0C there was growth, which is shown in the generation times above. Within 0.97 aw, D-value at 42^0C was significantly the lowest among the different aw values with that at 0.82 being significantly the highest.

Table 2 D-Values within pH=6 (Simulated low Acid Food) at different water activities (aw) and temperatures

aw	0.82	0.93	0.92
At pH=6	Mean ± SE	Mean ± SE	Mean ± SE
4^0C	$86.8^{a\ 1}$ ±11.3	$19.5^{a\ 2}$ ±21.0	n.a.
25^0C	$55.1^{b\ 1}$ ±11.3	$21.6^{a\ 2}$ ±21.0	n.a.
37^0C	$17.2^{c\ 1}$ ±11.3	$44.8^{b\ 2}$ ±21.0	n.a.
42^0C	$4.8^{c\ 1}$ ±11.3	$4.1^{c\ 2}$ ±21.0	$2.5^{a\ 3}$ ±0.8

- n.a.= Not applicable, in these conditions there is growth.
- Among rows means with different letters are significantly different
- Among Columns: means with different numbers are significantly different

Within the simulated alkaline food, at 0.82 aw D-value at 42^0C was significantly the lowest, at 37^0C was significantly the highest with those at 4^0 and 25^0C being in between. At 0.93 aw, D-vale at 42^0C was significantly the lowest, and that at 4^0C was significantly the highest, threst being in between and significantly different from each other.

Table 3 D-Values within pH=8 at different water activities (aw) and temperatures

aw	0.82	0.93	0.92
At pH=8	Mean ± SE	Mean ± SE	Mean ± SE
4^0C	$36.70^{a\ 1}$ ±22.29	$35.23^{a\ 2}$ ±0.37	$20.62^{a\ 3}$ ±1.04
25^0C	$18.03^{a\ 1}$ ±22.29	$11.43^{b\ 2}$ ±0.37	$24.23^{b\ 3}$ ±0.85
37^0C	$406.0^{b\ 1}$ ±22.29	$16.07^{c\ 2}$ ±0.37	$27.27^{c\ 1}$ ±0.85
42^0C	$4.67^{c\ 1}$ ±22.29	$5.30^{c\ 2}$ ±0.37	$5.13^{d\ 3}$ ±0.85

- Among rows means with different letters are significantly different
- Among Columns: means with different numbers are significantly different

3.2.2 D-value within different temperatures at different pH and water activity

At simulated fridge storage (4^0C), within aw=0.82, pH outside the optimum (pH= 6) showed no significant differences both have D-Values which are significantly

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lower. Within aw=0.93, D-values at pH=4, 6 and 8 differ significantly from each other with that at 4 being the lowest and at 8 was significantly the highest (table 4). Concerning the significance within different pH between different aw, D-values tended to be lower the higher the aw value.

Table 4 D-Values within temperature (T=4^{0}C) at different water activities (aw) and temperatures

aw	0.82	0.93	0.97
At T=4^{0}C	Mean ± SE	Mean ± SE	Mean ± SE
pH=4	31.27$^{a\ 1}$ ±2.61	13.23$^{a\ 2}$ ±0.62	20.62$^{a\ 3}$ ±0.97
pH=6	86.87$^{b\ 1}$ ±2.61	19.57$^{b\ 2}$ ±0.62	n.a.
pH=8	36.70$^{a\ 1}$ ±2.61	35.17$^{c\ 1}$ ±0.62	13.10$^{d\ 2}$±20.97

- n.a= Not applicable, in these conditions there is growth.
- Among rows means with different letters are significantly different
- Among Columns: means with different numbers are significantly different

At simulated room temperature storage (25^{0}C), within the different aw, D-values recorded at pH=8 were significantly the lowest and at pH=6 were significantly the highest (Table 5). Noting that at aw=0.97 and pH=6 there is no death rate but growth rate (Table 5).

Table 5 D-Values within temperature (T=25^{0}C) at different water activities (aw) and temperatures

aw	0.82	0.93	0.97
At T=4^{0}C	Mean ± SE	Mean ± SE	Mean ± SE
pH=4	31.00$^{a\ 1}$ ±2.07	14.13$^{a\ 2}$ ±0.44	24.23$^{a\ 3}$ ±0.28
pH=6	69.77$^{b\ 1}$ ±2.07	21.60$^{b\ 2}$ ±0.44	n.a.
pH=8	18.03$^{c\ 1}$ ±2.07	11.43$^{c\ 1}$ ±0.44	18.73$^{b\ 1}$ ±0.28

- n.a.= Not applicable, in these conditions there is growth.
- Among rows means with different letters are significantly different
- Among Columns: means with different numbers are significantly different

At 37^{0}C as shown by Table 6, two three digit D-values were noticed at pH=4 and aw=0.93 and pH=8 and aw=0.82. Within the same pH (4, 6 and 8) the D-values differ significantly at different water activities.

Table 6 D-Values at different water activities (aw) and temperatures

aw	0.82	0.93	0.97
At T=4^{0}C	Mean ± SE	Mean ± SE	Mean ± SE
pH=4	28.27$^{a\ 1}$ ±1.90	264.00$^{a\ 2}$ ±1.97	27.27$^{a\ 3}$±0.88
pH=6	17.23$^{b\ 1}$ ±1.90	44.83$^{b\ 2}$ ±1.97	n.a.
pH=8	406.00$^{a\ 1}$ ±1.90	16.07$^{c\ 2}$ ±1.97	25.57$^{d\ 3}$ ±0.88

- n.a.= Not applicable, in these conditions there is growth.
- Among Columns: means with different letters are significantly different
- Among rows: means with different numbers are significantly different

At incubation temperature of 42^{0}C (Table 7), within the water activities 0.82 and 0.93, D-values at pH=4 were significantly the highest, while the D-values measured at aw=0.97 were significantly highest at pH=8 and significantly the lowest at pH=6.

Table 7 D-Values within temperature (T=42^{0}C) at different water activities (aw) and temperatures

aw	0.82	0.93	0.97
At T=4^{0}C	Mean ± SE	Mean ± SE	Mean ± SE
pH=4	9.03$^{a\ 1}$±0.03	6.77$^{a\ 2}$±0.04	5.13$^{a\ 3}$±0.03
pH=6	4.87$^{b\ 1}$±0.03	4.13$^{b\ 2}$±0.04	2.57$^{b\ 3}$±0.03
pH=8	4.67$^{c\ 1}$±0.03	5.30$^{c\ 2}$±0.04	7.80$^{c\ 3}$±0.03

- Among rows means with different letters are significantly different
- Among Columns: means with different numbers are significantly different

3.3 Z-Value

The temperature sensitivity indicator is defined as Z (equation 2); a value represents a temperature range, which result in 10-fold change in D values [15]. There was no significant difference between z values recorded within and among different pH (4, 6 and 8), within and among different water activities (0.82, 0.93 and 0.97) out of the growth neighbpourhood (pH=6 and 4^{0}C, 25^{0}C, and 37^{0}C) and it was found to have a mean value of 25.31±3.68.

3.4 Construction of D and generation time values rubric

Combining the values of this study we end up in a rubric that shows we have growth only at pH=6 and aw=0.97. Furthermore, it shows clearly that at aw=0.75 and lower, and at temperatures 60^{o}C and higher *pseudomonas fluorescens* would not survive (Fig. 3). Furthermore, at

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42^0C at water activities of 0.82, 0.93 and 0.97 we have a one digit D-Value. At 4^0C, 25^0C and 37^0C incubation temperatures we have two digit D-values (Fig. 3). Only at aw=0.93 and pH=4 and at aw=0.82 and pH=8 we recorded a three digit D- values (Fig. 3).

Water Activity	pH	Recorded *Pseudomonas fluorescens* Response					
	4	21	24	27	5	TS	TS
0.97	6	GT: 47	GT: 11	GT: 8	3	TS	TS
	8	13	19	26	8	TS	TS
	4	13	13	264	7	TS	TS
0.93	6	20	20	45	4	TS	TS
	8	35	35	16	5	TS	TS
	4	31	31	28	9	TS	TS
0.82	6	87	70	17	5	TS	TS
	8	37	18	406	5	TS	TS
	4	TS	TS	TS	TS	TS	TS
0.75	6	TS	TS	TS	TS	TS	TS
	8	TS	TS	TS	TS	TS	TS
	4	TS	TS	TS	TS	TS	TS
0.65	6	TS	TS	TS	TS	TS	TS
	8	TS	TS	TS	TS	TS	TS
Temperature ^{0}C		4	25	37	42	60	100

Fig.3 D-values (minutes) and Generation time (GT - minutes) of Pseudomonas fl. at different water activities and acidity levels (pH) at different incubation temperatures

- TS: D-Value too short to be detected in this study
- All decimals are rounded up.

IV. DISCUSSION

The generation time revealed the conditions at which we should worry for our product. If we have food with pH=6, water activity= 0.97 and storage temperature between 4^0C and 37^0C we should be careful. The higher the temperature lower the generation time thus at 37^0C we would reach the critical level of *pseudomonas fluorescens* around 1.4 times faster than that stored at 25^0C and around 6 times faster than that stored at 4^0C (Fig. 2) (Fig. 3). Furthermore, it was noticed that all growth outside these neighborhood was zero and actually was replaced by death rate Classification of commercial apple juices based on multivariate analysis of their chemical

profiles [18]. At pH=4 food is considered high acid food. As shown in D-value results and the overall summary table (Fig. 3), at this pH there is no growth but a recorded death rate which is lowest in value at temperature = 42^0C and non-existent at Temperatures higher than that. In this category of food we can look at pomegranate (pH=4.04), grape verijuice (pH=2.84), Sour apple juice (pH=3.64) [19]. These foods might be considered unsusceptible for this bacterium.

Considering other food category, namely the low acid food with pH range between 4.6 and 7 they are more susceptible. Since at pH=6 and aw=0.97 we noticed growth. For this type of foods to be safer from this bacterium the pH should be lowered to make it high acid food or increased to fall in the alkaline food category, and/or lower the water activity. Example of this food category are the dairy products, which are known to be the most susceptible to this bacterium, which is in accordance with the results of this study. Since dairy products are sensitive to changes in pH and/or aw since both change the properties of the product, extra care should be taken to prevent cross contamination. Especially that it can grow under fridge conditions at aw=0.97.

As for the alkaline foods, pH>7, it followed the same trend of the high acid food where the lowest D-value was recorded at 42^0C and temperatures of 60^0C and 100^0C the D-values were too short to be recorded by this study. Food that fall under this category are Alkaline-fermented foods food products that are widely consumed in Southeast Asia and African countries and has a fermentation culture based on the dominant microorganisms, Bacillus spp., which hydrolyze proteins into amino acids and ammonia [20].

After collecting the data of the *Pseudomonas fl.* a rubric table was constructed as a preliminary guide to see the susceptibility of the food to this bacterium (Fig. 3). We need to know, however, the aw, pH and the storage temperature. All foods with aw<0.83 are safe. Furthermore, outside of the growth zone and at incubation temperature=42^0C D-values were one digit, thus less than 10 minutes. If we take 10 as the representative value, it means within 2 hours we would reach the total death time of 12D. In addition to that, at 37^0C and water activities of 0.82 and 0.93 the D-values were 405 and 264 minutes. These values should be validated with further studies. However, if we take them as basis the total death time of 12 D would be 3.3 to 2.2 days respectively. The rest of the D-values are less than 45 min. considering the maximum as representative number 9 hours would be needed to reach the total death time of 12D.

V. CONCLUSION

Low acid food of water activity near 0.97 and stored in fridge room temperature and slightly warm room temperature are the most susceptible to the deterioration due to *Pseudomonas fluorescens.* Foods with aw less than 0.83, like jams, are not susceptible irrespective of pH or storage temperature. The D-value rubric table might serve as a quick guide for categorization of the degree of susceptibility of food in question based on pH, aw and temperature of incubation.

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Domains and Standards of School Leadership: Evaluation of Tertiary School Teachers

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***Abstract*— *School Leaders are modifiers of teaching and learning, crucial to maintaining good teachers and necessary for improving educational standards. This study described Standards of School Leadership in terms of: Leading Learning and Teaching Domain, Leading School Development Domain, Organizational Management Domain, and Professional Growth and Development Domain. The descriptive method of research was used in this study. A total of 107 tertiary school teachers which have permanent appointment or considered as regular employee for more than 3 years were surveyed around Nueva Ecija. After analyses of data, the following conclusions were formulated: first, domains of school leadership can be viewed from leading learning and teaching, leading school development, organizational management, and professional growth and development. Second, among these domains, organizational management was found to be the focus of school leaders. Third, school leaders create a culture of professional learning that fosters continuous improvement in learning, teaching and assessment. Fourth, school leaders engage in a continuous process of evidence-based school self-evaluation. Fifth, ensure the safe functioning of the school on a day-to-day basis. Last, school leaders recognize the need to manage workload to ensure a sustainable work/life balance. The researchers want to recommend some matters based from the formulated conclusions. It is indeed noticeable that organizational management is the main focus of the school leaders thus, it is recommended that school leaders should not let other domains of school leadership be taken for granted. Continuous harnessing on the strengths based on the standards is highly recommended. On the others hand, strengthening of the following is also recommended: school leaders should foster a commitment to inclusion and equality of opportunity of each student; promote communication within the school and manage challenging and complex situations and build professional networks with other school leaders.*

Keywords*— *School Leader, School Leadership, School Development, Leading Domain, Teaching Domain.

I. INTRODUCTION

School Leaders are modifiers of teaching and learning, crucial to maintaining good teachers and necessary for improving educational standards. Standards are a rallying point for the articulation of ethical principles and values, and are instruments that can continually be used to make judgments on school leaders ' results (Ingvarson et al., 2006). Leaders will demonstrate the same leadership characteristics that teachers expect: openness to new ideas, ability to be motivated by performance and flexibility in the face of challenge (Lashway, 2002).

