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Ice nucleation bacteria- a challenge for agriculture

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ABSTRACT

Ice nucleating bacteria can harm plants by stimulating the formation of ice in their tissues. On the other hand they contribute to cloud formation and rain precipitation on earth. It looks like they can play a role to local weather formation. In the same time the ice nucleating bacteria, has proteins which can bind ice crystal and contribute to the crystals formation. They can be dangerous during late frosts in the spring in orchards, affecting the blossoms, and producing damages and crop losses. They can be used in different purposes, in order to obtain ice in different conditions. The damage in orchards is highlighted. Some bacterial products were issued in order to fight with this kind of frost and to protect plants.

Keywords—ice nucleating bacteria, plant protection, *Pseudomonas*, *INA* genes

I. INTRODUCTION

The bacteria stimulating ice formation are known in agriculture and in food industry and environmental microbiology too. For example, some bacteria from milk, can determine an abnormal freezing of this product. Strains of *Pseudomonas fluorescens* were found responsible for it. The temperature for ice nucleation in milk, was of -1, 7°C, for the culture of bacteria, and -1, 4°C for a bunch of bacterial concentrated cells [1]. In the same time, in dilution without any cell, did not appear ice crystals. The bio aerosols are [2] pollen, fungal spores, bacteria, seeds and other bio particles, which serve to dissemination of organisms, and can serve as nucleation centers for clouds droplets, ice crystals and precipitation. Distribution in air and in rain water of such microorganisms, show a percent of 2.2 to 19, 4% in rain water and 1, 8-9, 5 % in the air samples [3]. They are able to speed up the ice formation at higher temperature [4], many of them, strains from *Pseudomonas* genus (*P. syringe*, *P. poae*, *P. fluorescens*, *P. graminis*, and *P. viridiflava*.)

II. POTENTIAL OF ICE NUCLEATING BACTERIA

A. Generalities

Some bacteria, can influence the climate by determination of precipitations and even participation in regulate weather at secondary, marginal level [5]. Bacteria are found in atmosphere, as bio-aerosols, and they are very diverse *Proteobacteria*, *Actinobacteria*, *Firmicutes*, *Acidobacteria*, *Bacteroidetes*, *Firmicutes* phyla [4]. Some bacteria are active ice nucleators [6], in special *Pseudomonas* strains bearing *INA* genes, and even some fragments of bacterial cells in quantity of 199-482/mL, and about 12% of bacteria bear the *INA* genes, and excreted membrane vesicles. In special *Pseudomonas* strains have this capacity of catalyze ice formation and have impact on precipitations formation? An older work, showed that plants pathogenic bacteria, like *Xanthomonas* and *Pseudomonas*, can participate to the condense formation in clouds [7]. The mechanism of ice nucleation is the hydrogen bonding at the contact point water –bacteria, imposing a structural order in the molecules network [8]. In fact, *Pseudomonas syringe* life cycle is linked with the water cycles in nature [9]. Ice nucleating activity has the strain *Pseudomonas antarctica* IN- 74, isolated from Ross Island in Antarctica [10]. The experiments shown that the ice nucleation activity remains even after cell death [11]. The responsible for the effect are special proteins, ice nucleation protein, determined

by *INA* genes, which allow ice crystals formation at temperature near melting point [12]. The protein, located in outer membrane, is monomer having about 118 amino acids and a GM of 118kDal in three domains [13] can control the ice crystals formation, and the heterogeneous water solution containing the nuclei for crystals formation, freeze at temperature higher than normal freezing temperature, at about -2 C, producing in function of freezing rate, damage of plants cells [14]. Even in snow were isolated bacteria with variable ice nucleation activity [15]. The ice nucleation activity decrease in presence of UV rays, NO₂ and ozone [16].

B. Damages in cultures

The same activity and phenomenon, happens in plants which determinate the plants frost damage in spring. First time this was reported in England [17]. The spring frost occurs and coincides with the presence of *Pseudomonas* strains in trees phyllosphere (*P. syringae*, *P. agglomerans* and *P. fluorescens*). This kind of bacteria was discovered even in subtropical area most of them being gram negative from *Pseudomonas* and *Sphingomonas* genera [18]. In wheat cultures, of various types, *Pseudomonas syringae* are the most frequent INA bacteria, and its can be propagated with seeds [19]. This was associated with diseases and destruction by late frost of stone fruits from orchards for the first time in Romania [20]. Infected flowers became brown and faded destroyed by the frost and ice [21], producing in the same time, the so called apoplexy of stone fruit trees, determining damages for farmers.

C. Possible applications

Some products were issued in Europe to fight the ice formation in plants tissues and limitation of the bacteria, in order to limits the phenomenon, and main were prevention with bacteria strains which do not nucleate ice, in order to avoid perish and destruction of flowers (Frostban (*P. syringae* 742 RS) Frostban B (*P. fluorescens* A506) and others. In Belgium, some researches [22] studied the pathogenity and aggressiveness of *Pseudomonas syringae* populations in orchards and concluded that there are no chemicals that prevent the evolution of bacterial diseases, which require finding alternative methods to prevent infection by using resistant varieties and biological control methods. Other researches focus on obtaining non-ice nucleating mutants of *Erwinia herbicola* and tested it on cultivated sunflower seedlings to avoid ice formation [23]. The same was obtained with *P. syringae*. Some authors [13] consider that's not good, because the wild strain can assure the formation of rain, an important element for the crops too. In the same time, some authors thing that the snow additive with bacterial content can be dangerous because they are phytopathogens, can change the species composition in mountains area [24]. The ice nucleating bacteria can be inhibited by use of copper sulphate [25]. Applications in plant protection, killing parasitic nematods using Snowmax –INA agent was designed [26]. Snowmax was created to supplement snow for skiing in ski resorts. The ice nucleating bacteria can be usefor destroying pest during winter [27].

The use of ice nucleation bacteria in food industry as texturing freezing food and in seeding the clouds for rain, are some possible applications [28]. Use of this kind of bacteria for rain making is still in study, being involved in so called bio-precipitation [13]. The ice nucleating bacteria, like bacteria from the genera *Pseudomonas*, *Xanthomonas* and *Erwinia*, can reduce super-cooling, freezing time and costs [29] and are in generally safe for humans having only a low risk [30].

III. CONCLUSIONS

The ice nucleation active bacteria, can have –together with other active particles in the atmosphere and influence on local weather, on precipitations, but can also contribute to the damage of cultures in special in early spring. Some characteristics of these microorganisms can be used to improve weather-were needed- to protect plants against pest and pathogens, or to contribute to preserve food. In order to protect the cultures from frost, and ice formation, we must find new tools, and the answer can be new researches to identify the best measure to be taken for preservation of cultures. There are still possible applications of this kind of bacteria that we can discovered in the near future.

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Shear Behavior of Lightweight Fiber Reinforced Concrete Beams

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ABSTRACT

In this study, fourteen reinforced concrete beams were tested to investigate the shear behavior of lightweight fiber reinforced concrete beams. Lightweight Expanded Clay Aggregate (LECA) was used as a partial and full replacement to the normal weight aggregate. The experimental program included three lightweight concrete beams with partial replacement of aggregate, nine lightweight concrete beams with full replacement of aggregate, and two normal weight control beams. In each group one beam was cast using steel fiber concrete, one with polypropylene fiber concrete, and one without fibers. The effects of parameters such as weight of concrete, type of fibers, area of stirrups, and shear span to depth ratio (a/d) on the beams behavior are presented. The response of the tested beams is analyzed in terms of mode of failure, deflection, strain, cracking load, and ultimate capacity. The test results are compared to those estimated from different design codes for lightweight concrete structures.

KEYWORDS -lightweight concrete; shear behavior; failure mode; cracking load; ultimate load

I. INTRODUCTION

The use of lightweight concrete (LWC) has increased rapidly in the last few years especially in the Western countries. While lightweight concrete derives considerable appeal from an improved strength-to-weight ratio, this material also boasts enhanced thermal insulation, fire resistance, and acoustic insulation properties. Lightweight concrete has thermal conductivity values half that of normal weight concrete (Chandra and Berntsson 2003) due chiefly to its low density and pore structure which traps air – being a poor conductor of heat. This low value means that heat does not easily penetrate through the material thus reducing a building's interior heating and/or cooling requirements, a reduction most welcome amid rising energy costs and growing concerns on climate change.

Although lightweight concrete is able to improve some properties of normal weight concrete, inevitably, trade-offs are made with others. From a structural stand point, a lower modulus of elasticity causes member deflections to be greater than in normal weight concrete counterparts. In addition, lightweight concretes have lower tensile strengths and a subsequently reduced shear resistance (ACI 213R-03). This is in lieu of the improved interfacial transition zone in lightweight aggregate concrete. A smaller net solid area in aerated concretes may also be a contributing factor to its lower tensile strength. These limitations do not necessarily diminish the value of lightweight concrete since the weaknesses can be overcome with appropriate structural design and detailing.

Already, internationally recognized building codes of practice acknowledge the role and potential of lightweight aggregate concrete by allowing the structural use of the material with associated design guidelines and equations suggested. However much of these design provisions are modified forms of normal weight concrete requirements and have remained unchanged based on research and data on lightweight concrete obtained in the 1950's.

Past studies have shown that the addition of steel fibers into the concrete matrix will enhance the shear strength and ductility in reinforced concrete (RC) members (e.g. Batson et al. 1972, Narayanan and Darwish 1987). Steel fibers increase shear resistance by providing post-cracking diagonal tension resistance across the crack surfaces. They also control crack spacing, similar to the

effect of stirrups, and this leads to reduced crack widths and an increase in shear resistance through aggregate interlock (Kwak et al. 2002). The use of steel fibers to enhance the shear response is particularly attractive in high strength concrete (Wafa and Ashour 1992) and lightweight concrete (Balaguru and Foden 1996), where the brittleness and suddenness of matrix failure is more pronounced compared to normal strength concrete. Several researchers have studied the shear performance of steel fiber reinforced concrete (SFRC) beams with normal and high strength matrices (e.g. Narayanan and Darwish 1987, Ashour et al. 1992, Kwak et al. 2002); however, the influence of steel fibers on shear strength of beams with lightweight aggregate has not been established, and very limited work on lightweight concrete with fibers has been reported (Swamy et al. 1993).

The advantages of using LWC in construction include its low density and low thermal conductivity. This leads to a reduction in dead load, faster building rates, and saving in air conditioning systems. However, the low shear capacity of LWC results in reduction in the ultimate strength of such beams. The use of different types of fibers has been investigated to overcome such reduction in shear strength of LWC beams.

II. RESEARCH SIGNIFICANCE:

This research was carried out for the following purposes:

1. To evaluate the effect of different types of fibers on enhancing the shear capacity of lightweight concrete beams.
2. To compare the obtained test results with various design Codes recommendations.

III. EXPERIMENTAL PROGRAM

To achieve the main aim of the current study, an experimental program consisted of fabricating and testing fourteen reinforced concrete beams: Three beams contain light-weight expanded clay aggregates (LECA) as a partial replacement to the normal weight coarse aggregates with a percentage equals 50%. The unit weight of this type of concrete ranged between 1860 kg/m³ to 2000 kg/m³. Nine beams contain light-weight expanded clay aggregates (LECA) as a full replacement to the normal weight coarse aggregates with a percentage equals 100%. The unit weight of this type of concrete ranged between 1650 kg/m³ to 1700 kg/m³. The other two beams were cast with normal-weight concrete for comparison purposes.

3.1 Mix Proportions and Materials

Eight concrete mixes were designed in this research. Two mixes (No. 1 and 2) were normal unit weights (control mixes). Mix No. 2 possessed normal unit weight with steel fibers. Intended compressive strength was 30 MPa for all mixes. Table (1) shows the details of the eight mixes. The used cement was Ordinary Portland Cement type CEM I – 42.5 complied with the Egyptian Standard. In the lightweight aggregate mixes, silica fume having a silica content of 96.5%, a specific gravity of 2.15 and specific surface area of 20000 cm²/gm was used as an additive to the cement with the case of polypropylene fiber only. Silica fume was added by a ratio of 10% of the cement content in mix No. 5 and No. 8. Local dolomite crushed stone size 10 mm and natural sand were used as coarse and fine aggregates, respectively, in mixes 1 and 2. While, in the lightweight aggregate mixes (mixes 3 to 5), coarse and light-weight expanded clay aggregates (LECA) were used as partial replacements to the normal-weight coarse aggregate, with a percentage equals 50% and 100% (by volume). The used coarse LECA had a volume weight of 600kg/m³ and a specific weight of 1.0, while the fine LECA possessed a volumeweight of 1100 kg/m³ and a specific weight of 1.6. In addition, a high range water reducing and set retarding concrete admixture of modified synthetic dispersion basis (complies with ASTM C 494 Type G and BS 5075 Part 3) was used in the designed normal weight and lightweight

mixes for reducing the amount of the mixing water. The used dosage of the admixture was 1% of the binding material. It must be mentioned that the amounts of water listed in Table 1 included the absorbed water by the coarse and fine aggregates. Finally, it should be mentioned also that the workability of the designed eight mixes was adjusted to be maintained at the same level. Slump tests were carried out on the fresh concrete and all mixes recorded slump values of 70 mm ± 20 mm.

Table 1: Proportions of Concrete Mixes

Mix No.	Type of Concrete	Cement (kg/m ³)	Silica Fume (kg/m ³)	Coarse Agg. (kg/m ³)		Fine Agg. (kg/m ³)	Fiber (kg/m ³)	Water (kg/m ³)	Admix. (kg/m ³)
				Dolomite	LECA	Sand			
1	NW	350	----	1224	----	612	----	180	3.5
2	NW	350	----	1224	----	612	SF-78.6	180	3.5
3	50-LW	350	----	381.32	235.4	612	----	180	3.5
4	50-LW	350	----	381.32	235.4	612	SF-78.6	180	3.5
5	50-LW	350	35	381.32	235.4	612	PPF-9.1	180	3.5
6	100-LW	350	----	----	470.77	612	----	180	3.5
7	100-LW	350	----	----	470.77	612	SF-78.6	180	3.5
8	100-LW	350	35	----	470.77	612	PPF-9.1	180	3.5

3.2 Details of the Test Beams

A total number of fourteen reinforced concrete beams divided to five groups (A, B, C, D and E) were fabricated and tested in this study. Table 2 shows the main properties of the tested beams. In group A; beam B1 was cast with mix No. 1 and beam S1 was cast with mix No. 2 (normal-weight concrete). In group B; beam B2 was cast with mix No. 3, beam S2 was cast with mix No. 4, and of lightweight aggregate, beam P2 was cast with mix No. 5 with reduced-weight concrete (partial replacement of lightweight aggregate). In groups C, D, and E; beams B3, B4, B5 were cast with mix No. 6 and beams S3, S4, S5 were cast with mix No. 7 and beams P3, P4, P5 were cast with mix No. 8 (full replacement of lightweight aggregate). In addition, the shear span was 600 mm (shear span to depth ratio ≈ 2.2) for all groups except group E which had shear span equals to 275 mm (shear span to depth ratio = 1).

The steel fibers used in this research were 30mm long with an aspect ratio of 50 and ultimate tensile strength of 1000MPa. The polypropylene fibers were 12mm long with an aspect ratio of 50 and ultimate tensile strength 440MPa, Fig. 1.

All the beams were 2000 mm long, 1800 mm span, 150 mm width and 300 mm total depth, with an effective depth equals to 275 mm. The main tensile reinforcing bars were 3 Φ 16 (high tensile steel 400/600) while the compression reinforcement was 2 Φ 8 (mild steel 280/420). The shear reinforcement (stirrups) was of diameter 6 mm (mild steel 280/420) at a spacing of 200 mm for group A, B, C, and E. In group D the shear reinforcement was of diameter 8 mm (mild steel 280/420). The deometry and reinforcement details of the tested beams are shown Figure 2. Six standard cubes of 150x150x150 mm and six standard cylinders of 300 mm height and 150 mm diameter were cast with

the test beams to determine the actual concrete compressive strength and splitting strength of each beam.

Table 2: Main Properties of the Test Beams

Group	Beam Ident.	Mix No.	Stirrups /m'	Type of Concrete	Mix. Designation	Concrete Strength, MPa
A	B1	1	5Φ6	Normal-weight	NC	41
	S1	2	5Φ6	Normal-weight	50-SFLW	37
B	B2	3	5Φ6	50% Lightweight agg.	50-LWC	26
	S2	4	5Φ6	50% Lightweight agg.	50-SFLW	27
	P2	5	5Φ6	50% Lightweight agg.	50-PPFLW	29
C	B3	6	5Φ6	100% Lightweight agg.	100-LWC	22
	S3	7	5Φ6	100% Lightweight agg.	100-SFLW	18
	P3	8	5Φ6	100% Lightweight agg.	100-PPFLW	19
D	B4	6	5Φ8	100% Lightweight agg.	100-LWC	22
	S4	7	5Φ8	100% Lightweight agg.	100-SFLW	18
	P4	8	5Φ8	100% Lightweight agg.	100-PPFLW	19
E	B5	6	5Φ6	100% Lightweight agg.	100-LWC	22
	S5	7	5Φ6	100% Lightweight agg.	100-SFLW	18
	P5	8	5Φ6	100% Lightweight agg.	100-PPFLW	19



Figure 1: Hooked steel fiber 30mm length, Polypropylene FIBERMESH® 3000mm length

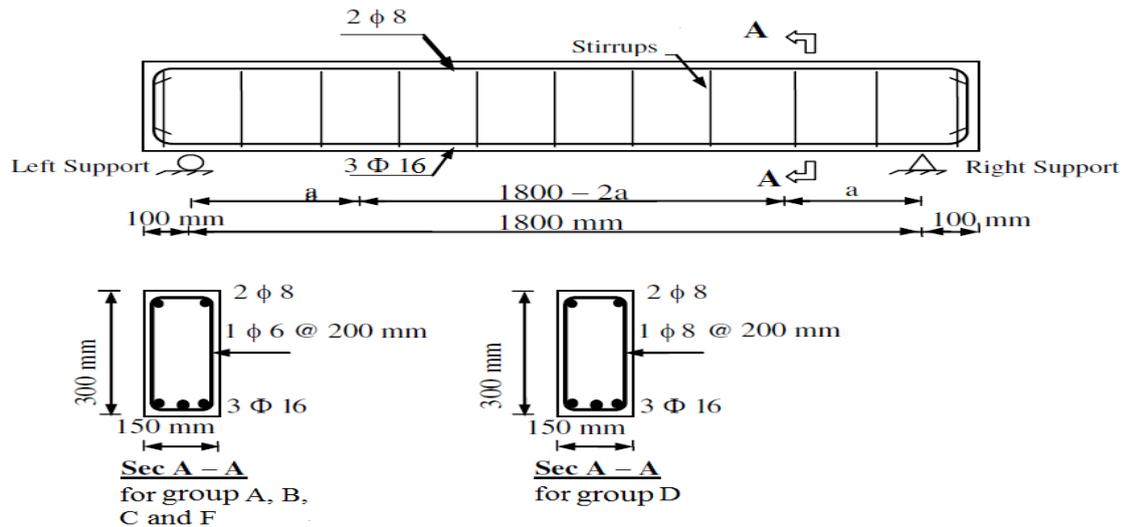
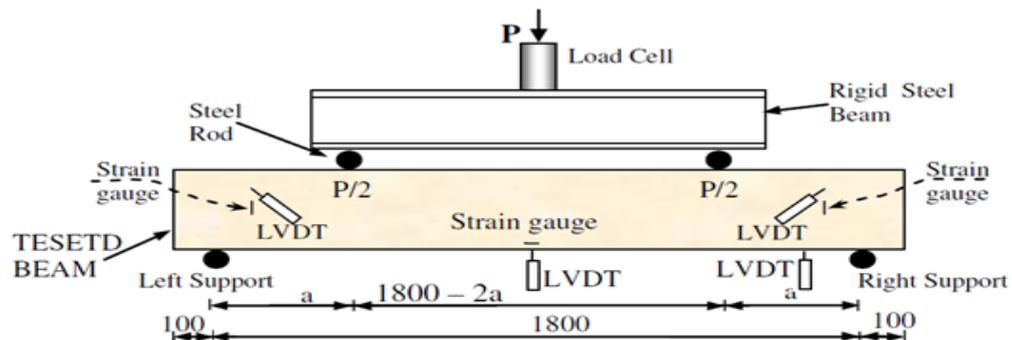


Figure 2: Geometry and Reinforcement Details of the Tested Beams

3.3 Instrumentation and Testing

The tests were performed using a 5000 kN hydraulic compressive machine. The mid-span deflection was measured for the tested beams using linear variable displacement transducer (LVDT). Similarly, the mid-shear span deflection and the mid-shear span deflection were measured using linear variable displacement transducer (LVDT). Strains were measured at the mid-span of the tensile steel by using 10 mm electrical strain gauges. Two 6mm electrical strain gauges were mounted on the vertical leg of the second left and right stirrups. Two LVDTs were attached in the maximum left and right shear regions at an angle of 45°. The strain gauges and LVDTs were connected to a data acquisition system. Figure 3 illustrates a schematic view of the loading setup and instrumentation of the tested beams. Also, Fig. 4 presents a general view of the test setup.