In order to keep pace with the current developments, an academic leader should attend conferences, lectures and workshops; further education would make her more informed and confident in the execution of her duties (Santos & Garcia, 2020).

Thus, it is necessary to identify what should be similar to a set of standards of school leadership, or basic aspects of good school leadership activities, regardless of where school leaders work (Ingvarson, 2006).

A school leader steers and promotes the institution's staff and job processes as the quality of education and school leadership are strongly linked (Bal & de Long, 2007). Certain important aspects of school leadership were described as aligning curriculum with established expectations, setting educational targets for student performance, evaluating progress against

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those goals and making adjustments to improve performance in the school program (Schleicher, 2012).

II. CONCEPTUAL FRAMEWORK

School leadership plays a key role in enhancing school performance by shaping teachers ' motives and abilities, as well as the atmosphere and community they work in, if considered efficient, it increases schooling productivity and equity (Pont et al., 2008).

Effective school leaders are active advocates of professional development, fostering the creation of professional communities and guiding school organizations to adhere to common values (Murphy et al., 2007).

On the contrary, the conservative standards system mistakenly views the principal as primarily responsible for a multitude of activities that could and should be reconsidered in terms of school administration rather than from a school leader viewpoint (Pitre & Smith, 2004).

III. OBJECTIVES OF THE STUDY

This study described Standards of School Leadership in terms of: Leading Learning and Teaching Domain, Leading School Development Domain, Organizational Management Domain, and Professional Growth and Development Domain.

IV. METHODOLOGY

The descriptive method of research was used in this study because it involves description, recording, analysis and interpretation of condition that really exists. It is appropriate to use descriptive method in gathering information about the present existing condition (Creswell, 2014). A total of 107 tertiary school teachers which have permanent appointment or considered as regular employee for more than 3 years were surveyed around Nueva Ecija.

The researchers distributed survey questionnaires which adapted Likert-scale type responses (Vagias, 2006) and analyzed it through statistical data treatment such as mean and weighted mean.

V. RESULTS AND DISCUSSIONS

Table 1. Leading Learning and Teaching Domain and Standards of School Leadership

Our school leader/s…	**Mean**	**Verbal Interpretation**
1. create a culture of professional learning that fosters continuous improvement in learning, teaching and assessment	3.43	Strongly Agree
2. foster the development of the full range of teacher competencies	3.12	Agree
3. foster a commitment to inclusion and equality of opportunity of each student	2.50	Agree
4. develop and implement a system to promote professional responsibility and accountability	2.54	Agree
5. manage the design, planning and implementation of the school curriculum	3.29	Strongly Agree
Average Mean	**2.98**	**Agree**

Legend	***Verbal Interpretation (VI)***
3.25 – 4.00	Strongly Agree
2.50 – 3.24	Agree
1.75 – 2.49	Disagree
1.00 – 1.74	Strongly Disagree

It shows on Table 1 that the leading learning and teaching domain of school leaders in tertiary schools got an average of 2.98 with a verbal description of *'agree'*. To state a few of its standards, these were their school leaders create a culture of professional learning that fosters continuous improvement in learning, teaching and assessment *(M = 3.43; VI = strongly*

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agree) and they also manage the design, planning and implementation of the school curriculum *(M = 3.29, VI = strongly agree).* This finding implies that tertiary school leaders are on hand and in support in creating and managing their school's curriculum and improvement of professional learning in the school.

Table 2. Leading School Development Domain and Standards of School Leadership

Our school leader/s…	**Mean**	**Verbal Interpretation**
1. establish and communicate a guiding mission and vision for the school	2.56	Agree
2. engage in a continuous process of evidence-based school self-evaluation	3.31	Strongly Agree
3. build and maintain relationships with parents, other schools, relevant agencies, and the wider school community	2.78	Agree
4. promote communication within the school and manage challenging and complex situations	2.53	Agree
5. manage and lead change to respond to the evolving needs of the school and the changing educational environment	3.30	Strongly Agree
Average Mean	**2.89**	**Agree**

Legend	***Verbal Interpretation***
3.25 – 4.00	Strongly Agree
2.50 – 3.24	Agree
1.75 – 2.49	Disagree
1.00 – 1.74	Strongly Disagree

The finding with regards to leading school development domain, as shown in Table 2, of school leadership shows an average mean of 2.89 (verbal interpretation = *'agree'*). This domain highlights the standards, particularly, school leaders engage in a continuous process of evidence-based school self-evaluation *(M = 3.31; VI = strongly agree)* and they also manage and lead change to respond to the evolving needs of the school and the changing educational environment *(M = 3.30; VI = strongly agree).* This suggests that school leaders maintain their involvement for the continuous changing on the evolving needs in light of the academic process.

Table 3. Organizational Management Domain and Standards of School Leadership

Our school leader/s…	**Mean**	**Verbal Interpretation**
1. manage human and physical resources and organizational structures and strategies to create and maintain a learning organization	3.32	Strongly Agree
2. foster ethical standards, implement the values of the school and demonstrate equality, fairness and justice for all	2.67	Agree
3. maintain a climate of security and well-being that enables and supports learning	3.25	Strongly Agree
4. encourage and facilitate the development of communities of practice in the area of management and leadership	2.93	Agree
5. ensure the safe functioning of the school on a day-to-day basis	3.45	Strongly Agree
Average Mean	**3.12**	**Agree**

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Legend	*Verbal Interpretation (VI)*
3.25 – 4.00	Strongly Agree
2.50 – 3.24	Agree
1.75 – 2.49	Disagree
1.00 – 1.74	Strongly Disagree

Table 3 presents the organizational management domain of school leadership. Based on the result, this domain got an average mean of 3.12 with a verbal interpretation of 'agree'. Its standards illustrate that school leaders ensure the safe functioning of the school on a day-to-day basis *(M = 3.45; VI = 'strongly agree'),* they manage human and physical resources and organizational structures and strategies to create and maintain a learning organization *(M = 3.32; VI = 'strongly agree')* and, also, school leaders maintain a climate of security and well-being that enables and supports learning *(M = 3.25; VI = 'strongly agree').* These findings imply that school leaders in terms of their organizational management, they lead and manage the school effectively.

Table 4. Professional Growth and Development Domain and Standards of School Leadership

Our school leader/s…	**Mean**	**Verbal Interpretation**
1. maintain and further develop leadership competencies through continuing professional development	3.10	Agree
2. recognize the need to manage workload to ensure a sustainable work/life balance	3.22	Agree
3. critique and develop their own practice as leaders of learning	2.62	Agree
4. build professional networks with other school leaders	2.57	Agree
Average Mean	**2.88**	**Agree**

Legend	*Verbal Interpretation (VI)*
3.25 – 4.00	Strongly Agree
2.50 – 3.24	Agree
1.75 – 2.49	Disagree
1.00 – 1.74	Strongly Disagree

Table 4 shows that the findings with regards to professional growth and development domain of school leadership got an average mean of 2.88 (VI = *'agree'*). The standards for this domain show that school leaders recognize the need to manage workload to ensure a sustainable work/life balance *(M = 3.22; VI = 'agree')* and they also maintain and further develop leadership competencies through continuing professional development *(M = 3.10; VI = 'agree').* This suggests that they seek to apply the understanding they acquire in a meaningful way to their practice on school leaders.

Table 5. Domains of School Leadership

	Mean	**Verbal Interpretation**	**Rank**
1. Leading Learning and Teaching	2.98	Agree	2
2. Leading School Development	2.89	Agree	3
3. Organizational Management	3.12	Agree	1
4. Professional Growth and Development	2.88	Agree	4

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Legend	*Verbal Interpretation (VI)*
3.25 – 4.00	Strongly Agree
2.50 – 3.24	Agree
1.75 – 2.49	Disagree
1.00 – 1.74	Strongly Disagree

Table 5 shows the ranking of domains of school leadership. First in rank is the organizational management *(M = 3.12; VI = 'agree'),* second is leading learning and teaching *(M = 2.98; VI = 'agree')* and, on third and last respectively are leading school development *(M = 2.89; VI = 'agree')* and professional growth and development *(M = 2.88; VI = 'agree')*. The ranking result suggests that school leaders focus most on the organizational management.

VI. CONCLUSIONS AND DISCUSSIONS

After analyses of data, the following conclusions were formulated: first, domains of school leadership can be viewed from leading learning and teaching, leading school development, organizational management, and professional growth and development. Second, among these domains, organizational management was found to be the focus of school leaders. Third, school leaders create a culture of professional learning that fosters continuous improvement in learning, teaching and assessment. Fourth, school leaders engage in a continuous process of evidence-based school self-evaluation. Fifth, ensure the safe functioning of the school on a day-to-day basis. Last, school leaders recognize the need to manage workload to ensure a sustainable work/life balance.

The researchers want to recommend some matters based from the formulated conclusions. It is indeed noticeable that organizational management is the main focus of the school leaders thus, it is recommended that school leaders should not let other domains of school leadership be taken for granted. Continuous harnessing on the strengths based on the standards is highly recommended. On the others hand, strengthening of the following is also recommended: school leaders should foster a commitment to inclusion and equality of opportunity of each student; promote communication within the school and manage challenging and complex situations and build professional networks with other school leaders.

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The Influencing Factors of Chinese Corporations' Leverage

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Abstract— *Faced with the pressure of economic downturn and structural transformation, high debt leverage has become a prominent problem of China's economic development. This article takes 2007-2018 annual data of non-financial companies listed on A-shares as an example, analyzes the influencing factors of Chinese corporations' leverage, the empirical results find that macroeconomic environment have a significant impact on corporate debt leverage ratio, and sufficient liquidity is conducive to increasing the willingness of enterprises to expand reproduction and has a positive impact on corporate debt leverage. Financial market factors have a significant impact on corporate debt leverage ratios, the greater the financial institution's support for the real economy, the stronger the company's ability to obtain debt financing. The operation indicators of enterprises have a significant impact on the corporate debt leverage ratios, profitability and leverage ratios have a negative correlation, and this negative correlation is the most significant of all influencing factors.*

Keywords— ***Chinese Corporations' Leverage Influencing factors.***

I. INTRODUCTION

After the outbreak of the financial crisis, the topics surrounding the financial crisis and the debt crisis aroused the interest of many scholars. Debt leverage, economic cycles, monetary policy, credit scale, shadow banking and other factors are intertwined, making the problem of debt leverage more complicated. Facing the downward pressure of the global economy and the pressure of economic structural transformation, excessive debt leverage has become a prominent issue of China's current economic development. How to trace the source and adapt to local conditions has become a huge challenge to regulators. According to BIS (International Settlement Bank) statistics, as of the third quarter of 2018, the leverage ratio of China's real economy macro debt was 252.7%, an increase of about 110% over 2008. Among them, the non-financial corporate sector leverage ratio was 152.9%, an increase of about 55% over 2008.

1.1 Definition of corporate debt leverage

From a macro perspective, it is commonly used to measure total debt / GDP to facilitate horizontal international comparisons (BIS, 2011; IMF, 2015; People's Bank of China Leverage Research Group, 2014; Li Y, 2015, etc.). From a micro perspective, the debt leverage ratio (that is, the asset-liability ratio) reflects the ratio of borrowed capital of the company to its own capital. The leverage ratio is high, indicating that the company has more borrowed capital than its own capital. Larger. It is basically the same that when discussing the issue of debt leverage from the perspective of the business sector, the debt leverage ratio indicator is used corporate debt leverage ratio= total corporate debt / GDP; when discussing the issue of debt leverage from a certain corporate industry or individual, the asset-liability ratio is used the debt leverage ratio = liability / asset.

1.2 China's Debt Leverage Situation

Since the US subprime mortgage crisis in 2008, China 's macro debt leverage has shown an upward trend as a whole

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(Figure 1). According to BIS (International Settlement Bank) statistics, as of the third quarter of 2018, the leverage ratio of China's real economy macro debt was 252.7%, an increase of about 110% compared to 2008. Among them, the non-financial corporate sector leverage ratio was 152.9%, an increase of about 55% over 2008. After decomposing, it is found that the high leverage ratio of China's macro debt is mainly reflected in the non-financial corporate sector.

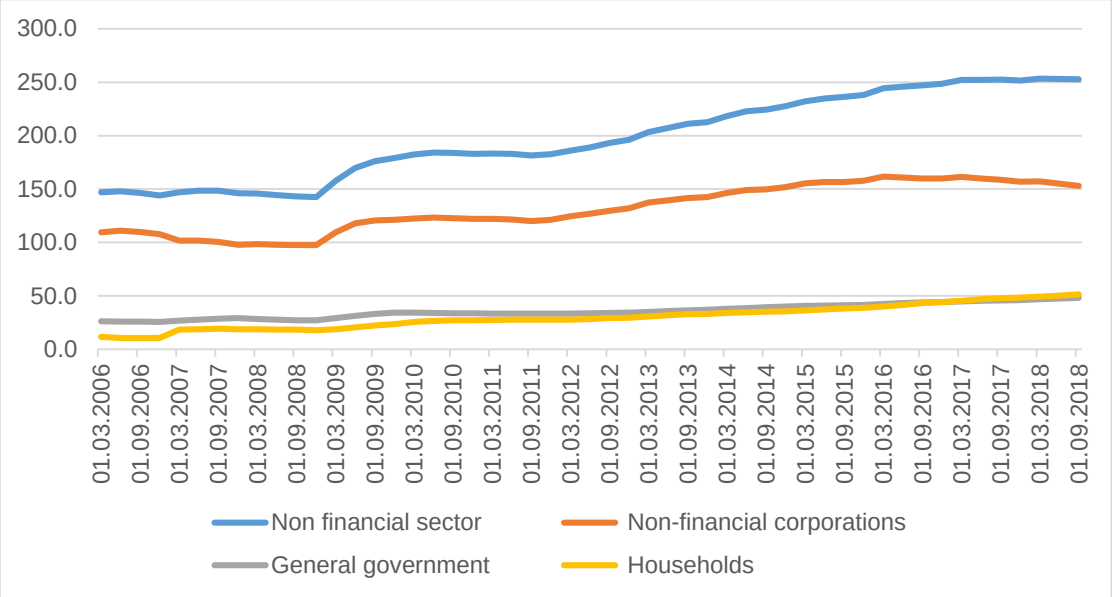

Fig.1: Macro Debt Trend of China's Real Economy (2006-2018)

Data source: BIS

In the context of the non-financial corporate sector debt leverage ratio is so high, we concern about the reasons of the rapid rise of debt leverage? It is not only academic issues, but also important policy issues. The structure of this article is as follows: the second part is literature review, the third part is the introduction of the basic model, the fourth part is the analysis of empirical results, and the fifth part is conclusion.

II. LITERATURE REVIEW

According the existing literatures,the influencing factors of Chinese corporations' leveragecan be roughly divided into micro and macro aspects. The micro level is mainly based on the enterprise itself, and selects indicators such as the company's capital structure, profitability, debt repayment ability, and cash liquidity; the macro level mainly studies the economic growth, monetarypolicy, inflation rate, and financial development.

From a micro perspective, the debt leverage ratio is closely related to its own operating efficiency. Ma J et al. (2016) believe that the excessive leverage of enterprises is closely related to the inefficient use of corporate funds. When enterprises are inefficient and have overcapacity, they can only borrow new debt to pay off old debt, the situation of capital and liabilities being ineffective. Bu D, etc. (2017) believe that excess capacity and rising leverage ratio are in the same direction, and the increase in leverage will cause further inefficient production capacity, resulting in the overcapacity and leverage ratio. Jiang Hand Zhang Y (2017) found that the enhancement of the company's own capabilities (enterprise assets, endowments) and the improvement of the overall industry boom have a negative inhibitory effect on the company's asset-liability ratio. Lu T and Yu Y (2015) believe that the reason for the high debt leverage ratio of non-financial companies is that China's capital-to-output ratio has increased and corporate profitability has declined.

From a macro perspective, the trade-off theory is that when a country's GDP growth rate is higher, companies have a higher level of profitability, and tend to use debt financing, the corporate debt leverage will also increase. The empirical results also validate this view (Tan X et al.,

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2018; Yang G, 2018, etc.). Studying the issue of leverage from the perspective of monetary policy can be roughly summarized into the following three perspectives: Firstly, the credit expansion caused by the expansion of the base currency. Specifically, the loose monetary environment and the enthusiasm for investment in the corporate sector have led to an increase in credit scale. Secondly, debt financing accounts for a relatively high proportion in the social financing structure. On the one hand, in developing countries where the level of financial development is not high and the legal environment is not sound, entity companies tend to use debt financing, which has led to a rise in the proportion of debt; on the other hand, in countries dominated by the banking system, the financial sector also The tendency to lend funds to companies with good credit qualifications, more mortgage guarantees, but low returns on assets Thirdly, the imbalance in the structure of resource allocation among macroeconomic sectors, commonly known as "soft budget constraints", is mainly manifested in the high debt leverage of state-owned enterprises in the corporate sector.

Based on the previous research results, this article comprehensively considers the effects of macroenvironment, financial market and micro factors on corporate debt leverage, and analyzes the influencing factors of corporation debt leverage of China.

III. INTRODUCTION OF THE BASIC MODEL

3.1 Introduction of the benchmark model

1.Panel regression model.

The steps of panel regression model is to estimate the OLS regression model firstly, and the estimate the fixed effect model, and perform an F test to determine whether a fixed effect model or ordinary least squares method should be selected. If the F-test indicates that a fixed-effect model should be selected, further Hausman's test is required to determine whethera random-effect model or fixed-effect model is more effective.

The general panel regression model can be expressed as:

$$y_{it} = \alpha + \beta x_{it} + \mu_i + \varepsilon_{it} \quad (3.1)$$

Where y_{it} is the dependent variable, x_{it} is the independent variable, u_i is the individual effect, and $\varepsilon_{it}$is the random disturbance term.

2.Dynamic panel model.

If the lagging term of the explanatory variable is added to the explanatory variable of the model, the model formed at this time is a dynamic panel model. If the dynamic panel model directly uses OLS regression or panel model regression, it will cause endogenous problems because it includes the lag terms of the explanatory variables. At this time, maximum likelihood estimation can be used. Kelejian and Prucha（1999）、Bell and Bockstael（2000）showed that compared with maximum likelihood estimation, the generalized moment estimation method (GMM) of the system is unbiased when estimating the dynamic panel model, and the method of system GMM estimation is more concise. The general dynamic panel model can be expressed as:

$$y_{it} = \alpha + \rho y_{it-1} + \beta x_{it} + \mu_i + \varepsilon_{it} \quad (3.2)$$

Where y_{it} is the dependent variable,and y_{it-1} is the lagging first-order term of the dependent variable, $x_{it}$is the independent variable, u_i is the individual effect, and $\varepsilon_{it}$is the random disturbance term.

3.2 Data sources

The data is the annual sample data of listed companies listed in China's A-shares, with a time span of 2007 to 2018. The sample data has been processed: (1) In view of the special characteristics of financial listed companies, delete such listed companies; (2) deleting the samples of which the listed company has missing data; (3) deleting the ST and PT listed companies' data; (4) choosing Winsorize tailing level of 1%.After data processing we got unbalanced panel data, involving 26470 samples from 3246 listed companies, with the longest time span of 12 years.

3.3 Variable Introduction

1. Explained variable. The dependent variable is corporate debt leverage. Since data from A-share listed companies, the asset-liability ratio (total debt / total assets) is used to represent it.

2. Macro environment explanatory variables. Macro

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explanatory variables include: GDP growth rate, M2 growth rate, and real interest rate. The GDP growth rate (gdpr) is represented by the year-on-year growth rate of GDP; the M2 growth rate (m2gr) is represented by the year-on-year growth rate of M2; and the real interest rate (loar) is represented by the US real loan interest rate.

3.Financial market explanatory variables. Financial explanatory variables include: Social financing scale, financial leverage, non-performing loan ratio. The scale of social financing (ltsf) is represented by the logarithm of the scale of social financing; the financial leverage (finl) is represented by the proportion of M2 in GDP; and the non-performing loan ratio (defr) is represented by the proportion of non-performing loans in financial institutions' loans.

4. Micro explanatory variables. Micro explanatory variables include: company size, profitability, financialization, growth, time to market, return on net assets, current ratio, proportion of fixed assets, corporate nature, non-debt tax shield. The company size (ltas) is represented by the logarithm of the total assets of the listed company; profitability (pabt) is represented by the proportion of listed companies' earnings before interest and taxes as a percentage of total assets; The growth rate (lrev) uses the logarithmic representation of the operating income of the listed company; the listed time (lyear) uses the current year-the listed listing time; The return on net assets (ROE) is represented by the proportion of the listed company's net profit to the owner's equity;the current ratio (liqu) is represented by the current assets of listed companies as a proportion of current liabilities; the proportion of fixed assets (pofa) is represented by the proportion of fixed assets of listed companies in total assets;

Non-debt tax shield (ndts) uses the depreciation of listed companies as a percentage of total assets.

3.4 Basic Statistics of Variables

The basic statistics of the model's explanatory variables, macro environment explanatory variables, financial market explanatory variables and micro explanatory variables are shown in Table 1.

Table1 Basic Statistics

variables	number	mean	sd	min	p50	max
debt	26470	0.428	0.210	0.048	0.421	0.888
gdpr	26470	0.109	0.041	0.068	0.097	0.208
m2gr	26470	0.135	0.049	0.081	0.133	0.285
loar	26470	2.141	0.871	1.137	2.155	5.223
ltsf	26470	11.939	0.327	10.996	12.008	12.327
finl	26470	1.880	0.176	1.487	1.907	2.085
defr	26470	0.105	0.062	0.052	0.109	0.349
ltas	26470	21.948	1.278	19.503	21.781	25.879
pabt	26470	0.060	0.058	-0.161	0.055	0.245
finc	26470	0.177	0.541	-1.069	0.021	3.538
lrev	26470	21.282	1.433	18.068	21.147	25.265
lyear	26470	9.919	6.794	0.000	9.000	25.000
ROE	26470	0.069	0.116	-0.597	0.073	0.349
liqu	26470	2.539	2.852	0.292	1.628	18.613
pofa	26470	0.225	0.168	0.002	0.191	0.723
ndts	26470	0.020	0.015	0.001	0.017	0.070

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3.5 Collinearity Test

Before using the model to analyze the relationship between variables, we need to test the multicollinearity between the variables. The usual method is to calculate the "Variance Inflation Factor" (VIF) between explanatory variables. Larger values indicate higher levels of collinearity among model variables. If the value of the VIF factor between the variables is less than 10, the collinearity problem is not serious, and these variables can be used for analysis.

Table 2 Collinearity Test Result

Variables	VIF	1/VIF
finl	8.880	0.113
defr	8.040	0.124
loar	7.520	0.133
ltsf	6.850	0.146
lrev	5.450	0.183
ltas	5.420	0.185
m2gr	4.510	0.222
pabt	4.110	0.243
ROE	4.080	0.245
gdpr	3.920	0.255
ndts	3.210	0.312
pofa	3.210	0.312
lyear	1.490	0.671
liqu	1.380	0.725
finc	1.050	0.952
Mean VIF	4.046	

According to Table 2, the VIF data of each explanatory variable involved in the model are lower than 10, indicating that the multicollinearity problem is within the allowable range, and the model can be established for further analysis.

IV. ANALYSIS OF EMPIRICAL RESULTS

4.1 Analysis of Empirical Results

A panel model is used to analyze the influencing factors of corporate debt leverage, we use Stata 16.0 software for OLS regression and fixed effect model analysis, and runs the F test. The OLS regression results of the model are shown in Table3.

Table 3 OLS Regression Results

debt	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
gdpr	0.215	0.041	5.280	0.000	0.135	0.294
m2gr	0.455	0.036	12.660	0.000	0.385	0.526

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loar	-0.016	0.003	-5.040	0.000	-0.022	-0.010
ltsf	0.002	0.008	0.310	0.753	-0.013	0.017
finl	-0.097	0.017	-5.720	0.000	-0.131	-0.064
defr	0.201	0.045	4.510	0.000	0.114	0.289
ltas	0.023	0.002	15.150	0.000	0.020	0.026
pabt	-1.037	0.029	-35.650	0.000	-1.094	-0.980
finc	-0.017	0.002	-10.990	0.000	-0.021	-0.014
lrev	0.026	0.001	19.070	0.000	0.023	0.029
lyear	0.004	0.000	23.620	0.000	0.003	0.004
ROE	0.164	0.015	11.300	0.000	0.136	0.193
liqu	-0.034	0.000	-100.160	0.000	-0.035	-0.034
pofa	0.013	0.009	1.430	0.152	-0.005	0.030
ndts	-1.595	0.100	-16.000	0.000	-1.790	-1.400
_cons	-0.405	0.076	-5.340	0.000	-0.554	-0.256

The regression results of the fixed effect model are shown in Table4.

Table 4 Regression Results ofThe Fixed Effects Model

debt	Coef.	Robust Std. Err.	t	P>t	[95% Conf.	Interval]
gdpr	0.077	0.030	2.570	0.011	0.018	0.136
m2gr	0.249	0.049	5.104	0.000	0.153	0.345
loar	-0.014	0.003	-5.468	0.000	-0.019	-0.009
ltsf	0.016	0.008	2.034	0.043	0.001	0.031
finl	0.058	0.013	4.314	0.000	0.031	0.084
defr	-0.145	0.028	-5.192	0.000	-0.199	-0.090
ltas	0.035	0.006	6.358	0.000	0.024	0.046
pabt	-0.434	0.048	-8.982	0.000	-0.529	-0.339
finc	0.020	0.011	1.776	0.077	-0.002	0.043
lrev	0.021	0.005	4.586	0.000	0.012	0.031
lyear	-0.003	0.001	-2.105	0.036	-0.006	0.000
ROE	0.012	0.021	-0.559	0.577	-0.053	0.029
liqu	-0.025	0.001	-29.939	0.000	-0.027	-0.024
pofa	0.033	0.021	1.602	0.110	-0.007	0.073
ndts	-0.540	0.228	-2.369	0.018	-0.987	-0.093
_cons	-0.660	0.095	-6.920	0.000	-0.848	-0.473

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sigma_u	0.121	
sigma_e	0.089	
rho	0.650	(fraction of variance due to u_i)

The R-square of the fixed effect model is 0.5026, and F test that all u_i = 0: F (3245, 23208) = 12.10, and Prob> F = 0.000. The F test results show that the intercept terms of the samples are not equal, so the results using the fixed effect model are more suitable than OLS, but the choice of fixed effect and random effect models needs to be determined by the Hausman test method.In order to save space, the results of the random effects regression are no longer listed, and Hausman's test results are:

Test: Ho: difference in coefficients not systematic
chi2(16) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 837.08
Prob>chi2 =0.0000

The Hausman test's P value is less than 0.05, which indicates that the null hypothesis was rejected, indicating that the model coefficients are significantly different, so the regression results of the fixed effect model should be used.

The overall regression results of the fixed-effect model will be analyzed from three aspects: macro environment factors, financial market factors, and micro factors:

1. Macroenvironment factors.

(1) GDP growth (gdpr) has a positive impact on corporate debt leverage (debt) at a significant level of 5%. The higher the GDP growth rate, the better the economic situation, the better the macroeconomic environment, and the increased confidence of enterprises in future development. According to the trade-off theory, when a company has a good level of profitability, when financing a project, debt financing is usually used to expand the production scale and increase output. It can also use the tax shield effect to reduce costs, so that corporate debt leverage is also improved. Conversely, when the growth rate of GDP declines, the macroeconomic and financial environment becomes tighter, and companies will reduce the proportion of debt financing. After 2009, China 's GDP growth rate has maintained an overall rate of more than 6%. The stable development of the macroeconomic environment has created relatively favorable conditions for the development of enterprises, and has also driven the financing needs of enterprises.