*All dimension are in mm.

Figure 3: Test Setup and Instrumentation of the Tested Beams

As shown in Figures 3 and 4, each beam was acted upon by symmetrical two vertical concentrated loads. In all groups spacing between the two loads were 600 mm except group E where the spacing was 1250 mm.

The measurements and observations were recorded at each load level. The test was continued after the ultimate load in order to assess the post peak behavior of the tested beams.



Figure 4: General View of the Test Setup

IV. Experimental Results

Table 3 illustrates the results of the compression and splitting tests of the specimens (cubes 150 x 150 x 150 mm for compressive strength and cylinders 150 mm diameter and 300 mm height for splitting strength and modulus of elasticity) which were cast with the test beams. These specimens were tested on the same day of testing of their beams. It must be mentioned that each value listed in Table 3 is the average of the test results of three specimens.

The compressive strength of mix No. 1, which was made of normal weight concrete, was 40.8 MPa while the splitting strength was 3.32 MPa, i.e. the splitting strength was 8.1% the compressive strength. In the same NW with steel fiber mix No. 2, the compressive strength was 35.5 MPa while the splitting strength was 2.75 MPa i.e. the splitting strength was 8.1% of the compressive strength. On the other hand, for the LW concrete partial replacement, mix No. 3, the compressive strength was 25.56 MPa and the splitting strength was 1.8 MPa, i.e. the splitting strength was 7% of the compressive strength.

Table 3: Actual Compressive Strength and Splitting Strength of the Specimens of the Test Beams

Beam Ident.	Type of Concrete	Actual Comp. Strength, MPa	Actual Splitting Tensile Strength, MPa	Ratio Splitting Tensile strength/ Comp. Strength
B1 (mix no. 1)	Normal aggregate	40.8	3.32	8%
S1 (mix no. 2)	Steel fiber with normal aggregate	35.5	2.75	7.75%
B2 (mix no. 3)	Partial replacement aggregate	25.56	1.8	7%
S2 (mix no. 4)	SF with partial replacement aggregate	26.66	2.37	9%

P2 (mix no. 5)	PPF with partial replacement aggregate	28.6	2.18	7.6%
B3, B4, B5 (mix no. 6)	Full replacement aggregate	21.35	2.01	9.4%
S3, S4, S5 (mix no. 7)	SF with full replacement aggregate	16.8	1.8	10.7%
P3, P4, P5 (mix no. 8)	PPF with full replacement aggregate	18.96	2.21	11.7%

The results indicate that, the light-weight concrete shows smaller tensile strength than the normal-weight concrete. In partial replacement and full replacement LECA aggregate, the splitting tensile strength of the reduced-weight concrete was 54%, and 61%, respectively, of that of normal-weight concrete.

Results of the Tested Beams

The experimental results are shown for mode of failure; load-deflection relationship; load-strain relationship; cracking load, and ultimate load for the tested beams. Table 4 lists the cracking and ultimate loads. In general, the results show that light weight concrete has smaller cracking and ultimate loads than normal weight concrete.

Modes of Failure

Figure 5 shows the cracking pattern of all the tested beams. As shown in this figure and Table 4, the cracking behavior of the tested beams followed different trends based on the studied variables.

Table 4: Cracking Loads and Ultimate Loads of the Tested Beam

Group	Beam Ident.	First Cracking load (kN)	Ultimate load (kN)
A	B1	114	195.77
	S1	155	217.93
B	B2	108	137.97
	S2	123	197.16
	P2	113	197.17
C	B3	67	119.68
	S3	97	177.67
	P3	103	166.01
D	B4	87	139.71
	S4	75	149.71
	P4	99	149.17
E	B5	79	193.96
	S5	91	235.59
	P5	130	277.26

For all beam the first crack started at the beam mid-span. This crack was followed by inclined shear cracks which extended rapidly across the section leading to sudden failure.



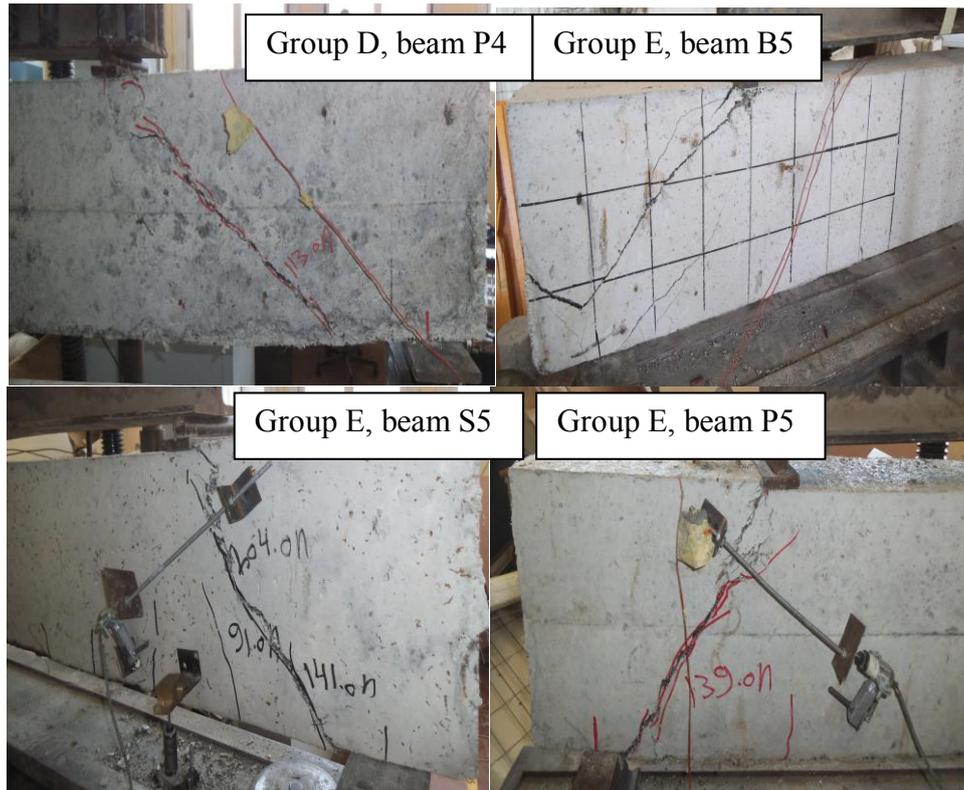


Figure 5: Failure Shape of Tested Beams

Deflection of the tested beams

The deflection behavior of the tested beams are shown in figures 6 to 8. For beams B1 to B5 without fibers, Fig. 6, beam B4 with 100% aggregate replacement and $\Phi 8$ stirrups showed the highest deflection before failure. This was due to the increase in stirrups diameter, which delayed the complete shear failure. Beam B5 had the maximum ultimate load among other beams due to the decrease in shear span and hence reduction in the applied moment.

For beams with steel or polypropylene fiber, there was an increase in the ultimate shear resistance of compared to beams without fibers. Also for beams with fibers, the brittle failure mode changed to ductile. Figure 7 shows that beam S2 with steel fibers and 50% aggregate replacement showed less deflection than beams S3 and S4 with 100% replacement. The same findings are applied in case of polypropylene fiber as shown in Fig.8.

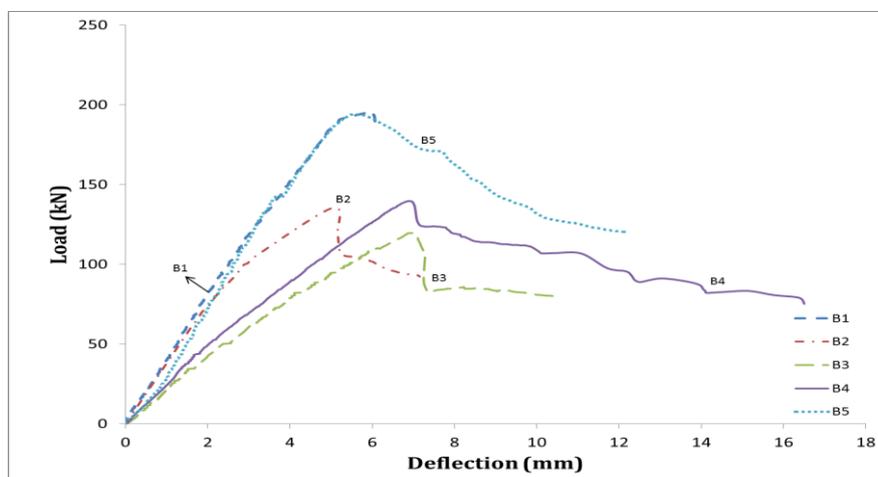


Figure 6: Load Mid-span Deflection Relationships of All groups without Fibers

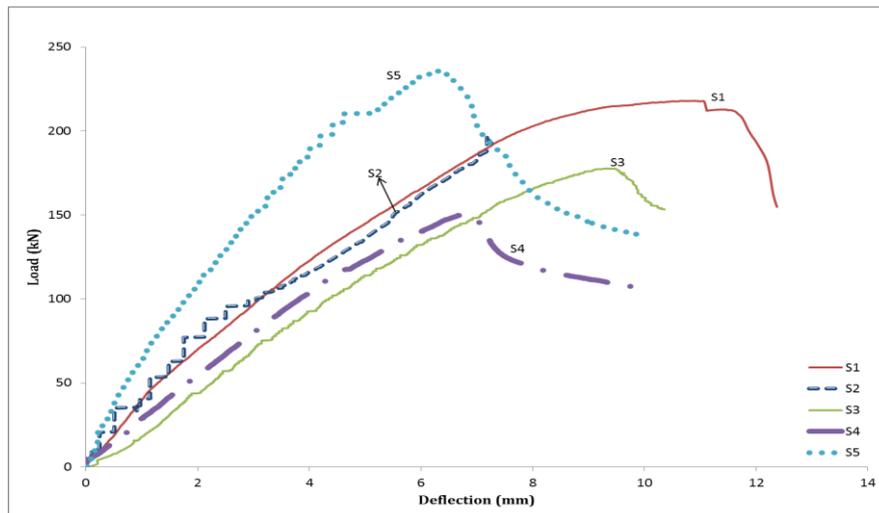


Figure 7: Load Mid-span Deflection Relationships of All groups with Steel Fibers

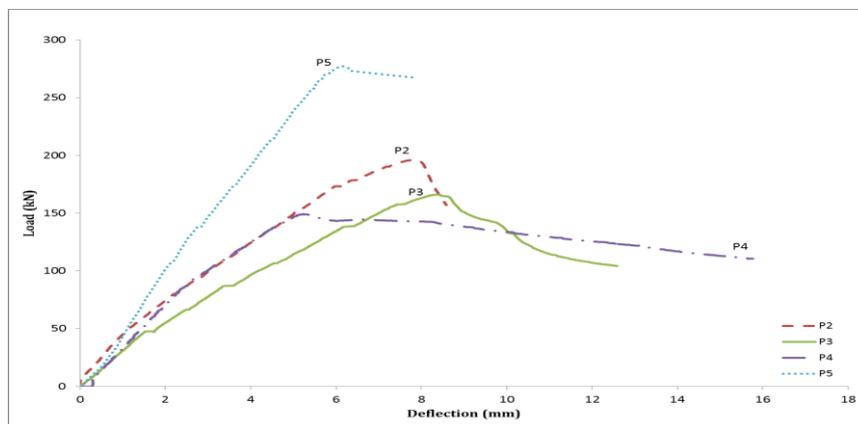


Figure 8: Load Mid-span Deflection Relationships of All groups with Polypropylene Fibers

Tensile Steel Strain

Figures 9 to 11 show the results of the steel tensile strain at the beam mid span. It can be seen from Fig.9 that in case of concrete without fibers, the normal weight beam B1 had the most ductile behavior compared to the light weight concrete beams. Beam B3 with 100% aggregate replacement experienced the largest strain at any load stage. Figure 10 shows that normal weight beam S1 with steel fiber had the most ductile behavior compared to all the tested beams. Comparing the results of beams B3 and S3, it can be shown that steel fibers enhance the ductility and help to delay the complete failure of the beam. The results show that the increase in stirrups diameter has the same positive effects as the steel fibers on the behavior of lightweight beams.

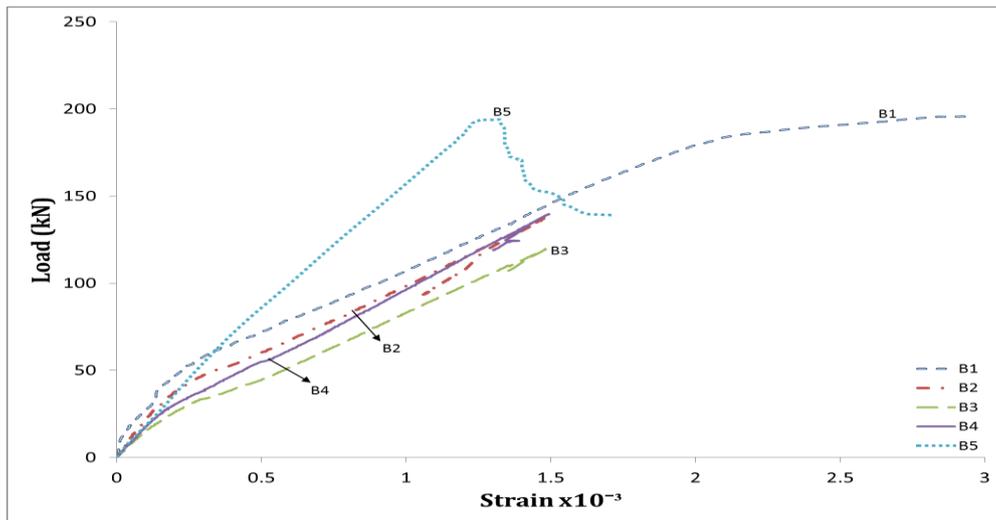


Figure 9: Load Tension Steel Strain Relationships of All groups without Fibers

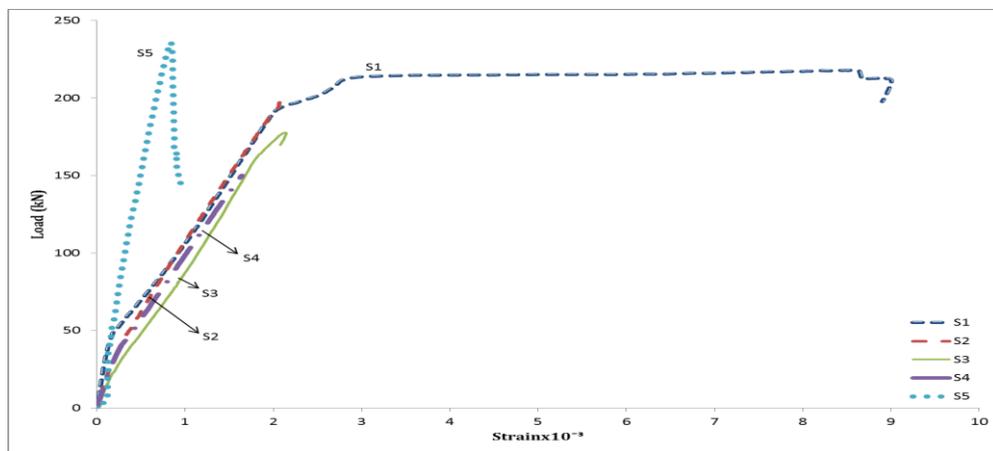


Figure 10: Load Tension Steel Strain Relationships of All groups with Steel Fibers

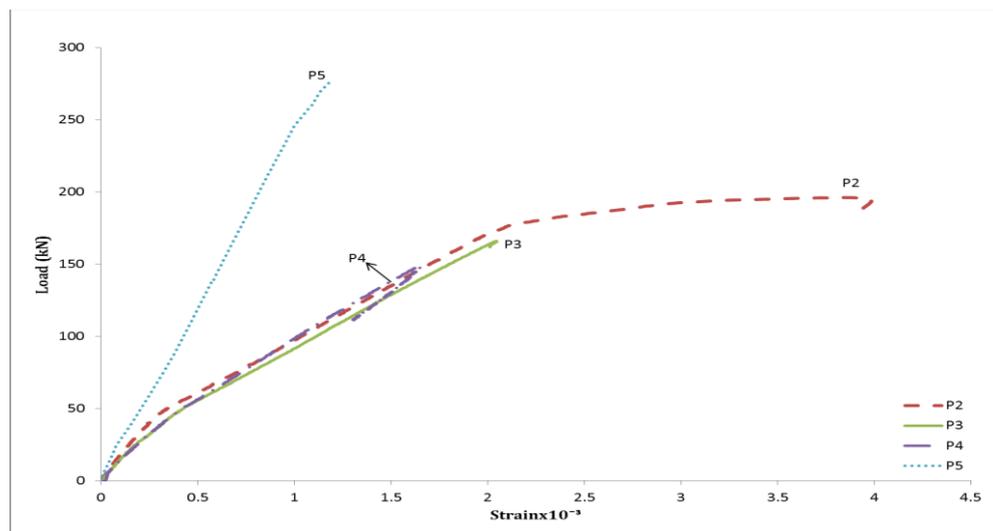


Figure 11: Load Tension Steel Strain Relationships of All groups with Polypropylene Fibers

Effect of weight of concrete

Figures 6 to 9 show the deflection and strain results for beams without fibers. Beam B1 has a control normal weight mix, while beams B2 to B5 have lightweight concrete mixture with different

replacement ratio or stirrups size. Comparing the results of beam B1 with those of the LW beams, the following remarks can be made:

- Due to the brittleness of the LW concrete, beams B2 to B5 experienced a sudden shear failure at lower ultimate load compared to B1.
- The LW concrete beams showed higher deflection than B1.
- Reductions in the ultimate load were observed in LW concrete beams compared to the NW. The ultimate load of B2 was 70% of that of B1. The ultimate load of B3 was 61% of the ultimate load of B1. Also, for beam with steel fiber, the ultimate load of S2 was 90% of that of S1.
- Adding steel fibers to lightweight concrete helps to restore the ultimate capacity of beams.
- Ultimate capacity of beam S2 with 50% aggregate replacement and with steel fibers was 197.2 kN compared to 195.8 kN for NW beam B1. Beam S3 with steel fibers and full LECA aggregate strength had an ultimate load of 91% of the control beam B1.

Effect of stirrup ratio

Comparing the results of B3 and B4 in Fig. 6 show that increasing the stirrups bar size from 6mm to 8mm has the effect of reducing the mid span deflection and increasing the ultimate beam capacity. The shear capacity of lightweight beam B4 is 17% higher than that of beam B3 with 6mm stirrups. Comparing the results of beam B4 with the normal weight B1 shows that the increase in stirrups size was not enough to substitute the reduction in ultimate capacity due to the use of lightweight concrete. The ultimate capacity of beam B4 was 71% of beam B1, Table 4. On the contrary, when using 50% aggregate replacement and steel fibers (beam S2) the ultimate capacity exceeded that of the control beam B1.