(2) The M2 growth rate (m2gr) has a positive impact on corporate debt leverage (debt) at a significant level of 1%. The growth rate of M2 reflects the easing of credit funds in the market. A high growth rate of M2 indicates that the financial market is more liquid, the cost of funds is lower, and corporate financing is relatively easy. This will stimulate companies to use debt financing to expand production scale, and it will also bring Increased corporate debt leverage. After the financial crisis, China launched a series of policies to stimulate economic growth. Among them, the "four trillion" series of plans injected sufficient liquidity into the market and expanded corporate financing needs.

(3) The real interest rate (loar) has a negative impact on corporate debt leverage (debt) at a significant level of 1%. The real interest rate index selected here is the U.S. real interest rate, which represents the global monetary and financial environment to a certain extent. The negative correlation between the two indicates that a decrease in the real interest rate will lead to an increase in the corporate debt leverage ratio. After the financial crisis, the Federal Reserve implemented quantitative easing policies. The low real interest rate has a resonance effect on the global monetary and financial environment to a large extent.

2. Financial marketfactors.

(1) Social financing scale (ltsf) has a positive impact on corporate debt leverage (debt) at a significant level of 5%. The social financing scale stock refers to the balance of funds obtained by the real economy from the financial system at the end of a certain period (end of the month, end of the quarter, or year-end), which in turn reflects the degree of financing support provided by the financial structure to the real economy. The positive relationship between the two shows that the increase in the scale of social financing is

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conducive to the expansion of corporate financing, which in turn promotes the expansion of production capacity, and will also increase the proportion of corporate debt leverage. As of December 2019, China's social financing scale stock reached 251.31 trillion yuan, an increase of 10.7% which strongly supported the reasonable growth of money and credit, and created a suitable monetary and financial environment for the development of enterprises. The positive effects of corporate debt leverage are in line with economic reality.

(2) Financial leverage (finl) has a positive impact on corporate debt leverage (debt) at a significant level of 1%. From a narrow perspective, financial leverage is a measure of the debt of financial institutions. It is usually measured by the credit / GDP of the private sector internationally (Cecchetti and Kharroubi, 2012; Ma Y et al., 2017). The increase in financial leverage indicates the credit expansion of financial institutions, that is, the expansion of financial institutions' balance sheets. The process of credit expansion is also the process of currency injection. It has a positive impact on liquidity and corporate financing, and it will also cause corporate debt. Increase in leverage.

(3) The non-performing loan ratio (defr) has a negative impact on corporate debt leverage (debt) at a significant level of 1%. The non-performing loan ratio shows the asset quality of commercial banks. It shows the ratio of non-performing loans to total credit. The non-performing loan ratio has decreased, which indicates that credit-granting companies are operating well and capital turnover is normal. Feedback from commercial banks is positive, and the financing environment is stable; Rising loan non-performing ratios indicate that credit companies have difficulty in capital turnover and business operations. At this time, banks and other financial institutions tend to shrink the size of loans. It is more difficult for companies to obtain financial support from commercial banks, which in turn causes corporate debt leverage to decline.

3. Micro factors.

(1) The company size (ltas) has a positive impact on corporate debt leverage (debt) at a significant level of 1%. Generally speaking, the larger the company's size, the stronger its ability to withstand financial risks, and the more confident the company is in operating and developing, the easier it is for companies to raise funds, which will increase corporate debt leverage.

(2) Profitability (pabt) has a negative impact on corporate debt leverage (debt) at a significant level of 1%. According to the financing priority sequence theory, when financing, an enterprise first chooses internal financing, then debt financing, and finally equity financing. The stronger the company's profitability and the more abundant the funds retained by the company, the lower the need for external financing, which can reduce external financing and reduce the level of corporate debt leverage.

(3) The degree of financialization (finc) has a positive impact on corporate debt leverage (debt) at a significant level of 10%. Under the loose monetary policy environment, the scale of China's financial industry has developed rapidly, and its profit margin far exceeds that of the real economy. As a result, more and more entities have invested funds in financial assets and attempted to accumulate profits through financial channels. According to empirical results, the higher the degree of corporate financialization, the higher the debt leverage ratio.

(4) Growth (lrev) has a positive impact on corporate debt leverage (debt) at a significant level of 1%. Generally speaking, growing companies have stronger demand for capital, the better the company's growth, and the more financing needs, the higher the level of corporate debt leverage.

(5) The listed time (lyear) has a negative impact on corporate debt leverage (debt) at a significant level of 1%. The longer it has been listed, the more mature of the company's business model, the more stable of its cash flow, and the lower the need for external financing, thus driving down the level of corporate debt leverage.

(6) The return on net assets (ROE) has a positive impact on corporate debt leverage (debt), but it is not significant. A high return on the company's net assets indicates a higher return on shareholders' equity. Under the condition that the overall profitability of the company is relatively high, the company tends to use debt instruments to finance, on the one hand, it can obtain sufficient residual profit, and on the other hand, it can also reduce the free cash flow of the company. In addition, according to the return on equity

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(ROE) = total net asset interest rate * equity multiplier = total net interest rate / (1-asset-liability ratio), an increase in ROE will lead to an increase in the asset-liability ratio, which is in line with financial management theory.

(7) The current ratio (liqu) has a negative impact on corporate debt leverage (debt) at a significant level of 1%. The more liquid assets a company has, the better its operation level, and the lower its external financing needs, which will drive down the level of corporate debt leverage.

(8) The proportion of fixed assets (pofa) has no significant influence on corporate debt leverage (debt). Based on the full sample data, the increase in the level of fixed assets may have positive and negative effects on corporate debt leverage. On the one hand, the increase in the proportion of fixed assets of the enterprise indicates that the company is expanding its reproduction operations and has a strong demand for funds. This is reflected in the increase in the debt leverage ratio; on the other hand, the higher the proportion of fixed assets, the better the production and operation ability of the enterprise, and the better the debt repayment ability, the enterprise can obtain considerable income in large-scale production and operation, reducing the need for external financing . In addition, the formation of fixed assets of an enterprise and the benefits it brings to the enterprise require a certain period of time, so its impact on debt leverage is not significant.

(9) Non-debt tax shield (ndts) has a negative impact on corporate debt leverage (debt) at a significant level of 5%. Non-debt tax shield refers to the deduction effect of expenses other than debt interest, such as depreciation and deferred tax losses. Non-debt tax shields and debt levels show a negative correlation, and this type of non-debt tax avoidance does not create the risk that debts will not be paid when due. Therefore, companies with a large number of non-debt tax shields use debt less than companies without non-debt tax shields. Non-debt tax shields can be used as a substitute for debt, reducing the corporate tax burden.

Among the micro factors, corporate profitability has the most significant impact on corporate debt leverage. This empirical result fully demonstrates that improving the company's own production and operation capabilities is critical to reducing debt leverage.

4.2 Robustness Test

The foregoing empirical analysis considers the effect of current variables on the level of corporate debt leverage ratio, without considering its dynamic characteristics. In this section, a dynamic panel model is used to test the robustness of the influencing factors of China's corporate debt leverage. Based on the static panel model estimation, the lagging first-order term L1.debt of the corporate variable leverage (debt) of the explanatory variable is added to establish a dynamic panel model. The system GMM method described above is used for estimation. What needs to be explained is that In GMM estimation, macro explanatory variables and financial explanatory variables are regarded as strictly exogenous, that is, IV-type instrument variables; and micro-explanatory variables are regarded as endogenous variables, that is, GMM-type instrument variables. The results are shown in Table 5.

Table 5 Dynamic Panel Model Regression Results

debt	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
L1.debt	0.594	0.012	49.590	0.000	0.571	0.618
gdpr	0.050	0.024	2.105	0.035	0.003	0.097
m2gr	0.062	0.033	1.859	0.063	-0.003	0.127
loar	-0.007	0.003	-2.646	0.008	-0.012	-0.002
ltsf	0.022	0.004	5.104	0.000	0.014	0.031
finl	0.088	0.010	8.703	0.000	0.068	0.108
defr	-0.294	0.071	-4.113	0.000	-0.434	-0.154

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ltas	0.004	0.005	0.855	0.393	-0.005	0.013
pabt	-0.431	0.044	-9.778	0.000	-0.517	-0.344
finc	0.004	0.001	3.166	0.002	0.002	0.007
lrev	0.028	0.004	6.231	0.000	0.019	0.036
lyear	-0.001	0.000	-4.606	0.000	-0.002	-0.001
ROE	-0.038	0.019	-2.036	0.042	-0.074	-0.001
liqu	-0.020	0.001	-24.016	0.000	-0.022	-0.018
pofa	0.053	0.016	3.236	0.001	0.021	0.085
ndts	-1.945	0.191	-10.176	0.000	-2.320	-1.570
_cons	-0.472	0.062	-7.603	0.000	-0.594	-0.351

The AR (1) value of the dynamic panel model is 0.000 less than 0.05, and the AR (2) value is 0.159 greater than 0.05, indicating that the model's interference term autocorrelation does not exist; the p-value of the Hansen statistic 0.263 is significantly greater than 0.05, indicating that the dynamics The tool variables used in the panel model are effective, and the dynamic panel model established is reasonable.

From Table 5, it can be seen that the lagging first-order term L1.debt of corporate debt leverage (debt) has a positive impact on corporate debt leverage (debt) at a significant level of 1%, and the impact coefficient is 0.594, indicating that corporate debt has increased in the current period. The next period of corporate debt also tends to rise, and corporate debt leverage is path-dependent. The impact of the remaining variables on corporate debt leverage (debt) is basically consistent with the regression results of the full-sample fixed-effects model, indicating that the analysis of the factors affecting corporate debt leverage is robust and supports the above findings.

V. CONCLUSION

This article uses a fixed-effects model to analyse the influencing factors of corporate debt leverage. The conclusions obtained are as follows: Firstly, macroeconomic environment indicators have a significant impact on changes in corporate debt leverage ratios, economic stability and sufficient capital liquidity are conducive to increasing the desire of enterprises to expand reproduction and expand the scale of financing. Secondly, financial market indicators have a significant impact on changes in corporate debt leverage ratios. The greater the financial institution's support for the real economy, the stronger the company's ability to obtain debt financing. Thirdly, the company's own production and operation indicators have a significant impact on the debt leverage ratios. the profitability indicators (such as profitability, return on net assets) and the leverage ratio show a negative correlation, and this negative correlation is the most significant among all influencing factors. There is a negative correlation between liquidity of funds and leverage, a negative correlation between company size and leverage, and a positive correlation between the degree of corporate financialization and leverage. In the long run, the reduction of corporate debt leverage ratio must be achieved by improving social productivity and achieving long-term stable economic growth. The company's own profitability is a stabilizer for adjusting corporate debt leverage. A very important measure to improve the profitability of an enterprise is to improve its independent innovation capability, that is, its own endogenous growth momentum. At the policy level, enterprises should be encouraged to improve their ability to innovate independently, increase the introduction of talents, and promote technological innovation as the focus of China's economic growth.

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Post IFRS Convergence Investigation: Corporate Social Responsibility Disclosure in Relation to Good Corporate Governance and Company Size

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Abstract**—***This research aims to determine the factors that influence the level of Corporate Social Responsibility Disclosures after International Financial Reporting Standards convergence by testing the effect of Institutional Ownership, Public Ownership, Board of Independent Commissioner Size and Company Size on Corporate Social Responsibility Disclosures index. Sample used are mining sector companies that listed on Indonesia Stock Exchange for period 2013-2016. The sources of the data were taken from audited financial reports and annual reports and sample were 19 banks which taken by using purposive sampling. This research uses quantitative approach with multiple linier regression analysis. The results show that institutional ownership, public ownership and company size have a positive and significant effect on corporate social responsibility disclosures. There is no evidence to suggest that board of independent commissioner size have any effect on corporate social responsibility disclosures. The results simultaneously show that Institutional Ownership, Public Ownership, Board of Independent Commissioner Size and Company Size have an influence on Corporate Social Responsibility Disclosures..*

Keywords**—*Corporate Social Responsibility Disclosure, Institutional Ownership, Public Ownership, Board of Independent Commissioner Size and Corporate Size*.**

I. INTRODUCTION

Understanding the international dimension was very important for those who want a business or acquire or supply financing across national borders (Choi & Gary, 2017). This improved the need for globally accepted accounting standards which will be very useful in presenting company reports and also as a unified perception in assessing or comparing information among multinational corporations. In this case International Financial Reporting Standards (IFRS) can meet those needs.

In Indonesia, the adoption of IFRS began in 2008 and is fully adopted to statement of financial accounting standards starting 1 January 2012 for all listed companies (go public). The most fundamental difference of the IFRS convergence is from the historical cost approach to turning into a fair value, rule-based approach to principle based and the last one IFRS is more demanding to make more and more detailed disclosure (Susilawati, 2017). The information disclosed in the annual report consists of mandatory disclosure and voluntary disclosure (Hidayat, 2017).

This study focuses on voluntary disclosure reflected in corporate social responsibility (CSR) disclosure, as CSR issues are increasingly being discussed over the past few years. This was because companies that do not pay attention to social aspects and promote sound corporate governance such as environmental pollution due to massive exploitation of natural resources, increased pollution and waste, poor product quality and product safety, investment misuse, customary violations, and gaps social and economic issues (Istifaro & Subardjo, 2017). In addition, the company's encouragement to implement CSR is due to

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Law Number 40 Year 2007 regarding Limited Liability Company. Subsection 74 paragraph 1 the law stipulates that "the Company which carries out its business activities in the field and or related to natural resources is obliged to carry out the social and environmental responsibility" (Hidayat, 2017). The CSR is also regulated in Law No. 25 of 2007 on capital-related capital market companies explaining the obligations for every investor to implement CSR (Maiyarni et al., 2014). Thus the company has been prosecuted legally to disclose CSR.