Effect of Shear-Span-to-Depth Ratio

Comparing the results of beam B3 with full aggregate replacement where $a/d=2.2$ and B5 with $a/d=1.0$, it can be seen that the shear failure load of B3 was 119.68 kN where that for B5 was 193.96, Table 4. The ultimate moment capacity of beam B3 was 35.9 kN.m compared to 26.67 kN.m for B5. This is due to fact that the failure in beam B3 was flexural shear failure where as in beam B5 the small shear span led to a clear shear failure at the beam ends. Using steel or polypropylene fibers in light beams with $a/d=1.0$ increased the ultimate capacity by 21% and 43%, respectively.

Shear Strength of lightweight concrete according to design codes

Concrete shear strength of the tested beams was compared to those proposed by different international codes, e.g. ACI 318-14, BS 8110, and Eurocode 2. The shear strength of lightweight concrete can be estimated according to the follows equations.

ACI 318-14 (2014):

$$V_c = 0.166\sqrt{f'_c}b_w d(1)$$

Where,

λ = *lightweight concrete* modification factor reflecting the reduced mechanical properties

$\lambda = 0.75$ for $\gamma_c = 1700 \text{ kg/m}^3$ and $\lambda = 0.85$ for $\gamma_c = 2000 \text{ kg/m}^3$ where γ_c is the concrete density.

f'_c = specified compressive strength of concrete, MPa.

b_w = web width, mm. d = distance from extreme compression fiber to centroid of longitudinal tension reinforcement, mm.

Eurocode 2 (1999):

$$V_{IRd,c} = \frac{A_{sw}}{s} \cdot z \cdot f_{ywd} \cdot \cot\theta \quad \text{and} \quad V_{IRd,max} = \alpha_{cw} b_w z v_1 f_{cd} / (\cot\theta + \tan\theta) \quad (2)$$

Where, $V_{IRd,c}$ design value of the shear resistance of a lightweight concrete member with shear reinforcement, f_{ywd} design yield strength of the shear reinforcement, α_{cw} coefficient accounts for the state of the stress in compression chord, v_1 strength reduction factor for concrete cracked in shear. f_{cd} is the design compressive strength of concrete, θ is the angle between concrete compression strut and the beam axis perpendicular to the shear force.

BS 8110-2:1985

$$V_c = 0.79 \left(\frac{100 A_s}{b_v d} \right)^{1/3} \left(\frac{400}{d} \right)^{1/4} \left(\frac{f_{cu}}{25} \right)^{1/3} / \gamma_m \quad (3)$$

Where, b_v breadth of the member, or for T-, I-, and L-beam, the breadth of the rib, A_s area of reinforcement, d effective depth to the centroid of the steel area, f_{cu} characteristic strength of concrete, γ_m partial safety factor for strength of materials. These results show that the three codes underestimate the concrete shear strength of partial and full replacement lightweight concrete beams.

Comparison results are shown in Table 5.

Table 5 Comparison of experimental results with other design codes

Beam	a/d	Stirrup diameter (mm)	V _{u,test} (kN)	V _{u,code} (kN)			V _{u,test} / V _{u,code}		
				ACI	Euro	BS	ACI	Euro	BS
B2 50% LW	2.2	6	69	35.85	36.51	34.24	1.92	1.89	1.75
B3 100% LW	2.2	6	60	31.54	31.75	31.35	1.90	1.89	1.89
B4 100% LW	2.2	8	70	42.2	56.42	44.14	1.65	1.24	1.59

V. Conclusions

This research investigated the shear behavior of light weight reinforced concrete and lightweight fiber reinforced concrete (FRC). A fixed amount of fibers (1.0% by volume) of steel and polypropylene fibers was used in FRC beams. LECA aggregate was used to replace the normal weight aggregate to produce partial or full lightweight concrete. The following conclusions can be drawn from the outcome of this study:

1. The ultimate shear strength of normal weight concrete beams and lightweight concrete beams increase by adding fibers to the mix.
2. The load deflection characteristics and the crack pattern of the lightweight concrete beams tested in this experimental program were similar to the expected behavior of normal weight concrete beams with and without fibers.
3. Decreasing the shear span to depth ratio a/d increases the shear strength of steel and polypropylene fiber reinforced light weight concrete beams.
4. Because of the low modulus of elasticity of polypropylene fiber, beams reinforced with this material have larger deflections and wider cracks than beams reinforced with steel fiber.

6. The use of end hooked steel and polypropylene fibers in volume fraction 1% did not influence the compressive strength of lightweight concrete. Polypropylene decreased the compressive strength of lightweight concrete full replacement because of high volume fraction which caused segregation and low workability. Adding 10% of silica fume had the effect of enhancing the compressive strength.
7. The tensile strength of LWC and NC were improved by using steel and Polypropylene fibers.
8. The results showed that both types of fibers improved the ductility behavior for normal and lightweight concrete beams compared to beams without fibers.
9. Increasing the area of stirrups was found to have more effect in increasing the shear capacity of lightweight concrete than adding steel or polypropylene fibers.
10. The shear strength of lightweight concrete estimated by different international codes are very conservative when compared to the shear strength obtained from the experimental tests in this research.

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Impact of Household Waste on The Water Quality of *Umuerim* River, Nekede, Owerri Nigeria

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ABSTRACT

The research was carried out to assess the quality of *Umuerim* River, Nekede in October 2016 which serves for domestic and fisheries uses among the rural inhabitants. The anthropogenic activities identified during reconnaissance visit include sand mining activities, discharge of household wastes into its channel across Owerri, and Agricultural practices that serve as non-point source. Water samples were collected from four sampling points (discharge point SP1, midstream SP2, downstream SP3 and upstream), in Nekede, using standard methods for sampling and analysis. Parameters analyzed include Lead, Zinc, Iron, Copper, Chromium, Nitrate, Sulphate, Phosphate, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD₅), Turbidity, pH, Conductivity, and Temperature. Results showed that Conductivity (range= 5.50 μ S/cm), Total Dissolved Solids (TDS) (range= 4.00 mg/L), Turbidity (range= 3.20 NTU) and Sulphate ions (SO₄) (range= 2.70 mg/L) recorded comparatively wide variations during the study period. Mean levels pH (6.24 ± 0.09), DO (1.45 ± 0.08) mg/L, BOD (0.49 ± 0.09) mg/L, and Turbidity (4.93 ± 0.67) NTU were outside the Federal Ministry of Environment's recommended limits in surface water. It is therefore, recommended that routine water quality analysis should be conducted for safe public consumption of the water.

Keywords: *Umuerim River, water quality, Household wastes, Parameter*

I. INTRODUCTION

Water is essential for livelihood as well as socio-economic development of any community and it is estimated that approximately one third of the world's population use groundwater for drinking [1]. Many communities in Nigeria rely on surface and groundwater for both domestic and agricultural water supplies because of its abundance, stable quality and also because it is inexpensive to exploit. However, the urbanization process threatens the surface and groundwater quality because of the impact of domestic and industrial waste disposal. Water pollution is any chemical, physical or biological change in the quality of water that has a harmful effect on any living thing that drinks or uses or lives in it [2]. Dissolved wastes and other materials that are dumped, spilled or stored on the surface of the land or in sewage disposal pits can be dissolved by precipitation, irrigation waters or liquid wastes and eventually seep through the soil in the unsaturated zone to pollute the groundwater [3]. Poor environmental management creates havoc on the water supply, hygiene and exacerbating public health [4]. [5] Emphasized on the importance of surface and groundwater globally as a source for human consumption and changes in quality with subsequent contamination can, undoubtedly, affect human health.

Heavy metals such as Fe, Cr, Ni, Cu and Zn are essential in living organisms because of their structural and functional roles in various physiological processes [6]. Essential heavy metals are required in trace quantities by organisms and if their concentration exceeds the threshold level they become toxic [7] especially at higher levels, [8], [9]. The World Health Organization (WHO) estimates that more than 20% of the world population (around 1.3 billion people) has no safe drinking water and that more than 40% of all populations lack adequate sanitation [10].

Household wastes are solid waste comprising of garbage and rubbish (such as bottles, cans, clothing, compost, disposables, food packaging, food scraps, newspapers and magazines, and yard trimmings) that originates from private homes or apartments [11]. The presence of a number of various household wastes, point and non-point sources of pollution around the *Umuerim* River poses a huge threat on

the water quality of the river with numerous health implications. Municipal solid wastes are made up of household wastes, construction and demolition debris, garden wastes, electrical and electronic wastes and sanitation residue from the street. Residential and commercial complexes generated the garbage that forms part of the wastes that is classified as municipal/household wastes. With population increase in Owerri metropolis and Umuerim in particular and, the change in lifestyles and food habits, the amount of municipal wastes has been increasing rapidly. In the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminum foils, plastics, nylon and non-biodegradable items that can cause incalculable harm to the environment [12]; [13]. Proper handling of biodegradable wastes will lessen the burden of solid waste that each city has to tackle (Hoorweg, 2000; Arisbisala, *et al*, 2004).

The use of the *Umuerim* River by the riparian population especially those using the water for domestic purposes necessitates the need to have the river assessed for its ability to carry the pollutants while maintaining water of suitable quality for its intended use. The human need for water is not only a function of quantity but also of the quality of the water (Kowalkowski *et al.*, 2007; WHO, 2006). Water can be polluted by substances that dissolve in it or by solid particles and insoluble liquid droplets that become suspended in it (Plant *et al.*, 2001), and this poor quality water causes health hazard and death of human being, aquatic life and also disturbs the production of different crops (Ashraf *et al*, 2010; Scipeeps, 2009). In fact, the effects of water pollution are said to be the leading cause of death for humans across the globe, moreover, water pollution affects our oceans, lakes, rivers, and drinking water, making it a widespread and global concern (Scipeeps, 2009). Many studies have detected elevated levels of both organic and inorganic pollutants and heavy metals in surface and underground water and water in the vicinity of solid waste landfills. This includes those of van der Broek and Kirov, 1971; Murray 1981; Albaiges 1986; Borden and Yanoschak 1990. It has been observed from other studies that leachates from wastes at dump sites are potential sources of contamination of both groundwater and surface water (Odukoya *et al.*, 2002). According to Ashraf *et al.*, (2010), industrial and municipal wastes have created multiple environmental hazards for mankind, irrigation, drinking and sustenance of aquatic life.

II. STUDY AREA

The *Umuerim* River originates from Otamiri River which is one of the major rivers in Imo state, Nigeria. The Otamiri River runs south from Egbu past Owerri and through Nekede, Ihiagwa, Eziobodo, Olokwu Umuisi, Mgbirichi and Umuagwo to Ozuzu in Etche in Rivers state from where it meets or flows to the Atlantic Ocean. The watershed covers about 10,000 km² with annual rainfall of about 2250-2750 mm. The watershed is mostly covered by depleted rain forest, having thick under brushes, creeping vines and deep green vegetation which is as a result of heavy decay of plant droppings and foliage. The mean temperature of about 25 degrees centigrade and relative humidity of about 75-85% is experienced within the region throughout the year. The study area is in the rainforest belt region having peak rainfall during the months of June, July and September and low rains in December and January (Ibe and Uzoukwu, 2001).

The *Umuerim* watershed is dominated by sandy soil with little percentages of clay, loam and silt. The area is acidic with pH of between 4.67-5.6 for upper and lower layers and 5.0-5.6 at the crest and valley bottom and lower at mid slope (Njoku *et al.*, 2011). The watershed also in addition has low organic carbon ranging between 0.676-3.764 meq/100g for upper soil layer, 5.34-4.27 meq/100g for lower soil layer and lower at the mid slope, low nitrogen concentration range of 0.008- 0.068% and 0.018-0.048% for upper and lower soil layers (Njoku *et al.*, 2011). The general slope of the *Umuerim* watershed is 0.016 (Simmers, 1988). The soil type belongs to ferralic. The soil profile is remarkably uniform throughout the area, deeply weathered and intensely leached (Ibe and Uzoukwu, 2001).

The study area is within the subequatorial region which is characterized by two major seasons namely, the rainy season and the dry season (Iloeje, 1972). It is under laid by the sedimentary sequence of the Benin formation (Miocene-Recent) and the underlying Ogwashi-Asaba formation (Oligocene). The Benin formation is made up of friable sands with minor intercalations of clay. The sand units are mostly coarse-grained. The formation starts as a thin edge at its contact with Ogwashi-Asaba formation in the north of the area and thickens southwards (seawards). The average thickness of the formation at the study area is 800 m. The terrain of the study area is characterized by two types of land forms; highly undulating ridges and nearly flat topography.

In terms of hydrogeology the study area is drained by two rivers, namely the Otamiri and Nworie(Fig.1.) The Otamiri River has maximum average flow of 10.7 m³/s in the rainy season (September-October) and a minimum average flow of about 3.4 m³/s in the dry season (November-February).

The total annual discharge of the Otamiri is about $1.7 \times 10^8 \text{ m}^3$ and 22% of this ($3.74 \times 10^7 \text{ m}^3$) comes from direct runoff from rainwater and constitutes the safe yield of the river (Egboka and Uma, 1985). The depth to groundwater varies from 15 m-35 m in parts of the Owerri urban area. The aquifers have reasonable thickness and are extensive (Ibe and Uzoukwu, 2001). In terms of geology and position it is located within southeastern Nigeria sedimentary basin. The study area consists of Owerri metropolis and environs and has boundaries with some local Government Areas such as Ohaji/Egbema, Owerri East/West, Mbatoli, Ngor Okpala (Fig.2) among others. It is bounded by latitudes $5^\circ 15''$ - $5^\circ 35''\text{N}$ and longitude $6^\circ 55''$ - $7^\circ 15''\text{E}$.

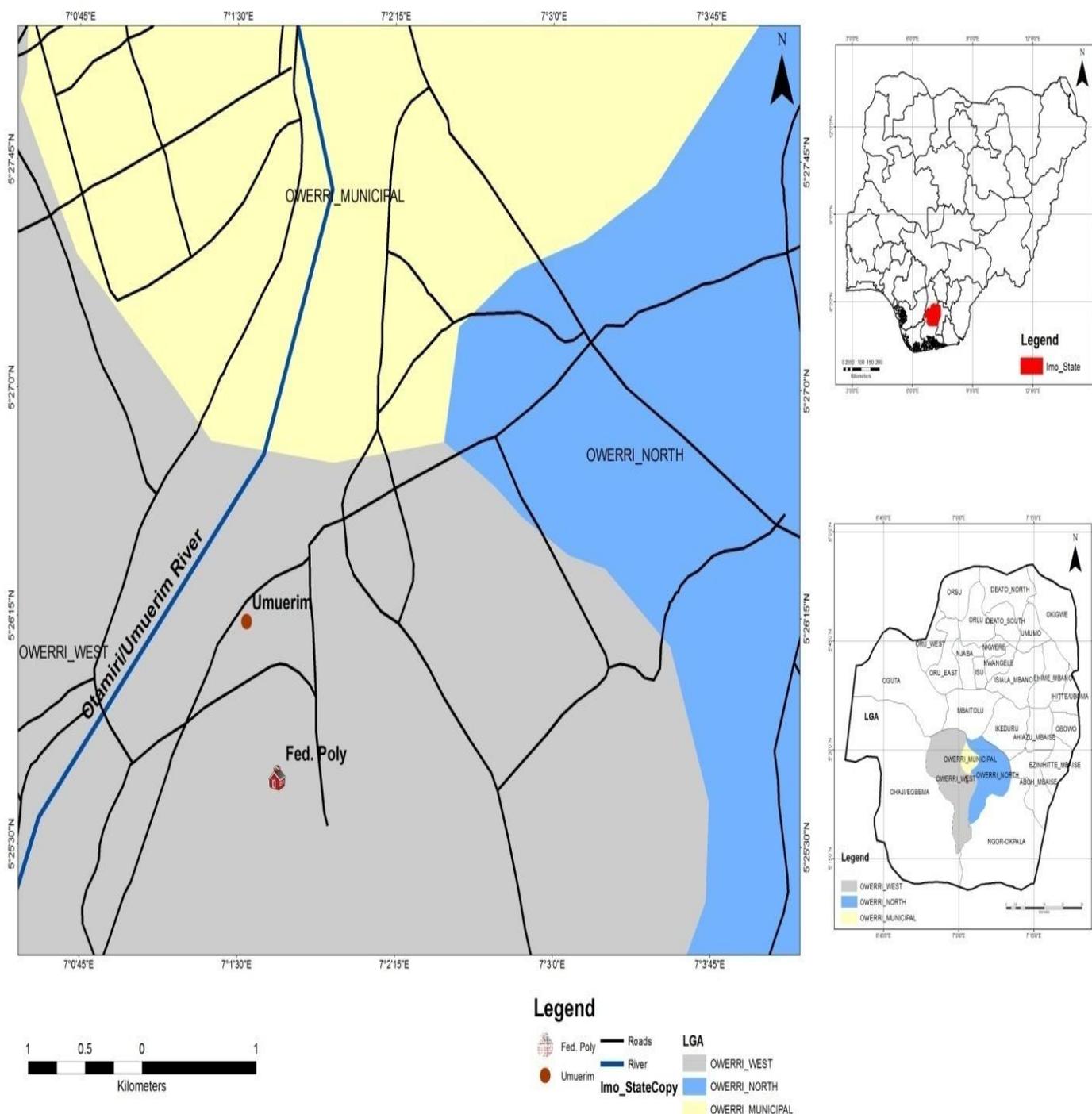


Fig. 1. Map showing Owerri municipal and Umuerim River

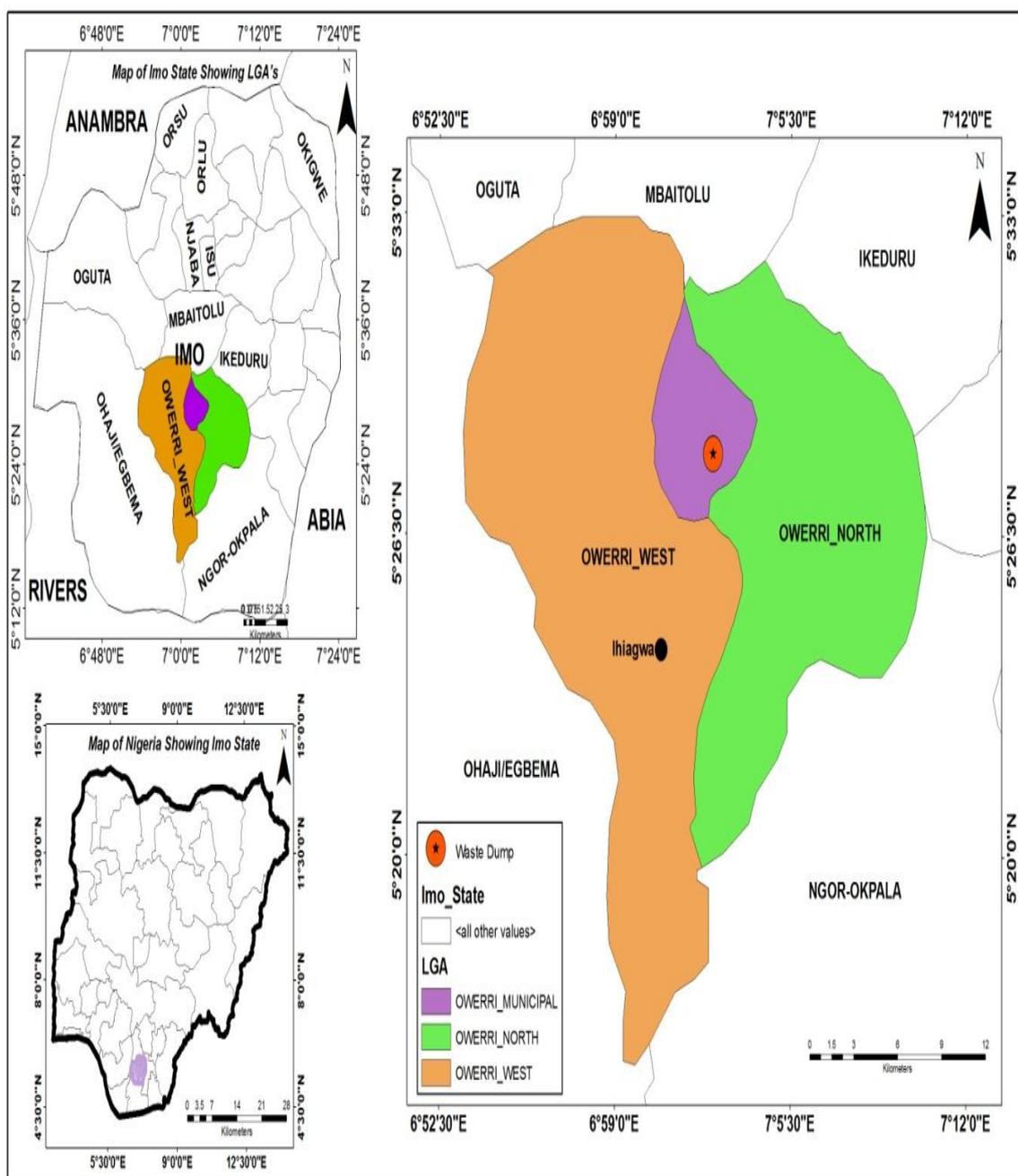


Fig.2.Showing Owerri Municipal L.G.A and neighboring L.G.As

III. MATERIALS AND METHODS

This study was preceded by reconnaissance visit which revealed lot of anthropogenic activities taking place in the area; such as open dumping, washing of automobiles, block industry, and domestic wastes discharge from households. The methodology involved collection of water samples at different stations; upstream, discharge point, midstream and further downstream, which was conducted during the month of October, 2016.