Disclosure of CSR aims to establish good and effective communication relationships between companies and the public and other stakeholders about how companies have integrated CSR (Istifaroh & Subardjo, 2017). This relates to stakeholder theory in which the company has responsibility for all stakeholders (Wanvik, 2015; Yu & Choi, 2016). To achieve that goal the company can implement Good Corporate Governance (GCG). GCG can reduce the problem of information asymmetry in agency theory. The implementation of GCG will be able to increase economic growth along with better corporate transparency and will benefit many parties (Lestari & Asyik, 2017; Sukasih & Sugiyanto, 2017). Under the GCG mechanism, companies are not encouraged only to promote ethics, fairness, transparency and accountability in all their affairs, but also continue to generate profits while maintaining good management standards (Ruangviset & Kim, 2014). The ownership structure was a very useful dimension to explain Corporate Governance (Aguilera & Cladera, 2015). Therefore, in this case the researcher projects GCG components consisting of institutional ownership and public ownership as well as other factors affecting GCG that is the size of the board of independent commissioners. Apart from GCG variables, researchers also examined the firm size relationship to CSR disclosure rates. This is because the size of the company as one of the main determinants of voluntary disclosure, the larger companies will reveal more information (Gisbert & Navallas, 2013).

The CSR disclosure movement has increased since the introduction of IFRS (Bruslerie & Gapteni, 2014; Smith et al., 2014). This is also one of the reasons that encourages researchers to reexamine the impact of Good Corporate Governance and company size on the level of disclosure of Corporate Social Responsibility after convergence IFRS, the year of sample testing starting from 2013 because in that year the number and understanding of IFRS convergence has been more both from the previous year which is the first year of IFRS convergence and empirical study in this research that is all banking companies listed in Indonesia Stock Exchange (BEI), because banking company is a financial institution whose role is quite crucial in economy, besides now many companies that failures and financial crises, financial institutions here can play a more important role in meeting their morale and ethics in achieving goals by engaging more CSR initiatives.

II. LITERATURE REVIEW

1. Agency Theory

Agency Theory proposed by Jensen & Meckling (1976) states that between agents and principal information gaps arise, the agent knows more information about the company than the principal or owner, this is often called the asymmetry of information (Hidayat, 2017). Agency theory can explain why accounting reports can be given voluntarily, it is also related to the separation between owners and supervision. Principal as owner but can only oversee the company without direct down in the management in accordance with the contract made between the principal and the agent.

2. Stakeholder Theory

Stakeholder theory explained the relationship between stakeholders and the information they received (Ningsih, 2017). In this case, the company as an entity that can not be run by itself has responsibility to the internal and external stakeholders. Thus, the stakeholders are: government, competitor companies, local communities, the international environment, outside agencies (NGOs and the like), corporate workers, environmental agencies, etc. whose existence is strongly influenced and influenced by the company (Herawati, 2015). Stakeholder theory can explain related to voluntary disclosure, because the company's need factor to meet its responsibility to stakeholders to disclose more information in order to expose how the company is run has been in accordance with the needs and interests of all parties associated with the company.

3. Signaling Theory

Signal theory suggests how companies should signal to users of financial statements (Fatoni et al, 2016). The company discloses information that can be goodnews, wherein that information can then increase its credibility. The company will disclose information that is not required but may have a positive impact on the company. Signaling theory can explain voluntary disclosure through the impulse to reveal more to external parties as a signal to the capital market that information asymmetry can be suppressed. This will give a good impact, external parties such as investors or creditors will be interested to invest in

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the company, financial costs become low and the value of the company will also increase.

4. Corporate Social Responsibility Disclosure (CSRD)

Corporate social responsibility (CSR) is a globally developed concept and its application has penetrated into all sectors (Maiyarni et al, 2014). Disclosure of CSR communicates the social and environmental impacts of a firm's economic activities on a particular group of interests to the community as a whole (Herawati, 2015). This is done to emphasize the important role of corporate communication in establishing and maintaining communication with multiple stakeholders to encourage ethically and socially responsible actions for various issues. Thus disclosure of CSR will be able to reduce the bad assumption to the company related to the implementation of its responsibilities to stakeholders (shim et al, 2017). Based on this, the company should report all aspects that affect the continuity of the company's operations to the community (Lestari & Asyik, 2015).

5. Good Corporate Governance (GCG)

In this study, researchers projecting Good Corporate Governance of the following three components:

5.1 Institutional Ownership

Institutional ownership is the ownership of the company's shares by financial institutions, such as insurance companies, banks, pension funds, and asset management (Sari et al, 2013). Ownership by institutional investors will encourage more optimal supervision of management performance, since share ownership represents a source of power that can be used to support or otherwise over the performance of management. Institutional investors are generally big shareholders because they have large funding (Sukasih & Sugiyanto, 2017).

5.2 Public Ownership

Public ownership is the proportion of shares owned by the wider community with the management. Public shareholding represents the level of corporate ownership by the public. This variable is indicated by the percentage of shares owned by the public is calculated by comparing the number of shares owned by the public with the total shares of the company in circulation (Rindawati & Asyik, 2015). With the ownership of the public, this will increasingly demand the company to more disclose company information. These demands are also related to the trust or perspectives of shareholders on the performance of the company.

5.3 Board of Independent Commissioner Size

One of the principles of Corporate Governance under the Organization for Economic Cooperation and Development (OECD) is the role of the board of commissioners (Nugraha & Andayani, 2013). Agency theory suggests that conflicts of interest between agents and principals can be reduced by proper supervision. The existence of an independent board of commissioners will improve the quality of supervisory functions within the company. the greater the independent board of commissioners shows better supervisory function.

6. Company Size

Company size is a measure of the size of a company (Susilo & Mildawati, 2015). A benchmark indicating the size of the firm is total sales, average sales rate, and total assets (Sari et al, 2013). But in this study, the indicator used to measure the level of firm size is total assets. The size of the company as one of the main determinants of voluntary disclosure, larger companies will reveal more information (Gisbert & Navallas, 2013).

7. Hypotheses

7.1 Relationship between Institutional Ownership of Corporate Social Responsibility Disclosure

The existence of corporate stock ownership by the institutional is expected to influence the management of the company in the disclosure of financial performance report and corporate social responsibility report. The higher level of corporate stock ownership by the institutional then it is expected that the higher performance of financial performance is revealed and the more expansive the disclosure of corporate social responsibility report. The results of Sari, Sutrisno, & Eko (2013) and Sukasih & Sugiyanto (2017) stated that institutional ownership significantly influences CSR disclosure level. Therefore, the following hypotheses are tested:

H1 : Institutional ownership has a positive effect on corporate social responsibility disclosure

7.2 Relationship between Public Ownership of Corporate Social Responsibility Disclosure

Public ownership factors can improve control of management and reduce self-serving behavior that may be possible (Agustia, 2013). Other results suggest that public ownership is most influential on the disclosure of Corporate Social Responbility This shows the greater the public ownership the greater the disclosure of the wider social information in order to improve the company

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image (Fatoni et al., 2016). Therefore, the following hypotheses are tested:

H2 : Public ownership has a positive effect on corporate social responsibility disclosure

7.3 Relationship Independent Board of Commissioners on Corporate Social Responsibility Disclosure

The existence of an independent board of commissioners will improve the quality of supervisory functions within the company. the greater the independent board of commissioners the better the supervisory function will be. The results of Agustia (2013) and Lamia, Zirman, & Yuneita (2014) stated that the size of the commissioners influences CSR disclosure. Therefore, the following hypotheses are tested:

H3 : Board of Independent Commissioner Size has a positive effect on corporate social responsibility disclosure

7.4 Relationship Corporate Size on Corporate Social Responsibility Disclosure

The size of the company as one of the main determinants of voluntary disclosure, larger companies will reveal more information (Gisbert & Navallas, 2013). Although the results of the Maiyarni (2014) study suggest that there is no firm size effect on CSR, other research results suggest that firm size has a significant positive effect on CSR (Alen, 2013; Hidayat, 2017, Rofiqkoh & Priyadi, 2016; Santoso et al., 2017). Therefore, the following hypotheses are tested:

H4 : Company size has a positive effect on corporate social responsibility disclosure

III. RESEARCH METHOD

1. Population and Sample

The population in this study is all listed banking companies (registered) in Indonesia Stock Exchange period 2013 - 2016. The total population in this study as much as 43 the company according to updated data August 04, 2017. Sampling used purposive sampling method. The number of samples meeting the criteria in this study were 19 companies later multiplied by the number of years of research period resulting in 76 observational studies.

2. Variable

There are 5 variables in this study, the dependent variable is the level of CSR disclosure and four independent variables such as institutional ownership, public ownership, size independent board of commissioners and company size. In this study the calculation of the index using items that have been used previously. Checklist is done by looking the disclosure of corporate social responsibility covers in seven categories, among others:

environment, energy, health and safety of labor, etc. labor, products, community involvement, and public. This category is adopted from research conducted by Hackston & Milne (1996). The seven categories are divided into 90 items of disclosure. Based on Bapepam Regulation No. VIII.G.2 regarding annual report and the suitability of the item to be applied in Indonesia then adjusted to the remaining 78 items of disclosure. Because the banking industry is not directly related to some categories, it is within this study has been selected as many as 42 items (nj = 42) that have been modified from the study of Goddess & Priyadi (2013). Briefly the measurement of variables as follows:

$$\text{Corporate Social Responsibility} = \frac{\sum Xij}{Nj} \quad (1)$$

$$\text{Institutional Ownership} = \frac{\text{Number of shares owned by the institution}}{\text{Number of shares outstanding}} \text{ x } 100\% \quad (2)$$

$$\text{Public Ownership} = \frac{\text{Number of shares owned by the public}}{\text{Number of shares outstanding}} \text{ x } 100\% \quad (3)$$

$$\text{Board of Independent Commissioner} = \frac{\text{Number of independent commissioners}}{\text{Number of commissioners}} \text{ x } 100\% \quad (4)$$

$$\text{Company Size} = \text{Ln (total assets)} \quad (5)$$

3. Analysis Method

Hypothesis testing in this research will be done by using regression model linear multiple, where in the regression analysis will be tested the influence between variables, institutional ownership, public ownership, independent board size and size company. Hypothesis test (Coefficient of Determination, Test Statistic F, Test Statistic t) against

disclosure of corporate social responsibility. But before testing the hypothesis, it will be done first classical assumption test which includes normality test, multicollinearity test, test heteroscedasticity and autocorrelation tests. Multiple linear regression models are shown in the equation following:

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$$CSRIit = \alpha + \beta 1IOit + \beta 2POit + \beta 3BICit + \beta 4CZit + \beta 4IOPOBICCZ + e$$

IV. RESULTS AND DISCUSSIONS

1. Normality Test

In this study the normality test was performed by Kolmogorov Smirnov test. The data we can say normal if the test significance value is greater than 0.05. The result of SPSS Ver 23.0 processing is obtained by processed data of Kolmogrof Smirnov with unstandardized model got significance value > 0,05 that is equal to 0,889 (Asymp. Sig) meaning data is normally distributed.

2. Multicollinearity Test

The multicollinearity test can be tested using tolerance values and VIF values. There is no multicolinearity if the tolerance values of all variables are greater than 0.1 and if the VIF value of all the variables is less than 10. This research has Tolerance value less than 0,100 > 0,100 and VIF <10 means there is no correlation between independent variables. Thus it can be said that there is no multicollinearity.

3. Heteroscedasticity Test

In this research, heteroskedastisitas test using Glejser test. By the criteria that if the result is greater than 0.05 then this indicates no symptoms of heteroscedasticity. This research can be proved that the significance level of Institutional Ownership variable of 0.524; Public Ownership variable is 0,683; Independent Size Board of Commissioner variable of 0.178; and the Company Size variable of 0.443, where all the variables are greater than 0.05. Thus the regression model in this study does not occur heteroskedastisitas problem.

4. Autocorrelation Test

Autocorrelation test in this research is done by using Test Runs Test. If the value of Asymp.Sig. (2tailed) greater than 0.05 then there is no autocorrelation problem. The result shows Asymp. Sig. of 0.065 > 0.05, this means that the data used is quite random and there is no problem autokorelasi.

5. Hypothesis Testing

5.1 Determination Coefficient Test

The value of Adj R Square is 0.485 which means that the dependent variable which can be explained by independent variable is 48.5% which is the contribution of the firm size variable, the size of the independent board of commissioner, the public ownership and the institutional ownership of CSR disclosure and the rest of 51,5% influenced by other variable not examined in this research.

5.2 Statistical t Test (t Test)

The result of t test of research variable is as follows:

• Variable Coefficient Tests X1 (Institutional Ownership)

From the test results of Institutional Ownership (IO) variables have t count> t table (8,447> 1,669), and significance (0,00 <0,05), hence, it can be concluded that Institutional Ownership (IO) is partially positive and significant to CSR disclosure on banking sector companies listed on the Indonesia Stock Exchange (IDX) period 2013-2015. So the results of this study in line with the hypothesis that the ownership of the institution have a positive effect on CSR disclosure (H1 accepted).

• Coefficient Tests of Variables X2 (Public Ownership)

From the result of examination of the variable of Public Ownership (PO) has t value> t table (2,633> 1,669), and significance (0,010 <0,05), hence, it can be concluded that Public Ownership (PO) partially positively and significantly influence to disclosure CSR in the banking sector companies listed on the Indonesia Stock Exchange (IDX) period 2013-2015. So the results of this study in line with the hypothesis that says that public ownership positively affect the disclosure of CSR (H2 accepted)

• Variable Coefficient Testing X3 (Board of Independent Commissioner)

From the test results of Board of Independent Commissioner (BIC) variables have t count <t table (0,876 <1,669), and significance (0,384> 0,05), hence, it can be concluded that Board of Independent Commissioner (BIC) to the disclosure of CSR to the banking sector companies listed in Indonesia Stock Exchange (IDX) period 2013-2015. So this result is not in line with statement of hypothesis of this research which states that the size of independent board of commissioner positive effect on disclosure of CSR (H3 rejected). However, this result is in line with Sha (2014) study stating there is no influence between the size of the independent board of commissioners and the level of CSR disclosure.