Sampling and Choice of Sampling Locations/Transportation

Four sampling points(upstream, discharge point, midstream, and downstream), designated as discharge point (SP1), midstream (SP2), downstream (SP3), and upstream point were established for comparative basis in the middle reaches of the River between Uzomiri and *Umuerim* communities, covering the area traversing the Federal Polytechnic site (Fig.1). Water samples were collected from four sampling points at different proximities (between 150 and 840 meters) to the River. Samples for biochemical oxygen demand (BOD) were collected in 250mL brown bottles. Water samples for trace metal were collected in plastic containers and fixed with conc. HNO_3 in the ratio of 2:500. Water samples for the other physicochemical parameters (sulphate, nitrate, phosphate, and total suspended solids) were collected with 500mL sterile plastic containers. Water samples were transported to the laboratory for analysis as soon as possible in an iced-cooler to maintain their integrity and ensure quality assurance and control.

3.4 *In-situ* measurements

Surface water temperature, conductivity, pH, Dissolved Oxygen (DO), turbidity and Total Dissolved Solids (TDS) were determined electrometrically with the HANNAH HI 9828 VI 4 PH/OR/EC/DO meter. The meter was pre-calibrated with the standard HI 9828-25 calibration solution. The desired physicochemical parameter was read off the LCD of the meter.

Nitration ions were determined by cadmium reduction method as adapted from APHA (2000) was employed in the determination of nitrate levels of the water samples. A cadmium based reagent pillow was added into 25mL of the water sample in a cuvette and shaken for one minute and allowed to stand for another five minutes for complete reaction to occur. The absorbance and concentration in mg/L was read at 500nm wavelength using HACH DR 2010 UV-visible spectrophotometer. The Sulphate ions was determined by barium chloride (Turbidometric) method (APHA, 2000) was adopted. The barium chloride based powdered reagent pillow was added into 25mL of water sample. The mixture was properly mixed and allowed to stand for five minutes for reaction to occur. The absorbance and concentration in mg/L was read at 450nm wavelength using HACH DR 2010 UV-visible spectrophotometer.

The Phosphate ions was determined by ascorbic acid method, according to APHA (2000) was adopted for the determination of phosphate level of the river water. Ascorbic acid based reagent powdered pillow was added into 25mL of the water sample in a cuvette. The sample was allowed to stand for two minutes for reaction to occur. The absorbance and concentration in mg/L was read at 890nm wavelength using HACH DR 2010 UV-visible spectrophotometer. For determination of Total Suspended Solids (TSS) an aliquot of the sample was filtered through a weighed glass-fibre filter paper, and the filter paper was oven-dried at 105°C for three hours according to ASTM D 1888-78 method. The weight of the filter paper was measure with a Meter H78AR balance. The difference in weight was taken as the TSS in mg/L. The heavy metals (Pb, Cd, Zn, Fe, Cu, Cr) contents of the river water was determined with the use of a Varian Spectra AA 600 Atomic Adsorption Spectrophotometer, as adopted from APHA (2000).The flame atomization method was used. Five milliliters of concentrated HNO_3 and a few boiling chips of Hengar granules were mixed with 250mL of the sample in a 400mL conical flask. The mixture was then boiled slowly and the content evaporated on a hot plate to the lowest volume possible (about 10–30ml) before precipitation occurred. Concentrated HNO_3 was added during the heating process. This was done to attain necessary complete digestion indicated by the observation of a light clear solution. During digestion, precaution was followed not to allow the sample dry completely. Ten milliliters of water was used to rinse the flask and added to the volumetric flask, which was further allowed to cool, diluted to 50ml mark and mixed thoroughly. From the mixture, the concentrations in mg/L of the trace elements in the cooled sample were determined by means of an atomic absorption spectrophotometer. The specific metal standards in the linear range of the metals were used to calibrate the equipment. The concentrated or digested samples were then aspirated and their actual concentrations obtained by referring to the calibration graph and necessary calculations made.

IV. Statistical Analysis

The descriptive statistics was used to obtain means, standard errors, range etc of the data set of parameters measured. The test of variance equality in means of concentrations of the physicochemical parameters was conducted with the One-way Analysis of Variance (ANOVA) at the 95% confidence limit.

V. RESULTS

The results of the concentrations of measured parameters of the study area and variations of the statistics are shown in this subsection.

The variations in physicochemical variables measured in Umuerim River, Nekede, Owerri during the study period are shown in table 1. Conductivity (range= 5.50 μ S/cm), Total Dissolved Solids (TDS) (range= 4.00 mg/L), Turbidity (range= 3.20 NTU) and Sulphate ions (SO_4) (range= 2.70 mg/L) recorded comparatively wide variations during the study period. Temperature, pH and Conductivity varied from 27.50-27.82 (27.63 ± 0.07) $^{\circ}$ C, 5.98-6.37 (6.2425 ± 0.09) and 22.50-28.00 (25.88 ± 1.20) μ S/cm respectively (Table 4.1). Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Sulphate varied from 1.28-1.60 (1.45 ± 0.08), 0.30-0.73 (0.49 ± 0.01) and 8.50-11.20 (10.38 ± 0.63) mg/L respectively.

Total Suspended Solids (TSS), Total Dissolved Solids (TDS) and Turbidity varied from 2.80-4.10 (3.70 ± 0.30) mg/L, 10.00-14.00 (12.75 ± 0.95) mg/L and 3.20-6.40 (4.93 ± 0.67) NTU respectively.

Table 1:Water quality parameters of the Umuerim River in Nekede

Parameters	SP1	SP2	SP3	Upstream	FME	
Temperature ($^{\circ}$ C)	27.58	27.82	27.62	27.50	NL	
pH	5.98	6.25	6.37	6.37	6.37	6.5-8.5
Conductivity (μ S/cm)	28.00	26.00	27.00	22.50	NL	
TSS (mg/L)	4.00	3.90	4.10	2.80	2.80	<10.0
TDS (mg/L)	14.00	13.00	14.00	10.00	10.00	500
DO (mg/L)	1.57	1.33	1.28	1.60	1.60	7.5
BOD ₅ (mg/L)	0.53	0.73	0.41	0.30	0	0
Turbidity (NTU)	4.80	6.40	5.30	3.20	1.0	1.0
NO_3^- (mg/L)	0.30	0.40	0.20	0.20	10.0	10.0
PO_4^{2-} (mg/L)	1.00	1.20	1.20	0.80	5	5
SO_4^{2-} (mg/L)	11.20	10.80	11.0	8.50	500	500
Pb (mg/L)	0.002	0.004	0.002	BDL	BDL	0.05
Zn mg/L	0.12	0.14	0.15	0.10	5.0	5.0
Fe mg/L	0.64	0.72	0.80	0.55	1.0	1.0
Cu mg/L	0.04	0.10	0.04	0.04	0.1	0.1
Cr mg/L	0.005	0.003	0.004	BDL	0.05	0.05

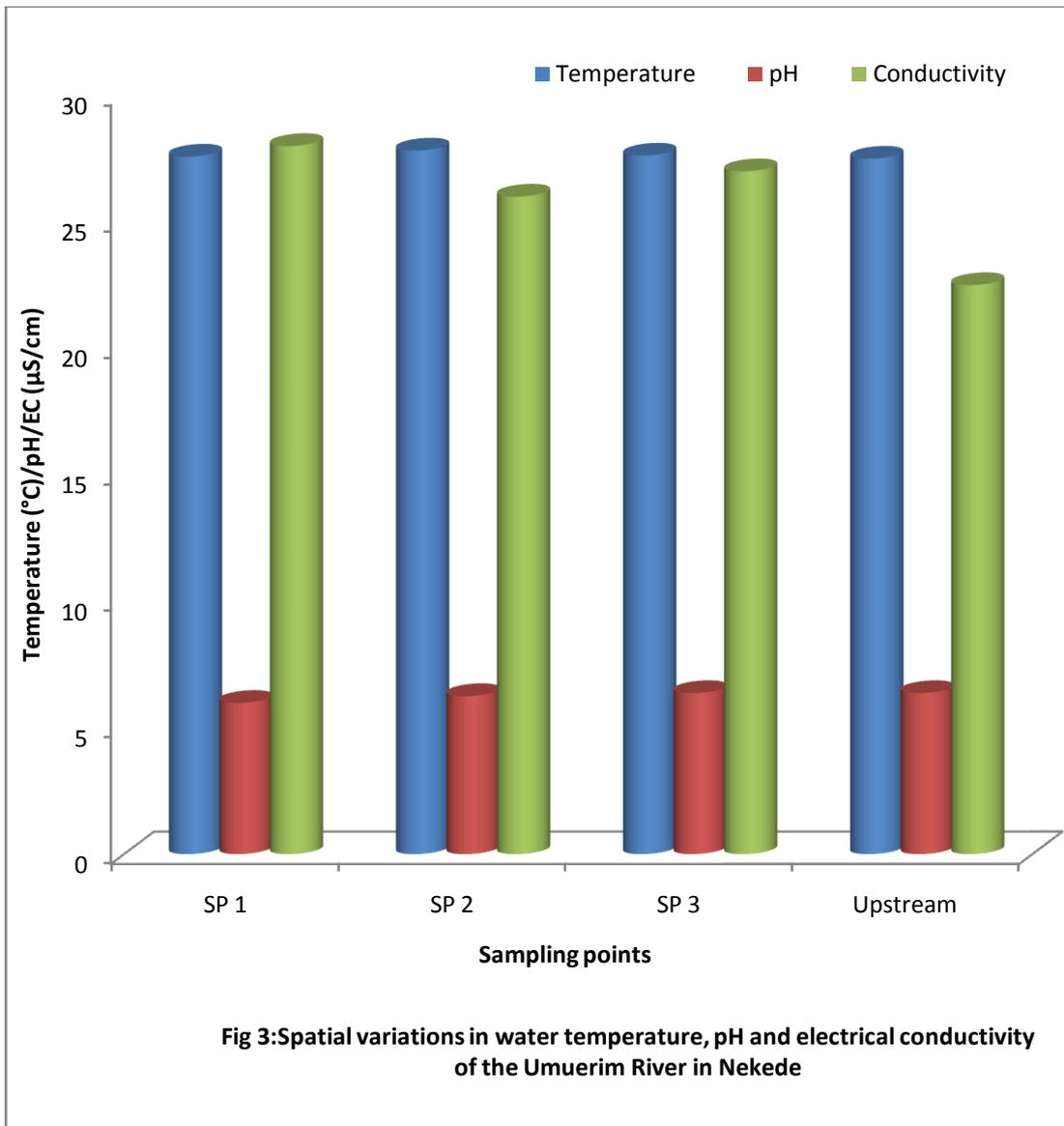
Table 2: Descriptive statistics of water quality parameters of the *Umuerim* River in Nekede, Owerri.

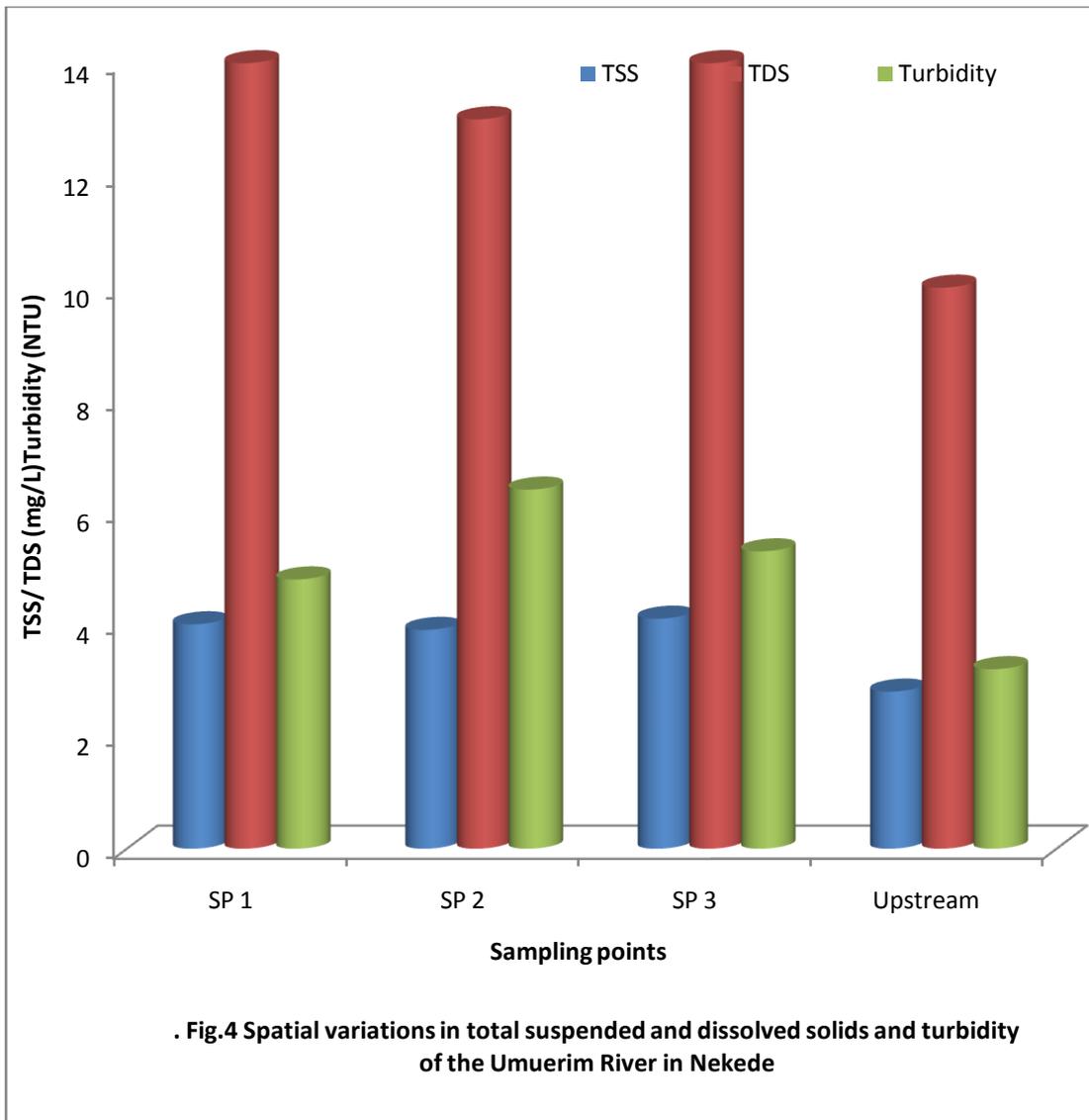
Parameters	Minimum	Maximum	Range	Mean	SE	FME	
Temperature (⁰ C)	27.50	27.82		0.30	27.63	0.07	NL
pH	5.98	6.37		0.39	6.24	0.09	6.5-8.5
Conductivity (μS/cm)	22.50	28.00		5.50	25.88	1.20	NL
TSS (mg/L)	2.80	4.10		1.30	3.70	0.30	<10.0
TDS (mg/L)	10.00	14.00		4.00	12.75	0.95	500
DO (mg/L)	1.28	1.60		0.32	1.45	0.08	7.5
BOD (mg/L)	0.30	0.73		0.43	0.49	0.09	0
Turbidity (NTU)	3.20	6.40		3.20	4.93	0.67	1.0
NO ₃ ⁻ (mg/L)	0.20	0.40		0.20	0.28	0.05	10.0
PO ₄ ²⁻ (mg/L)	0.80	1.20		0.40	1.05	0.10	5 >
SO ₄ ²⁻ (mg/L)	8.50	11.20		2.70	10.38	0.63	500
Pb (mg/L)	0.00	0.00		0.00	0.00	0.00	0.05
Zn (mg/L)	0.10	0.15		0.05	0.13	0.01	5.0
Fe (mg/L)	0.55	0.80		0.25	0.68	0.05	1.0
Cu (mg/L)	0.04	0.10		0.06	0.06	0.02	0.1
Cr (mg/L)	0.00	0.01		0.01	0.00	0.00	0.05

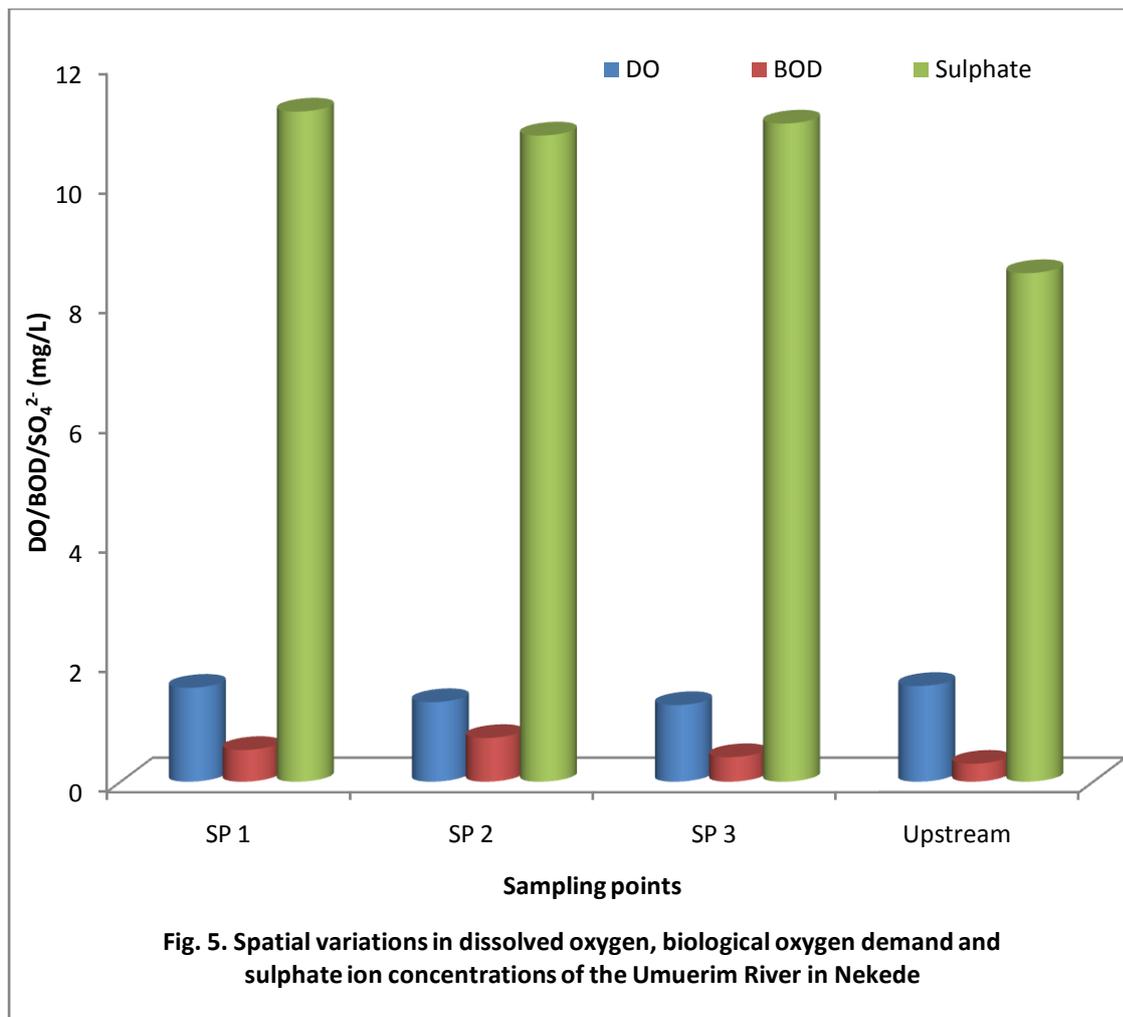
SE= standard error of mean, DO= Dissolved Oxygen, BOD= Biological Oxygen Demanded, TSS= Total Suspended Solids, TDS= Total Dissolved Solids, FME= Federal Ministry of Environment, 2001

Spatial Variations in Water Quality Parameters

Longitudinal spatial variations were observed in the physicochemical parameters measured in the study as shown in the figures below:







Umuerim River is facing severe degradation from anthropogenic activities in the catchment area. These activities include in block industry, stream sand mining, washing of automobiles, household wastes and agricultural waste input. The wide variations recorded in levels of conductivity, TDS, turbidity and sulphate ions of the other indicates that the rate of their input was higher than those parameters that had narrow variations.