• From the result of the test of variable of Company Size (LNZISE) has t value> t table (3,503> 1,669), and significance (0,001 <0,05), hence, it can be concluded that Company size (LNZISE) partially have positive and significant to CSR disclosure to banking sector

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companies listed in Indonesia Stock Exchange (IDX) period 2013-2015. So this result is in line with statement of research hypothesis that size companies have positive influence on CSR disclosure (H4 accepted).

5.3 F Test

The results can be seen that the value of sig 0.000 where the value is smaller than the value siginifikansi 0.05 and the value of F arithmetic 18.658> 2.50 Thus it can be concluded that the variable Ownership Institution, Public Ownership, Size of Board of Independent Commissioners and Company Size influence positive and significant simultaneously or collectively to CSR Disclosure on the annual report of the banks listed on the Indonesia Stock Exchange 2013-2016. These results support the hypothesis that Institutional Ownership, Public Ownership, Size of Board of Independent Commissioners and Company Size affect simultaneously to CSR disclosure (H5 accepted).

V. CONCLUSION

Based on the results of the analysis of research data, it can be concluded that the ownership of Institution, Public Ownership and Corporate Size partially have a positive and significant impact on CSR disclosure in banking sector companies listed in Indonesia Stock Exchange period 2013-2016. this means the greater the shares owned by the company and the public then the level of CSR disclosure also increased. Likewise with the size of the company, the greater the company's CSR disclosure is also increased. Size of Board of Independent Commissioner variable has no effect on CSR disclosure level. This means that the number of independent boards does not necessarily encourage the company to increase its CSR disclosure. However, simultaneously all the variables in this study have a significant influence on the level of CSR disclosure.

Increased CSR activity can provide a good image of the company. The more disclosure of CSR gives the company an assessment that the company's management is good, because the company's need factor to meet its responsibility to stakeholders to disclose more information in order to expose how the company is run has been in accordance with the needs and interests of all parties associated with the company. Based on the results of the research and the conclusion above, the research has practical implications. This research can contribute to the company that the results of this research can be input to understand what factors influencing corporate social disclosure in the banking sector, because the results of this study found that the ownership of institutions and the public and the size of the company in line with the level of CSR disclosure. Thus, corporate management in terms of ownership of public institutions and the higher the disclosure of CSR also increased. Various parties such as investors and creditors can predict the level of CSR disclosure of a company in the future by looking at the relationship between variables on CSR disclosure in this study.

Limitations in this study first lies in the sample used in this study only focused on the banking sector listed in Indonesian securities, so the conclusions generated from this research can not be generalized in other industrial sectors. Second, Adj R Square's result of this research is 48.5% of the variables used in this study namely the ownership of the institution, the public ownership, the size of the independent board of commissioners and the size of the company, so that there are 51.5% other variables that affect the index of completeness of voluntary disclosure annual report of the bank but not contained in this study. For further research it is advisable to involve all industry sectors and can multiply other variables such as audit committees, managerial ownership, listing age and other variables that may affect CSR disclosure so that results can be better.

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Impact of Rice Tariffication Law in selected Rice Farmers in Nueva Ecija, Philippines

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Abstract— *This paper discussed the impact of rice tariffication law in selected farmers in a certain barangay in Nueva Ecija, Philippines. The descriptive method of research was utilized and the questionnaire served as the instrument for collecting data.*

Findings showed that the initial impact of the law that had already experienced by the selected farmers was the declining farm gate prices of "palay". This situation affected their income and livelihood. Despite this problem, most of the farmers responded that they would continue in rice farming because this is the only way they know how to earn a living. As initial support from the government, most of the respondents received free certified inbred seeds and availed rice credit assistance with minimal interest rates. Additionally, they were given trainings to enhance their skills and knowledge of rice production.

Keywords— ***Agriculture, rice farmers, rice production and rice tarrification law.***

I. INTRODUCTION

Tariffs and quantitative restrictions (QRs) are two policy instruments used in dealing with the international trade of goods. Tariffs are the taxes imposed by the government on both imported and exported products, while quantitative restrictions (QRs) are measures such as quotas, bans, and licensing requirements imposed by the government to limit the volume of a particular commodity that enters the country [1].

The Philippines acceded to the World Trade Organization (WTO) in 1995. Under the agreement on agriculture, QRs and other protective measures that may distort free trade will be removed and replaced by reduced tariff rates. Rice was, however, exempted from the removal of QR because of food security issues [2]. The Philippine requested QR on rice imports until 2005 but was extended until 2012 and then extended again until June 30, 2017. For several years, the government has adhered to rice QRs in protecting the local rice industry and to prepare the local farmers to become competitive in the world market.

As trade liberalization is being pushed through, the Philippine rice industry bears the impact of global competition. Liberalizing trade means loosening the restrictive measures to a certain degree to ease the flow of goods and services in and out of the country [3]. After 24 years since the membership of the Philippines with WTO, QRs on rice imports have finally been lifted through the passage ofRA 11203 (An Act Liberalizing the Importation, Exportation and Trading of Rice, Lifting for the Purpose the Quantitative Import Restriction on Rice, and for Other Purpose) also known as the Philippine Rice Tariffication Law which took effect on March 5, 2019. The law essentially allows for the liberalization of rice imports. This removes the previously placed quota and replaced with higher tariffs on rice imports, permitting traders to import a near-unlimited quantity of rice [4]. The new law provides the following tariff rates: 35% for rice imports originating from Association of Southeast Asian Nations (ASEAN) member states; 40% for rice imports originating from non-ASEAN countries and within the minimum access volume (MAV) of 350,000 metric tons; 180% for rice imports originating from non-ASEAN countries and above the MAV [5].

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The law provides safety net measures for local farmers underthe Rice Competitiveness Enhancement Fund (RCEF) which is expected to help and support the rice farmers to cope up with the liberalization of the rice market. The government will allocate P10 billion annually for the next six years to support the Filipino rice farmers and this will be assessed after the first three years of its implementation. The P10-BRCEF will be allocated and disbursed as follows: 50% for rice farm types of machinery and equipment, 30% for rice seed development, propagation and promotion, 10% for expanded rice credit assistance and10% for rice extension services. The law provided furthermore that tariff revenues in excess of the P10 billion will be earmarked for the following: rice farmer financial assistance, titling of agricultural rice lands, expanded crop insurance program on rice and crop diversification program. In addition, the NFA will buy rice exclusively from local farmers for its buffer stocking mandate for emergencies and disaster relief [5].

Even though the government gives assurance that proper implementation and measures will be put in place, rice farmers are still concerned that tariffication law would hurt them and the local rice industry in the long term. The objective of this study is to determine and analyze the impact of rice tariffication law on selected rice farmers in Nueva Ecija, Philippines.

II. MATERIALS AND METHODS

The study utilized the descriptive method of research and used the quotasampling technique in selecting respondents in a certain barangay in Nueva Ecija, Philippines. Based on the 2018 socio-economic profile of the Brgy, 515 households are engaged in rice farming. The researchers selected 10% of the total population as sample size which consists of 52 respondents. The data were collected using structured questionnaires and were analyzed and interpreted using statistical tools such as frequency and percentage. The study also utilized secondary data from the Philippine Statistics Authority (PSA).

III. RESULTS AND DISCUSSION

A. Profile of the respondents

Based on the gathered data, 81% of the respondents are male, 52% belong to ages more than 50 years old, 40% are elementary graduates, 38% are with the farming experience of 31-40 years, 60% belong to a household with 1-5 members, 58% are with farm areas of 1-3.99 hectares, 35% are marginal farmers with farm area below 1 hectare and source of farmland were mostly inherited (42%) and rented (42%).

In addition, 69% is currently a member of eligible farmer association or registered rice cooperative and 94% are currently enlisted to Registry System for Basic Sectors in Agriculture (RSBSA) which are requirements to become eligible farmer-beneficiaries and to access RCEF programs.

B. Awareness of the Respondents

Table 1. Awareness of the Respondents in the Rice Tarrification Law

Particulars		Frequency		Percentage		Total	
		Yes	No	Yes	No		
1	Are you familiar with Rice Tariffication Law?	42	10	81%	19%	52	100%
2	Are you well-informed about the law and how it will be implemented?	16	36	31%	69%	52	100%
3	Are you in favor of Rice Tariffication Law?	0	52	0%	100%	52	100%
4	Do you think the assigned government agencies can effectively and efficiently implement the RCEF programs?	33	19	63%	37%	52	100%
5	Do you think the RCEF programs will really help you to improve your yield and income?	32	20	62%	38%	52	100%
6	Do you think we can really compete with cheap rice imports?	19	33	37%	63%	52	100%

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Table 1 presents the awareness and perception of the respondents about RTL. Based on the gathered data, 81% of the respondents are familiar with the newly enacted law but 69% said that they have little knowledge about the law and how its implementation. According to them, they are not well-informed about the law and they only heard some information from other farmers and news from Television and social media sides.

All farmers responded that they were not in favor of the newly enacted law. Because they believed that it is the main reason for declining palay prices.

Meanwhile, 63% of the respondents agreed that the government agencies are effective and efficient in implementing RCEF programs and 62% of respondents are believing and hoping that RCEF programs will help to increase their yield and income.

On the other hand, 63% of the respondents believed that it would be hard for them to compete with the cheaper price of imported rice and they also believed that it will take time before they can cope up with the liberalized rice market. Imported rice is cheaper than domestically produced rice. The reason behind this price gap is because the palay production in the Philippines is costlier as compared to the major rice exporting countries such as Vietnam and Thailand. For instance, palay production in the Philippines costs 90 percent higher than in Vietnam. The Philippines produces palay at Php. 12.41 per kg and milled rice at Php. 19.24 per kg, while Viet Nam's cost is only Php. 6.53 per kg and Php. 9.92 per kg respectively [6].

C. Impact of RTL

Table 2. Impact of Rice Tariffication Law to the Farmers

Particulars		Frequency		Percentage		Total	
		Yes	No	Yes	No		
1	Do you already experience the effect of Rice Tariffication Law?	52	0	100%	0%	52	100%
2	Is the effect of the said law being good to your livelihood?	0	52	0%	100%	52	100%
3	Do you think the law helps in bringing down the price of milled rice in the market?	16	36	31%	69%	52	100%
4	Do you still want to continue in farming rice?	43	9	83%	17%	52	100%
5	Are the government programs under RCEF already reached you?	37	15	71%	29%	52	100%
	Free usage of rice farm types of machinery and equipment given to eligible farmers association and registered rice cooperative	0	52	0%	100%	52	100%
	Free certified inbred seeds	48	4	92%	8%	52	100%
	Rice credit assistance with minimal interest rates & minimum collateral requirements	32	20	62%	38%	52	100%
	Trainings for skills on rice crop production, modern rice farming techniques, seed production, farm mechanization and knowledge/technology transfer	13	39	25%	75%	52	100%

Table 2 presents the impact of rice tariffication law to the respondents. According to the respondents, they already experience the initial effect of the law and 100% responded that it has a negative effect on their life because it drastically brought down the prices of palay. While the farm gate prices of palay are continuously declining, the prices of farm inputs that they are using are costly. Reduction in palay prices negatively affects the income of the farmers, most especially the small farmers. According to data from [7], the average palay production cost per kilogram in 2017 was Php. 12.42 and the average farmgate price of dry palay were Php18.21. With this cost and price,

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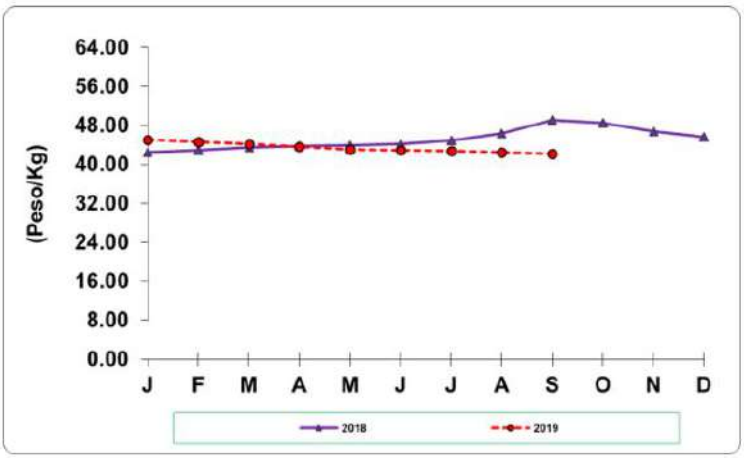
farmers earned a profit percentage of 46. 62%. If the farmgate price will decrease to Php. 12.44 per kg as projected by [8], the farmers must decrease their production cost to Php. 6.65 per kg to earn the same level of percentage profit. Though this profit margin is still too narrow to make economic sense to farmers.

Moreover, 69% of the respondents believed that the law is not helping in bringing down the prices of milled rice in the market. According to data from [9], this year's average retail price of rice from January to September 2019 was ₱43.47 per kilogram. This was lower by 2.5 percent from the previous year's level of ₱44.58 per kilogram. The monthly retail prices during the period were lower than their respective levels in 2018 except for the first three months of 2019 (Figure 1).



Monthly Retail Prices for Rice
Philippines, January 2018 - September 2019

Source: PSA

Figure 1

Despite the declining prices of palay, 83% of the farmers responded that they will continue to be rice farmers because this is the only way for them to earn a living for their family. The declining farmgate prices of palay can possibly affect the future decisions of farmers to continue on rice farming and if that happens there is a possibility that it will affect the supply of local rice in the country.

As to the implementation of safety net measures or the RCEF programs, rice farm types of machinery and equipment are not yet given to eligible farmers' association and registered rice cooperative. Meanwhile, 92% of the respondents already received free certified inbred seeds, 62% already availed rice credit assistance with minimal interest rate and 25% already attended trainings to enhance their skills and knowledge on rice production.