The results also showed a trend of high concentrations of DO in Upstream and low concentration at SP3, which gradually increased in SP1. This observed spatial variation also reflects input of oxygen demanding pollutants mainly at SP3 and a gradual river recovery capacity downstream.

The concentration of DO in *Umuerim* River was below the recommended limits in fresh water (7.5 mg/L) by Federal Ministry of Environment. Low concentrations of DO in the *Umuerim* River could be associated with direct discharges of untreated Anthropogenic effluents and municipal sewage in the Owerri Municipal where the river had earlier coursed through. Municipal sewage and Anthropogenic effluents contain organic substances, which are biodegradable, require a large amount of oxygen for oxidation process by micro-organisms and causes depletion of DO. In aquatic systems, excessive organic and inorganic input (from industrial and urban waste) may reduce the availability of DO. Recommended concentration of DO is 4.0 mg/L for fishes (McNeil and Closs, 2007). However, most species are distressed when it falls between 2.0 - 4.0 mg/L. Low level of DO (less than 2.0 mg/L) can cause fish mortality (McNeil and Closs, 2007). Municipal sewage and Anthropogenic effluents decrease DO level and increase BOD level in stream water (Singh et al., 2005).

The highest level of BOD recorded in SP2 may be due to the discharge of higher volumes of oxygen-demanding wastes into the stream (Khan et al., 2003 and Singh et al., 2005). However, the level of BOD in *Umuerim* River was above the recommended limit 0.0 mg/L in freshwater by FME (2001).

Similarly, high concentrations of TDS which were recorded in SP1 and SP3 were below the permissible limit of 500 mg/L by FME. High values of TDS could have resulted from effluents containing higher concentrations of soluble salts related with natural and anthropogenic sources.

The high concentrations of TSS which was recorded in SP3, was within the permissible limit of <10.0 mg/L recommended by FME (2001).

The mean level of turbidity recorded in this work was above the permissible limit of 1.0 NTU by FME (2001).

The highest concentration of NO_3^- ions which was recorded in SP2, could be associated with agricultural activities in the catchment area. Elevated concentration of NO_3^- ions comes from agricultural fields after surface runoff. Yang *et al.* (2004) and Morrison *et al.* (2001) also reported similar reason of high level of NO_3^- ions in stream water, which was below the permissible level (10 mg/L) recommended by FME (2001).

In contrast, highest level of PO_4^{2-} ions was observed in SP2 and the lowest in Upstream. These were below the permissible limit of 5 mg/L recommended by FME (2001). The level of SO_4^{2-} ions was also below the permissible limit of 500 mg/L recommended by FME (2001). Municipal sewage was identified as the possible source of PO_4^{2-} ions. The elevated concentration of PO_4^{2-} ions could be due to human impacts on streams and may be associated with direct discharge of raw sewage (Singh *et al.*, 2005) from the earlier parts of the river in Owerri municipality. Higher level of PO_4^{2-} ions may also occur as a consequence of the use of detergents (Perona *et al.*, 1999; Sundaray *et al.*, 2006). Higher concentrations of PO_4^{2-} and NO_3^- ions may cause eutrophication in streams and lakes (Morrison *et al.*, 2001).

Cr concentration in Umuerim River was below the permissible limit (0.05 mg/L) recommended by FME (2001). Large volumes of effluents are produced during tanning process, which contain high concentration of chromium and soluble salts such as NaCl (Moten and Sami, 2000). These contributions could come from abattoirs sited along the course of the river in the Owerri Municipal. Indiscriminate use of Cr salts in tanneries is one of the main sources of its increased level in drains and streams. Cr is mainly found in industrial wastes from the chrome tanning process. About 70% of the total amount is taken up by the hides and about 30% remains unabsorbed, which goes into the effluent and sludge. Continuous discharges of Cr, even in low concentrations, have been reported to have toxic effects on aquatic life and can disrupt the food chain in aquatic ecosystems (Bosnic *et al.*, 2000). High pH allows Cr to convert into complex substances and become part of suspended particulate matter, which settles down as effluents travel the distance from the source. Higher concentration of Cr in sediment is toxic to aquatic organisms in general and particularly to bottom dwelling organisms. Maximum concentration of Zn which was recorded in SP3 was however, below the permissible limit of 5.00 mg/L recommended by FME (2001). Maximum concentration of Fe which was recorded in SP3 was below the permissible limit 1.0 mg/L recommended by FME (2001). Maximum concentration of Cu which was recorded in SP1 was below the permissible limit of 0.1 mg/L recommended by FME (2001).

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Community Participation Level in Business Capital Strengthening

(A Case Study at LEM Sejahtera Andomesinggo, Konawe Regency, Indonesia)

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ABSTRACT

The purpose of this research is to know the community participation level in business capital strengthening at LEM *Sejahtera* Program. This research was conducted in AndomLEMnggo Village Beselutu District, Konawe Regency, Indonesia. The study was conducted during 12 months. This research begins by determining the respondent purposively ie the perpetrator who knows and understands the problem, and is directly involved with the research problem. The number of respondents in this study is determined as much as 25% of the total population. So the number of respondents or actors in this study were as many as 38 people. For qualitative data collection, the determination of informants is based on preliminary information about the existence, their roles and functions, work programs and institutional activities. Results of the study showed that: the level of participation of members of LEM *Sejahtera* in business capital strengthening program is high. Members have mobilized themselves in an integrated activity (savings and regular meetings) and the parties only act as facilitators.

Keyword : community participation, capital business strengthening, LEM *Sejahtera*

I. INTRODUCTION

Society Economic Institution LEM *Sejahtera* is a community institution at the village level formed from the community, by the community and for the village community by collecting and utilizing all the potential resources in the village to improve the capacity of human resources and to create a prosperous society for all members of the community (the Cocoa Farmers, specially). In realizing the welfare of farmers there are three phases namely: 1) Human Resource Development; 2) Network development Business partnerships (network business) and 3) phases Increasing. The third competitiveness can be achieved through the empowerment of farmers' economic institutions (Wan Abbas Zakaria, 2014). Community participation in farmer institutions, the higher the participation level both the intensity and quality of participating, the more encouraging the institutional effectiveness (Anantanyu, 2014). Based extension system should be institutionalised in order to ensure sustainability in the transfer of the technologies. The system should be able to lead to the building of the capacity of the local farming community to continue utilising and transferring these technologies to solve their problems and ultimately creating sustainable farming systems (Noordin Q and Senior Agroforester, 2015). More importantly, however there must be government support either in cash or in kind (Olukotun GA, 2008).

Nikoyan (2015) explains that the participation rate of farmers can be classified into several levels, namely: Very low participation level, Low participation, Medium participation, High participation, and very high participation level. Studies from Mundau and Tanga (2016) show that there is some or no involvement of project members in the various phases of the project cycle. Furthermore, there is consultation with local leaders, but not during the project assessment phase. Governments at all levels and development partners have not really succeeded in mobilizing and

creating desired awareness on how community participation should be addressed and achieved. Understanding the fact that participatory models have neither imposed any task upon governments nor other development agency but effective community participation is unlikely to occur without serious attention from the government. (E. D. Laah et al, 2013).

The research on about participation has also been done by Tanwir M and Safdar T (2013). about The Rural Woman 's Constraints to Participation in Rural Organizations. Azunna C (2018) about Post-colonial agricultural participation in livelihood strengthening. The study conclude that the introduction and adoption of AVM brought about substantial changes to the farmers livelihood capitals. Community participation in natural resource management in madurai district-TN India (Britto S and Rani S. 2017). Research Usadolo SE and Caldwel M (2016) about investigates a rural community project (Nguni Cattle Project) that uses Participatory Rural Appraisal (PRA) as a tool for its operational focus. The main objective of the study is to identify how the stakeholders are reflecting the PRA goal of the project.

II. RESEARCH METHODS

Paradigm and Type of Research

This research paradigm is based on post-positivistic philosophy which views social reality as something intact, complex, dynamic, meaningful and interactual supported by quantitative This research is a case study that is intensive testing, using various sources of evidence against an entity limited by time and space, this test links the cause and effect (Daymon and Holloway, 2002).

Location and Analysis Unit

This research was conducted at LEM *Sejahtera* in AndomLEMnggo village Besolutu Sub-district of Konawe Regency, Indonesia during 12 months.. Site determination was done purposively. The study analysis unit is a community participating in LEM *Sejahtera* program and other institutions involved in capacity development and capacity building.

Types and Data Sources

Primary Data, is data obtained from the object of research by conducting in-depth interviews on informants with the help of questionnaires. Data on the level of participation of members in program implementation and institutional capacity. Secondary Data, is data obtained from relevant agencies that have to do with this research.

Data Collection and Informant Determination

This study was started by determining the respondents purposively (25% of the total population members of LEM *Sejahtera* which amounted to 150 people) so that obtained 38 people. For qualitative data collection, informant determination is based on preliminary information about the existence of LEM *Sejahtera*, its roles and functions, work programs and institutional activities.

Data Analysis

Data analysis used in this research is qualitative analysis method. According to Daymon and Holloway (2008), qualitative analysis is a process of organizing, structuring and interpreting irregular data. Qualitative analysis consists of three stages: data reduction, data presentation and conclusion. The analytical tool to know the Community Participation in the implementation of LEM *Sejahtera* is done by combining the level of community participation in the LEM *Sejahtera* program according to Anas Nikoyan (2015) with the participation typology according to Pimbert and Presty (1997)

RESULTS AND DISCUSSION

The level of community participation in business capital strengthening programs is based on their involvement in savings and loan activities, buying and selling of production facilities and cocoa beans and attendance in monthly routine meetings. Business capital is sourced from members and from government and private / banking aid.

Participation of members in efforts to strengthen managed business capital is largely categorized as high and partly in very high and medium categories. This is indicated by the liveliness of members who have settled staple savings and Compulsory savings but for voluntary savings and Simaya is still low. The proportion of owned capital is mostly sourced from members' self-saving deposits (staple savings, Compulsory savings, voluntary savings and Simaya) and the accumulated

Time Operating Income generated annually. The categorization of member participation levels in the business capital strengthening program can be seen in Table 1.

Table 1. Community Participation Level on Business Capital Strengthening of LEM *Sejahtera* Program

Participation Level	Outstanding Public Position		Respondent Frekuensi	%
	Participation Level	Typology of Participation		
Medium	Involvement: Members are involved in the business capital strengthening	Members have joined in LEM <i>Sejahtera</i> just following the program set by LEM <i>Sejahtera</i> .	3	7,90
High	Empowerment: Active members in the strengthening of business capital (savings activities - borrowing and buying and selling of means of production) and conducting regular meetings and not dependent outside parties LEM <i>Sejahtera</i>	Community members have mobilized themselves in the savings and together the board takes the initiative to hold monthly meetings. Outsiders, in this case, extension agents and other institutions only act as facilitators and monitor the various activities of LEM <i>Sejahtera</i> related to the strengthening of business capital.	27	71,05
Participation Level	Community Position To Outside Parties		Respondent Frekuensi	%
	Participation Level	Typology of Participation		
Very High	Collaboration: Members of LEM <i>Sejahtera</i> are active in savings - loans, buying and selling of production facilities independently and no longer dependent on outside parties . Actively conducting monthly regular meetings without any compulsion from any party, and acting as a motivator for the members around him	Members of LEM <i>Sejahtera</i> are active in savings - borrow and sell - buy production facilities independently and are no longer dependent on outside parties. Actively conducting monthly regular meetings without any compulsion from any party, and acting as a motivator for the members around him	8	21,05
Total			38	100,00

Based on Table 2 it is known that most of the respondents have a participation rate in the strengthening of business capital that is high as much as 27 people (71.05%). The monthly routine meeting held by LEM *Sejahtera* is used as a vehicle of unity for the citizens as well as to obtain various information related to the implementation as an evaluation of activities that have been implemented during the last month, as well as a vehicle to get information about various activities related to the planning or program the have been implemented institution, both activities derived from the facilitation of government, private and self-help activities and implemented by deliberation. In this meeting also carried out Compulsory savings transactions, the return of member savings and loan services for members in need. This condition indicates that the empowerment activities in the

business empowerment activities of LEM Sejahtera which have been carried out facilitators have been running well

The activities of LEM Sejahtera members in the strengthening of business capital in each aspect in the form of principal savings, Compulsory savings, voluntary savings, Simaya, borrower and or buyer of production facilities and monthly routine meetings are described as follows.

Member Participation in Staple Savings

Total staple savings of the Years 2014, 2015 and 2016 are IDR 141,018,000, IDR 148,108, - and IDR 148,500,000, -. This data shows that there is an increase in the amount of staple savings each year. This happens along with the development of the number of members who are members of LEM Sejahtera. Based on the results of the study also known that all respondents have paid staple savings of IDR 1.000.000, - / member.

Participation of members in staple savings is high categorized . The high participation of members is indicated by the awareness of members in making payments without having to be forced to pay off the staple savings that have become mutual agreement. This condition is reinforced by the repayment time of staple savings by some members, of whom 8 directly repay the staple savings when registering as a member, 27 people pay off the deposit for a period of one year and only 3 people pay off the staple savings for two years after registering as a member. Respondents' perceptions of the repayment time of staple savings can be seen in Table 3

Table 2. Perception of Respondents to Staple Savings Payment

No.	Description	Frequency	Percentage (%)
1.	Cash	8	21,05
2.	Credit ≤ 1 Years	27	71,05
3.	Credit 1,1 – 2 Years	3	7,90
Total		38	100

Based on Table 2 it is known that all respondents (100%) have paid staple savings, 8 people (21.05%) of which paid the principal savings directly paid (cash), 27 people (71.05%) paid staple savings by credit less than or equal to one year and 3 (7.90%) of other respondents repay staple savings by way of credit more than one to two years and declaring themselves register as a member.

Member Participation in Compulsory Savings

Number of Compulsory savings of members Year 2014 IDR 62,028,000, -; Year 2015 increased to IDR 77,065,000, - and Year 2016 IDR 92,027,000, -. These data indicate that the number of Compulsory savings of members has increased significantly each year. This is in accordance with the development of the number of members who joined in the LEM Sejahtera and the accumulated compulsory savings from the previous year.

Table 3. Respondents' perceptions of the repayment time of compulsory savings at LEM Sejahtera During the Year 2016

No	Description	Frequency	Percentage (%)
1.	Never Delinquent	34	89,47
2.	Delinquent a Month	3	7,90
3.	Delinquent Two Months	1	2,63
Total		38	100,00

Based on Table 3 of 38 respondents, 34 people (89.47%) said that the compulsory savings were never delinquent, 3 people (7.90%) stated they had been delinquent a month and the rest as much as 1 person (2.63%) for two months. In general, members who have arrears of mandatory contributions from the area so do not hold monthly meetings to pay compulsory dues. Based on these results it can be concluded that the number of members in performing mandatory savings is very high.

Member Participation in Voluntary Savings

Year 2014 voluntary savings IDR 27,884,000,-; Year 2015 increased to IDR 25,609,000, - while in 2016 decreased to IDR 20.839.000,-. These data indicate that there is a fluctuating increase. Members' participation in voluntary savings is categorized as very low. This is indicated by the perception of respondents as shown in Table 4.

Table 4. Respondents' Perceptions of Voluntary Savings on LEM *Sejahtera*

No	Description	Frequensi	Percentage (%)
1.	Have Voluntary Savings	20	52,63
2.	Do not Have Voluntary Savings	18	47,37
Total		38	100,00

From Table 4 it can be seen that from 38 respondents 20 people (52.63%) of them have voluntary savings and 18 people (47.37%) do not have voluntary savings. Based on the financial statements of the board of LEM *Sejahtera* known that the amount of voluntary savings of respondents ranged from IDR 10,000, - to IDR 3,000,000. This condition shows that the participation of respondents in voluntary saving is still low. Stakeholders must make effort to address the various constraints identified by respondents (Adeogun, 2015)

Member Participation in *Simaya* Savings

Total *Simaya's* savings Year 2014 Rp 15,077,000, -; Year 2015 increased to Rp 16,425,000, - while in the Year 2016 decreased to Rp 4.905.000, -. This data indicates that there is a fluctuating development of the number of *Simaya* from year to year. Perception of respondents to *Simaya* as shown in Table 5.

Table 5. Respondents' Perceptions of *Simaya's* Savings on LEM *Sejahtera*

No	Description	Frequency	Percentage (%)
1.	Have <i>Simaya's</i> savings	6	15,79
2.	Do not have <i>Simaya's</i> savings	32	84,21
Total		38	100,00

From Table 5 it can be seen that from 38 respondents only 6 people (15.79%) have *Simaya's* savings and most others 32 people (84.21%) do not have *Simaya's* savings. Based on the financial report of the board, it is known that the amount of *Simaya's* savings ranges from IDR 71,000 to IDR 2,000,000. This condition indicates that the participation of respondents in *Simaya's* savings is still very low.

Participation of Respondent as Borrower and or Buyer

Based on the results of the research is known that there are members of LEM *Sejahtera* who only lend money or goods (production facilities), there are only buying goods and some are doing

borrowing money as well as buying goods. Respondents' perceptions of borrowing activities and or purchase of production facilities can be seen in Table 6.

Table 6. Respondents' Perceptions of Loans and or Purchases on LEM *Sejahtera*

No	Description	Frequency	Percentage (%)
1.	Borrowing (Money or Goods)	7	18,42
2.	Buying Goods	4	10,53
3.	Borrowing and Buying	27	71,05
Total		38	100,00

Based on Table 6 it can be seen that from 38 respondents mostly borrowed either money or goods as well as purchase of production facilities in cash to LEM *Sejahtera* as many as 27 people (71.05%), 7 people (18.42%) only conduct lending activities and 4 people (10.53%) only purchase the means of production in cash

This condition indicates that all respondents have participated in the business activities of LEM *Sejahtera*, either in the form of savings and loan business as well as sales of production facilities in the form of subsidized fertilizer. Thus the participation of members in lending and or purchasing activities is high. The participation of members in this activity is due to the fact that the respondent engages in borrowing activities both in the form of money and goods and also conducts the purchase of production facilities with full awareness and because of the basic needs that they must fulfill. Respondents are also keenly aware that by lending and / or purchasing production facilities will have an impact on the scale of business and the remaining business return (RBR) they will earn each year. This condition also shows that savings and loan business and sales of production facilities LEM *Sejahtera* have been running well.

Participations of Respondents of Monthly Routine Meeting Activities

Based on the results of the research note that LEM *Sejahtera* organizes routine meetings held every 15th of the month.

Table 7. Perceptions of Respondents of Monthly Routine Meeting Activities at LEM *Sejahtera* Year 2016

No	Description	Frequency	Percentage (%)
1.	Active	14	36,84
2.	Less Aktive	17	44,74
3.	Not active	7	18,42
Total			100,00

This condition indicates that the participation of respondents in of Monthly Routine Meeting Activities at LEM *Sejahtera* is still very low.

III. CONCLUSION

The level of participation of members of LEM *Sejahtera* in business capital strengthening program is high. Members have mobilized themselves in an integrated activity (savings and regular meetings) and the parties only act as facilitators. Participation is the "catalyst" of the government opening process, and trust represents a key input of the public participation (Duțu A and Diaconu M, 2017).

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Knowledge management and its importance in improving the performance of small and medium-size enterprises

Study of a sample of small and medium-size enterprises in western Algeria

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ABSTRACT

The present research paper aims at elucidating the importance of using Knowledge Management as a modern management tool in small and medium-size enterprises operating in western Algeria and its role in improving their performance.

An attempt is made in this research to give a *theoretical definition* of knowledge management, define its requirements and functions, explain performance and its components, and elucidate the importance of Knowledge Management in institutions. In addition, a brief overview is given about small and medium-sized enterprises and their *characteristics in Algeria*.

Moreover, the study was conducted on a sample of small and medium-size enterprises in western Algeria, using questionnaires which were distributed to 40 managers of these institutions. These questionnaires were collected and analyzed by means of the *Statistical Package for the Social Sciences (SPSS – manufactured by IBM Corporation)*.

A set of conclusions could be drawn at the end of the research:

- Small and medium-size enterprises in western Algeria use Knowledge Management as a modern management approach;
- There is a statistically significant correlation between Knowledge Management and Performance in the institutions under study;
- There is a statistically significant impact of Knowledge Management on the overall performance of the institutions under study.

I. Introduction

Recent trends and developments have led to more intense competition among individuals, organizations and even countries; they have engendered the emergence of a number of new approaches, systems and concepts in order to address these changes and to withstand and resist competition. The most recent and prominent of these concepts is Knowledge Management (KM) which consists of putting the acquired knowledge and skills in the hands of employees at the right time and in the appropriate form and ease-of-use in order to achieve higher levels of accomplishment.

Knowledge management (KM) has become the key strategic asset and the best way for organizations to achieve the best performance if it is polarized and used efficiently. Small and medium-size enterprises are most closely linked to this approach. This type of institutions has succeeded in imposing its role in the economic life. Small and medium-size enterprises (*SMEs*) proved to be hugely effective in the economic system because they have contributed to building an integrated industry in developed countries. These institutions have also become a leading player in the economic development, through the creation of new jobs; this has raised the interest of all countries in Knowledge Management.

Presently, the sector of small and medium-sized enterprises (SMEs) represents between 90 and 99% of the total number of companies in many countries. The reason for this is that SMEs are different from the other institutions; they have a simple organizational structure, a limited capital, some

flexibility and speed of adaptation to external changes, etc. However, in this new environment, in which the uncertainty management process has taken place and competition has become more intense, these institutions must adapt to the new changes and adopt the best and most modern management strategies that rely on information, technology and knowledge management in order to achieve the best possible performance and thus to struggle against both domestic and foreign competition.

II. Research problematic

Algeria, like the rest of the world, has strived in recent years to change its economic trends from oriented economy to market economy, by taking several measures that would help to get out of the crisis and remedy the repeated mistakes and failures of its large public-sector institutions. Algeria has encouraged the development of small and medium-size enterprises (SMEs) as a means of achieving the economic development, particularly because these institutions suit well the economic and social characteristics of Algeria.

Despite the remarkable increase in the number of this type of enterprises in Algeria since 2001*, one must acknowledge that the practical reality proves that this growth is not commensurate with the objectives sought by the various government programs which were established to facilitate and stimulate this type of institutions. In addition, the number of companies going bankrupt is continuously on the rise; this is certainly attributed to the large number of problems the SME sector is facing. The most prominent of these is the lack of awareness of workers and managers of these institutions for the need to modernize the methods of management and keep up with the recent developments in contemporary business organizations.

Based on the above, we can ask the following question:

How can Knowledge Management be used to serve as a modern approach to management and as an effective way to improve the overall performance in small and medium-size enterprises in Algeria?

In order to find an appropriate answer to this problem, a *particular focus is placed* on small and medium-size enterprises in the western region of Algeria, particularly in the Provinces (Wilayas) of Ain-Temouchent, Oran, Mascara, Sidi Bel-Abbes, Saida, and Tlemcen.

A questionnaire was distributed to managers only, without resorting to employees, since Knowledge Management should begin with the director of the enterprise.

Importance and objectives of the study

The present study is fundamental; it aims to:

- Highlight the meaning and importance of Knowledge Management in contemporary business organizations;
- Clarify the meaning of performance and define the ways to improve it in contemporary institutions;
- Identify the characteristics of Algerian small and medium-size enterprises;
- Get closer to small and medium enterprises (SMEs) in western Algeria and become

* Date of issuance of the law on the promotion of small and medium-sized enterprises in Algeria.

informed about the prevailing management methods.

The objectives of the study are to:

- Enrich scientific research with the important and sensitive subject of Knowledge Management in small and medium enterprises;
- Demonstrate the relationship between Knowledge Management (KM) and Innovation performance (IP) in this type of institution;
- Confirm the positive impact of Knowledge Management (KM) on the overall performance (OP) in SMEs;
- Attempt to sensitize the managers of *small and medium-sized businesses* (SMBs), which are under study, about the importance of this modern way of management in order to achieve the continuity and survival of their institutions in the *light* of globalization and *intense competition*.

Hypotheses of the study

Based on the above, the following hypotheses may be suggested:

First key Hypothesis: Small and medium-size enterprises in western Algeria use Knowledge Management with its five components, namely *knowledge recognition, knowledge creation, knowledge storage, knowledge application, and knowledge transfer and dissemination* as a modern management approach.

Second key hypothesis: There is a statistically significant relationship between Knowledge Management and its five components, namely *knowledge recognition, knowledge creation, knowledge storage, knowledge application, and knowledge transfer and dissemination*. It is important to know that the global performance in SMEs in western Algeria has as a significance level of 0.05.

- **Tird key hypothesis:** There is a statistically significant impact of Knowledge Management processes on general performance in SMEs in western Algeria with a significance level of 0.05.

Previous studies

-**The study of Houari Maaradj and Dalal Stouh**, entitled "*Assessing the manager's attitudes towards the application of Knowledge Management in Algerian institutions*". This study aimed at identifying the capacity and readiness of Algerian public institutions to implement the Knowledge Management system. In order to reach this goal, 48 questionnaires were randomly distributed to a group of directors, assistant directors, and department heads in public institutions. The results of the study were as follows:

- There is a positive trend among managers in Algerian institutions towards the application of Knowledge Management and its components;
- The level of execution of core knowledge management processes in public institutions does not help to implement knowledge management and its components;
- The level of readiness of human resources, in terms of preparation and rehabilitation, in these institutions helps to some extent in the application of knowledge management and its components;
- The level of *Information and Communications Technology (ICT)* infrastructure does not facilitate to implement knowledge management and its components;
- Algeria has not fully embraced the shift towards the digital economy yet; its public institutions still lack some of the basic components of the technology infrastructure on which knowledge management and its applications are founded.

- **The study of Khachali**, under the title: "*Knowledge management and its impact on organizational performance - A field study in Jordanian industrial companies*". This study aimed at identifying the impact of knowledge management on the organizational performance of the Jordanian industrial companies. The study was conducted on a sample of 264 workers, selected from 37 industrial companies. The needed information was collected through a questionnaire, which was specifically designed for that purpose. The study provided the following important results:

- A statistically significant relationship exists between the components of knowledge management, i.e. knowledge acquisition, knowledge transfer, and knowledge response.
- There is a significant effect of knowledge management components on comparative performance;
- There is a significant effect of knowledge of response on comparative performance; however, the components of knowledge acquisition and knowledge transfer do not have a significant effect on internal performance.

- **The study of Zack and al.**, entitled: "*Knowledge Management and Organizational Performance: An Exploratory Analysis*". The objective of this study was to highlight the impact of using Knowledge Management on the outcomes of organizational performance within commercial organizations. The researcher designed a questionnaire to collect the needed information for his study; it was then distributed to 1500 managers who studied or received training in a leading North American Business School. *The study reached the following essential results:*

- There is a direct relationship between knowledge management and organizational performance;
- There is a direct and significant relationship between financial performance and organizational performance;
- There is no direct relationship between the financial performance and knowledge management practices;
- There are other factors that affect financial performance; these are the relationship of the company with customers, product development, and operational excellence.

Comments on previous studies

Our current study, which addresses Algerian institutions, provided findings that are fully consistent with those reported in the first study (**Houari Maaradj and Dalal Stouh**). The present study resulted in similar results; it found out that although Algerian institutions focus on some components of knowledge management only, like using modern technology and stimulating workers' motivation, ..., they still lack some basic elements of technology infrastructure that are required for an efficient management of knowledge and its applications, in addition to poor communication and teamwork, which generally lead to weak and inadequate implementation of Knowledge Management.

Our study is different from the previous one; ours focuses on a particular type of institutions, namely small and medium-size businesses, which today have become one of the most important means of achieving economic development in most economies throughout the world. Therefore, it is urgent for these institutions to catch up with modern organizations and adopt Knowledge Management as a novel management approach.

Our research is consistent with Khashali's study as well as with that of Zack et al. regarding the relationship between knowledge management and performance; this study arrived at the same conclusion, which is that knowledge management has a positive impact on performance in institutions.

The current work differs from that of Khashali as it deals with all five Knowledge Management components, namely knowledge recognition, knowledge generation, knowledge storage, knowledge application and knowledge transfer and dissemination. Moreover, the results of the conducted test showed that all these components have an impact on the overall performance within the institutions under study. Similarly, Al-Khashali found out that there is a significant influence of knowledge of response on comparative performance, while knowledge possession and knowledge dissemination do not have any significant impact on internal performance.

The current study differs from that of Zack and al. because the latter focuses on commercial institutions and businesses, while the first one centers on productive companies where the performance level can be easily and accurately measured, through productivity, product quality, level of creativity, as well as customer satisfaction. In addition, researchers reached the conclusion that performance is not influenced only by Knowledge Management, but also by other factors such as the company's relationship with customers, product development, and operational excellence. It is worth mentioning that the present study did not address other factors affecting performance within the institutions under study.

I- The theoretical framework of the study

An attempt is made, through this axis, to address the different theoretical concepts of Knowledge Management and performance, and the relationship between them.

First: Knowledge Management

1. What is Knowledge Management?

The definitions of Knowledge Management do not differ much among authors and researchers. In 1999, *Peter Drucker* succinctly defined Knowledge Management as "The coordination and exploitation of organizational knowledge resources for cost-effectiveness and competitiveness." (Alan Frost - www.Knowledge management.tools.net).

David *Skyrme* is considered as one of the most prominent contributors to the concept of knowledge management; he states that : " Knowledge Management is the clear, explicit and frank management of vital knowledge and all related processes of creating, organizing, disseminating, using and exploiting knowledge to achieve the objectives of the organization" (www.Syrme.com/KMbasic/definition.htm).

Based on the above mentioned definitions, one may admit the following definition of knowledge management as: "A set of initiatives, techniques, processes and strategies that allow getting the appropriate knowledge at the right time from the right people in order to organize, manage, store, disseminate, share and use that knowledge within each one of its departments in order to improve performance and create productivity, and consequently to achieve competitive advantage".

2. Importance of Knowledge Management

The importance of knowledge management can be evidenced through the experiences of many companies in developed countries that have spent huge amounts of money to implement these experiences. As a result, many of these companies reaped great benefits. Therefore, one can state that Knowledge Management plays a fundamental role in organizations. These benefits may therefore be summarized by saying that Knowledge Management is:

- A great opportunity for organizations to reduce costs and raise their internal assets in order to generate new revenue (Al-Kubaisi, Salah al-Din, 2005, p. 43).
- A means to motivate and encourage the creative capacities of the organization's human resources to produce better knowledge and allow for the early detection of unexpected problems;
- A positive evolution in the new economic environment, which forces the enterprise to be highly competitive and successful. This may be possible through perspicacity, creativity, adaptability, and acquisition of huge amounts of information in a very short time.
- A way to work on the *principle* that '*Prevention is better than cure*'. It encourages innovation management but not reaction management; it also has the capacity to deal with acute and emergency crises, as well as to unleash the intellectual potential and the technical capacities of the personnel within the institution, at all levels. It also contributes to increase the operational efficiency, improve productivity and provide better solutions to problems as well.
- A knowledge base on which awareness about the needs and aspirations of customers is founded. It works to reach and attract new customers and maintain loyal clients. It also strengthens the relationship between colleagues (professional knowledge), employees and administration (human knowledge).

3. Knowledge Management processes

Although researchers generally differ on the basic phases of Knowledge Management (KM), no doubt that these processes operate in a sequential, complementary and integrated manner. Knowledge management processes may be divided into three basic stages:

- Diagnosis, acquisition and creation of knowledge.
- Storage and dissemination of knowledge.
- Application of knowledge and follow-up.

Second: What is performance and how is it related to knowledge management?

1 - Definition of performance

Institutional performance is the common denominator of all the efforts that are exerted by the administration and employees within the institutions. A large number of researches and studies have been conducted on the topic of performance which has become an important and fundamental concept within every organization. Unfortunately, no unified and comprehensive definition of performance has been agreed upon so far due to its ever-changing characteristics. Performance is sometimes defined as the ability of the organization to allocate resources and use them optimally; it is sometimes associated with the workers' productivity and human factors, and sometimes it appears as the result of productivity and its images.

Performance can be defined as: "*A behavior that produces an outcome*"; it is the way an individual reacts in response to a particular task that is whether imposed by others or done by the individual himself (Nobli Najla, 2014/2015, p. 141). Therefore, performance may be viewed as the organization's ability to achieve its long-term objectives, including the goals of *profit* maximization, survival, growth and adaptation, using both physical and human resources, with high effectiveness and efficiency, under continuously changing environmental conditions (Suleiman Al-Fares, 2010, p. 71).

2. Performance characteristics

Organizational performance is characterized by the features cited below (Eyad Ali Al-Dajani, 2010/2011, p. 149):

- It maintains the stability of work and its continuity through accumulated expertise and previous experiences that can enrich the institution; it helps to pass on these experiences from generation to generation so that the institution is not affected by the absence or change of leadership.

- It helps to maintain the administrative and financial stability of the institution, by adopting specific policies, regulations and rules; it orientates the efforts of all individuals working in the institution towards its development within a clear framework of duties and responsibilities, with a collective participation in achieving the objectives. The head of the organization is not the only person responsible for the management, administration and decision-making.
- It constantly focuses on the development and rehabilitation of the human resources by attracting the best talent through the policy adopted by the institution in the recruitment operation.
- It helps to strengthen the workers' loyalty and affiliation to the institution and its systems. This institution, which should be regarded as belonging to all, requires hard work in order to ensure its survival and maintain its progress.

3 - Relationship between knowledge management and performance

Knowledge Management (KM) has a significant impact on organizational performance in various dimensions; it affects individuals, processes and products, and influences the overall performance of the organization.

A - The impact of Knowledge Management on employees:

Knowledge Management affects the employees because it:

- Improves their learning process; employees may *learn from each other's* experience as well as from external sources of knowledge. This allows their learning to grow steadily so as to achieve the ability to change in response to the requirements of technology;
- It makes employees more flexible and enhances their satisfaction at work; it also helps them to build and strengthen their learning capacities to solve and cope with the various problems they face in the business world.

B - The impact of Knowledge Management on processes

Knowledge management aims to (Amina Moulay, Mimoun Kafi, 2015, p. 72):

- Help to carry out processes in accordance with the pre-set objectives of increasing operational efficiency within the organization;
- Increase the efficiency of operations by simplifying processes and reducing costs;
- Achieve operations in a creative and modern way, based on increasing reliance on knowledge sharing among employees in order to find innovative solutions within the organization where Knowledge Management is used as a brainstorming tool.

C - The impact on products

Knowledge Management affects different products and outputs because it:

- Impacts value-added products. Knowledge management processes help the organization to develop new products and improve the existing ones; consequently, it helps to achieve higher added value products as compared with previous ones. (Khadr Mesbah Ismail Titi, p. 123)
- Affects knowledge-based products through knowledge bases owned by investment companies that are specialized in the development of software industry (Khadr Mesbah Ismail Titi, p. 123).

D - Impact on overall performance

Knowledge Management can have a significant impact on the overall organizational performance of the institution through the development and innovation of new products which should result in increased returns and profits. This also occurs when the Knowledge Management strategy adopted is in line with the organization's business strategy or with the organization's vision and policy. KM affects revenue and expenses which depend on the adequacy between managers and industry. As a result, this leads to increased customer loyalty to the organization. In addition, KM uses knowledge to gain competitive advantage with respect to competitors and business partners.

II- The practical framework of the study

The results of the field study were first reviewed within the context of this investigation. This was done by means of a questionnaire that included a set of questions related to knowledge management and to the overall level of performance within small and medium-size enterprises, in western Algeria.

First: Study methodology and data collection tools

Considering the type of subject under study, the researcher considers that the method that is best suited for the case study at hand is the descriptive analytical approach, where the data and information are collected from library and Internet sources, for the theoretical part of the study. The questionnaire was distributed to the managers of small and medium-size enterprises operating in western Algeria, for the practical side. The present study attempts to diagnose, analyze, link, and interpret, classify and measure data, and also to determine the type of relationship between its variables, causes and trends, and finally to derive the results from them.

1- Community and sample of the study

The study population consists of a sample of 40 small and medium-size enterprises operating in western Algeria; each institution was given one questionnaire. The statistical tools and methods used were all based on the *Statistical Package for the Social Sciences (SPSS)*.

2 - Study tool

In view of the nature of the exploratory study, the methodology used in the descriptive approach, and the possible alternatives, and based on the topic of the study, its objectives, queries, and the desired data, the researcher used the form tool which, in its final form, included 47 questions divided as follows:

- 04 questions relating to personal information about the manager, like the age, qualifications, seniority and size of his institution;
- 43 questions whose answers were formulated according to the five-point Likert scale, which comprised the following two axes:

The first axis included 24 questions on knowledge management processes which were divided into five dimensions as follows:

Dimension 1: Knowledge recognition. It included 4 questions that focus on the level of awareness of managers and workers in the institutions under study, in view of the importance of knowledge management in their institutions;

Dimension 2: Knowledge generation. It included 5 questions that focus on the availability of instruments, such as the training of employees and the realization of modern scientific methods, to generate knowledge within the institutions under study;

¹The Likert Scale is a method of measuring behaviors and preferences, using psychometric tests. It was developed by psychologist Rensis Likert, who used questionnaires, especially in statistics. The scale is based on responses to the degree of approval or objection to a statement.

Dimension 3: Knowledge storage. It included 6 specific questions on the availability within the institution of the technical and technological means to store its innovative knowledge;

Dimension 4: Knowledge application. It included 5 questions related to the extent of application of knowledge management within institutions;

Dimension 5: Knowledge dissemination. It included 4 questions on the concern of institutions in disseminating knowledge, through the use of modern communication technologies, flexible organizational structure and exchange of tasks among workers inside the institution.

The second axis included 19 questions on overall performance within the institutions under study; it was divided into four dimensions as follows:

Dimension 1: Workers' satisfaction. It included 6 questions that focused on the satisfaction of workers at work within the institutions under study;

Dimension 2: Internal processes. It consisted of 4 questions on the quality of production, level of innovation, and cost reduction in the institutions under study;

Dimension 3: Customer's satisfaction. It comprised 5 questions relating to the level of interest of the studied institutions in taking into consideration the expectations and desires of their customers; it also examined their degree of satisfaction in a timely manner and appropriate form.