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D. 2019 Dry Season and Wet Season Farmgate prices of fresh palay

Table 3. 2019 DS and WS Farmgate Prices of Fresh Palay

T									
Prices (Pesos)	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00
Frequency			1	1	2	2	10	17	19
Percentage	0%	0%	2%	2%	4%	4%	19%	33%	37%
Total	52 = 100%								
2019 WS Farmgate Prices for Fresh Palay									
Prices (Pesos)	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00
Frequency	2	4	30	10	4	0	2	0	0
Percentage	4%	8%	58%	19%	8%	0%	4%	0%	0%
Total	52 = 100%								

Table 3 shows the 2019 DS and WS farmgate prices of fresh palay. Based on the gathered data during the 2019 DS, 37% of the respondents were able to sell their harvested palay at P18.00 and the lowest selling price was P12.00.

During the 2019 WS, 58% of the respondents were able to sell their harvested palay at P12.00 and the lowest selling price was P10.00

According to data of [9], the average farmgate price of palay from January to September 2019 was ₱18.27 per kilogram. This was 13.1 percent lower than the previous year's average price of ₱21.02. The monthly average farmgate prices per kilogram of palay showed a decreasing trend during the period, from ₱19.84 in January 2019 to ₱16.05 in September 2019 (Figure 2).

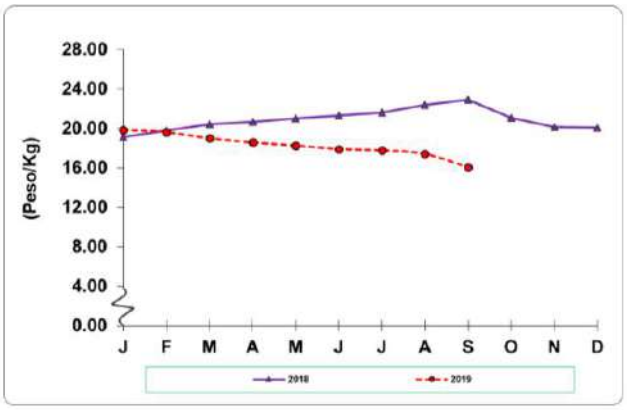

Figure 2

IV. CONCLUSIONS AND RECOMMENDATIONS

Most of the respondents are familiar with rice tariffication law but they have little knowledge of how it works and how its implementation. According to them, they are not well-informed about the law and they only heard some information from other farmers and news from television and social media sites [10]. All of them responded that they are not in favor of the newly enacted law. The initial impact of the law was the declining farmgate prices of palay. Reduction in palay prices negatively affects the income of the farmers, especially the small farmers. Based on PSA data, it can be noted that there was a big difference in percentage change or reduction in

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the average farmgate price of palay and the average retail price of rice. The average farmgate price of palay was drastically declined while the average retail price of rice was hardly moved. Despite the declining prices of palay, they still want to continue in rice farming because this is the only way for them to earn a living for their family. The declining farmgate prices of palay can possibly affect the future decisions of farmers to continue on rice farming and if that happens there is a possibility that it will affect the supply of local rice in the country. Most of the respondents already received support from the RCEF programs of the government such as free certified inbred seeds, availed rice credit assistance with minimal interest rate and attended trainings to enhance their skills and knowledge on rice production.

It is recommended to encourage all farmers, especially the small farmers, to become a member of eligible farmer association or registered rice cooperative and to enlist to Registry System for Basic Sectors in Agriculture (RSBSA) for better access to information, agriculture-related programs and services of the government. In addition to the support from the government, rice farmers must consider diversifying their crops to improve their income. Likewise, they should be provided with the mostappropriate solutions which aimed to reduce their difficulties[11] in rice framing[12].Lastly, the government should provide the farmers with needed assistance and should undergo training to ensure their development [13] as cited in [14].

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Stability Enhancement of Pleiku Power System using a Distribution Static Synchronous Compensator (D-STATCOM)

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Abstract**—** *This paper presents the simulation results of using a static synchronous compensator (D-STATCOM) based on voltage source converter (VSC) to enhance voltage stability and improve the stability of the actual Pleiku Power System. The PI controller based D-STATCOM is applied to stabilize and improve voltage waveforms at load buses in the studied power system under three-phase short circuit fault. Simulation results in a time domain are presented to show effectiveness of using the D-STATCOM for stability and improvement of voltage quality when small disturbances occur, and of enhancing voltage magnitude, mitigating voltage oscillation in transient conditions under a severe disturbance in the power system.*

Keywords**— *D-STATCOM, VSC, PI.***

I. INTRODUCTION

In recent years, power engineers are increasingly concerned over the stability of the electrical power. Presently in modern industries, load equipment uses electronic controllers which are sensitive to poor voltage quality and will shut down if the supply voltage is and may mal-operate in other ways if harmonic distortion of the supply voltage is excessive. Many efforts have been taken by utilities to fulfill consumer requirement, some consumers require a level of power quality higher than the level provided by modern networks of electricity. It shows that some measures must be taken in order to achieve higher levels of power quality. The Facts devices and Custom power devices are introduced to electrical system to improve the power quality of the electrical power. DVR, STATCOM/D-STATCOM, ACTIVE FILTERs, UPFC, UPQC etc are some of the devices used to improve the power quality of the current and voltage. By the help of these devices we are able to reduce the problems related to power quality. Under this work, among the different custom power devices D-STATCOM has been used to improve the quality of power under different conditions. The general theory about the D-STATCOM operation and its main components is discussed in next part.

D-STATCOM [1] is a voltage source converter (VSC) that is connected in shunt with the distribution system by means of a tie reactance connected to compensate the load current. In general, a coupling transformer is installed between the distribution system and the D-STATCOM for isolating the D-STATCOM from the distribution system. In addition, the device needs to be installed as close to the sensitive load as possible to maximize the compensating capability. Being a shunt connected device, the D-STATCOM mainly injects reactive power to the system.

The role of D-STATCOM is specifically appreciated in case of a weak AC system [2].

Application of D-STATCOM in distribution systems has gained considerable attention. While [3] discusses the dynamic performance of a D-STATCOM coupled with an energy storage system (ESS) for improving the power quality of distribution systems, [4] presents a study about the influences of a D-STATCOM on the dynamic behavior of distribution networks. The performance of a D-STATCOM as a voltage controller or a power factor controller is analyzed in [4].

To provide this voltage support, a D-STATCOM is connected to the micro-grid in [5]. It is well known that a D-STATCOM can provide reactive power support in normal operation. However, it can release the energy stored in it dc capacitor during transients to provide ride through to facilitate load shedding. In [5], the effect of sudden power loss is investigated with and without the D-STATCOM connection. A representative example of D-STATCOM is given in [6]. The goal of this paper is to investigate the main impacts of D-STATCOM on the

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stability performance and protection system of a distribution network. The simultaneous usage of ac generators and D-STATCOM devices is analyzed. The stability studies were carried out using the phasor solution method for network representation, and electromagnetic (EM) transient analysis was employed in the protection studies.

This paper is organized as follows; section 2 presents D-STATCOM model. In section 3, Strategy of controlling D-STATCOM is also carried out in this Section. Then, in section 4 simulation results of D-STATCOM with PI controller in studied system are proposed. Finally, conclusion is discussed in 5.

II. THE D-STATCOM SYSTEM CONFIGURATION AND MODELLING

The structure of D-STATCOM along with its operating modes is shown in Fig. 1. The main components of D-STATCOM are – a VSC (voltage source converter), controller, filter, and energy storage device. The system scheme of D-STATCOM is shown in Fig. 2. These are briefly described as follows:

Isolation transformer: It connects the D-STATCOM to the distribution network and its main purpose is to maintain isolation between the D-STATCOM circuit and the distribution network.

Voltage source converter: A voltage source converter consists of a storage device and devices of switching, generating a sinusoidal voltage at any required frequency, magnitude and phase angle. In the D-STATCOM application, this temporarily replaces the supply voltage or generates the part of the supply voltage which is absent and injects the compensating current into the distribution network depending upon the amount of unbalance or distortion. In this work, an IGBT is used as the switching device.

DC charging unit: This unit charges the energy source after a compensation event and also maintains the dc link voltage at the nominal value.

Harmonic filters: The main function of harmonic filter is to filter out the unwanted harmonics generated by the VSC and hence, keep the harmonic level within the permissible limit. Energy storage unit: Energy storage units like Flywheels, batteries, superconducting magnetic energy Storage (SMES) and super capacitors store energy. It serves as the real power requirements of the system when D-STATCOM is used for compensation [3].

In case, no energy source is connected to the DC bus, then the average power exchanged by the D-STATCOM is zero assuming the switches, reactors, and capacitors to be ideal.

Fig. 3 represents the schematic scheme of D-STATCOM in which the shunt injected current Ish corrects the voltage sag by adjusting the voltage drop across the system impedance Zth and value of Ish can be controlled by altering the output voltage of the converter [4].

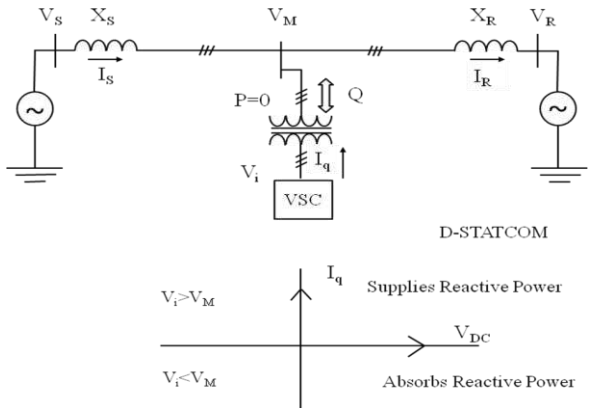

Fig. 1: Structure and operating modes of D-STATCOM

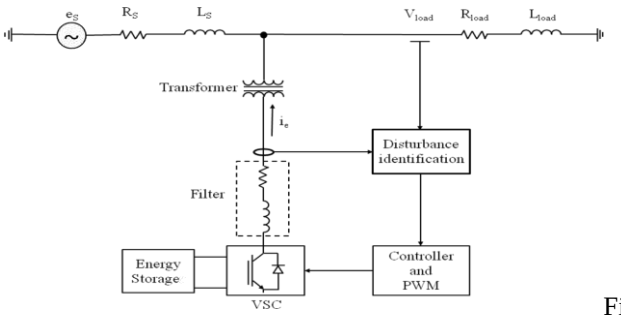

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Fig. 2: System scheme of D-STATCOM

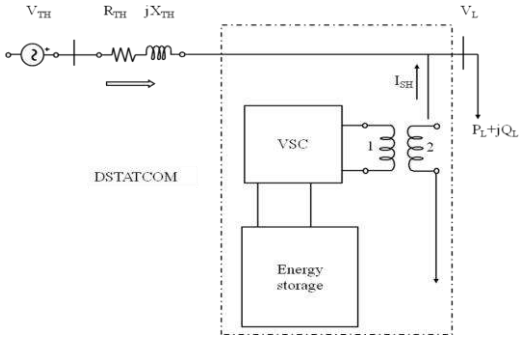

Fig. 3: Schematic diagram of D-STATCOM

The effectiveness of the D-STATCOM in correcting the fault depends on the value of Zth or fault level of the load bus. When the shunt supplied current Ish is set in quadrature with VL, the desired correction of voltage can be achieved without injecting any active power into the system. Alternatively, when the value of Ish is decreased, the same correction of voltage can be achieved with minimum apparent power injection into the system. The

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contribution of the D-STATCOM to the load bus voltage equals the injected current times the impedance seen from the device also, that is the source impedance in parallel with the load impedance. The ability of the D-STATCOM to compensate the voltage dip is limited by this available parallel impedance. It helps to reduce the voltage fluctuations at the PCC (point of common coupling) [5], [6]. Voltage dips can be mitigated by D-STATCOM, which is based on a shunt connected voltage source converter. VSC with pulse-width modulation (PWM) offers fast and reliable control for voltage dips mitigation. The topology of the D-STATCOM connected at distribution level is shown in Fig. 4. In the proposed model, the application of D-STATCOM to improve the power quality in a distribution network with Single Line to Ground (SLG) fault and Double Phase to Ground (DPG) fault and three-phase fault is investigated.

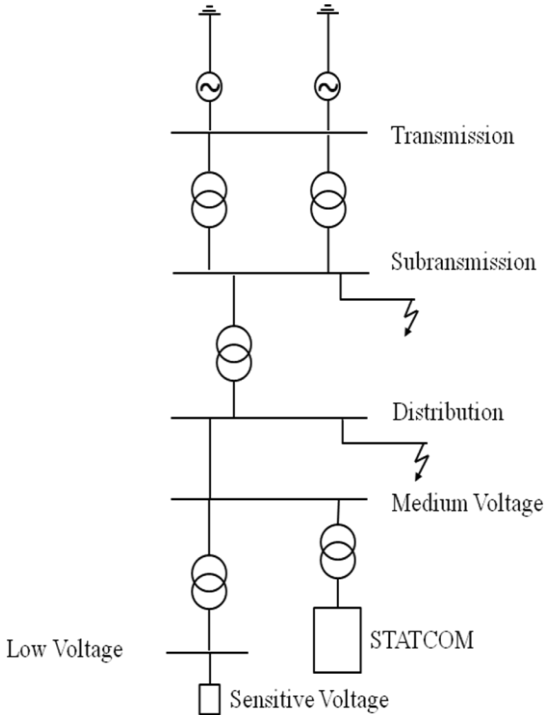

Fig. 4: Topology of the power system with D-STATCOM

III. STRATEGY OF CONTROLLING D-STATCOM

The output voltage of the GTO converter (Vi) is controlled in phase with the system voltage (Vs), as shown in this Fig. 5, and the output current of the STATCOM (I) varies depending on Vi. If Vi is equal to Vs, then no reactive power is delivered to the power system. If Vi is higher than Vs, the phase angle of I is leading with respect to the phase angle of Vs by 90 degrees. As a result, leading reactive power flows from the STATCOM (capacitive mode). If Vi is lower than Vs, the phase angle of I is lagging with respect to Vs by 90 degrees. As a result, lagging reactive power flows into the STATCOM (inductive mode). The amount of the reactive power is proportional to the voltage difference between Vi and Vs. Note that this is the same basic operating principal as a rotating synchronous condenser. Working and V-I characteristic of the STATCOM is shown in Figs. 6-7.