Dimension 4: Institution growth and development. It comprised 4 questions that are related to the high market share and profitability of the institutions under study.

3 - Measuring the validity of the paragraphs of the questionnaire and its stability

Two methods are used to validate the questionnaire. The first approach is based on the honesty and sincerity of a group of arbitrators who are professors with specific knowledge in the field of economics. The researcher presented the questionnaire, in its initial form, to a group of professors in business administration, economics and statistics, from different universities; they all expressed their views on the form of the questionnaire. Once the *necessary changes* were made, it was distributed to a group of institutions operating in northwestern Algeria. Eight copies were recovered from the city of Oran, 4 from Tlemcen, 7 from Mascara, 5 from Sidi Bel-Abbes and 16 from Ain Temouchent, for a total of 40.

The second approach used the internal consistency test. Once the data collected were dumped into the SPSS program, the researcher studied the validity of the questionnaire by measuring the internal and structural consistency of its paragraphs. A strong correlation was found between the paragraphs of each axis and its overall rate. All correlation coefficients were high (between 0.533 and 0.941) with a significance level between 0.000 and 0.034. Therefore, the questions about these axes can be trusted; they can be used in what they are *intended to measure*.

Moreover, the results obtained from the analysis of structural validity indicated that the correlation coefficients are at the significance level of 0.01, for knowledge awareness, knowledge storage, knowledge application and knowledge dissemination. The probability value for each dimension is less than or equal to 0.01, with a significance at the level of 0.05 for knowledge generation. Furthermore, the probability value was estimated at 0.02 for this dimension. In addition, the correlation coefficients for the performance axis showed a significance level of 0.01 for all dimensions. Therefore, it can be said that there is a strong correlation between the different axes of the questionnaire and the overall rate of its paragraphs. Thus, the questionnaire is valid and can be used to measure what it is intended to measure.

The Cronbach's alpha coefficient was used for the measurement of stability. This stability of the axes ranged from 0.842 to 0.916, indicating the stability of the study scale.

Second : Data analysis and hypothesis testing

1 - Descriptive analysis of personal data:

The characteristics of sample members are summarized in the following table:

Table 01 - Personal characteristics of respondents

Percentage	Recurrence	Variable classes	Variable
10%	4	Less than 30 years of age	Age
30%	12	From 30 to less than 40 years	
45%	18	From 40 to less than 50 years	
15%	6	50 years and older	
10%	4	<i>High school level</i>	Educational level
7%	2	Vocational training certificate	
50%	28	Bachelor's degree (3 years)	
7%	2	Master's degree	
10%	4	<i>Post-Graduate Diploma</i>	
40%	16	Between 2 and 5 years	Expériences
35%	14	Between 5 and 10 years	
25%	10	More than 10 years	
50%	20	Small enterprise	Size of the enterprise
50%	20	Medium enterprise	

Source: Elaborated by the author, based on software SPSS results

From the above table, the following conclusions may be drawn:

Age: The above results indicate that the largest proportion of managers are aged between 30 and 50 years, with a cumulative rate of 75%. This is the appropriate age for creating and managing an institution. Furthermore, 15% of them are over 50 years old, which gives the researcher some confidence about the answers provided by respondents, who are characterized by intellectual maturity.

Educational level: from the above results, one can clearly observe that about 67% of managers have a bachelor's degree or more, which represents a strength point for the institutions under study. The higher the manager's level of education is, the more his professional competence grows and his comprehension of modern management techniques becomes greater. This will certainly contribute, in an effective way, to the profitability of the institution, and would give greater confidence to the researcher in the results given by the study. These findings indicate that the respondents understood the questionnaire; their answers present a high degree of credibility.

Years of seniority: The percentages depicted in the table are consistent with the age variable previously discussed. In general, the managers' ages range from 30 to less than 50, which means that the majority of them have a work experience greater than two years but not exceeding ten years, with a cumulative rate of 75%. This is a positive indicator of the managers' experience in management and its components.

Size of the institution: The results in the table indicate that although the sample was chosen randomly, the number of small enterprises was found equal to that of medium-size enterprises, i.e. each type representing 50% of the total number.

2 – Testing the study hypotheses

A - Analysis of the first main hypothesis: The first main hypothesis is as follows:

H₀: Small and medium enterprises in western Algeria do not use Knowledge Management and its five components, namely knowledge recognition, knowledge generation, knowledge storage, knowledge application and knowledge dissemination as a modern management approach.

H₁: Small and medium enterprises in western Algeria use Knowledge Management and its five components, namely knowledge recognition, knowledge generation, knowledge storage, knowledge application and knowledge dissemination as a modern management approach.

To study the first main hypothesis, the researcher used the *one-sample t-test*, and the results obtained are summarized in the following table.

Table 02: Test results (*One-sample t-test*)

	Test value = 3					
	t	ddl	Sig. (bilateral)	Average difference	95% Confidence Interval for the differences	
					Inferior	Superior
Knowledge Management	5.444	39	0.000	0.61300	0.3853	0.8407

Source: Elaborated by the author using the software SPSS results We can clearly note, from the previous table, that the significance value is equal to 0.000, which is smaller than the significance level of 0.05. Moreover, the calculated t value is equal to 5.444, which is greater than the value 1.645 in the T statistic table, at the degree of freedom 39. Based on this, the null hypothesis is rejected but the alternative hypothesis, which states that the managers of the institutions under study use Knowledge Management in administering their institutions, is accepted.

B - Analysis of the second main hypothesis:

The second main hypothesis addresses the relationship between the use of Knowledge Management in the institutions under study and the level of overall performance. The hypothesis may be formulated as follows:

H₀: There is no statistically significant relationship between Knowledge Management (KM) with its five components, namely knowledge recognition, knowledge generation, knowledge storage, knowledge

application and knowledge dissemination, on one side, and Overall Performance (OP), on the other, in small and medium-size enterprises in western Algeria, at the significance level of 0.05.

H₁: There is a statistically significant relationship between Knowledge Management with its five components, namely knowledge recognition, knowledge generation, knowledge storage, knowledge application and knowledge dissemination, on one side, and Overall Performance (OP), on the other, in small and medium-size enterprises in western Algeria, at the significance level of 0.05. In order to test this hypothesis, the simple Pearson's correlation coefficient was used, and the results obtained are depicted in the following table.

Table 03: Pearson's correlation coefficient between Knowledge Management and Performance

		Performance
Knowledge Management	Pearson's correlation	0.541**
	Sig. (bilateral)	0.001

Source: Elaborated by the author, using the software SPSS results

This table indicates that the correlation coefficient between Knowledge Management (KM) and Performance is equal to 0.541. Moreover, the probability value is equal to 0.001, which is below the significance level of 0.05; this means that a statistically significant correlation exists between Knowledge Management and Performance.

Through the preceding results, We can reject the null hypothesis and accept the alternative hypothesis, which states that a statistically significant correlation exists between Knowledge Management and its five components, i.e. knowledge recognition, knowledge generation, knowledge storage, knowledge application and knowledge dissemination, on one hand, and Overall Performance (OP), on the other, in small and medium-size enterprises; the significance level is at 0.05.

C - Analysis of the third main hypothesis

The third major premise is the causality hypothesis which addresses the impact of using Knowledge Management in small and medium-size enterprises in western Algeria on their Overall Performance. This hypothesis is presented as follows:

H₀: There is no statistically significant impact of Knowledge Management processes on Overall Performance within small and medium-size enterprises in western Algeria, at the significance level of 0.05.

H₁: There is a statistically significant impact of Knowledge Management processes on the Overall Performance within small and medium-size enterprises in western Algeria, at the significance level of 0.05.

The simple linear regression was used to test the hypothesis, and the results obtained are depicted in the following table.

Table 4: Simple linear regression to examine the impact of Knowledge Management on Performance.

Summary of models

Model	R	R ²	Adjusted R ²	Standard error of the estimate	Change statistics				
					Variation of R ²	Variation of F	ddl1	ddl2	Sig. Variation of F
1	0.541 ^a	0.292	0.274	0.60275	0.292	15.690	1	38	0.000

a. Predictors: Knowledge Management (Constant)

ANOVA^a

Model		Sum of squares	ddl	Mean square	F	Sig.
1	Regression	5.700	1	5.700	15.690	0.000 ^b
	Residual	13.806	38	0.363		
	Total	19.506	39			

a. Independent variable: Overall Performance

b. Predictors: Knowledge Management (Constant)

Coefficients^a

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	(Constant)	1.711	0.499		3.429	0.001
	Knowledge Management	0.537	0.136	0.541	3.961	0.000

Dependent variable: Overall Performance

Source: Results of software SPSS

It is easy to observe from the first table, that R^2 is equal to 0.292 and the adjusted R^2 is estimated 0.274. This indicates that Knowledge Management has improved the Overall Performance with institutions studied by only 29.2%. However, 70.8% of performance improvement can be attributed to other variables that have not been taken into consideration in this study.

The results in the second table may be summarized as follows:

The sum of squares due to regression is 5.70, and the sum of squares is equal to 13.806, which total sum of squares is 19.506.

The number of degrees of freedom associated with the regression is 1, while that associated with residuals is 38.

The mean square regression is estimated at 5.70, and the mean square of residuals is estimated 0.363.

The value of the contrast analysis test in the linear regression is 15.69.

The significance level is equal to 0.000, which is smaller than 0.005, the significance level of the null hypothesis. In addition, the calculated P value, which is estimated at 15.69, is greater than the t-value of 4.0847, at the degrees of freedom levels of 1 and 38. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted. Consequently, it can be concluded that there is a statistically significant impact of the independent variable of Knowledge Management (KM) on the dependent variable of Overall Performance in small and medium-size enterprises in western Algeria.

Table 3 clearly indicates that the *y-intercept* of the regression line is 1.711, which represents *a* in a straight line equation (i.e. $y = a + bx$). Therefore, the regression line is: $y = 1.711 + 0.537x$

Where *x* represents the independent variable and *y* is the dependent variable. So, the regression line equation may be written as:

$$\text{Overall Performance} = 1.711 + 0.537 \text{ Knowledge Management (or OP} = 1.711 + 0.537\text{KM}).$$

Consequently, it is possible to reject the null hypothesis, which states that Knowledge Management (KM) has no impact on Overall Performance (OP) within small and medium-size enterprises in western Algeria, and accept the alternative hypothesis that confirms the impact of Knowledge Management on Overall Performance within small and medium enterprises in

western Algeria.

3 - Discussion of study results: The field study resulted in the following set of findings:

- There is a medium to high degree of agreement between all managers interviewed regarding each dimension of Knowledge Management, which indicates that everyone is aware of the importance of using Knowledge Management as a new approach to *governing SMEs*;
- There is a medium to high degree of agreement between the respondents that their overall performance is continuously improving as compared to previous years; their overall performance is better than that of competitive institutions. This means that changing and developing new management methods helps to greatly improve performance;
- Small and medium-size enterprises in western Algeria use Knowledge Management as a modern approach to governance with its five components, i.e. knowledge recognition, knowledge generation, knowledge storage, knowledge application and knowledge dissemination;
- There is a statistically significant correlation between Knowledge Management (KM) and Overall Performance (OP) in the institutions under study;
- There is a statistically significant impact of Knowledge Management (KM) on Overall Performance (OP) within the small and medium-size enterprises under study.

III. Conclusion

Currently, Knowledge Management is considered as one of the most decisive and modern methods of management; it has proved useful in achieving excellence within institutions that adopted it. Indeed, this study was conducted to determine the extent to which this approach is used in the management of small and medium enterprises operating in western Algeria, and how this method may affect the overall *institutional performance*.

In order to answer the research problem, it was decided to *divide this study into two major parts*. The first part, which concerned the theoretical framework of the study, included a set of concepts related to knowledge management and performance; the relationship between them was also investigated. The following results could be found:

- In light of the fierce competition and great technological development, managers cannot ignore the importance of Knowledge Management in their enterprises;

- Knowledge Management is viewed as the primary resource for organizations to achieve profit, profitability and competitive advantage on the market;
- Knowledge Management is closely linked to the human element and all his/her ideas, information and experiences; it is also associated with the way the institution uses the human element to achieve its objectives;
- The concept of performance is not limited only to the *individual's behavior* within the institution; it also includes many variables such as the employee's satisfaction, customer's satisfaction, and the institution's evolution as compared to its competitors;
- Knowledge management has a significant impact on the company's performance because it can influence the learning process of employees as well as their satisfaction at work. KM can also affect the internal processes by improving production and launching the spirit of creation and innovation within the institution. It can also raise the customer's satisfaction by supplying the product or service in the appropriate form and at the right time.

The second part of the study concerned the practical framework of the research. It was conducted on a sample of 40 institutions, all operating in the western region of Algeria. The results of hypothesis testing were as follows:

- The first hypothesis, which states that small and medium-size enterprises operating in western Algeria were aware of the importance of Knowledge Management (KM) and used it, has been validated;
- The second hypothesis testing was performed and it was found that a close relationship exists between Knowledge Management and performance within the institutions under study;
- The third hypothesis testing confirmed that Knowledge Management affects only 29.2% of the overall performance within the institutions under study, while 27.8% may be attributed to other variables not considered in this research.

In addition to the results obtained from hypothesis testing, the author was able to get to some other interesting results through observation and contact with the managing directors of the institutions

under study; these may be summarized as follows:

- Some uncertainty still exists as to whether managers fully understand the proper meaning of Knowledge Management, the way it should be used and its importance within the institution;
- Despite the remarkable progress in using modern technologies in Algerian institutions, many of them, especially small and medium-size enterprises, still fall far behind expectations in using these technologies in the promotion of the institution and its products through the Internet, and the acquisition of new knowledge through it;
- Small and medium-size enterprises lack the culture of leadership training; they should organize some internal and external *cultural training* programs for their workers in order to enhance their knowledge and skills;
- Many small and medium-size enterprises suffer from *poor teamwork*; their employees are generally not involved in decision-making and problem solving within the institution. This is considered as one of the most important disincentives to achieve high employee loyalty and commitment to the institution he/she works in.

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Development of Regional Infrastructure and Regional GDP Inequality in Indonesia

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ABSTRACT

This research was conducted to analyze the influence of the Influence of Economic Infrastructure (Transportation And Warehousing, Electricity And Gas, Information And Communication) And Social Infrastructure (Education And Health) On Increasing Gross Regional Domestic Revenue (PDRB Daerah In the short term, the expenditure of ILG has the effect of reducing regional GDP, thereby increasing the imbalance between the western and eastern regions by 30 percent. But in the long run it will decrease inequality. The same condition can happen in the long term (western region) that has advanced impact spread effects to the region (47 percent), ILG (78 percent), IIK (37 percent, IP (17 percent) All of these variables are positive and significant, except for the coefficient of IK (- 47 percent) long-term consequences of increasing budget allocations for electricity infrastructure k and gas carry consequences on health infrastructure.

Keywords: Economic Infrastructure, Social Infrastructure, Gross Regional Domestic Revenue

I. Introduction

Infrastructure plays a strategic role in encouraging the smoothness and acceleration (acceleration) of the development process. Availability of infrastructure will accelerate development in an area or country. The faster and the increased economic development to be implemented, the more infrastructure facilities needed. Without the availability of adequate infrastructure, it is certain that an economic activity or development will generally run haltingly. The procurement of an infrastructure will greatly affect the development of other economic sectors. Availability of adequate infrastructure both in quantity and quality, is an absolute requirement for economic growth to be achieved. Infrastructure development is needed to achieve equity, reduce poverty and improve quality of life. Provision of infrastructure with low quantity and quality will hamper the economy and cause a high cost economy. This condition is a problem in the national economy (Indonesia) and in every region (Province) in Indonesia. Infrastructure development is the responsibility of the government, so that the government budget allocation for infrastructure development is crucial to the development process taking place, as well as the improvement of national economic growth and economic growth of the region in the country. Various research results generally conclude that the realization infrastructure development in Indonesia is too low. As a result the Indonesian economy is not able to achieve its potential growth rate. Post Crisis, its percentage to GDP is relatively low, about 1 percent to GDP (2000), with a tendency to increase to about 3.9 percent of GDP (2009). The 2009-2013 data shows that the average ratio of development spending on infrastructure to GDP is about 4.3 percent. The government is aware of the low realization of infrastructure development in Indonesia in the post-crisis era. The first ten years since 2000-2009, public expenditure or government spending on infrastructure in Indonesia only ranged from 0.8 to 1.7 percent to GDP. The economic growth of a country is influenced by capital accumulation in the form of investments in land, equipment and machinery, facilities and infrastructure, natural resources, human resources both in quality and quantity, technological progress, information access, innovation and self-development capability and work culture (Todaro, 2000: 37). Capital accumulation occurs when a portion of the income is saved and reinvested in order to enlarge the output and income in the future. Direct earning investments must be supplemented by a supporting investment called economic and social infrastructure investments, for example road construction, electricity provision and construction of communications facilities, all of which are absolutely necessary to sustain and integrate all productive

economic activities. The existence of infrastructure can increase productivity and output for the population where infrastructure can facilitate and increase the intensity of economic activity.

Infrastructure development is one of the most important aspects to encourage and accelerate the process of national development. Infrastructure plays an important role to drive economic growth. This is considering the rate and growth rate of a country can not be separated from the availability of infrastructure such as transportation and warehousing, telecommunications, and energy, education and health. In general, the role of infrastructure is significant in accelerating economic growth and development. The World Bank (1994) defines the terminology of infrastructure divided into three parts. First, the economic infrastructure is in the form of public utilities (electric power, telecommunication, water, sanitation, gas); public works (roads, dams, bridges, canals, irrigation and drainage); and transportation sector (railway, bus terminal, port, airport). Second, social infrastructure such as education, health, housing, and recreation. Third, the administrative infrastructure of law enforcement, administrative control and coordination. Therefore, the implementation of infrastructure development needs to be studied to see its impact on the increase of Regional Gross Domestic Product (PDRB) area (Province) in Indonesia. After the economic crisis occurred in Indonesia, the percentage of infrastructure development tended to decline, as shown by the shrinking length of the railroads, as well as the low number of toll road construction only five km per year. From the development expenditure it appears that the percentage of financing for infrastructure development tends to decrease, from about 5 percent of the value of GDP in the pre-crisis period, to 2 percent of GDP. Infrastructure investment has been going on for quite a long time with huge funds or capital, its contribution to increasing economic growth is also very significant, although it can lead to an imbalance in output due to policies that are too development-oriented and more growth-minded than oriented to equity principles. Therefore it is very important to study or analyze the role and contribution of infrastructure development to regional GDP (Province) in Indonesia.

II. Theoretical Framework

In development and economic growth, infrastructure has strategic roles and contributions, and economists and other experts outside economists do a lot of theoretical research on infrastructure. The relationship between infrastructure such as roads, electricity and telephone with economic growth has been widely analyzed, although the results of the research are not always the same but there is a consensus that infrastructure development is necessary but not an adequate element of economic growth and that the provision of appropriate types of infrastructure in place being efficiently is more important than the large amount of investment invested in the infrastructure sector or the amount of infrastructure built (Hull, 1999). Infrastructure development should also involve the private sector and the community in order to achieve sustainable development. There must be an appropriate combination of large and small scale infrastructure to achieve the target of economic equity and poverty alleviation. Therefore, a more integrated approach to infrastructure development, from planning to service to the community, ensures synergy between sectors, regions and regions.

2.2. Theories of Economic Growth

Economic growth is one of the areas of investigation long discussed by economists, the Merkantilis School of thought, the economic thinkers between the late sixteenth and the late seventeenth centuries, much to discuss the role of foreign trade in economic development. At the beginning of this century Schumpeter became well known for his book on economic development, the book *The Theory of Economic Development*, and the business cycle or conjuncture. After that the theory of Harrod-Domar and Neo-classical theory has further enriched the analysis of economic growth (Sukirno, 2008: 432). According to Schumpeter the higher the rate of progress of an economy the more limited the possibility to innovate, then the economic growth will be slowed down the road, will eventually reach the level of unbalanced state or stationary state. However, in contrast to the classical view, Schumpeter's view of the underdeveloped state is achieved at a high growth rate.