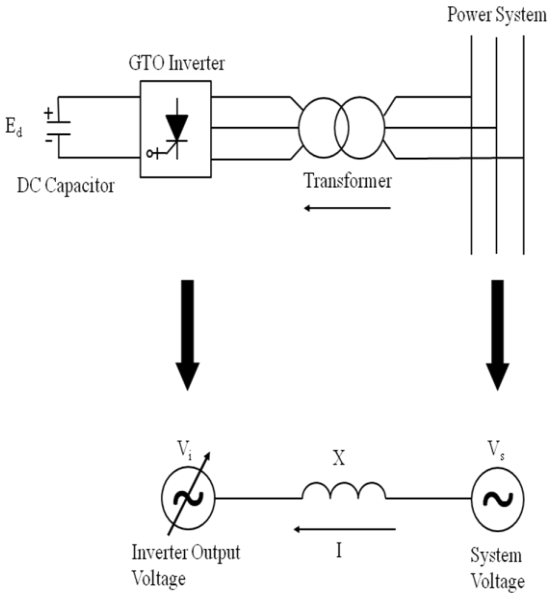

Fig. 5: Control strategy of D-STATCOM

The D-STATCOM smoothly and continuously controls voltage from V1 to V2. However, if the system voltage exceeds a low-voltage (V1) or high-voltage limit (V2), the STATCOM acts as a constant current source by controlling the converter voltage (Vi) appropriately. Thus, when operating at its limits of voltage, the quantity of reactive power compensation provided by the STATCOM is more than the most-common competing FACTS controller, namely the Static Var Compensator (SVC).

IV. D-STATCOM WITH PI CONTROLLER IN PLEIKU POWER SYSTEM

Fig. 8 shows the test system implemented in MATLAB/SIMULINK to carry out simulations for the D-STATCOM. In this test model, outgoing feeder with two major loads is Nam Hoa (selling electricity through low-voltage grid) and Nutifood (sold electricity through medium-voltage grid) which is two typical loads according to the voltage level of outgoing feeder.

Suppose that in the case of placing the D-STATCOM device (22kV, +/- 1Mvar) at the Nutifood node and assuming a short-circuit problem at this node and Nam Hoa

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node [7-11]. D-STATCOM simulation model as shown in Fig. 9.

The comparative transient responses of the studied system with D-STATCOM (presented as blue lines) and without D-STATCOM (presented as red lines) when a three phase fault is simulated at Nam Hoa bus at t= 0.05 sec. and cleared after 0.01 sec are plotted in Figs. 10-18.

From these results, it shows that with D-STATCOM, the load bus as well as the capacity of the line are significantly improved when a three-phase short-circuit occurs.

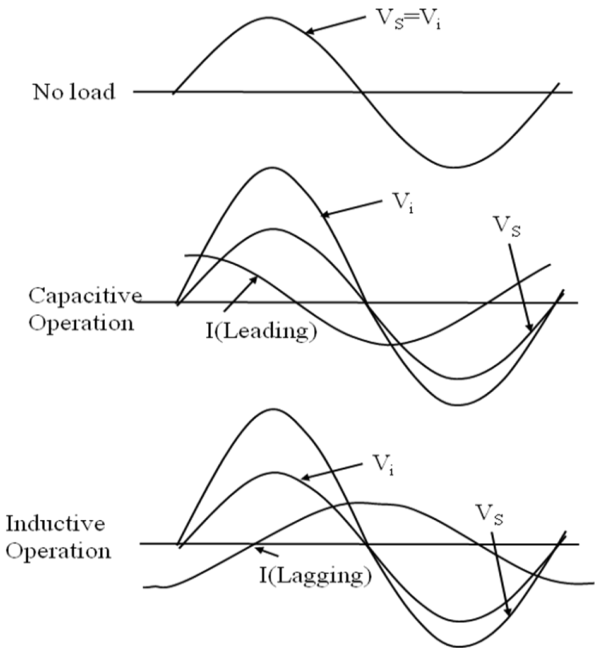

Fig. 6: Working of D-STATCOM

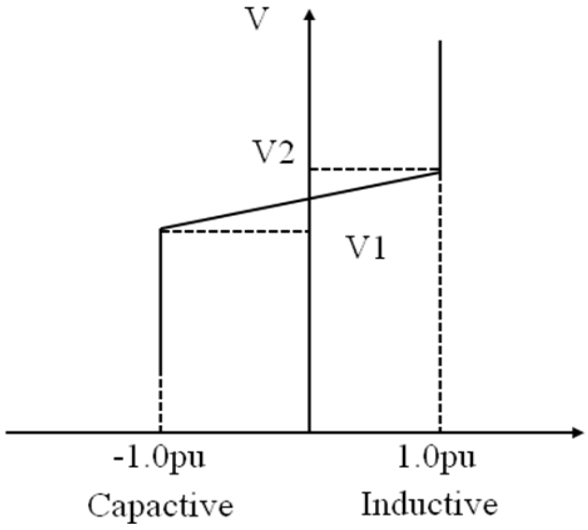

Fig. 7: V-I characteristic of D-STATCOM

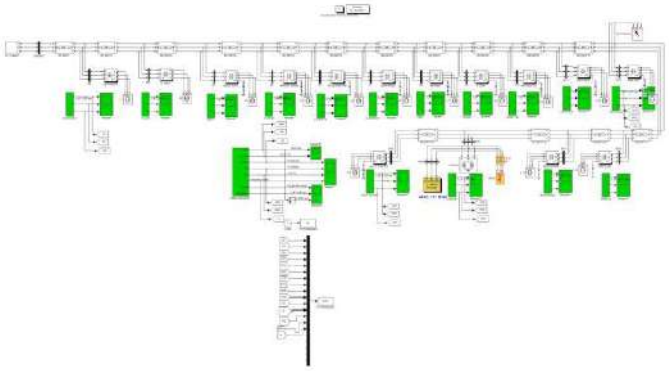

Fig. 8: Simulink model of test system with DTATCOM

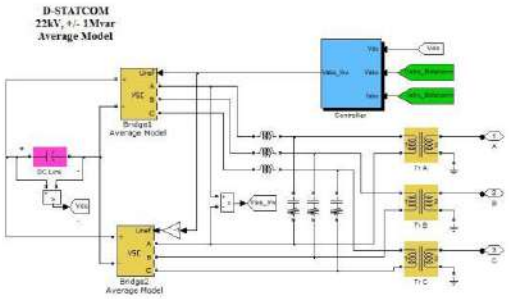

Fig. 9: D-STATCOM simulation model.

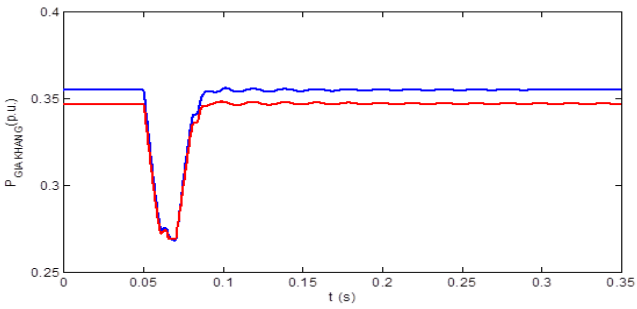

Fig. 10: Gia Khang line active power

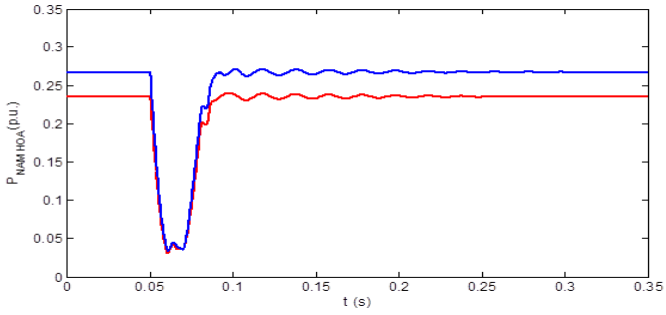

Fig. 11: Nam Hoa line active power

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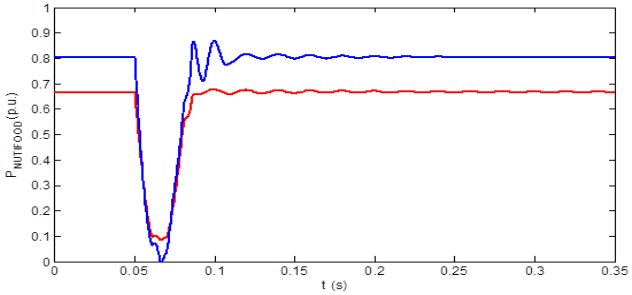

Fig. 12: Nutifood line active power

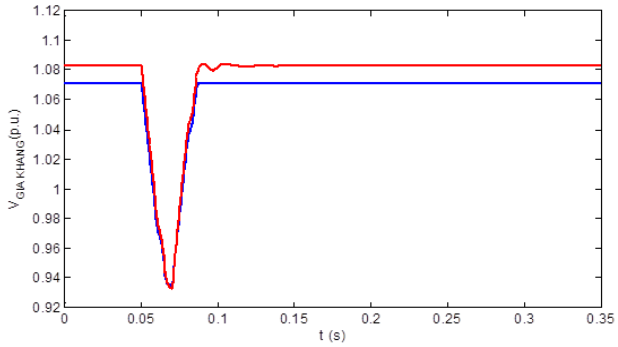

Fig. 13: Gia Khang bus voltage

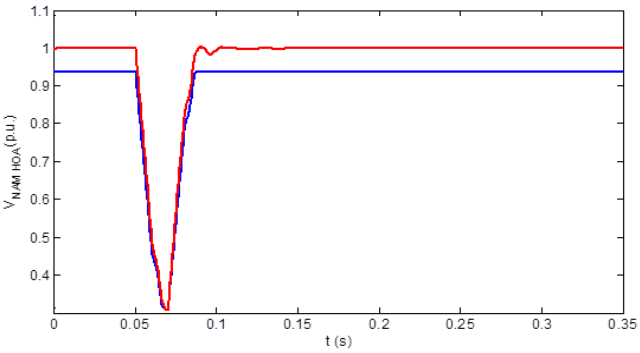

Fig. 14: Nam Hoa bus voltage

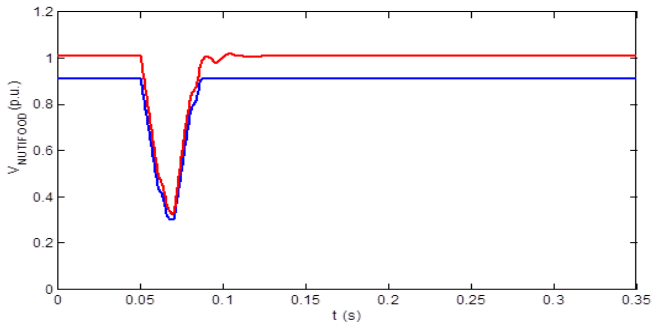

Fig. 15: Nutifood bus voltage

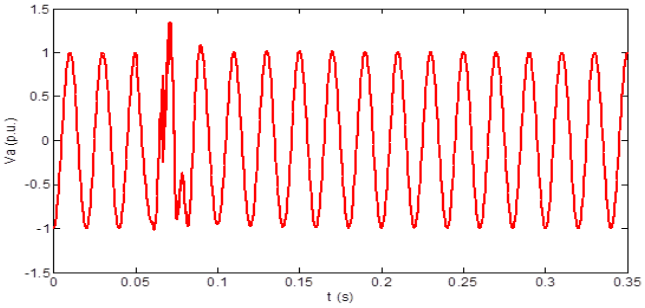

Fig. 16: Reactive power response of D-STATCOM.

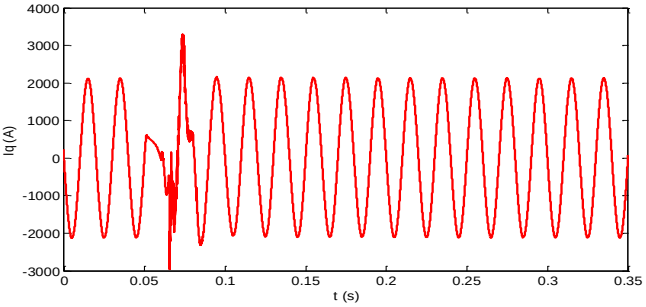

Fig. 17: Curent response of D-STATCOM.

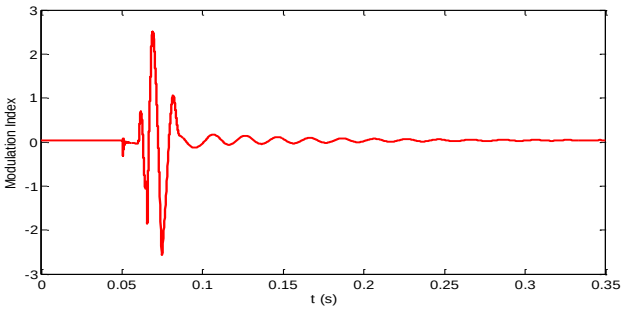

Fig. 18: Modulation coefficient of D-STATCOM

V. CONCLUSION

In this work, the investigation on the role of D-STATCOM is carried out to improve the stability in Pleiku distribution networks. Proportional-Integral (PI) controller is used with the device to improve its performance. Test system is analyzed and results are presented in the simulation section. The results shows the satisfactory performance of D-STATCOM in the distribution networks under three-phase fault conditions and it can be concluded that D-STATCOM effectively improves the stability in distribution networks.

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