Neo-classical growth theory was first developed by Robert Solow, who won the Nobel prize in 1987 for his theory. His theory was put forward in the *Quarterly Journal of Economics* published in February 1956, in a paper entitled: *A Contribution of the Theory of Economic Growth* (Sukirno, 2007: 451). The Neo-classical theory argues that economic growth stems from the growth and development of the factors that affect aggregate supply. Thus the approach is very different from Harrod-Domar's theory that economic growth is determined by the demand side, which is dependent on the development of aggregate demand.

2.3. Ready Condition With Population Growth

How does population growth affect the steady state ?. To answer this question, it should address how population growth, together with investment and depreciation, affect the accumulation of working capital. As explained earlier, investment increases the capital stock, and depreciation lowers it. But now there is a third force in action to change the amount of working capital. Growth in the number of workers causing capital per worker fell. Used lowercase as the number variable per worker. Thus, $k = K / L$ is capital per worker, and $y = Y / L$ is output per worker.

To fully understand the process of economic growth, it is worth while out of the Solow model and developing models that explain the technological advances that come from outside. These models are often called endogenous growth theory. Because it rejects the Solow model assumption of technological changes that come from outside (exogen). Endogenous growth theory was pioneered by Paul Romer and Robert Lucas (Dornbush& fisher, 2008: 78). The idea that increased investment in knowledge will increase growth is key to linking higher savings rates with higher levels of balance growth (Rudiger&Dornbush, 2008: 79).

2.4. Accelerate Development Policy

Since the end of the second world war, various countries have tried to accelerate economic growth and development so that the level of society's prosperity can be improved. Some countries have achieved rapid development and prosperity. Nevertheless there are also countries that have not been able to develop its economy. Political and economic stability is an important requirement that needs to be met to realize rapid economic growth. In addition, government development policies and development policy approaches that are in line with available resources, are critical in their efforts to accelerate economic growth and development.

2.5. Developing Infrastructure

Modernization of the economy requires a modern infrastructure as well. Various economic activities require infrastructure to develop, roads and bridges, airports, ports, industrial estates, irrigation and water supply, electricity and telephone networks need to be developed. The development of infrastructure must be in harmony with economic development. At a low stage of development, the necessary infrastructure is still limited. At this stage the construction consensus is to build roads, bridges, irrigation, electricity and other infrastructure in a simple level. The more advanced an economy, the more infrastructure is needed. Thus developing the infrastructure must be continuously carried out and must be harmonized with the economic progress that has been achieved and which is to be realized in the future.

2.6. Peran Infrastructure In Achieving Development Objectives

The development of a nation aims to improve prosperity and realize social justice for all its people. For that development requires a proper approach, in order to achieve growth with equity. Higher levels of economic growth, generated by including the widest participation of all people in the development process, is a faster and fairer way of development. Infrastructure plays an important role for it. In addition to encouraging increased investment, infrastructure plays a role in expanding the reach of community participation and equity of development outcomes. The nature and types of infrastructure needed by a nation are influenced by the characteristic nature and pattern of the population dispersion peculiar to the nation. The role of infrastructure for the Indonesian nation becomes very strategic, considering Indonesia which is the largest archipelagic country in the world consists of 13,000 islands with uneven population distribution patterns. Most Indonesians (about 78 percent) live in Java and Sumatra (ZahedySaleh, 2014: 11-12),

2.7. Definition of Infrastructure

Until now there is no definite definition of infrastructure, but there are several agreements on it. According to Mac Millan's Dictionary of Modern Economics (1996) infrastructure is a structural element of the economy that facilitates the flow of goods and services between buyers and sellers. While The Routledge Dictionary of Economics (1995) provides a broader understanding that the infrastructure is also the main service of a country that helps economic activities and community activities can take place that is by providing transportation and other supporting facilities. According to Grig (1998) and Robert J.Kodoatie (2005: 8) infrastructure refers to the physical system that provides irrigation, drainage, building construction and other public facilities needed to meet basic human needs in the social and economic sphere.

2.8. Type and Classification of Infrastructur

Economic infrastructure usually has a natural monopoly characteristic because the procurement and operation of economic infrastructure will be more economical if it is only done by one company rather than two or more companies. A natural monopoly usually occurs when the economies of scale necessary to provide a good or service are left to one company (Mankiw, 2001: 376). If there are two or more companies that provide water services to the public, then the market share or market share of each company becomes so small that no company can produce profitably.

2.9.Isu and Infrastructure Problems

The problems of infrastructure in Indonesia must be addressed given the strategic role of infrastructure in realizing the long-term goals of national development. If not accelerated infrastructure development, then it becomes an obstacle to the competitiveness of the nation and hinder efforts of equity of development. Indonesia's improved macroeconomic conditions in the past 10 years have attracted investors, but unfortunately infrastructure constraints have caused economic growth to be below their potential level. In addition, income inequality in recent years has also worsened (Saleh, 2014: 43-44). On the other hand, Indonesia is judged by some people internationally to become a big economy in 2025, and it is said that a number of people abroad deserve entry into the group of BRIC countries (Brazil, Russia, India and China). But what is the cause of this infrastructure problem.

2.10.Pengaruh Human Capital Against Economic Growth

Human capital is an important determinant of economic growth. This is mostly explained in the endogenous growth model or new growth model. Endogenous growth models reject the assumption of marginal returns to capital investment diminishing marginal returns to capital investment that are used as neoclassical models. Endogenous growth models suggest that investment returns will be even higher when aggregate production in a country gets bigger. Assuming that private and public (government) investments in the field of human capital or resources can create an external economy (positive externalities) and spur productivity gains that can offset the natural tendency to decrease the yield scale. From the above explanation, it appears that human capital (human capital) is an important factor in increasing the economic output of a country. Therefore, investment for human resources improvement becomes important in development, especially in building two main elements of human capital, namely health and education. Improving skills and knowledge is an opportunity for a country to grow. Education in particular the increasing number of years of school study is a requirement for the next stage of economic development (Frankel, 1997).

2.11.Research

Economic growth can be seen in two forms, namely; extensively with the use of many resources (such as physical, human or natural capital) and intensively with the use of more efficient (more productive) resources. When economic growth is achieved by employing much labor, it does not result in per capita income growth. But when economic growth is achieved through the use of more productive resources, including labor, it generates higher per capita income and raises the average living standard of the community. Growth also requires physical capital and human resources as well as structural changes that include transformation of production, change. composition of consumer demand, international trade and natural resources as well as changes in socio-economic factors such as urbanization as well as population growth and distribution.

Furthermore Amrullah (2006) found that each type of infrastructure has a significant effect on economic growth except water infrastructure. Triwahyuni (2009) found that road, electricity and health infrastructure have a positive and significant impact on the productivity of Indonesian economy. Perwita Sari (2009) found that economic infrastructure (length of road, number of telephone user families, number of electricity user families, and social infrastructure (number of schools) have a positive impact on economic growth so as to help the Disadvantaged District become an open and inter- so that access to various factors of production becomes easier to reach Nuraliyah (2011) found that based on data panel estimation of electricity infrastructure, clean water and health infrastructure in Java have real and positive effect to economic growth while outside Java only electricity and water infrastructure net that has a real and positive impact on economic growth, the road infrastructure both in Java and outside Java is not significant in increasing economic growth. In addition, economic growth in Java can reduce poverty, while economic growth outside Java can not be reduce poverty. Hapsari (2011) found that the variable length of road and the amount of electricity have a significant effect on the GRDP, while the electric and water variables have no significant influence on economic growth. EvantiSyahputri (2013) emphasized that road infrastructure, electricity and clean water provide a positive and significant impact on regional economic growth in the province of West Java.

Zamzami (2014) obtained results that the variable length of roads, irrigation and education significantly influenced PDRB in Central Java. Furthermore, irrigation infrastructure gives the most influence to GRDP in Central Java.

2.12. Framework Thought

Physical capital (physical capital) and human capital (human capital) plays an important role in economic growth. The availability of physical capital is closely linked to the availability of funds for investment. The linkage of infrastructure to economic growth is indicated by the increase in output. Lack of availability of infrastructure in an area causes the potential of existing resources in the area difficult to develop. If local infrastructure is available and well-developed, it will encourage the growth of existing production sectors in the region which will eventually increase regional economic growth (Provincial GDP) and Increase regional per capita income (province) in Indonesia. The Cobb-Douglas Production Function (Cobb-Douglas Function) explains that output productivity consists of capital, labor, and technology. Any increase in capital, labor and technology will affect the change in the level of output produced. Capital used (physical capital) is economic infrastructure which includes: road, electricity, and telephone. While the capital resources (human capital) include: (education and health).

III. Descriptive Statistics Analysis

To find out whether there are differences in infrastructure (ITP, ILG, IIK, IP, and IK) between islands and regions is used descriptive statistic analysis tool. By using descriptive statistics, it can be seen the comparison of mean, maximum, minimum, standard deviation and standard error of each infrastructure within an island or region. Thus it can be compared whether the Western Region of Indonesia is more dominant in control of all infrastructure or Eastern Region. Similarly, the PDRB value owned by each province will be analyzed through descriptive statistical analysis. It is also to know whether KBI has more GRDP or KBI.

3.1. Specification Model.

The model used in this dissertation is based on the Barro (1990) model with infrastructure as input for production aggregates (Canning & Pedroni, 1999: 8). Assumptions used. Barro is total factor of production with form $\text{Log } A_{it} = a_0 + b_1 \log X_{1t}$ which is fixed effect from each province with index i and index t as a certain time. It is also assumed that an optimal level of infrastructure can maximize the growth rate. If the infrastructure is below the growth that maximizes the infrastructure, then the addition of infrastructure will increase output, otherwise if it is above the optimal level then the addition of infrastructure will reduce the level of output.

The inner model is based on the model used by Canning with some adjustments. This is done because of the conformity with the data operational variables studied. As inputs used operational variables are: regional PDRB (34 provinces), investment in social infrastructure (education and health), economic infrastructure (transportation and warehousing, electricity and gas, information and communication), and additional dummy variables ie differentiation of area between Western Indonesia (KBI) and Eastern Region of Indonesia (KTI) Canning Model is an expansion of the Cobb-Douglas production function. which has the form, as follows: However, in this dissertation, the infrastructure capital is then divided into 2 (two) major sections, namely the variables of economic infrastructure concerning (transportation and transportation, electricity and gas, information and communication) and social infrastructure concerning (education and health). Then the dummy variable is the regional difference between the Western Region of Indonesia and the Eastern Region of Indonesia, so the equation model also uses a natural-logarithmic transformation, then the equation is:

$$Y_{it} = \alpha_0 + \alpha_1 ITP_{1it} + \alpha_2 ITG_{2it} + \alpha_3 IIK_{3it} + \alpha_4 IP_{4it} + \alpha_5 IK_{5it} + \epsilon_{it}$$

Where :

1. Y is the output which is the GRDP of every province (34 provinces) at constant prices in 2010.
2. K is capital divided into physical capital and capital resources categorized into investment of economic infrastructure and social infrastructure
3. Area (region) is dummy variable. 1 for Western Indonesia (KBI) and 0 for Eastern Indonesia (KTI).
4. Transport and Trade Infrastructure (ITP)
5. Infrastructure of electricity and gas (ITG)
6. Information and Communication Infrastructure (IIK)
7. Educational Infrastructure (IP)
8. Health infrastructure (IK)
9. α_0 is the constant (intercept) of the Y axis, when (ITP), (ILG), (IIK), (IP), and (IK) are assumed to be 0 (zero).

- 10. $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ are regression or slope coefficients
- 11. ϵ adalah residual (disturbance error)
- 12. i is region or province (34 provinces) and t is time (2010 - 2016).

In this study, variables considered ceteris paribus are technological progress, labor (population), and natural resources. Furthermore, this research uses dummy variable that is Area (region) that happened in Indonesia between Indonesia Western Area (KBI) with Eastern Indonesia (KTI). It is intended to know the effect of (difference) of infrastructure development that happened between KBI and KTI have implication to PDRB inequality between KBI and KTI. Thus the model equation above is changed to:

$$IW_{it} = \alpha_0 + \alpha_1 d_i + \alpha_1 ITP_{it} + \alpha_2 ILG_{2it} + \alpha_3 IIK_{3it} + \alpha_4 IP_{4it} + \alpha_5 IK_{5it} + \epsilon_{it} \dots \dots \dots$$

Where :

- IW = Williamson Index
- d = Dummy Variable (KBI = 1, KTI = 0)
- $i, t = 34$ (province), and time (2010-2016). Where:
- IW = Williamson Index
- D = Dummy Variable (KBI = 1, KTI = 0)
- $i, t = 34$ (province), and time (2010-2016).

2 Estimation Method

To estimate the model with panel data can be done OLS method Ordinary least square method. Equation is developed into a quadratic model with the aim of looking at the U-shape curve of each variable so that:

$$Y_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 ITP^2 + e_2 \dots \dots \dots$$

$$Y_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 ILG^2 + e_3 \dots \dots \dots$$

$$Y_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 IIK^2 + e_4 \dots \dots \dots$$

$$Y_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 IP^2 + e_5 \dots \dots \dots$$

$$Y_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 IK^2 + e_6 \dots \dots \dots$$

Furthermore, equation model is used to estimate the effect of infrastructure on regional inequality (IW), so that the equation of IW categorical estimate is as follows:

$$IW_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 ITP^2 + e_2 \dots \dots \dots$$

$$IW_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 ILG^2 + e_3 \dots \dots \dots$$

$$IW_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 IIK^2 + e_4 \dots \dots \dots$$

$$IW_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 IP^2 + e_5 \dots \dots \dots$$

$$IW_{it} = \alpha_0 + \alpha_1 ITP + \alpha_2 ILG + \alpha_3 IIK + \alpha_4 IP + \alpha_5 IK + \alpha_6 DUM + \alpha_7 IK^2 + e_6 \dots \dots \dots$$

4. Analysis.

4.1. Descriptive Statistics Analysis of KBI and KTI Infrastructure 2010-2016.
 To find out the condition and existence of infrastructure that occurred in the Western Region of Indonesia (KBI) and Eastern Region of Indonesia (KTI) from the Year 2010-2016 used descriptive statistical analysis.

Table of Descriptive Statistics Infrastructure (billions of rupiah) Year 2010-2016 Western Indonesia (KBI) and Eastern Indonesia

Infrastruktur	Statistik deskriptif			
	Western Indonesia Region (KBI)		Eastern Indonesia (KTI)	
	Average (mean)	sample variance	Average (mean)	Sample variance
ITP	14438,151	203965922,5	3727,261	8641636,601
ILG	2050,924	12063053,3	51,084	2644,688
IIK	18764,815	902092612,6	2956,117	10106813,55
IP	14924,748	481570199,8	3586,765	11106367,620
IK	4454,824	38417707,1	1702,697	2031435,569
Jumlah	54633,462	1.638.109.495	12023,924	2031435,569

Source: Statistics Indonesia several years (processed), 2016

From the table explained that the average allocation of transportation infrastructure and warehousing (ITP) for KBI Rp 14438.151 (billion rupiah) is much larger when compared with KTI Rp 3727.261 (billion rupiah). Proportion of 79.5 percent for KBI, while KTI 20.5 percent. In other words, the ratio (ratio) of transportation infrastructure and warehouse allocation allocation between KBI and

KTI is 3.9: 1. Similarly, the allocation of electricity and gas infrastructure (ILG) expenditure for KBI Rp 2050,924 (billion rupiah) is bigger compared to KTI Rp 51,084 (billion rupiah). The proportion of ILG for KBI is 97.6 percent, while KTI is 22.4 percent. In other words, the ILG (ratio) between KBI and KTI is 40.15: 1. Thus the allocation of information and communication infrastructure spending (IIK) for KBI Rp 18764.815 (billion), while KTI Rp 2956,117 (billion rupiah) . The proportion of IIK for KBI is 86.4 percent and KTI 13.6 percent. In other words, the ratio of IIK between KBI and KTI is 6.4: 1 for KBI. Not much different from the allocation of education infrastructure spending, where KBI Rp 14924,748 (billion rupiah) and KTI Rp 3586,765 (billion rupiah). The proportion of IPs for KBI was 80.6 percent, and KTI was 19.4 percent. Comparison between KBI and KTI is 4.2: 1. Similarly, the allocation of health infrastructure spending is larger for KBI than KTI. Where is KBI Rp 4454,824 (billion rupiah) and KTI 1702,697 (billion rupiah). The proportion of IK expenditure allocation for KBI was 72.4 percent and KTI 27.6 percent. Comparison between KBI and KTI is 2.7: 1. Thus it can be concluded that the allocation of infrastructure spending (transportation and warehousing, electricity and gas, information and communications, education and health) is much greater in the Western Region of Indonesia (KBI) than in Eastern Indonesia (KTI). From this condition can be described that the development is more developed (advanced) in the Western Region of Indonesia (KBI) compared with Eastern Indonesia (KTI).

4.2. Analyzed Statistics Analysis of PDRB ADHK Series 2010 from 2010-2016

To know the condition and the difference of Bruto Regional Domestic Product (PDRB) value between KBI and KTI from 2010-2016 used descriptive statistic analysis. More details can be seen in Table

Table
Analysis of Descriptive Statistics of PDRB ADHK Series 2010 year 2010-2016
Western Indonesia (KBI) and Eastern Indonesia (KTI)

	PDRB ADHK Seri 2010 (billion rupiah)	
	Western Indonesia Region (KBI)	Eastern Indonesia (KTI)
Average (mean)	390445,379	90226,643
Variant Sample	1,74358E+11	10303255182

Source: Statistics Indonesia various years (processed) 2017.

From the table it is explained that the average value of GRDP ADHK Seri 2010 for the Western Region of Indonesia (KBI) Rp 390445,379 (billion rupiah) and Eastern Indonesia (KTI) Rp 90226,643 (billion rupiah). This means that the average value of the KBI's GRDP is much greater than that of KTI. The proportion for KBI was 81.2 percent while KTI was 18.8 percent. Thus the regional economic output (GRDP) is more dominant in KBI.

4.3 The impact of ILG ^ 2 (squared) on the 2010

ADHK Series GRDP To find out the impact of ILG ^ 2 (rank 2) on the 2010 ADHK Series GRDP can be seen in Table

Table ILG ^ 2 (second rank) Estimate Results of the 2010 ADHK Series GRDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.292968	0.307460	17.21514	0.0000**
ITP	0.334828	0.064010	5.230907	0.0000**
ILG	0.782495	0.105291	7.431766	0.0000**
IIK	0.371676	0.073711	5.042343	0.0000**
IK	-0.474954	0.088623	-5.359237	0.0000**
IP	0.174980	0.072474	2.414379	0.0166*
DUM	-0.299548	0.075903	-3.946485	0.0001*
ILG^2	-0.040589	0.007523	-5.395388	0.0000**

Source: Results of Data Processing with Eviews 10. 2017. * Significance 5 percent

** significance of 1 percent. Estimates using OLS

The table shows that the impact of ILG ^ 2 on GRDP is negative (-0,040,589) and significant. Because the coefficient $\beta < 0$, then the curve U-shaped inverted. This illustrates that in the short run, the increase in ILG budget allocation has the effect of reducing regional GDP, thereby increasing the imbalance between the western and eastern regions by 30 percent. But in the long run will decrease inequality. This situation can also occur equally in long-term (western) regions that have advanced impact spread effect on the eastern region. This is evident from the coefficients of ITP (34 percent), ILG (78 percent), IIK (37 percent, IP (17 percent) All positive variables are positive and significant except for the coefficient of IK (- 47 percent) the consequences of increasing budget allocations for

electricity and gas infrastructure bring consequences on health infrastructure.

IV. Conclusion

Based on the results of the research and discussion that has been done, the analysis of descriptive statistics with data of 2010-2016 is known that the allocation of infrastructure spending (transportation and warehousing / ITP, electricity and gas / ILG, information and communication / IIK; education / IIP and health / IK) is much larger in the Western Region of Indonesia (KBI) compared to Eastern Indonesia. With this picture it is known that development is more developed (concentrated) in the Western Region of Indonesia compared with Eastern Indonesia (KTI).

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